

Ministry of Electronics and Information Technology
Government of India



THE INDIA BOOK

40+ STORIES & PERSPECTIVES FROM INDIA'S CYBERSCAPE



“ Technology can bridge gaps and connect communities. It can also

deliver services

that make a difference in our daily lives. ”

Shri Narendra Modi
Hon'ble Prime Minister of India



“Digital technologies and the internet, which represent some of the finest creations of the human mind are today a ‘global common good’; which we can harness for

bridging the digital divide

empowering and improving the quality of life for our citizens.”

Shri Ravi Shankar Prasad

Hon'ble Minister of Law & Justice and
Electronics & Information Technology
Government of India



“ Digitisation will accelerate in a big way.

Digitisation

is all about citizen empowerment. ”

Shri Alphons Kannanthanam

Hon'ble Minister of State,
Ministry of Electronics & Information Technology,
Ministry of Tourism (Independent Charge)
Government of India

From the desk

OF THE CHIEF EDITOR

SANJEEV GUPTA

The gifts of India's digital revolution have been earned by the innovation, courage, and endurance of a remarkable set of individuals in enterprise, government, and civil society. The digital fruit we harvest – the billions unlocked in value; the millions of disempowered, empowered – we owe to the seeds they have sown. As India advances into cyberspace, its progress continues to be guided by these digital pioneers and champions.

The India Book compilation, published in commemoration of the Fifth Global Conference on Cyberspace, New Delhi, 23-24 November 2017, samples the hard-won experience and perspectives of some of these digital pioneers.

The articles they have written for the Book reflect how they think about the domains to which they contribute so magnificently. Together, the articles offer the reader a radar screen, which can track the transformation that cyberspace has unleashed in our country.

The articles are as diverse as the digital domains they describe, and the voices they carry. Their coverage ranges from the technological substrate of connectivity and devices on which India's digital revolution is founded; through the transformation this revolution has wrought in enterprise and governance; to the future this revolution offers this country.

And yet I would suggest that these articles, despite their diversity, are unified by a single shared impulse: one activated by Mahatma Gandhi, Father of Nation: "Whenever you are in doubt, recall the face of the poorest and the weakest man whom you may have seen. Then you will find your doubts and your self melt away."

More than 50% of the world's population still cannot access the internet – a large disempowered sea of humanity. One billion mobile connections exist in India, but a majority of unique subscribers have to access services through common services centers (CSCs). So, one of the foremost vision areas of Digital India is to bridge the gap between the haves and have-nots by enhancing our broadband footprint, and also alongside, provide services through SMS, IVRS, USSD, etc.

mKisan portal is a case in point where more than 6000 experts have already sent nearly 17 billion advisory SMSes to 20 million farmers.

Our connectivity projects and device initiatives reach for the last citizen in the last village. Our biometric identity and digital service programmes seek to empower India's most marginalised, on every axis of socioeconomic inclusion. Our enterprises and innovation seek to capture value and generate prosperity for the entire country.

India's great push into cyberspace has a thousand different campaigns, a crucial one being providing services in a unified manner through m-governance. The thrust is on integration of databases through APIs so that the common man does not need to run from pillar to post to access the most basic of services, benefits.

The India Book seeks to capture that sense of purpose.

Swami Vivekananda, India's relentless prophet of action, once said: "All human knowledge proceeds out of experience... all our knowledge is but harmonised experience." Today, a billion Indians harness cyberspace's power in their climb toward a knowledge society.

We trust The India Book is a glimpse into the experience and perspective that makes this climb possible.

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PS. Both Indian and International numbering systems have been used.
1 Crore = 10 Million = 100 Lakh

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1

DigiDhan

INDIA'S DIGITAL PAYMENT STRATEGY

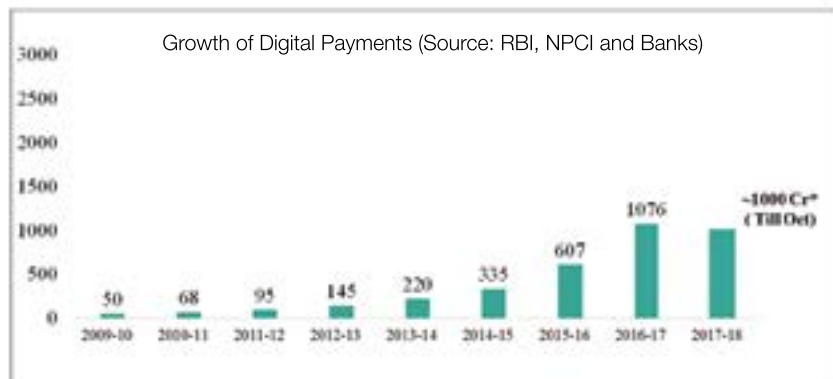
AJAY SAWHNEY



India is at the cusp of transformation towards Digital Economy, enabled by Digital Payments. In the last decade, there have been great advancements in mobility, spread of internet and banking services, emergence of Aadhaar platform and the evolution of several innovative payment systems. These developments have allowed the payments space in India to mature, forming a cohesive ecosystem and aiding rapid growth in e-commerce / m-commerce, fintech and sector specific integrated services.

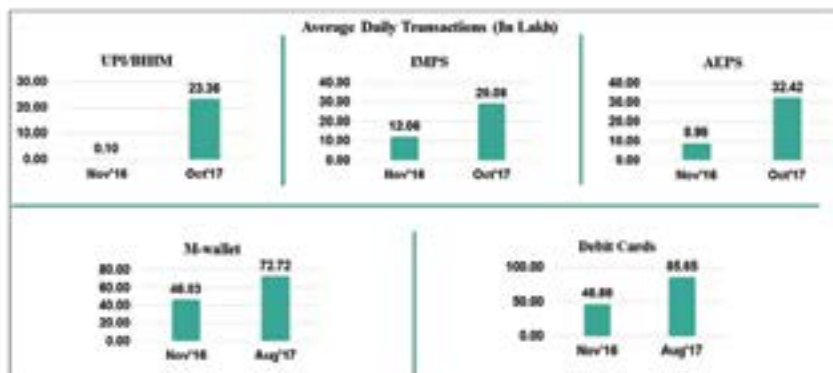
Satya Nadella, CEO, Microsoft, in his book 'Hit Refresh', while noting India's leap forward in the digital and technological arena, has observed "Aadhaar now has scaled to over one billion people, rivalling the growth of other platform innovations such as Windows, Android or Facebook". He also recognized the creation of IndiaStack, a set of APIs (application programming interfaces) that allows governments, businesses, startups and developers to utilise the unique digital infrastructure to enable presence-less, paperless, and cashless service delivery.

There has been a significant growth of digital payments, as indicated below:



GROWTH OF DIGITAL PAYMENTS TRANSACTIONS

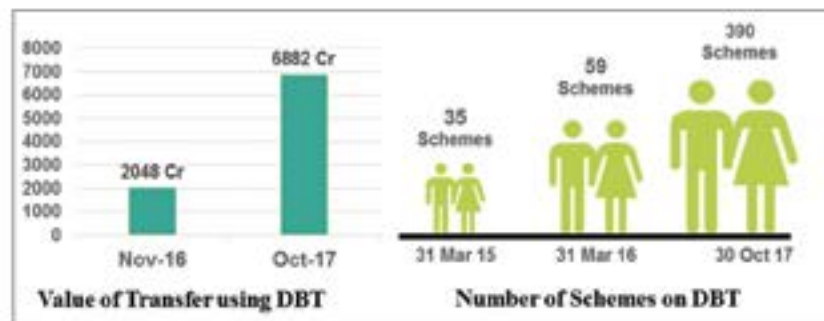
In 2016-17, the volume of digital transactions increased by 77% over the previous year to reach 1076 crore transactions. This growth is sustained in 2017-18 as well with 1000+ crore digital transactions having taken place from April to October, 2017. [One Crore = 10 Million = 100 Lakh] This increase can be attributed to the development of digital payment platforms like Aadhaar-enabled Payment System (AePS), Bharat Interface for Money (BHIM)-UPI, BHIM Aadhaar and Bharat QR code. In Dec, 2016, NPCI launched BHIM app (based on BHIM-UPI platform), which has been downloaded by around 2 crore users. Payment Service Providers like Paytm, as well as aggregators like Uber and Ola, have enabled BHIM-UPI as a mode of payment. BHIM-UPI based apps such as Tez (by Google) and PhonePe have also added innovative payment options to a competitive market. This has helped the BHIM-UPI platform to move up from just around 5 lakh transactions per day in Aug, 2017 to cross a milestone of 55 Lakh transactions on a single day on 13th Nov, 2017 to emerge as the most popular digital payment platform after cards and wallets. Since demonetization, five modes of payments namely BHIM-UPI, Immediate Mobile Payments System (IMPS) Aadhaar enabled Payments System (AePS), mWallets and Debit Cards have significantly contributed to the growth of digital transactions:



Growth of Digital Payment Transactions (Source : NPCI and RBI)

The trinity of Jan Dhan, Aadhaar and Mobile (JAM) is serving as the foundation for schemes that benefit the citizens.

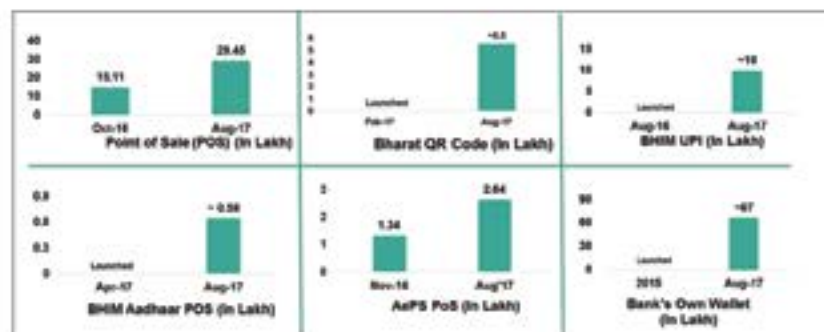
This has enabled Direct Benefit Transfer (DBT) under Government Schemes like PAHAL, MGNREGA and NSAP etc. wherein funds are transferred directly to the bank accounts of beneficiaries. The digitized mode of transactions powers DBT and this is just one example of the transformative impact of digital payments. The number of central and state schemes onboarded on DBT platform has reached 390 with a cumulative fund transfer of INR 2,33,867 crores resulting in savings of INR 57,029 crores (upto 2016-17).



Growth of DBT Transfers and Schemes (Source : DBT mission)

GROWTH OF DIGITAL PAYMENT ACCEPTANCE INFRASTRUCTURE

The banks and NPCI have also upped the ante on the payment acceptance infrastructure front, wherein the digital payment acceptance infrastructure has increased from 15.11 Lakh PoS machines in Oct, 2016 to 115.6 lakh (PoS machines, Bank wallets, BHIM(UPI), Bharat QR Code, Bank QR Codes, BHIM Aadhaar Pay, and USSD (*99#) in Aug, 2017. Similarly, there has been remarkable growth in the number of Pre-Paid Instruments (PPIs) in the market and the regulatory regime is now moving towards greater interoperability of PPIs.



Growth of Digital Payments Acceptance Infrastructure

DIGITAL PAYMENT OPTIONS FOR EVERYONE

In order to enable citizens from different economic strata to send and receive digital payments, suitable technical solutions are on offer. People with smart phones have a host of options to make payments through Internet banking, mobile banking, several PPIs, and apps that run on BHIM-UPI platform. People having feature phones can opt to make transactions using USSD.

INCENTIVIZING DIGITAL PAYMENTS

The Merchant Discount Rate (MDR) regime is lightly regulated to keep the rates at reasonably low levels for digital transactions and to incentivize the merchants to accept digital payments. As the volume of transactions goes up, there may be further scope of reduction in MDR.

Strategy to enable widespread participation of Merchants, Billers and Individuals
In order to augment the digital payment acceptance infrastructure, the Government of India is promoting the use of BharatQR code and BHIM Aadhaar, in addition to other modes, at all cash counters and payment acceptance points.

In respect of payments that are repetitive in nature, such as utility payments, the strategy is to onboard all the utilities and regular billers on the Bharat Bill Payment System (BBPS). This provides consumers a wide range of payment options for the payment of any bill. In addition, billers, merchants and entities that receive payments are being encouraged to offer the following options to the citizens:

A. Print Bharat QR code (preferably dynamic) on bills, and

B. Enable the following options at all physical payment receipt counters:

- Pull request through Mobile no. / Virtual Payment Address (VPA) wherein a request of bill amount is received on BHIM/UPI enabled App of the customer
- Prominent display of printed static Bharat QR code at the billing counter to enable customer to scan and pay
OR
- Dynamic Bharat QR code on a display facing the customer. Considering the benefits of digital payments, payment accepters are encouraged to offer a visible discount on digital payment vis-à-vis cash.

The versatility of Aadhaar platform, the creation of a unified national market through the implementation of Goods and Service Tax (GST) and the growth of digital payments is expected to accelerate and fuel India's march towards becoming a Trillion Dollar digital economy.

Ajay Sawhney is Secretary, Ministry of Electronics & Information Technology (MeitY). He is also a former CEO of National e-Governance Division (NeGD).



2

Digital economy & INCLUSIVE GROWTH

MRUTYUNJAY MAHAPATRA

THE FOUNDATION

The Government's push for a cashless economy cannot have been better timed, considering the wide availability of affordable mobile devices and internet access. As per a joint report of the Internet and Mobile Association of India (IAMAI) and the market research firm IMRB, between October 2015 to October 2016, the growth rate of mobile internet usage in urban India was 9%, while rural India saw a growth of almost 3 times at 26% during the same period. This particular growth of mobility-fuelled internet has been the primary reason why the financial industry is looking at the bottom of the pyramid to truly achieve inclusive growth.

The Indian financial sector had long struggled to cater to the unbanked in a cost-effective manner. The unbanked suffered because of lack of access to savings and credit, and those with access had to face high fees/ charges. However, mobile when phones were leveraged as a channel for delivering digital finance, there were reduced costs and increased efficiencies.

Digital finance involves creation of value, storage of value, and transfer of this value between participants in an efficient, secure and cost-effective manner by leveraging digital technologies. The framework for creation of a digital transformational network for inclusive growth needs to address the following layers to be effective:

- a) Consent layer: A secure and modern privacy data sharing framework to secure the identity of the participants
- b) Cashless layer: Electronic payment systems to enable digital transfer of value between the participants
- c) Paperless layer: End-to-end digitization of existing systems and processes
- d) Presence-less layer: Digital systems eliminating the need for physical presence of the participants

DIGITAL INNOVATIONS

One of the key outcomes of digital innovations has been the development of new products and services providing better quality at a lower price. The consumer at the bottom of the pyramid has long sought value at an economical price. While the FMCG sector addressed this concern first, prohibitive delivery costs prevented other industries from making much headway. With the introduction of mobile as a delivery channel, responding to the needs of the excluded group has become easy for the financial industry. Another outcome of digital innovation has been disintermediation.

Disruptive business models have emerged. Some FinTechs are assessing creditworthiness of customers on the basis of their mobile usage, in case the customers have no formal credit history,

A bird's eye view of digital innovations in the financial inclusion space shows that the focus of the industry has been on two offerings: payments and micro-finance. Mobile wallets, e-commerce companies, NBFCs and many other players have been trying to make headways into the payments business with innovative offerings. With the push for digital services, many new bank accounts have been opened since 2014 with access to alternate channels. The ease of opening a mobile wallet makes it a viable option as the entry point for the unbanked into formal banking system. SBI is the first bank to launch a wallet-linked debit card (the 'Buddy Debit card' linked to SBI Buddy—the bank's mobile wallet)

The initial focus of the industry had been to incentivise the usage of digital wallets. Monetary and non-monetary benefits to the customers had pushed the digital transactions to a new high. However, to make this transition a movement, the industry is pushing micro-merchants to go digital. Usage of QR codes has eliminated some upfront investment costs, as customers use their own phones to scan the codes. Initial investments in PoS machines are also being undertaken. Banks are also incentivising the merchants by undertaking fund flow based credit assessment taking into account the seasonality of their cash flow. With the launch of Bharat QR, acceptance of payments has been made institution-agnostic.

MSMEs are recognized as growth engines for emerging economies worldwide. Lack of timely and adequate credit from the formal institutions, however, has been a major hindrance to their growth. The primary reason is the lack of documentation/ credit history and unconventional business models. Several FinTechs and start-ups have identified this space as the next growth sector. Credit assessment and delivery are technology-based in order to reduce the onboarding and transactional costs for the MSMEs.

THE SBI CHAPTER

One of the guiding principles of State Bank of India (SBI) has been inclusive growth. SBI offers specialised products and services aimed at the urban poor and the rural customers, with the aim of integrating them into the formal economy. The IT-led information revolution at the turn of the century opened up new avenues to deliver these offerings to the remotest of corners rapidly in a cost effective manner, in true reflection of our 'inclusion of all' philosophy.



Under the Pradhan Mantri Jan Dhan Yojana (PMJDY), SBI has opened more than 8 crore accounts till date and issued Rupay cards to eligible customers in order to drive digital transactions. A substantial number of these cards were issued in some of the most challenging areas of the country. SBI opted for the business correspondent (BC) model primarily, which leverages technology-based solutions and apps to provide access to banking services for the unbanked and the remote. Kiosk banking has also been adopted. This channel provides state of the art technology, at a low cost for both the customers and the service providers.

Through its 58000+ customer service points, the bank is leveraging technology for propagating financial inclusion via internet-powered kiosks that offer a bouquet of services ranging from account enrolment to NPA recovery, Aadhaar seeding to interoperable ATM card-based transactions. Initiatives/ services

channelized through Aadhaar Enabled Payment Systems (AEPS), automated e-KYC, Immediate Payment Service (IMPS), Micro ATM along with more than 30 other types of services are available on kiosk. Work on voice-based and facial recognition systems is also in progress to cater to illiterate customers.

CONCLUSION

The digital economy is an inclusive economy in a true sense. The rich and the poor; men and women; the well-educated and the barely literate; are all participants; are all included; and the transactions range from the very high to everyday kirana-store levels. e-Governance and financial inclusion initiatives have made rural customers part of the India success story. The digital space is geography-neutral. And therefore, with the right user interfaces, sky is the limit!

Mrutyunjay Mahapatra is the Deputy Managing Director & Chief Information Officer of State Bank of India (SBI). He heads the entire Information Technology vertical of the State Bank Group.

3

You are YOUR OWN IDENTITY

NANDAN NILEKANI

You are who you claim to be. This may sound self-evident, but for many of India's 1.3 billion residents, particularly the poor and the marginalized, this was not easy to prove. Establishing one's credentials and identity is imperative for access to most societal exchanges (from making financial transactions to accessing transportation to enabling means of communication) and greater so for access to the government benefits and entitlements.

In their seminal work on examining rising inequality in India (Indian income inequality, 1922 - 2014: From British Raj to Billionaire Raj?), Piketty and Chancel established that while average incomes since the early 1980s had not even doubled for the bottom half of the population, the top 1% saw incomes increase more than four-fold.

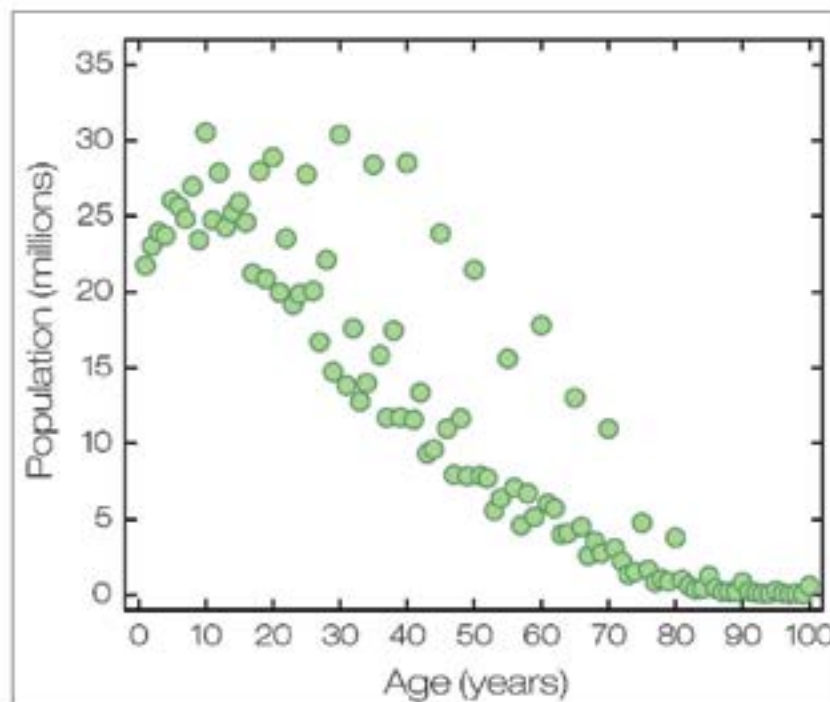
This drastic disparity has fomented decades of migration, especially from rural to urban India. With over 400 million migrants, India is clearly a nation on the move. Migration has meant a change in the agency of an individual from being part of a household to being herself. Or from an entry on a familial ration card¹ to a unique individual identity.

A proof of identity is indispensable in order to gain access to services such as telecom and banking, to draw entitlements and for many other modern necessities. Those at the intersection of growing inequality and rising migration are at the greatest risk of being vulnerable without robust identification. It was estimated that the number of people without an individual identity document was close to 400 million or a little less than half of India's population.

In recognition of these trends and the allocation of public resources to cushion the crippling impact of the twin realities of migration and inequality, India began working on Aadhaar, the world's largest developmental initiative back in 2009, with the endeavour to establish that residents themselves are their own identities.

For decades, India imported western ideas of identity and identifiers. Signatures and birth certificates may help uniquely identify individuals in a developed country with a literate population, where almost all births take place inside hospitals. But in the Indian context, those founding assumptions fail. An interesting example of this is the following graph. Made from the 2011 census data, this graph plots population distribution by age. Notice that there are two arcs.

One thick line follows a smooth power law. The sparser arc, is made of data points from those who round their age to the nearest number (15, 20, 25, etc.). You can see that there are tens of millions of people in India who do not even know their own true age!



Graph 1: Population distribution by age, Census 2011

Aadhaar was conceptualized ground-up, for the Indian context – a context shared by much of the developing world. A fine example of this is Aadhaar's design principle of inclusion. If you had none of the 18 government sanctioned identity documents (driving licence, bank statement, electricity bill etc.), you could use the referral system, i.e. your local elected representative could send in a letter saying that you are who you claim to be. Aadhaar relied on facial, iris and fingerprint biometrics for uniqueness because de-duplicating a billion people, many with no ID to begin with, was impossible in any other way. But the inclusion mandate also meant that there were exception processes for those who had no or missing fingers or irises.

¹Chancel, Lucas & Piketty, Thomas. (2017). 'Indian income inequality, 1922 - 2014: From British Raj to Billionaire Raj?' WID.world Working Paper Series No. 2017/11. World Wealth & Income Database.

²The Ration Card is an official document that entitles holders to (generally subsidised) rations of food, fuel or other goods issued by the Government of India.



The guarantee was that if you were a resident of India, no red tape could stop you from getting a unique 12-digit number. The enrollment was, by design, meant to include, not exclude. This was a strange, new thing in India. Moreover, getting an Aadhaar, by itself did not guarantee any benefits or entitlements. Unlike the driving licence needed to drive, or the ration card needed to procure ration, Aadhaar was not linked to any one specific function. Aadhaar was a platform for identification that would be leveraged by as many future programmes as possible. It was a one-time exercise in enrollment, which would yield continuous future benefits. This is why Aadhaar is a foundational ID. In fact, the very word 'Aadhaar', in Hindi, means 'a foundation'.

This nuance was not lost on the intended beneficiaries. People enrolled for Aadhaar in droves, despite no immediate benefits attached to getting one. 50 million residents enrolled in the first year and 600 million (approx. 50% of the population) in 4 years. Aadhaar crossed 1 billion in just 5 ½ years. This was fast, not just by government scheme standards, but also by the standards of large internet platforms.

A pleasant byproduct of having biometrics securely stored in the Central Identity Data Repository, was that it was possible to build algorithms that let us check incoming biometrics against the verified ones recorded during enrollment. Instead of rejecting matches against existing entries for de-duplications, the software confirms matches against an existing Aadhaar number for authentication. Once this simple light switch had been flipped, little did anyone know, a plethora of use-cases had been unleashed. Many of which, even Aadhaar's founding team had not even imagined!

So how does a foundational ID help the nation? Once you can prove that you are who you claim to be, by Aadhaar authentication, no one can deny you your entitlements. Aadhaar has obliterated the intermediation that left the poorest Indians bereft of benefits meant for them. The government's Direct Benefits Transfer programme directly transfers subsidies to the Aadhaar-linked bank accounts of beneficiaries. By looking up the Aadhaar numbers as the index, the government can be sure it is not double-spending on fake and duplicate accounts.

But that is only a simplistic understanding of how Aadhaar helps change the game. If every end transaction is linked to an Aadhaar number and verified by biometrics, suddenly the entire backward supply chain becomes transparent and auditable. Take ration shops for example – the shopkeeper can no longer fudge price books and sell subsidized grain procured at INR 2.00 per kg at the market price of INR 30.00 per kg. Similarly, as the accounting is automated due to Aadhaar, the wholesaler and the distributor can no longer skim off the top and write-off the errors.

Amidst the impressive macro numbers of Aadhaar, individual stories are often overlooked. Earlier, to prevent citizens from double-claiming, ration cards were allocated to ration shops. You could only get your grain from one ration shop, creating a monopoly. You were completely at the mercy of the store owner, and had no recourse if he raised prices, or supplied low quality ration.

The system assures no double-spending and thus the monopoly is dismantled. Ration shop owners scramble to better serve their customers and retain their business. Also, in a country with such staggering migration numbers, India is able to extend food security to its most vulnerable. In Andhra Pradesh, for instance, the number of migrants who claimed ration at a store other than their home store was as high as 14% of the eligible population.

Most importantly, the power equation has changed. The beneficiaries, from being at the mercy of store owners, have now become their customers. Aadhaar has given them the power of choice. What has changed is not a de-duplication of a beneficiary list, but the way the government thinks about delivering services to its residents. Aadhaar is no longer just an identification platform, it has propelled a mindset-shift. Aadhaar has completed over 12 billion authentications in the past six years, and is currently authenticating 61 million transactions daily. Aadhaar has over 1.18 billion users. That amounts to a little over 88% of the country's population and 99% of its adult population. It is being used not just for collecting ration or pensions, but also for a variety of other purposes such as opening bank accounts, getting sim card connections, filing income tax, checking into airports, etc.

Building on the foundation of Aadhaar, the government has started building more such open application programming interfaces (APIs) as digital infrastructure. The goal is to enable paperless, presence-less and cashless transactions for every Indian. They call it the India Stack. It includes revolutionary offerings such as Unified Payments Interface (UPI) for users to transact cashlessly direct from bank account to bank account; e-KYC electronic Know Your Customer (e-KYC) enabling a rapid, paperless verification of addresses, identities, etc.); e-Sign, whereby users can attach legally valid electronic signatures to documents; and the DigiLocker, the national Digital Locker System launched by the Government, a platform where documents and certificates can be issued and certified. More APIs are being built and added every year.

It is important to note that as large and complex as these systems sound, Aadhaar is able to achieve such scale precisely because it kept things simple. Aadhaar did not try to collect any information beyond what was needed to identify you: Name, Date of Birth, Address, Gender and Biometrics. Enrollment is fast, because it is hard to not get in! Real-time authentication means that the government can redesign systems to solve India's hard problems. At the heart of it all of this is the goal to empower the resident. Aadhaar is a foundation, but it is not a foundation for government programmes, it is the resident's foundation. It is her Aadhaar to demand her rights, to improve her life and to empower herself. After all, who gives anyone the right to say you are not who you claim to be.

Nandan Nilekani is an entrepreneur, bureaucrat and politician. He co-founded Infosys and is presently its Non Executive Chairman. He was earlier the Chairman of the Unique Identification Authority of India (UIDAI).





4

Aadhaar

A FOUNDATION OF NEW INDIA

AJAY BHUSHAN PANDEY

'A ship is safe in harbour, but that is not what ships are built for' - John A Shed

Aadhaar has emerged as a powerful instrument which enables people to establish their identity anywhere anytime, receive their entitlements and exercise their rights without any fear of being excluded or their rights taken away. We see every day how people use Aadhaar to open bank accounts, avail door-step banking, make digital payments through their fingerprints and receive benefits under PDS, MNREGS, LPG Subsidy, Ujjwala, Pensions, Scholarships Schemes directly from the government without any unscrupulous middlemen usurping them. Aadhaar has thus brought transparency in governance and delivery system and cleansed it of fakes, duplicates and conmen/ intermediaries, which have yielded savings to the tune of INR 60,000 crore (1 Crore = 10 Million = 100 Lakh) in the last two and half years. In an independent study by the World Bank 'Digital Dividend 2016', it has been estimated that Aadhaar can potentially save INR 72,000 crore every year by plugging leakages.

India has also embarked on a major revolution towards a transparent economy through digital payments. Digital payment, thus far, has traditionally been an exclusive privilege of only few who could afford debit or credit cards and could handle pins, passwords, OTPs and their likes. India's cash to GDP ratio is around 12%, which is among the highest in the world. The share of digital payments is said to be at about five percent of total personal consumption or even lower at two percent of total transactions, which are among the lowest in the world. Now with 1.18 billion Aadhaars, and an equal number of mobile phones in our country, we are now blessed with unique opportunity to take digital payment to the masses by making it available to every stratum of our society, rich or poor, urban or rural, young or old and make India truly a digital economy.

Aadhaar will make India leapfrog over the traditional payment systems such as cheques, drafts, debit cards, POS devices and transition to innovative modes of digital payments not seen and possible even in most advanced countries of the world. BHIM with UPI was launched by Prime Minister on 30th Dec 2016. UPI will have a far-reaching impact because it is India's own Internet of digital payments. UPI is real time and fully interoperable across all banks. There are 350 million smart phone users in India who can use UPI to make digital payments upto INR 1 lakh without any card or POS device to any individual or merchant with accounts in any bank. Merchants can also use Bharat QR Code to receive payments from their customers.

In India there are 300 million people living in rural and urban areas who do not have credit cards, debit cards, smart phones or feature phones or who are not so financially literate who can handle PINs, passwords etc.

How do they pay digitally? For them, BHIM Aadhaar, which was launched by Prime Minister on 14th April 2017, will prove very convenient. In this mode, a retail corner shop would not need an expensive point of sale device such as a debit or credit card swipe machine. He can use his own smart phone with a finger print scanner, which costs around INR 2,000 and install the BHIM Aadhaar app and link it to his bank account. Its customers can pay small amounts upto RS 2,000 through their fingerprints without needing a debit or credit card. Upon Aadhaar authentication of the fingerprint, the money will be debited from the Aadhaar linked bank account of the customer to credit the account of the merchant. Since more than 700 million people have linked their Aadhaar with their bank accounts, each one of them can now use his fingerprints to make digital payments without having to possess any debit card, PIN etc.

However, when one talks of using Aadhaar in welfare schemes or digital payments, beneficiaries of leakages, cash economy as well as traditional payments systems thriving on high 'Merchant Discount Rate' (MDR) oppose the move by raising concerns on Aadhaar database being insecure, fingerprints being vulnerable to hackers and cyber-attacks etc. as if earlier systems based on physical signatures, cheques, debit cards, ATM cards, PIN etc. were absolutely safe and had no vulnerabilities. They would circulate stories showing how unsafe biometrics are, how IRIS and finger prints of German Chancellor Angela Merkel and her Defence Minister were extracted from their high resolution digital photographs, how a silicon replica of a fingerprint was used to hack into an iPhone, how Pentagon was hacked, etc and thereby create a technophobia against adoption of new technologies. They conveniently forget that people have been writing cheques and putting their physical signatures on documents for ages, knowing fully well how easy it is to forge a signature. Similarly, we often read in newspapers about frauds in ATMs, debit cards, and Internet banking through cloning, scheming, spoofing, phishing etc and yet we have not stopped using them. The critics and, at times, even technologists forget that every technology is vulnerable and is subject to risks. What is needed is mitigation of risks and not abrogation of technology. It is a basic lesson in a Risk Management 101 class.

So far as the Aadhaar-based payment system is concerned, it is robust and secure which is evident from the track record of Aadhaar Enabled Payment System (AEPS). The AEPS provides doorstep banking through more than 1,30,000 banking correspondents to people living in remote villages and enables them to withdraw or deposit money using their finger prints on Aadhaar based Micro-ATMs. During the last four years more than 700 million transactions have been carried out without a single case of financial loss due to fraud or identity theft.

A comparative analysis of incidents of hacks, thefts, and frauds across various modes of payment would easily establish that the Aadhaar-based system is far more secure than most traditional payment systems. Notwithstanding its past record, Aadhaar continuously reviews emerging threats and takes measures in time to counter them and minimize risks.

Further, three major reforms have taken place during the last six months which would go a long way in making UPI and Aadhaar based payment systems even more secure. Firstly, the Parliament, in February 2017, amended the Income Tax Act to mandatorily link PAN with Aadhaar, which has also been upheld by the Supreme Court. Secondly, the Supreme Court in Lokniti Foundation case has required that more than 100 crore existing mobile SIM cards be biometrically verified with Aadhaar by February 2018. Thirdly, the Government amended the Prevention of Money Laundering Rules in June this year to require every bank account to be verified and linked with Aadhaar and PAN by 31st December 2017.

In BHIM Aadhaar and UPI, since the bank accounts and mobile numbers of sender and receiver of the payment are linked to their Aadhaar and PANs, the transactions will undoubtedly be safer. In the worst case, if money is unauthorizedly transferred from one's account, the beneficiary of the recipient's account can be easily identified through Aadhaar and justice can be delivered. The Aadhaar Act has stringent provisions for punishment up to three years imprisonment. Additionally, an appropriate limit on the value of a transaction would further deter the hackers and fraudsters it may not be worth their risks. These measures together should provide a complete sense of security to people when they use their fingerprints and mobile phones for payments.

India has set an ambitious target of achieving 2500 crore of digital payment transactions in the current year. The efforts are on with RBI, banks, NPCI, Master Card, VISA etc to bring down the transactions costs to minimum so that consumers are not at disadvantage for choosing to pay digitally.



USA in 2010 took series of reforms through Dodd Frank Act to protect consumers of digital transactions. European Union passed regulations in 2015 to rationalize and reduce transactions fees. Australia and South Africa followed the suit through their twin peak regulations. It is necessary do so in India too to ensure mass adoption of digital payments. Democratization of digital payments through UPI and BHIM Aadhaar will lead India to a less cash economy. It will not only help India rid of black money and tax evasion but also empower a large number of hitherto excluded Indians by bringing them into financial mainstream. India is the only country which has a system like Aadhaar to build innovative payment platforms over it.

The recent move to link bank accounts and mobile numbers with Aadhaar is also being criticized as an exercise towards invasion of privacy. Some of them question this move on the ground that when they are not receiving any subsidy or benefits of the government, why they are being forced to verify their banks accounts and mobiles numbers with Aadhaar. The critics gave similar arguments when verification of PAN with Aadhaar was made mandatory. However Supreme Court rejected the argument and upheld the PAN-Aadhaar linking. One must appreciate that objective of linking bank accounts with Aadhaar is to weed out bogus, fictitious, and benami bank accounts used for money laundering, terror funding, tax evasion, fraud, crime, and parking ill-gotten wealth etc. PMLA rules were amended in June 2017 to require that every bank account be verified with Aadhaar. One must appreciate that verification of his bank accounts with Aadhaar enhances his own security. We often read in the media how innocent people are tricked everyday by the fraudsters to part with their debit card numbers, PIN, mobiles etc. which are used to fraudulently siphon out money from their accounts. By the time complaints are lodged, these fraudsters withdraw the money and disappear. If every bank account is verified with Aadhaar, then beneficiaries of such crimes can be traced and brought to justice.

Similarly, Aadhaar verification of the bank accounts will help expose real beneficiaries behind the shell companies, benami, corrupt, tax evaders, and money launderers or those involved in siphoning of public money or even terror financing. The extent of problem can be gauged by the fact that post demonetization, 35,000 shell companies deposited and withdrawn INR 17,000 Crores. 3 lakh directors of over 2 lakh shell companies have been disqualified. Most of them, being benami or fictitious, would be hard to trace. Aadhaar will prevent such things in future. Aadhaar verification has recently helped the Government of Maharashtra to ensure that farm loan waivers are availed only by deserving and genuine farmers when it detected that Aadhaar numbers of around 19 lakh out total 30 lakh account holders, purportedly of farmers, sent by banks were prima-facie found bogus or incorrect as they were random 12-digit numbers like 11111.... etc. which UIDAI either never issued or the Aadhaar numbers belonged to someone else.

Similarly, in this digital age, mobile phones are increasingly used for online identity confirmation through OTP and enabling digital transactions. We have seen how criminals get SIM cards issued in fictitious names by producing fake voter cards, Ration cards etc. and use them to commit frauds, crimes, and even terror and disappear without leaving any trace. Considering this widespread menace, Supreme Court in Lokniti Foundation case has rightly approved verification of SIM cards with Aadhaar.



No doubt, Aadhaar has also enhanced government's ability to directly connect, reach, and serve people which unfortunately is projected as increase in the State's power and Aadhaar being perceived and termed as an instrument of state surveillance. In the age of digital revolution, India's effort to provide unique identification to its people and digitize its citizen databases – public or private – is mistaken as an exercise towards invasion of privacy. It is obvious that beneficiaries of black money and criminals are advancing privacy to stall Aadhaar so that their illegal activities continue unabated. It must be realized that non-digitization of databases is not an option in this digital era. Often the current debate reminds us of Europe's Luddite movement in 19th Century when mechanization was opposed on fears of job loss. We saw similar things when computerization was introduced in banks in India in 80s. Aadhaar is facing similar resistance. The critics of Aadhaar tend to forget that Aadhaar empowers people more than the government.

In fact, Supreme Court, in the recent Binoy Vishwam Vs Union of India (commonly known as PAN-Aadhaar) case, recognized the value of Aadhaar by observing "menace of corruption and black money has reached alarming proportion" and "UID is adopted, it may go a long way to check and minimise the said malaise". It further said that "by making use of the technology, a method is sought to be devised, in the form of Aadhaar, whereby identity of a person is ascertained in a flawless manner without giving any leeway to any individual to resort to dubious practices of showing multiple identities or fictitious identities." and "Aadhaar or UID, which has come to be known as most advanced and sophisticated infrastructure, may facilitate law enforcement agencies to take care of problem of terrorism to some extent and may also be helpful in checking the crime and also help investigating agencies in cracking the crimes".

It will also be useful to know how other developed democracies have used unique identification numbers to cleanse their system. USA introduced Social Security Number (SSN) through an enactment in 1935 for a limited purpose of providing social security benefits during the Great Depression. However, in 1942, President Franklin Roosevelt expanded the scope through a historic executive order no. 9397 which mandated all Federal agencies to exclusively use SSN in their programs. In 1962, SSN was adopted as official Tax Identification Number (TIN) for income tax purposes (just as Indian Parliament recently introduced section 139 AA in the Income Tax Act to mandatorily require Aadhaar for PAN and Income Tax returns).

In 1976, Social Security Act was further amended to say that any State may, in the administration of any tax, general public assistance, driver's licence, or motor vehicle registration law utilize the social security account numbers for the purpose of establishing the identification of individuals and may require any individual to furnish SSN. Section 7 of Aadhaar Act seeks to do the same in India.

The mandatory use of SSN by State did not go unchallenged in US courts which eventually held mandatory use of SSN to be constitutional. In *Doyle vs. Wilson*, it was held that "mandatory disclosure of one's social security number does not so threaten the sanctity of individual privacy as to require constitutional protection." In other cases, courts held that "requiring an SSN on a driver's licence application is not unconstitutional, nor is a requirement that welfare recipients furnish their SSNs" and "preventing fraud in federal welfare programs is an important goal, and the SSN requirement is a reasonable means of promoting that goal". In United Kingdom too, almost every important service requires National Insurance Number (NIN). It is required from those who want to work, open bank accounts, pay taxes, want to receive child benefits, and even those who want to vote.

The critics would say that neither SSN nor NIN is based on biometrics. First, we need to know what constitute biometrics. Photograph is a biometric and today technologies can do face matching just like finger print matching. Would the critics argue that with advent of face matching technology, practice of obtaining photographs for identification be banned? In SSN, photographs are taken. In Aadhaar, considering huge population, least intrusive biometrics such as photograph, fingerprints, and IRIS are required for ensuring uniqueness. Collection of such minimal biometrics for a legitimate purpose is an age old established practice also sanctioned by law in India and as well as in advanced democracies.



If you want a driver licence, sell or buy properties, or want passport, you are statutorily required to give your biometrics. It cannot be a case of anyone that Right to free movement is his fundamental Right and therefore he can refuse to give his biometrics for driver licence. Therefore, collection of biometrics by State per se for a legitimate purpose cannot be contested.

As regards objections to the State creating a system of central number in a central database, critics of Aadhaar need to ask themselves that whether widespread mandatory usage of SSN in USA or NIN in UK and presence of these numbers in most citizen databases, which potentially empower the State to track every person from cradle to grave have rendered their citizens vulnerable and have made the countries surveillance states. Obviously, they would say there are safeguards which prevent such things happening there.

So, now let us see what the safeguards are in Aadhaar which will prevent it from being used as a 'electronic leash' or an 'instrument of state surveillance'. Aadhaar accords highest importance to the privacy of people and more so in the age of growing digital connectedness and, therefore, since its inception, has adopted the principle of privacy by design which is achieved through – Minimal Data, Federated databases and Optimal Ignorance which in turn ensure that no agency – UIDAI or Government or a private agency is able to track and profile any individual. UIDAI during Aadhaar enrolment collects minimal data that is name, address, date of birth, gender and biometrics. We don't ask income, religion, profession, caste, etc. When people use Aadhaar for accessing various services, their information remain in silos of federated databases of those agencies. No one agency can have 360 degree view of a person. Each agency remains optimally ignorant.

But critics have apprehensions that an agency, particularly the State, may not choose not to remain optimally ignorant and start connecting the silos of databases through Aadhaar. It will serve them better if they read Aadhaar Act 2016 and the Regulations. The Act covers the basic tenets of privacy protection measures relating to informed consent, collection limitation, and use and purpose limitation and sharing restrictions. I am yet to see any other law in India which accords such importance to privacy and data protection. The restriction on use and sharing imposed under the Act are equally applicable to State or a private entity. Any violation is a criminal offence punishable with three years' imprisonment. While UIDAI will welcome any constructive debate or suggestions to further strengthen the legal provisions, but to say that there is no privacy law and therefore Aadhaar cannot be allowed to go ahead is not correct because privacy provisions related to Aadhaar are engrafted in the Aadhaar Act itself.

Therefore, the time has come for India to set sail and use this technological marvel to leapfrog in its journey to a developed nation and usher into a new India.

[Numbering system: 1 Crore (Indian) = 10 Million = 100 Lakh (Indian)]

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Dr Ajay Bhushan Pandey is the Chief Executive Officer of Unique
Identification Authority of India (UIDAI).
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5

E-commerce

UNBOXED WITH MADE.IN.INDIA INNOVATIONS

SACHIN BANSAL

A few years back, I received a 'Thank You' email from a student in a small town in India's hinterlands. He had just passed the Joint Entrance Examination -- a tough, national-level test that students take to secure seats in some of the country's most premier engineering colleges. In the email, he wrote about the lack of access to quality books and study material in his hometown, and went on to say that if it were not for Flipkart making those books accessible through online shopping, he could have never hoped to pass the test.

It is easy to think of the email as a simple note of thanks, but it is actually a murmur of the larger tectonic shifts witnessed in Indian society and the economy over the past decade or so: a meteoric rise in people's aspirations fulfilled by a growing inclination for a digital life. The forces of mobile telecom, wireless internet and an Indian internet sector focussed on solving India-specific problems are inextricably embedded in people's lives today.

As such, India's digital journey has been truly transformative and inclusive, thanks to the slew of 'Made in India' innovations from home-grown internet companies, be it in e-commerce, ride hailing, travel or fintech.

India has the world's second largest mobile subscriber base, with wireless tele-density at about 92% in July, 2017¹. Total broadband subscribers as of July was about 310 million with mobile internet users increasing by about 10 million a month. That is a staggering number -- an indication of India's demographic strength, current stage of digitisation and scope for future growth. It is also a barometer of the speed at which we must innovate to ensure future adopters of the internet are just as well-served as those currently online. Progress has been made for sure in the past decade, but India's vastness, its multitude of cultures and the sheer size of its population means India has some very unique needs. Global models, therefore, may have little impact here.



¹TRAI, Highlights of Telecom Subscription Data as on 31st July, 2017



When Binny and I started Flipkart in 2007 as an online seller of books, we recognised some of those early shoots of a digital revolution but found the challenges steep in equal measure. E-commerce at the time was a relatively unknown, untested phenomenon for Indian consumers. The perception was that e-commerce could not be trusted, and it became our first call of duty to change that. We realised that to build trust we had to devise a method to allow customers to pay for a product after having received it, an unheard-of concept in e-commerce until then. In 2010, Flipkart launched Cash on Delivery (CoD) on scale in India, an innovation that quite literally unboxed e-commerce in the country. CoD became the catalyst that fuelled our growth and propelled internet entrepreneurship in India more broadly. People had access to quality products, at affordable prices, delivered right at their doorsteps. Importantly, they trusted it.

CoD shattered the high entry barrier customers faced in trying e-commerce, but it was only one of many instances of India-specific problem-solving emanating from Flipkart. 'Selection', to cater to unique tastes of Indians, was solved by bringing local sellers and international brands online. 'Affordability' was introduced with programmes such as No Cost EMI. 'Accessibility' was solved by building the widest logistics and last-mile network, and a mobile website that worked seamlessly on poor internet bandwidth. These India-born innovations, including the web technology, have all inspired global internet giants, a testament of the innovation prowess of the home-grown internet sector and its impact on people's lives.

While the unboxing of e-commerce in India has brought a range of benefits for Indian customers, as the young person who wrote that email experienced, it has also given entrepreneurs, small factories, traders and craftsmen access to millions of new customers. The resulting direct and indirect employment sums up to millions. It is, therefore, critical that the Indian internet ecosystem is nurtured and recognised as a critical industry, akin to other sectors such as telecom, IT and banking, whose health and contribution is paramount to the economy firing on all cylinders. Without a booming home-grown internet sector, it will be an uphill task to empower millions and ensure social and economic inclusion of marginalised sections.

Of particular note is that the disruptions in recent years have not solely come from private enterprise, but equal credit goes to the government for its thrust on digitisation. With Aadhaar and India Stack, India has jumped ahead of several more developed countries to a paperless, cashless, presence-less system of governance and social security. The Goods and Services Tax has simplified logistics and taxation a great deal, even if there may be some teething problems. With United Payments Interface (UPI), a real-time payment system facilitating interbank transactions on a mobile platform, banking has taken new meaning.

The home-grown internet industry has since gone on to build products and services on national platforms, casting as wide a net as possible to ensure the benefits reach the maximum number of people. PhonePe, a Flipkart company, launched India's first UPI based mobile app with the aim of making digital payments so easy and safe that people never feel the need to carry cash or cards again. That is a lofty goal by any standards, especially in India where cash heavily dominates day-to-day life. But it is a goal worth aspiring for.

Ultimately, I believe India needs a comprehensive digital ecosystem that works for people. And to build it requires addressing the issues around data security of Indian internet users.

In my view, if people are to feel convinced to embrace digitisation, we must ensure the highest levels of security and privacy. And that can only happen if India has its own data centres which home-grown internet, private and public companies can use. As India become more digitally ready, that will become a cornerstone for growth, one which fuels innovations and unboxes more new-age industries.

Sachin Bansal is the co-founder of Flipkart and currently serves as its Chairman.

E-commerce

UNBOXED (THROUGH DATA & MOBILE)

SANJAY MOHAN

SOME HISTORICAL BACKDROP

It was the first internet wave in the late 1990s. India witnessed the setting up of business-to-business (B2B) portals, matrimonial sites, job search directories, etc.; getting its first taste of businesses powered by the internet. However, barring a few, most of these businesses did not survive because of low internet penetration, slow internet speed, small user bases for online shopping, inadequate logistics infrastructure and low consumer acceptance of e-commerce at the time. Many of these businesses collapsed during the dotcom bust of 2000.

Come 2005, low-cost carriers entered the aviation sector and started accelerating the online travel industry. Then Indian Railways started e-ticketing and accepting electronic payments through credit cards. Eventually, consumers got accustomed to e-tickets and the scepticism regarding online usage of credit cards reduced considerably.

Post 2007, a number of start-ups stepped into the Indian e-commerce market to make it big. These businesses focussed heavily on understanding the evolving market challenges, paving the infrastructure for logistics, and priming the consumer for product acceptance. Forward and backward linkages were strengthened to develop the new age e-commerce sector.

The changes in consumer lifestyles, the rise in disposable incomes of the middle class and the lure of convenience, acted as catalysts in adoption of e-commerce as a way of life for many Indians. Just a few years earlier, food and grocery were never thought of as items for online trading. However, with consumers adapting to changes in lifestyles while opting for convenience, there are now numerous small and large e-commerce companies selling provisions and perishable items.

Today, India has reached an inflection point in its journey of digital transformation. The internet has become an integral part of the growing urban Indian population. Be it online bill payment, shopping, travel, doctor's appointment or sending gifts to loved ones, e-commerce is now at the core of Indian consumer behaviour.

Indian e-commerce firms are now looking beyond big cities to focus also on smaller towns. There are various reasons for this new focus. A slew of new ingredients are fuelling the growth of e-commerce beyond the metros and tier-1 cities, such as, growing internet penetration, entry of global majors, rise in smartphone adoption, innovation in mobile technologies, millennial consumers and digital payments, etc.

ENABLERS – DATA, MOBILE, IDENTITY, PAYMENT

At present, India has some 450 million internet users, out of which 100 million are e-commerce shoppers. The average data consumed by an Indian smartphone user is 4.1GB per month and if the Ericsson Mobility Report 2017 is to be believed, by 2022, this will go up to 11GB per month.

The growth of the mobile market in India is not surprising. As per Mary Meeker's internet trends 2017 report, cheaper wireless data has encouraged greater smartphone ownership and has also caused data consumption to jump 9X year over year. In India, the mobile share of web traffic is close to 80%, well above the global average. That India's internet revolution will be driven by mobile, is well accepted, in a country where most first time Internet users come online through their smartphones.

WAY FORWARD

While internet- and smartphone penetration have triggered much growth in the industry, focus on areas, such as payments and technology, will further bolster the sector. In the area of payments, let's all come together to make digital payments more mainstream, more streamlined.

On the technology front, companies have started doing some good work on personalization of offerings. E-Commerce firms will perhaps have to consciously move away from the 'one for all' concept. This is the realm of Big Data and machine learning, and the country is taking some positive, confident steps in this direction. That said, these are early days still.

¹ The Economic Times. (2017). India's Internet user base to cross 450 million by June 2017: IAMAI. 01 March 2017. Available at <https://tech.economictimes.indiatimes.com/news/internet/indias-internet-user-base-to-cross-450-million-by-june-2017-iamai/57411523>

² The Economic Times. (2017). Number of online shoppers may cross 100 million by end of 2017. 10 January 2017. Available at <https://economictimes.indiatimes.com/industry/services/retail/number-of-online-shoppers-may-cross-100-million-by-end-of-2017/articleshow/56430027.cms>

³ The Mobile Indian Network. (2017). Average data usage will go up to 11GB per month by 2022: Report. 16 June 2017. Available at <https://www.themobileindian.com/news/average-data-usage-will-go-up-to-11gb-per-month-by-2022-report-18170>

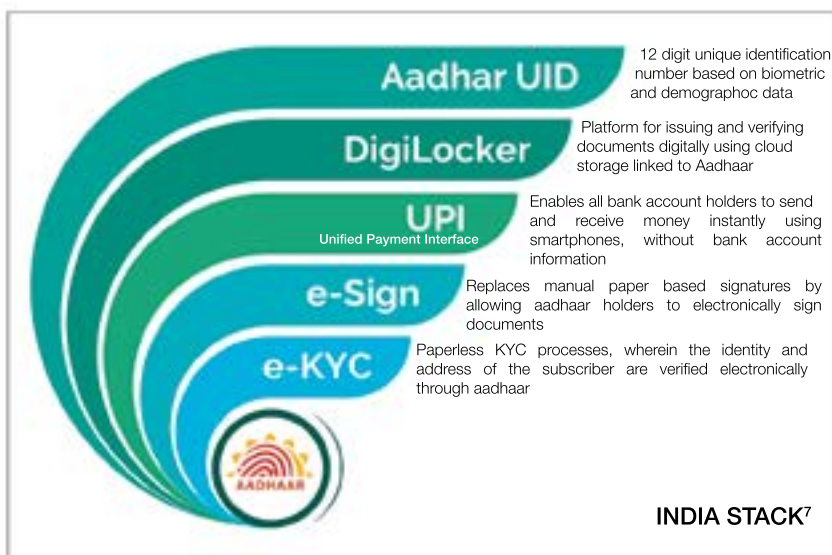
⁴ <https://www.recode.net/2017/5/31/15693686/mary-meeker-kleiner-perkins-kpcb-slides-internet-trends-code-2017>

⁵ <https://tech.economictimes.indiatimes.com/news/internet/mary-meekers-internet-trends-2017-key-india-takeaways/58940234>

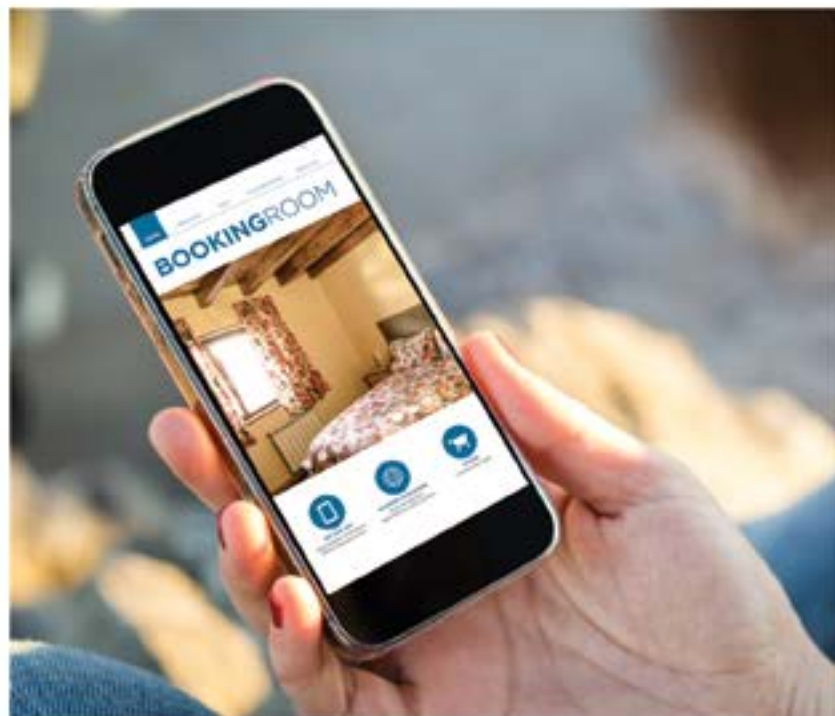
India's next hundred million should experience a more seamless way of coming online. Voice-based, conversational commerce will need to become mainstream and perhaps more fundamental research work is required in the area of voice recognition for Indian dialects.

While we have seen a lot of technological transformations over the last two decades, there is set to be an exponential growth of the kind not witnessed before. In India, we are witnessing the rising usage of stacked architecture, called the India Stack, in the financial services sector. Jan Dhan Yojana, Aadhaar and mobile phones have created a fundamental layer of customer identification and access, on which multiple digital transactions can be built. This has the potential to solve our financial inclusion problem by eliminating the classical roadblocks of paper-based identity proofs, interaction with a physical bank and the availability of hard cash. The entire stack is an "open" resource, which means anyone can access and leverage it. This constitutes a paradigm shift in technology architecture where innovation happens at the bottom of the stack and is available as a public good at a very low cost to everybody. This shift could very well have profound implications.

From booking plane tickets, to buying clothes from an online site unseen in any physical form, eCommerce has offered consumers choice, convenience and ease as never experienced before. As the ecosystem starts to fall in place, the coming years will witness rapid innovations that would propel Indian eCommerce sector towards unparalleled growth.



Sanjay Mohan is the Group Chief Technology Officer, MakeMyTrip Ltd., leading the overall technology for MakeMyTrip, Golbibo & Redbus. He is responsible for developing and executing global technology strategy for the combined entity.



⁷India Stack.org. Available at <http://indiastack.org/bridging-indias-financial-divide-startups-can-leverage-india-stacks-limitless-possibilities/>

Breakthrough in

GOVERNMENT PROCUREMENT: GOVERNMENT E-MARKETPLACE (GEM)

RITA A. TEAOTIA

INTRODUCTION

The GDP of India stands at around USD 2.3 trillion¹ out of which India procures 20% of GDP publicly². The procurement of goods and services of the right quantity and quality, at the right time and price and from the right source, is always crucial. Over the years, incremental improvements in public procurement were undertaken at the Centre as well as the States. However, public procurement continued to remain cumbersome, difficult, time-consuming and prone to allegations of irregularities and corruption.

NEED

The existing systems of procurement, namely direct purchase, tendering, rate contract (RC) etc., were extremely time consuming. Usable databases of the last purchase price and facility for price comparisons were virtually absent. This led to difficulties in assessing the reasonability of the discovered price. Although the RCs provide ease of purchase to the buying Departments, this system suffered from inherent defects, namely limited competition with chances of cartelization owing to limited suppliers. Directorate General of Supplies and Disposal in its 65 years of existence, had 3000 sellers on RC (and 20,000 products only), fixed annual price and product model, a poor track record among RC holders, and quality issues with the stores.

THE SOLUTION

With the aim of reforming the entire public procurement process, the Union Government took a momentous decision in 2016 to transform public procurement and make it totally transparent, efficient and accountable. This was achieved through development of the Government e-Marketplace (GeM), which is a technology-driven platform, providing an end-to-end online procurement platform for common use goods and services required by various government organizations. The GeM e-Governance initiative is a giant leap towards the Government's commitment towards 'Minimum Government, Maximum Governance'. Procurement through GeM has now been made mandatory as per Rule 149 of GFR 2017 and several states have also amended their procurement rules/ Acts to enable procurement through GeM.

GeM was launched by the Commerce and Industry Minister on 9 August, 2016. It is now managed by the GeM Special Purpose Vehicle, a 100% Government owned, Section 8 Company under the Department of Commerce. Within a year GeM has grown from just desktop computers and taxi services to:

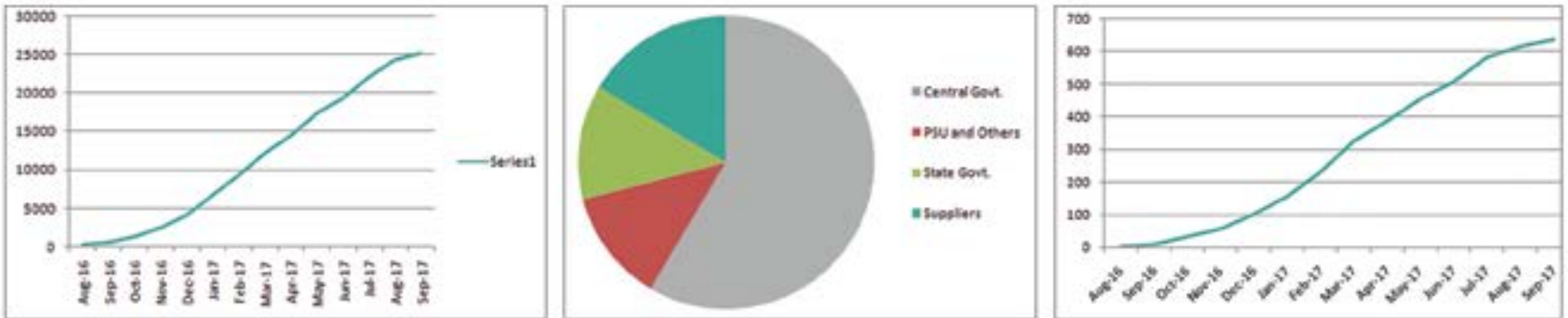


GeM has been selected as one of the winners of the South Asia Procurement Innovation Awards of the World Bank, 2016

¹World Bank

²<http://blogs.worldbank.org/governance/public-procurement-rich-country-s-policy>

The journey was supported by an intensive and sustained capacity-building exercise as illustrated in the accompanying charts.

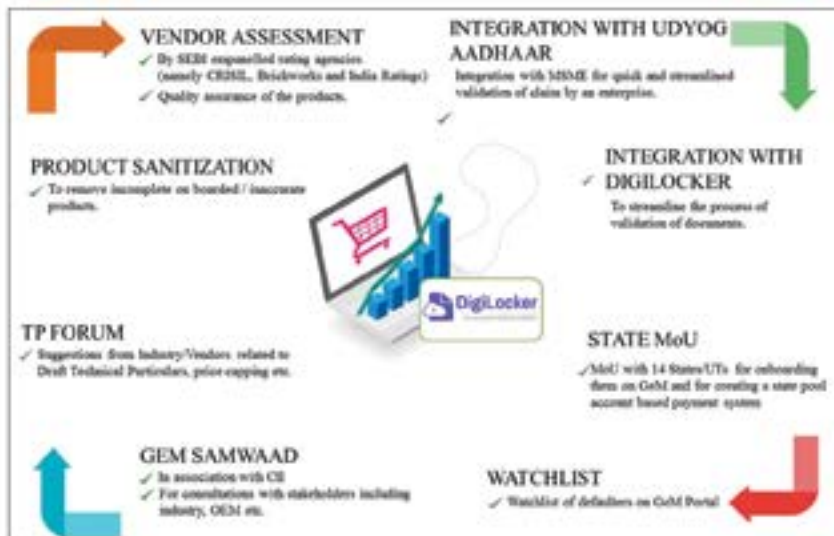


PRE- AND POST- GEM ERAS

The following comparison between the older rate contract system and the newer GeM offering clearly brings out the clear advantages of the GeM platform:

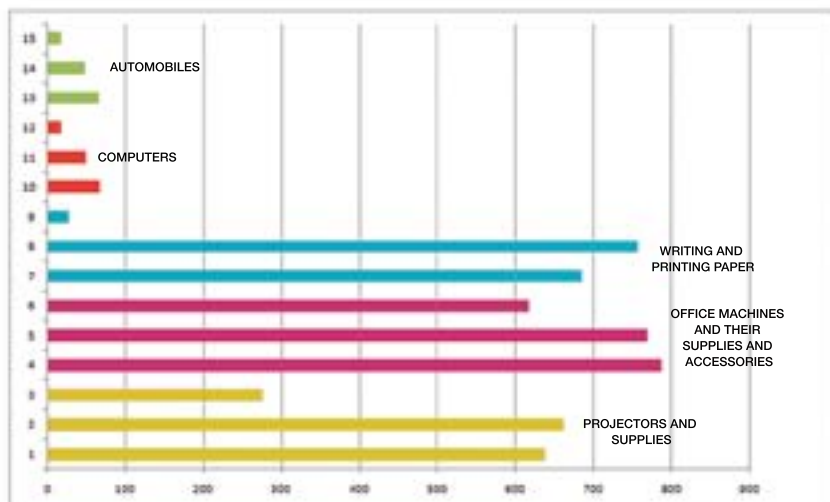
DGS&D	GEM
Registration very cumbersome with physical inspection, etc. (Average time 4-6 months)	Registration of vendors and buyers online and based on trust; made possible through GeM integration with Aadhaar, MCA21, PAN, NIC (Registration within 10 minutes)
Rate Contract restricted to registered vendors; Limited vendor base (About 2500-3500 suppliers in 250-300 item categories)	Open marketplace – 32,000+ sellers and counting
Localised vendor base: NCR, Agra-Kanpur, Ludhiana and Kolkata	Current supplier base from different regions: opportunity to do business with Government
Tendering involved manual rate negotiation; resultant opacity and possible cartel formation	Totally reengineered and objective processes; obviating paper submissions, subjective discretions and visits to offices of buyers for transacting business
Duration of RC one year or more – vendors, products and price locked for years- to the disadvantage of the Government	The suppliers no longer get a licence to supply one model at a fixed price for one full year; they have to participate in multiple daily biddings on GeM and compete.

KEY FEATURES OF GEM



SAVINGS ON GEM

On an average GeM-based savings are approximately 25% excluding automobiles (which is standard 12%), owing to a wide vendor base, competition, transparency in price discovery, and time-bound acceptance of goods, services and payments. Also, for most of the products, vendors are required to offer a minimum discount of 10% over the MRP. For items that were earlier available on DGS&D RC, the GeM prices cannot be more than the RC rates for such items. The figure below depicts the major category-wise savings:



Demand Aggregation (DA) has further pushed the prices south. In one such case, wherein around 1.2 lakh smartphones were required to be procured for buyers from 5 States, savings of INR 6.69 Crores (66.9 million) was achieved by procurement through GeM.

GEM - VALUE FOR BUYERS AND SELLERS

Some of the key value to buyer and suppliers on GeM are as follows:



SCALABILITY AND SUSTAINABILITY

GeM is conceptualized around generally acceptable and prudent financial rules in Government departments, making it easy to replicate, adopt, or adapt the solutions by any government entity, be they from the central or state governments, PSUs, or autonomous-bodies. GeM's architecture has been designed to make it easy to scale-up and up-scope, as it is modular. Functionalities of the portal have been so formatted to allow modification for use by other institutions or national states with minimal efforts, thereby reducing wastage. By doing this, GeM curbs the need for Government buyers starting individual e-solutions and seeks to bring them all under one roof of a universal procurement solution. GeM is developed as a full stack open-source application platform and deploys effective load balancing and caching to make it a high-availability solution even during peak loads.

KEY LESSONS LEARNED

1. All stakeholders need to disrupt and transform their business models and processes appropriately, thus bringing in synergy required for synchronicity.

2. Existing business model of OEM including authorized channel partner and local level vendors needs to be transformed in the spirit of openness and trust that GeM embeds in its design and architecture.

3. Barrier-free entry means significant number of sellers would adopt technology for the first time. Thus capacity building at grassroot level is required to ensure that the opportunity created by GeM is leveraged fully by stakeholders concerned.

4. Constant calibration and balancing of the barrier-free entry and openness with the need for quality of product and services for buyers especially high volume and high value products.

5. Analytics specially to identify deviant behavior, consistent compliance with Government of India rules and implementing price competitiveness is required.

6. Full transparency also needs to be safeguarded against potential cartelization as also provide space for commercial privacy.

Ms. Rita A. Teotia serves as Secretary, Department of Commerce, Ministry of Commerce & Industry, Government of India. Ms. Teotia was earlier Special Secretary in the Department of Telecommunications, Ministry of Communications & Information Technology.





Speech synthesis

IN INDIAN LANGUAGES & FUTURE PERSPECTIVES

ARUN BABY, ANJU THOMAS, JEENA J PRAKASH, ANUSHA PRAKASH & HEMA A. MURTHY

I. INTRODUCTION

Building speech synthesis systems for Indian languages is difficult owing to the fact that digital resources for Indian languages are hardly available. Vocabulary independent speech synthesis requires that a given text is split at the level of the smallest sound unit, namely, phone, the waveforms or models of phones are concatenated to produce speech. The waveforms corresponding to each of the phones is obtained manually (listening and marking), when digital resources are scarce. Manually labelling of data can lead to inconsistencies as the duration of phonemes can be as short as 10ms.

The most common approach to automatic segmentation of speech is, to perform forced alignment using monophone HMM models (corresponding to the sound units in a language) that have been obtained using embedded reestimation after flat start initialisation. Parsers are available for each of the languages under consideration. These results are then used in a DNN/SGMM framework to build better acoustic models for speech synthesis/recognition. Segmentation using this approach requires large amounts of data and does not work very well for low resource languages. To address the issue of paucity of data, signal processing cues are used to restrict embedded reestimation.

There are many issues in building TTS systems for Indian languages. Although there are many languages that use the Devanagari script, there are a number of languages that use their own scripts. A common label set was first developed to generate a common framework for all Indian languages. Voice activity detection is first performed to determine the voiced regions in an utterance. Short-term energy (STE) and spectral flux (SF) are computed on intra voiced segments. STE yields syllable boundaries, while locations of significant change in spectral flux are indicative of fricatives, and nasals. STE and SF cannot be used directly to segment an utterance. Minimum phase group delay based smoothing is performed to preserve these landmarks, while at the same time reducing the local fluctuations. Boundary corrections are performed at the syllable level, wherever it is known that the syllable boundaries are correct. Embedded reestimation of monophone HMM models is then restricted to the syllable boundaries. The boundaries obtained using group delay smoothing results in a number of false alarms. HMM boundaries are used to correct these boundaries. Similarly, spectral flux is used to correct fricative boundaries. Thus, using signal processing cues and HMM reestimation in tandem, robust monophone/triphone HMM models are built. These models are then used in a DNN framework to obtain state-level frame posteriors. The boundaries are again iteratively corrected and reestimated. A major problem with HMM parameter estimation is the lack of large amounts of data.

State-tying is commonly used approach to reduce the number of HMM states for parameter estimation. State-tying is primarily based on the merging of similar sounds. As Indian languages belong to a different family of languages compared to other Western languages, a set of rules that are common across different languages was first designed. Linguists and phoneticians across the country were consulted to arrive at this.

The final waveforms are then used in a Unit selection synthesis/Statistical parametric synthesis framework to build speech synthesis systems for 13 Indian languages. Both quantitative and qualitative assessments indicate that there is a significant improvement in quality of synthesis.

II. TTS CONSORTIUM EFFORT FROM 2009-2017

The TTS consortium funded by MeitY, Gol under the guidance of TDIL, MeitY India has developed TTS systems for 13 Indian languages using this novel approach. The languages include Assamese, Bengali, Bodo, Gujarati, Hindi, Kannada, Marathi, Malayalam, Manipuri, Odia, Rajasthani, Telugu, Tamil, and 13 flavours of L2 Indian English.

The TTS consortium has created a website (www.iitm.ac.in/donlab/tts/) where a number of different resources are available. There were two phases to the consortium effort.

A. PHASE I – 2009–2011

The first phase was to develop TTS systems that were integrated with screenreaders. ORCA under linux, and NVDA2010 under windows were integrated. Initially there was lot effort spent on collecting data from appropriate voice talents. Some salient features include accommodation for the agglutinative nature of Indian languages. Selection of optimal text was crucial to this phase. It is very common to find a large number of words that are concatenated to make new words. Such words should not be present in the training data, as these words are not articulated properly. Finally, Chandamama stories were taken to build the corpus. Data was collected from a voice talent. The voice talent had to be carefully chosen so that the voice was amenable for modification. Labelling was performed semi automatically, where signal processing cues were provided for manual labelling. Syllable-based unit selection synthesis based systems were developed for Tamil, Telugu, Hindi, Marathi, Bengali and Malayalam. Use of syllable as a unit for synthesis was the novelty of the proposed work. The quality was found to be much better than diphone based systems.

These systems were integrated with ORCA/ NVDA. Visually challenged persons were trained to use these systems to interact with computer systems. Training workshops were conducted at a number of different places. Figure 1 shows a photograph of a workshop in progress at IIT Madras. A participatory design approach was used to design the interfaces [1]. Over a 5-year period about 180 visually challenged students were trained to use Microsoft Office, excel, email and Internet in the vernacular.

B. PHASE II: 2012–2017

The Phase I systems were large footprint and were therefore limited to desktops with adequate RAM and hard disk. The entire voice would require anywhere between 700MB-1GB of space. In the meanwhile, this period saw the proliferation of smartphones. The objective was modified to include “small footprint synthesisers” for 13 Indian languages. During Phase I, it was observed that most vernacular websites included quite a lot English text. During Phase I, whenever such text was found, the voice was replaced by an American/British English voice which sounded unnatural. This issue is addressed in Phase II, where every language also provides a bilingual version to enable code switching between the native tongue and English by the same voice. Owing the small footprint requirement, statistical parametric speech synthesis systems were built around the hidden Markov model based speech synthesis systems (HTS). Although HTS systems are capable of generalisation for unseen sequences, during training appropriate state-tying and clustering should be performed. Hidden Markov model (HMM) based classification and regression trees are available for English which organise the HMMs based on context, rules of languages. Also the graphemic representations vary from language to language. For scalability, a common label set (a superset of sounds across the 13 languages) (Figure 2) and a common question set (CQS) were developed first. A subset of the CQS is given below:

QS "LL-Low_Vowel" {a^{*}, aa^{*}} QS "LL-IVowel" {i^{*}, ii^{*}}
 QS "LL-OVowel" {oi^{*}, o^{*}, oo^{*}, ou^{*}} QS "LL-UVowel" {u^{*}, uu^{*}}
 QS "LL-Glide" {y^{*}, w^{*}, yq^{*}, zh^{*}}

Next, a common parser that works for all the 13 languages was developed. The parser was developed such that the “language dependent” and “language independent” components were separated [2]. The labels obtained in Phase I was still erroneous. This issue was addressed by using both machine learning and signal processing in tandem. Signal processing was used to determine stop consonant, fricative and nasal boundaries. The machine learning algorithm used these boundaries as sentinels during training[3], [4]. Figure 3 shows a part of a Hindi speech utterance labeled using this approach. TTS systems using this procedure were developed for 13 different Indian languages and the corresponding Indian English flavours. Degradation mean opinion score (DMOS) listening test shows an average relative improvement of 14.8% with this approach

Different applications were developed to make the TTS services available on the Android platform :

- (1) Tamil TTS app
- (2) Hindi TTS app and (3) Indic TTS app - for text-to-speech synthesis of 13 Indian languages
- (4) Tamil learning

app and (5) Safe pregnancy app. Given that today vocabulary independent TTS is available, the consortium has partnered with IndusOS to integrate TTS with the operating system for smart phones. The system for IndusOS is capable of “translating and reading SMSes in the tongue of the user.” All the data and systems have been released under GPL license for use by both commercial and research establishments.

Specific MoUs have been signed with Wipro, Samsung, Timbre Media, Shinano Technologies, Inferon online services, etc. We have also assisted TCS Ignite team - Chennai and Digital Impact Square - a TCS foundation initiative. The following companies have signed the online license agreement: (1) Amity Software Systems Limited (2) Amazon (3) Australian Survey Research (4) Crosscode Technologies Private Limited (5) datametica (6) Dheeyantra Research Labs (7) eVenturers (8) Everest IT Services Pvt. Ltd. (9) GMX (10) gnani.ai (11) Hungama Digital Media Entertainment Pvt.Ltd. (12) ICFOSS (13) Idea (14) Manorama Social Mobile Analytics Cloud (15) Meritnation (16) Microsoft (17) Mihup (18) Mindtree (19) niqotin (20) Nithra Edu Solutions India Pvt Ltd (21) Pratham (22) Process 9 (23) Reliance Industries Limited (24) Samsung (25) TCS(26) Tevatel (27) Timbre Media (28) Trinity Unicepts Pvt. Ltd (29) Wipro (30) Yandex. The educational institutes that have signed the online license agreement are listed below:(1) CMU (2) IIT Bombay (3) IISc (4) Gujarat University (5) IIT Bhubaneswar (6) IIT Guwahati (7) IIT Hyderabad (8) UIUC (9) NIT Calicut (10) The Chinese University of Hong Kong (11) Siksha 'O' Anusandhan University (12) NIIT University (13) Shri Guru Gobind Singhji Institute of Engineering & Technology (14) UT Dallas. Table I shows the download statistics of the online Indic TTS resources (website: www.iitm.ac.in/donlab/tts/).

DOWNLOAD TYPE	COUNT
Database	2450
CLS	402
Unified Parser	375
Hybrid Segmentation	262
Pruning	148
Voices	760
Android Applications	570
Synthesis Documents	1433

III. TTS IN INDIAN LANGUAGES – THE FUTURE

The drawback of the current day TTS systems is lack of prosody. Prosody of speech utterances can vary from context to context. For example, the prosody used in news has to be very different from that of story-telling.

Naturalness of speech in different tasks is related to prosody. Some efforts in this direction are in progress at the various participating institutions. Other applications include dynamic IVRs in different languages (basically a system that understands the anxiety of user and provides appropriate responses), health care (where a person can get his/her prescription/lab report read out), weather reports (for farmers, people on the road), a Google map enabled with Indic voices can be of great use to taxi companies like Uber and Ola to help navigation in the vernacular. Information about traffic congestion can be also be announced on the radio (with local content). Last but not the least, persons with cerebral palsy, visual challenged can be brought into the main stream with TTS technologies in the vernacular. All of these systems require smart designs on smart phones for speed of responses. Android based platforms that are cheap and fast are required. This suggests that most of the tasks must be done in hardware. Building TTS hardware can go a long in enabling robust and cost effective technologies. Further, extensive effort on dialogue design must be under-taken to suit the Indian environment where all of us polyglots, for example, multilingual dialogue design.

The authors are from Department of Computer Science and Engineering,
Indian Institute of Technology Madras, Chennai

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9

Empowerment

THROUGH DIGITAL ENGAGEMENT

AS EXPERIENCED BY A COMMON MAN IN INDIA

MUKESH KHULLAR

The digital world is now omnipresent. There is no walk of life that has remained untouched by some or the other aspect of information and communication technology. Processing chips are becoming smarter, supporting penetrative analysis of the scale and complexity that is generating newer options never seen before. Citizens are experiencing the power of a digital world that has made the world smaller, and an unprecedented volume and range of knowledge is easily accessible by all. Citizens, and the institutions governing citizens' lives are getting empowered through such knowledge that is progressively getting further enriched through continuous evolution of new technologies in the digital world.

INVOLVED CITIZENRY

Empowerment through digital engagement is most distinctly visible on social media where citizens express their feelings, post comments, share content format (text or media) of their choice. Amateur citizen journalists armed with phone camera videos are, nowadays, quite a force to reckon with.

Governments are increasingly interacting with citizens digitally. Mygov.in, an online portal of the Government of India, is an example of such engagement. Nearly 5 million registered members have posted about 4 million comments on more than 650 topics in the past three years.

Such crowd sourcing of ideas and suggestions are enriching the content of government programmes, and redefining and sharpening their delivery mechanisms.



Members are recognized for their constructive suggestions through special mentions by Hon'ble Prime Minister in his monthly radio address 'Mann ki Baat' and by way of awards for their contributions through essay and films competitions like 'what can I do for clean India' organized by Mygov.in for 'Swachh Bharat Mission'.

A similar portal 'Aaple Sarkar' (Our Government) has been started by State Government of Maharashtra for technology enabled participative governance. Here citizens avail online services, raise grievances and make suggestions on improving any aspect of governance.



Hon'ble Chief Minister takes up the complex pending grievances in a monthly 'Lokshahi Diwas' where the related administrative heads of the departments sit together and find ways and means not only to redress individual grievances but also amend policies or programmes so as to ensure that similar grievances don't recur. Another aspect of the interaction is the analysis of the language used in the grievances or suggestions which gives a valuable feedback on the mood of the citizens in terms of their trust in the governing institutions.

'Aaple Sarkar' is receiving more than a million feedback inputs every year. Aaple Sarkar outlets, operated by village level entrepreneurs engaged by CSC e-Governance Services, offers a physical service point in the field where citizens can go, to deliver feedback and access services. 20,200 centres have already become operational and the citizens are availing themselves of the 400 plus citizen services guaranteed under Right to Service Act enacted by the State Government and available on the Aaple Sarkar portal. The scope of the initiative is now expanded to open more than 25,000 outlets in hinterland where citizens could walk in for these services. The response of the citizens has been overwhelming as the government is now easily accessible to them in their immediate neighbourhood, thus, bridging a digital divide in terms of internet penetration and digital literacy.

ALL PERVADING MOBILE PHONES AND INTERNET

A communications revolution of sort has been ushered through mobile telephony services by the private sector. Like wildfire, cellular phones have spread far and wide and are within easy grasp of everybody, rich or poor.

Leapfrogging the developmental deficits in social sector, the usage of mobile telephony is empowering citizens by increasing their productivity multifold. New opportunities are presented in connecting citizens to the markets. Internet-based content is more easily accessible to citizens. Getting information as a product, engaging in interactive sessions and enabled to transact online, empowers citizens to enhance their efficiency and self confidence.

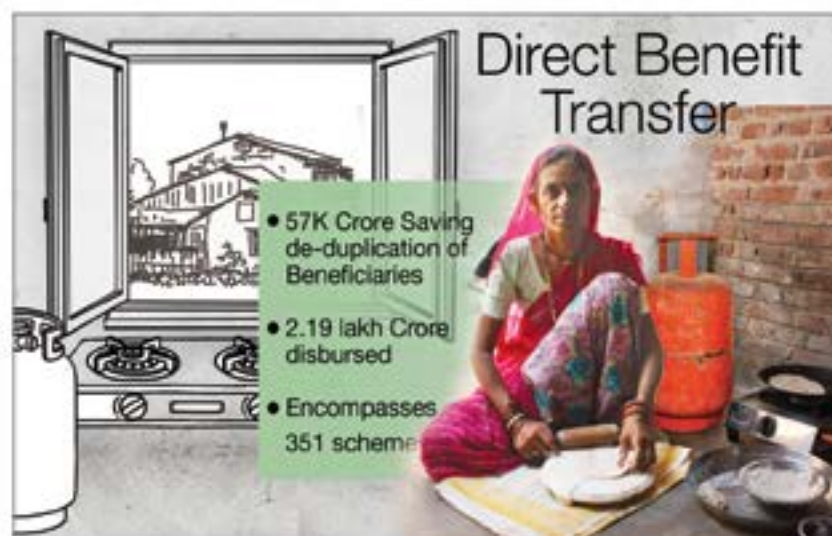
Digital financial transactions using mobile wallets like 'BHIM' is another revolutionary concept that is getting popular because of the convenience it offers. Making bill payments of utilities, trading in stocks and bonds, buying various other financial services like travel insurance, renewal of automobile and life insurance policies etc. are all facilitated with online self service.



Online shopping that offers choice to people among various brands with all technical brochures available at the press of buttons, is getting popular. Amazon, Flipkart, Snapdeal and a host of other online shopping malls are increasing their sales exponentially with the digitally empowered consumers showing their preference for buying from such facilities. Online transactions, home delivery of products, quality assurance, take-back policy, have made consumer the true king in the market. With knowledge and transparency in product offering, consumers are dictating the market choice for the products that meet their needs.

INCLUSIVE DEVELOPMENT

Leveraging technology enabled anytime banking, Government of India launched Jan Dhan Yojana for financial inclusion of all its citizens. More than 250 million new accounts have been opened in no time to ensure that no one was left without any bank account.



Another technology enabled initiative was making the unique identity -- Aadhaar -- easily available to all interested citizens, which has seen an unprecedented mass movement to cover more than a billion population within five years. Financial entitlements under various social security programmes and scholarships to deserving students get correctly targeted and the amount is being regularly disbursed with low transaction costs.

A revolutionary direct benefit transfer programme is benefitting millions of Indians with huge savings, defraying costs and delays in an assured manner.

COLLABORATION FACILITATED

The modern world is about individualism, about individuals to express, excel and flower. Digital technology is enabling collaboration for individuals to work in a team so as to create a multiplier effect for mutual benefits.

A host of collaboration, productivity and communication suites like group messaging, video conferencing, task management, calendar scheduling, project management, knowledge management etc. have reduced distance, kept team members in continuous contact and reduced the need for personal meetings, thus generating extra time to be able to do multitasking through non-intrusive collaboration across domains, geographies and hierarchical levels.

HASSLE FREE MOVEMENT

In a connected world, distances are getting reduced with faster modes of travel. Booking ticket for travel by air, train, bus or taxi or a room to stay anywhere in the world is now all done very easily from anywhere at any time using any of the various travel apps on mobile phones. One can even choose a specific seat while booking a ticket.

The real remarkable story is about technology enabled taxi aggregating service providers like Uber, Ola and others. A car is hired using these service providers and the amount is paid online or by swipe of a card for the standardized service availed. Technologies like GPS/ GIS guided navigation tools are used to select the shortest distance for commuting to the destination. Traffic conditions known through crowd sourced data by the navigation service provider, help to predict the exact time to cover the distance with suggestions of alternate routes during heavy traffic situations. Logistics have become more predictable, hassle-free and comprehensible.

ON DEMAND IT INFRASTRUCTURE

For supporting digital enterprise or digital presence, infrastructure by way of system software, processing power, storage and networks and their administration is all available on cloud in an on-demand basis.

‘Meghraj’ offered by ‘National Informatics Centre’ of Government of India is an example. An online performance assessment report application developed for All India Services officers was replicated and rolled out for 5000 Group A officers of 12 cadres in State Government of Maharashtra in three months flat. Speed of implementation and roll out has been possible due to cloud architecture and service support from NIC. ‘Meghraj’ made the application available within three days of the request.

At a fraction of cost, infrastructure service providers are assuring quality of service on availability of developed applications, thus asking entrepreneurs to focus on improving the content of their offering. Lead time is getting reduced as a result and an enterprise could be set up without engaging a big digital support team, thus empowering new age entrepreneurs with a head start.

CYBER SECURITY

Along with empowerment comes the danger of cyber security. Ease of operations may also, simultaneously, make the systems vulnerable to intruders hacking the application with false identities. Cascading or ripple effect of such security breaches can reduce the connected world to mute spectators to thefts.

Security safeguards must be provided to prevent such digital frauds while maintaining the user-friendliness of processes. Cyber security measures are necessary to ensure that online transactions remain credible.

Online financial or sensitive transactions using one-time passwords as a means of verifying identity is a simple and popular method which sometimes is built on top of captcha or Aadhaar linkage.

ANYTIME LEARNING

In the education sector, the rise of digital platforms is making available online courses – as part of various curricula, leading to award of recognized certifications or degrees, and to impart special skills to attend to new requirements of any academic domain in the fast-changing world.

Assessment of competence through online objective type multiple question tests is not only faster, but also tests the understanding of the examinees more thoroughly.

E tutors available online use various digital techniques like animation and appealing graphics that makes the understanding of complex issues a simple process. Such tutors not only help the students but also extend the reach and availability of the limited tutoring resources to larger audiences.

WAY FORWARD

Digital engagement today has become a necessity. Autonomous systems are now being built through advanced machine learning tools.

People are getting further empowered through technologies that help them to bridge the language barrier to converse in different languages without having to learn the language.

Digital assistants are becoming smarter to take care of multi dimensional needs of any individual. Available all through the day without availing any break, such personalized assistants are transforming the lives of individuals in a spectacular manner.

Despite security concerns, digital entanglement is getting deeper and wider. As a result, individuals are turning more resourceful and innovative in making lives more predictable, easier and meaningful.

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..... Mukesh Khullar is Additional Chief Secretary, General Administration
..... Department, Government of Maharashtra and Ex Secretary, Information
..... Technology, Government of Maharashtra. He looks for opportunities to
..... enhance user experience with technology.
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Digital inclusion

FOR ALL IN CYBERSPACE – “SABKA SAATH”

MOHAMMED ASIF IQBAL

India is in the midst of several digital revolutions and fundamental changes, that are happening in the way citizens avail themselves of various services from both government and private organizations, which, in turn, are transforming their operating models to optimally use digital solutions to reach out to citizens and/ or customers.

As a nation, we need to ensure that every citizen is a beneficiary of the change offered by the digital revolution. Digital transformation has made it easier for all citizens to access products and services for all citizens – particularly empowering citizens with disabilities in easily accessing what they need, despite mobility and other constraints. The ability of digital technologies to empower the disabled is especially noteworthy: the world is home to more than a billion people with some form of disability, 70-100 million of whom reside in India¹.

The Government of India has undertaken several initiatives to ensure that the cyberspace offers equal access to all, including citizens with disability. The Accessible India Campaign (AIC) of the Department of Empowerment of Persons with Disabilities (DEPwD), Ministry of Social Justice and Empowerment, launched by Hon'ble Prime Minister Shri Narendra Modi on the International Day of Persons with Disabilities, 3 December 2015², which aims to create a barrier-free, conducive environment for all Indian divyangjan – explicitly focuses on this need. Accessibility of information and communication system is a specific, critical AIC pillar: seeking to make at least 50% of Central and State Government websites accessible by divyangjan.

Government applications including the Income Tax Department's income tax e-filing website, the Indian Railway Catering and Tourism Corporation Limited's railway services booking portal, and the initiatives and websites of the Ministries of Electronics and Information Technology (MeitY), Social Justice and Empowerment, and Women and Child Development are some of the finest examples of undertaking the accessibility journey, all with features largely accessible to disabled citizens. MeitY has initiated a project to make government portals accessible, under which many websites have been made accessible as per the Guidelines for Indian Government Websites (GIGW) / W3C standard WCAG 2.0³. The Government of India has also notified a National Policy on Universal Electronic Accessibility, which it followed up with the launch of 'Accessible India Campaign (Sugamya Bharat Abhiyan)' with the objective of achieving complete accessible physical infrastructure, transport system and information and communications technology (ICT) ecosystem. These are accompanied by defined timelines and quantitative targets, in compliance with this national mission.

The Government has also initiated the process for considering insertions of accessible hardware and software as part of their tendering process as per international standards. It has also conducted numerous training sessions on digital accessibility for vendors for delivering government software projects.

Non-profit organizations and private sector have also immensely contributed to the journey of digital inclusion in India. For example, the DAISY Forum of India (DFI) is a consortium of Indian not-for-profit organizations involved in production and distribution of books and reading material in accessible formats for persons who cannot read normal print due to visual, cognitive or physical disabilities. DFI has collaborated with Government of India to launch Sugamya Pustakalaya, an online library⁴ of digital books in accessible format for print impaired citizens. DFI is currently in the process of converting course curriculum of primary, secondary and higher education for 19 major States of India. Enable India, another non-profit organization, is currently developing a mobile app with a technical dictionary of sign language; consisting of frequently used words in various manufacturing sectors. This will enable career counselors to impart skills to hearing-impaired people.



¹http://meity.gov.in/writereaddata/files/National%20Policy%20on%20Universal%20Electronics%281%29_0.pdf

²<http://guidelines.gov.in/>

³<http://meity.gov.in/writereaddata/files/National%20Policy%20on%20Universal%20Electronics%281%29.pdf>

⁴<http://pib.nic.in/newsite/PrintRelease.aspx?relid=149198>

Indian computer programmers have made significant contributions towards enhancing features of open source windows screen reader software, which provide audio output of computer software. Non-visual display access (NVDA), an open source screen reading software, is now available in seven Indian languages including Hindi, Bengali, Tamil, Marathi, Kannada and Indian English⁵. Text-to-speech in nine Indian languages – developed in consortium mode and funded under MeitY's Technology Development for Indian Languages (TDIL) programme – has been integrated with both LINUX based ORCA and NVDA screen readers. Specialized training has also been provided to visually challenged persons in association with National Association for Blind (NAB).

This innovation thrust reaches beyond government. Avaz, another Indian invention, is an alternative and augmentative communication device, which generates speech from limited muscle movements like that from the head or the hand. It can be used by people with speech disorders such as aphasia, autism, cerebral palsy, and intellectual disability⁶. This device is 90% cheaper than the devices which are available in developed countries and cater to Indian languages. Similarly, Indian IT firm Mindtree has developed Kabi, an app that can assist speech-impaired children in quick communication with the external world, by allowing them to select pictograph images on their handheld android devices. Bleetech Innovations, based in Mumbai, has developed the Blee Watch: a smart watch especially designed for the needs of hearing impaired citizens⁷. The watch enables recording emergency sounds like doorbell, fire alarm, baby's cry into the connected app. Whenever that sound is played next, Blee Watch notifies the user with unique vibration patterns, colours and icons. Blee Watch can also indicate the feel of music even if it cannot be heard: Blee Watch converts sound into vibration patterns; allowing users to express this music through dance, on the basis of these vibration patterns.

Innovation for the disabled goes beyond device technology. Inclove, a start-up venture in India, has developed an app designed to find friend, life-partner or companion for those with disabilities.



Citizens with disability still face immense challenges while navigating cyberspace. To illustrate this further: blind and visually impaired citizens may not be able to access government notifications which are uploaded as image documents (without alternative text descriptions), since screen readers, at least today, cannot read images. To address this issue, MeitY has issued instructions to scan circulars/ notifications in e-Pub or OCR based PDF document. Even as audio and video content in cyberspace increases, hearing-impaired citizens would not be able to access this digital content if there is no caption for the content. Citizens with learning disabilities will face barriers in viewing a confusing, inconsistent presentation of material if the digital content is not designed appropriately.

Digital accessibility is enabling an environment that helps easy access of computer, software and electronic resources (including web pages, software, mobile devices, e-readers etc.) and communications. It also facilitates navigating the web, mobile apps, electronic media, etc. and empowers citizens with disability comprising of blindness, low vision, colour blind, auditory disability, motor disability, speech disability, cognitive disability and seizure disorder.

Instead of creating dedicated solutions for citizens with disability within the cyberspace; the focus should be on universal design offering access to all, including citizens with disability. The design of products, environment, programmes and services should be user friendly for all regardless of sex, age, situation or disability to the greatest extent possible, without the need for adaptation or specialized design. Universal design shall not exclude assistive devices for particular groups of citizens with disabilities where this is needed.

Digital accessibility will also benefit others, including senior citizens with changing abilities due to aging. Access to the web, mobile apps, software applications, document formats such as e-books, PDFs, etc. should be seen as fundamental rights worldwide. The good work must continue.



¹ <https://eveningpost.blogspot.in/2017/03/accessible-india-campaign.html>

² https://en.wikipedia.org/wiki/Ajit_Narayanan

³ https://topics.revolvy.com/topic/Ajit_Narayanan

Mohammed Asif Iqbal is Principal Consultant, PricewaterhouseCoopers India. His work has included designing and implementing social inclusion strategies for marginalised groups, and launching global toolkit for engaging disabled talent.

According to Census 2011, there are 26.8 million persons with disabilities (PwDs) in India, constituting 2.21% of the total population. About 15 million are male and 11.8 million are female, including persons with visual, hearing, speech and locomotor disabilities; mental illness, mental retardation, multiple disabilities and other disabilities. The vision of the Government is to build an inclusive society in which equal opportunities are provided for the growth and development of persons with disabilities so that they can lead productive, safe, independent and dignified lives. While a separate department, The Department of Empowerment of Persons with Disabilities, has been created in May 2012 to empower persons with disabilities through its various institutions/ organizations and schemes for rehabilitation, almost all other departments and ministries of the central and state governments are trying to mainstream disability-related issues in their policymaking and implementation of various programmes/ schemes.

1. ROLE OF ICT IN EMPOWERING PWD

Digital India, a flagship programme of the Government of India, aims to transform India into a digitally empowered society and knowledge economy. Its focus is on making technology central to enabling change. The vision of Digital India is centered on three areas, namely, creation of digital infrastructure as a utility for every citizen; providing governance and services on demand, and; digital empowerment of all its citizens.

ICTs today are the most important medium for communication, information, education and entertainment the world over. Television, radio and mobile have become indispensable features of the lives of people across the globe. Proliferation of web-enabled services has changed the nature of citizen-government relations. Every country, every region, is benefitting from the role of ICTs in economic and social development. It is hence imperative to ensure that PwDs are not excluded from the use and benefits of ICTs. These technologies can serve as critical enablers towards enabling PwDs to participate on an equal basis in all aspects of society and development. These can help PwDs have greater access to knowledge and various public services, thereby empowering them to live independent and dignified lives.

2. THE UNITED NATIONS CONVENTION ON RIGHTS FOR PWDS (UNCRPD) AND ACCESSIBLE ICT

India is one of the first few countries to endorse and sign the United Nations Convention on Rights of Persons with Disabilities in the year 2007. Article 9 of the Convention explicitly endorses the rights of PwDs to access ICTs on an equal basis without discrimination.

The Convention defines communication as “including all possible means of communication that may eliminate barriers: the term includes languages, display of text, Braille, tactile communication, large print, accessible multimedia; as well as written, audio, plain language; human reader and augmentative and alternative modes, means and formats of communication, including accessible ICTs.”

3. ACCESSIBLE ICT : WEBSITES, TELEVISION AND MOBILE ACCESSIBILITY

Accessibility of websites is critical for persons with disabilities. For a website to be accessible it must adhere to the Web Content Accessibility Guidelines (WCAG) formulated by the World Web Consortium which forms the universal basis for web accessibility. The WCAG guidelines are based on four principles:-

- (i) The website should be perceivable, i.e. the user must be able to perceive the content through the senses, either through the browser or with assistive technologies such as Screen Readers.
- (ii) Secondly, the website should be operable, i.e. the user should be able to interact with all controls and perform all functions through the keyboard, mouse or a supportive device.
- (iii) Thirdly, understandability, i.e. the user should understand the function/ content and how to use it.
- (iv) Fourthly, Robustness, i.e. a wide range of technology and user agents should be able to access the contents.

The advent of the internet has heralded a new age of web-based services providing lifelong education, employment, government services and various private services. For persons with disabilities, accessibility of websites can enhance opportunities for empowerment and social participation.

Equally important is accessibility of television. Television programmes cannot be enjoyed by persons with visual and/ or hearing impairment(s) unless the programmes are designed for accessibility of the equipment and programme content. For a television programme to be completely accessible, it should have captions (for persons with hearing impairments to understand the dialogue and action of a programme). Audio description is a vital feature for accessibility of television and other forms of screen-based home entertainment by visually impaired persons. Audio description 'narrates', what is happening on the screen like changes of location, facial expressions, gestures and so on.

The narration pieces are inserted between dialogues to avoid interrupting the natural flow of the programme. Also important are accessibility of the remote control (simple and easy to use) and that of the set top box (which may allow audio feedback to visually impaired users while navigating through the menu).

Mobile phones have become an integral and critical part of our lives today. There are three primary areas in which accessibility interventions can be made – handset, software and content. Handset accessibility can be achieved through visual or vibrating alerts, adjustable volume control, tactile indicators, voice recognition, auto text and teaching screens, text-to-speech software etc. Software accessibility can be part of the operating system or can be introduced through third party applications for screen reading as well as different functions. Content accessibility is extremely important. For example, bill payments to be made by persons with disabilities is possible only when the software content adheres to Web Content Accessibility Guidelines.

4. DISABILITY INCLUSIVE ICT AGENDA

The Accessible India Campaign (Sugama Bharat Abhiyan) has been conceptualized by Department of Empowerment of Persons with Disabilities., It was launched by the Prime Minister of India, Shri Narendra Modi, on 3rd of December 2015, on the occasion of the International Day for Persons with Disabilities. The initiative focuses on accessibility of built environment, transport, ecosystem and information communication technologies. The Accessible India campaign has set the following objectives and targets under the vertical of “Information and Communication Eco-System Accessibility”:

- A. Enhancing the proportion of accessible and usable public documents and websites that meet internationally recognized accessibility standards
- B. Enhancing the proportion of daily captioning and sign-language interpretation of public television news programmes

The Department of Empowerment of Persons with Disabilities and the Ministry of Electronics and Information Technology have collaborated for an expeditious implementation of these targets and many public websites are nearing completion in terms of accessibility as per WCAG standards.

5. THE CHALLENGE AHEAD

The main challenges to the availability of assistive technologies for persons with disabilities are the lack of awareness and the lack of effective training support. Addressing the barriers to accessibility requires collaboration between government, civil society organizations and the corporate sector. The Government can play a key role in stimulating the introduction of ICT-enabled solutions which are adapted to the needs of PwDs; incentivizing availability of accessible technologies and promoting the affordability of assistive technologies especially in social, educational and economic sectors. The private sector should come forward in a proactive manner and through public-private collaboration, promote a national innovation system for development and diffusion of knowledge of accessible products and assistive technologies.

There is a strong case for synergies between the Digital India programme and Accessible India Campaign, both being flagship programmes of the Government of India, to promote development of accessible ICTs for PwDs, as this is crucial today in enabling PwDs to enjoy their basic human rights.



Mukesh Jain is Joint Secretary & CEO, National Trust, Department of Empowerment of Persons with Disabilities, Ministry of Social Justice & Empowerment

CITATIONS :

1. www.un.org/esa/socdev/documents/disability/Toolkit/ICTandDisability.docx
2. <http://www.rdsjournal.org/index.php/journal/issue/download/v5i3/78>
3. Census India 2011.



12

A billion

MOBILE NATION

R. S. SHARMA

Telecom services have significantly changed the way individuals lead their lives and engage in economic activities. It has created new ways of interaction and socialization amongst people, facilitated innovative business models and services, and offered more productive ways for businesses.

Starting from a nascent market that had a little over 14.5 million phone connections in 1997 and “telephone on demand” as an early policy goal, the Indian telecom sector has grown to become the second largest telecom market in the world, boasting of over 1.2 billion subscribers today. Along with better connectivity, the quality of service^[1] has also improved by leaps and bounds cushioned by affordability. The phone device has transformed from a luxury to a necessary utility good for social and economic mobility.

The growth in the Indian telecom sector has been fuelled by a mix of several important factors, including the emergence of growth opportunities, healthy investments in the sector, and rapid development of technology. In addition, factors such as India’s large population, high economic growth in the country, intense competition in the sector, low tariffs, infrastructure sharing and the introduction of enabling regulatory reforms, are also widely acknowledged as being responsible for the exponential growth seen in the Indian telecom industry. At the same time, increasing awareness about the benefits of telecom services has continued to fuel the user demand for more and better services.

In the last decade (2006-16), the sector’s revenues have grown from INR 873.12 billion to INR 2453.51 billion, at a compounded annual growth rate (CAGR) of more than 10 percent.^[2] Telecom services, through fixed-line telephony, mobile phones, wireline and wireless Internet have had a significant impact on the economies of countries globally. In the Indian context, a study titled “An econometric analysis of the impact of mobile, 2009” performed on Indian states indicates that states with higher mobile penetration can be expected to grow **faster**, with a growth rate 1.2 percent points higher for every 10 percent increase in the mobile penetration rate. The study also finds evidence of a critical mass, around a penetration rate of 25 percent, beyond which the impact of mobile on growth is amplified by network effects.

The dawn of the Internet-age in India ushered in a new wave of changes, creating immense opportunities for both service providers as well as users of Internet services. At the end of June 2017, India had over 431 million Internet users, of whom 300 million were making use of broadband Internet services. These numbers are only growing day by day.

The increasing penetration of the internet, through smart phones, has drastically influenced our lives. A study conducted by the GSM Association and Deloitte found a positive relationship between the amount of mobile data consumption and economic growth. The results in the study indicate that mobile data usage per 3G connection has a positive effect on the growth rate of GDP per capita. The Internet has become an enabler of growth: helping companies keep costs down, target customers better and sell goods and services in markets around the world much more easily. Using the Internet, governments can service citizens in a convenient, efficient and transparent manner and at much lower costs.

The digital world today offers a host of opportunities in various sectors of the economy such as agriculture, e-governance, health, mobile banking and online education. These services offer great promise for the goal of sustainable growth by opening doors to economic growth and the socio-economic development of the society.

As noted in a recent report on ICTs and Sustainable Development Goals (SDGs), information and communications technologies (ICTs) can implement SDGs by efficient up scaling of critical services in health, education, financial services and agriculture; reducing deployment costs in urban and rural settings; enhanced public awareness and faster upgrading of services and jobs.

The growth of the telecom sector in the last twenty years has brought with it a tremendous increase in the welfare of telecom users as well as efficiency and innovation in many other allied sectors of the economy. Yet, much still needs to be done in terms of bridging the digital divide and ensuring better access to high-speed Internet connectivity across diverse demographic profiles and geographical areas.

Despite the many leaps that have been made in terms of providing greater and better-quality Internet connectivity to users in the country, there still remains a large part of the population that are unconnected to the online ecosystem, particularly in rural areas. Out of a total Internet subscriber base of 431.21 million at the end of June-17, 293.82 million were based in urban areas while 137.35 were in rural areas^[3]. The difference is even starker if we take into account the rural-urban divide among the subscribers of broadband Internet, which has 224.17 million urban subscribers as compared to only 76.67 million rural ones. Digital infrastructure is the basic requirement in addressing the digital divide among the different strata of the society. Access to ubiquitous, good quality and affordable broadband is the key to roll out various citizen centric programmes and initiatives that help in eliminating inequalities in access and obtaining information.

Development of infrastructure, deployment of high end network technology, small cells in congested and rural areas, central quality of service (QoS) body for off-deck content, supportive regulatory policies can lead to improved data connection and thereby increasing the number of subscribers. Efforts such as laying down an optical fibre network and connecting the 250,000-gram panchayats/villages, under Digital India mission, will shape the course of the rural economy⁴.

With the introduction in 4G, the telecom industry has shifted from the voice-centric state to data centric state. This throws up new challenges in the form of privacy and data security issues. The convergence of technology and media are enabling efficient content sharing. However, with ever-increasing content getting shared, the security and rights of shared content are likely to be compromised.

The service delivery platforms used today are cloud-based, that integrate smart devices, infrastructure, and processes data from large number of scattered sources in real time. Without security, no cloud service could be effectively offered. Specially, the users should have confidence that their data is secure in the cloud. Security is needed not only for data but also for services and application to avoid their usage beyond trust boundaries.

It is imperative that the digital platform used for public services are secure and should ensure confidentiality, integrity and authenticity. This will instil a feeling of security amongst the citizens and will motivate them to use the networks without the fear of their data and information getting compromised.

Engaging these key challenges requires deep collaboration between the government and the industry. The challenges can be overcome through partnerships among communities, governments, sectoral organizations, regulators, researchers and consultants and private sector entities.

India has made great strides in the telecom sector. However, instead of resting on our laurels, it is time to work together to get everyone online regardless of income, age, gender, and education, and empower every citizen of India through ICT; transforming the country into a knowledge economy with high intellectual capital.

R. S. Sharma is Chairman, Telecom Regulatory Authority of India (TRAI). Previously, he was Secretary to the then Department of Electronics and Information Technology (now the Ministry of Electronics and Information Technology); and before that, Director General and Mission Director, Unique Identification Authority of India (UIDAI).



¹<http://connect-world.com/2010/08/15/telecommunications-revolution-in-india/>

²<https://timesofindia.indiatimes.com/business/india-business/telecom-subscriber-base-in-india-crosses-1-2-billion-mark/articleshow/59581169.cms>

³http://www.trai.gov.in/sites/default/files/Indicator_Reports_Ending_Sep_30122016.pdf

⁴<http://indiatoday.intoday.in/story/digital-india-internet-users/1/913797.html>



13

A billion “EMPOWERED” MOBILES & A TRILLION DOLLAR DIGITAL ECONOMY

SUBHO RAY

According to TRAI, as of July 2017, India had 1186.79 million wireless (or mobile) phone subscribers in India. Urban India, with 682.69 million users has a tele-density of 168.21% while rural India with 504.1 million users has a tele-density of 57.04¹. This in itself is a great story for a country where till barely 20 years back, citizens had to wait for years to have their own telephones. However, and happily, this is not the greatest of stories from India anymore. Somewhere along the mobile growth path, Indians discovered and then embraced mobile data and the mobile Internet. With the “empowered” mobile phone began perhaps the greatest story of tech adoption and use in India in recent years.

A recent IAMAI-IMRB study suggested 373 million mobile Internet users in December 2016 and is estimated to have reached 410 million by June 2017². The popular social networking site Facebook has 241 million of registered users from India (more than any other country)³! With 5G around the corner and smartphone shipment expected to cross 500 million annually⁴, 700-800 million mobile internet users would happen sooner than most of us could have predicted a couple of years back.

Even with this modest penetration of mobile internet, some important sectors of the economy have been “disrupted”. The digital commerce sector in India was worth INR 1,68,891 crores (1688.91 billion) in December 2016. The online travel sector (consisting of online ticketing, hotel booking, car/cab hiring etc.) was worth INR 95,198 crore (951.98 billion). E-tailing has taken the country by storm and was worth INR 59,876 crore (598.76 billion) last December⁵. Digital advertising was more than a billion dollars last year⁶ and in the payments segment, the pre-paid instruments (PPI) transactions alone were worth INR 102 billion in the month of August 2017⁷. In the same vein, some totally new segments have been added to the economy, notably the large segment of shared economy whose full value would be unlocked in the next decade.

Based on the recent growth trajectory of mobile Internet, the Ministry of Electronics and Information Technology forecasted that the digital economy would be a Trillion Dollar Economy by 2022. As someone who is very conservative with numbers but has worked with the digital industry for the last 12 years, I am going to stick my neck out and say that this is a very conservative projection and is based on “all things remaining the same” assumption.

Between now and 2022 will all things really remain the same? Certainly not. Here are the key things that would change:

A) SOCIALLY RELEVANT INTERNET:

Digital technology has yet just touched a few sectors and started making a dent. It will expand into new sectors, especially socially relevant sectors such as health, education and skills, governance and agriculture. It is my view that a socially relevant mobile internet would pave the way for onboarding the next 500 million internet users. The vision of Socially Relevant Internet can only be realized when a child in the remotest village can access digital classrooms; when a local level healthcare centre can use remote diagnostics and telemedicine technologies for **speedier** treatment; when local farmers can reap the advantages of Internet of Things (IoT) based crop and weather monitoring; when farmers can access national mandi rates for their products via the National Agriculture Market (NAM) and strike business deals instantaneously using blockchain technology; when artificial intelligence-based technologies can help suggest farmers the best choice for crop selection during sowing season and when government subsidies reach beneficiaries directly and instantaneously.

B) DIGITAL TRANSFORMATION:

Traditional manufacturing and services sector are untouched by digital so far. However, in the next five years traditional industry will go through a critical phase of digital transformation that would increase their scope and scale. This transformation would come about in partnership with digital companies and by adopting new technologies such as blockchain, artificial intelligence (AI), machine to machine (M2M) communications and such like. Digital transformation would fundamentally change the way traditional companies have so far thought about their target customers, product mix, scalability and growth – in short, they would enter Industry version 4.0.

C) NEW DISRUPTIONS:

At present, a few start-ups – mainly Indian and some from overseas – have just about started to make a dent in a few segments such as payments, retail, advertising, etc. There is much headroom for growth for digital in these segments; and in the next five years it is anyone’s guess that each of several sectors would be 50% digital. More importantly, new segments such as lending, insurance, mutual funds, entertainment, food retail, pharma, retail, and local media, among others, are ripe for disruption – bringing additional value to the digital economy.

¹TRAI Press Release No. 73/2017.

²Internet in India 2016, IAMAI-Kantar IMRB study

³<https://www.statista.com/statistics/268136/top-15-countries-based-on-number-of-facebook-users/>

⁴Based on Counterpoint Research, Quarterly market Monitor

⁵Digital Commerce Report 2016, IAMAI-Kantar IMRB study.

⁶Digital Advertising Report 2016, IAMAI-Kantar IMRB study.

⁷RBI Database of Indian Economy, Payment system Indicators.



D) INNOVATIVE REGULATIONS:

Finally – and this is the master key – not “all will remain the same” on the policy front. Since 2014, digital has been big on the agenda of the government, mainly on the side of national level projects such as Aadhaar etc. However, increasingly we would be seeing innovative policies to push the frontiers of digital. My guess is that we will see a thrust in the following areas:

a. Innovative policies for access to Internet. It is time that through creative policies we took advantage of emerging access technologies like Loon Project, innovations in 5G technology, Visible Light Communications, etc. to leapfrog into the future of access technologies in India. Another very large and critical aspect of access is Indic, and access of content in a language of choice.

b. Innovative policies for electronic manufacturing. If we are going to need 500 million smartphones in India in the next five years, it is best to make most of them in India!

c. Innovative policies around adoption of basic technologies such as Internet of Things (IoT), artificial intelligence (AI), machine learning, and blockchain etc. Without these, digital transformation of traditional manufacturing and service sectors would not be possible.

d. Innovative policies for Indian and overseas digital start-ups to set up and run in India. The management principles of digital businesses are paradigmatically different. They are based on the principles of computer science rather than mechanical engineering! Here you collect data first and look for consumers later. Our policies and regulations have to understand and reflect this new reality.

e. Innovative policies for large scale experimentation zones of futuristic products such as hyperloop, driverless cars, drone which bring together a multiplicity of digital technologies. Such experimental zones will train and recruit local human resources both technical and otherwise, will bring FDI at scale and help early adoption locally and exports globally. In a super-connected world, it is very discouraging to hear driverless cars being tried in Vietnam or Doha and the next Tesla factory going to China. We would do well to remember that in a tech-driven world, our comparative advantage lies in innovative regulations.

With a little creative nudge from the government, it seems that much more than a trillion-dollar economy can be achieved with attendant benefits of employment, livelihood enhancement and empowerment of people.

Dr. Subho Ray is President of Internet and Mobile Association of India (IAMI) since 2006. IAMI works towards promotion of internet and internet based companies.

14

A billion mobile

NATION (THE SMARTPHONE CONNECTION)

RAHUL SHARMA

Today, technology has permeated into multiple aspects of both our private and public lives – from ordering groceries to booking a taxi ride, train and flight tickets; from filing tax returns to applying for a passport. Digital technology has become an integral part of our lives and most of us cannot imagine a single day without access to the web. This is one picture. However, the other picture is where millions are still offline¹, yet to experience the internet, having never witnessed what the technology has to offer.

Young, digitally-savvy people across the country are already massive users of the Internet and social media services, but the same may not be true for the elderly, the less well off, and those living in rural areas². The interesting insight however is that mobile subscriber base today, is approximately three times the Internet adoption in India³. And with an Indian population that is young, literate and digitally savvy, the opportunity for a digitally driven demographic and the dividend is enormous. When you put the mobile phone at the centre stage of this digital adoption, connecting the next billion in the country to the worldwide web will be the single biggest opportunity. Digital then will be the true transformer in India's growth story becoming the propeller of economic and social growth.

THE UNTOLD JOURNEY OF INDIA AND UN-EXPLORED BHARAT

The world can't ignore a billion plus population. One that is gearing up to become one of the largest digital generations. 2017 was the first year to host the prestigious India Mobile Congress, outlining the due importance that the country deserves given the humongous potential of a billion plus mobile users in the years to come.

To reach its full potential, the internet will need to be accessible and affordable to all, remain open, and trustworthy. Various studies have shown that the price of data along with the cost of owning a device, a charger and other accessories, is part of what is keeping people offline.

The Government and private players have taken initiatives to ensure that infrastructure is built to provide millions of unconnected citizens with access to affordable connectivity. While the last mile broadband is in works, smartphones are playing the crucial role of narrowing this divide. If you look at the new digital adopters in the country, most of them haven't used a desktop or a laptop, but have rather leapfrogged to the digital world by embracing a smartphone.

The available data suggests that India has over 400 million Internet users, of which, the majority use smartphones to access to the internet⁴.

This also tells you that there is a need to build affordable infrastructure as well; and building such infrastructure over the vast rural landscape across the length and breadth of the country is a massive task. This is where the ubiquitous mobile can play an equalising role, to bring everyone the benefits of the digital age. We need to embrace the fact that in the next few years, the use of mobile phones would help deliver quality healthcare, education services, improved banking and much more.

I recently read a newspaper report⁵ talking about Mewat, a village in Haryana, where girls are using internet through a smartphone to solve problems. The news report spoke about how Nazneen, a resident from this village got a Micromax Phone as a gift on Eid (in a place where even access to a smartphone or the internet could be considered a taboo for girls). Taking a bold step, she used the smartphone to help her friend solve a personal matter in 10 minutes, by being able to connect her with law authorities. This simple incident makes you believe how the ubiquitous smartphone and internet access when trickled down to a billion plus population can solve a far larger number of problems than ever imagined. The mobile can help connect the remote areas where even electricity isn't a constant, give them a window to the world and a flight to their dreams.

Imagine how mobile data services could help tackle key issues such as education, health, finance, agriculture, governance and bring remote areas in the mainstream as well.

¹IAMAI-IMRB report says there are a potential 750 million users in Rural India. Livemint.com, 02 March 2017. Available at

<http://www.livemint.com/Industry/QWzI0YEsfQJknXhC3HiuVI/Number-of-Internet-users-in-India-could-cross-450-million-by.html>

²IAMAI-IMRB report says there are a potential 750 million users in Rural India. Livemint.com, 02 March 2017. Available at

<http://www.livemint.com/Industry/QWzI0YEsfQJknXhC3HiuVI/Number-of-Internet-users-in-India-could-cross-450-million-by.html>

³COAI report, ET Telecom, 23 October 2017. Available at <https://telecom.economictimes.indiatimes.com/news/indias-total-mobile-subscriber-base-stands-at-94-6-66-mn-in-september-airtel-leads-with-29-80-market-share/61186988>

⁴TRAI report, Moneycontrol, 04 June 2017. Available at <http://www.moneycontrol.com/news/uncategorized/india-added-60-million-new-internet-users-in-2016-trai-2318343.html>

⁵Sharma, Sumedha. (2017) Revolution behind the veil. The Tribune, 21 October 2017. Available at <http://www.tribuneindia.com/news/trends/revolution-behind-the-veil/484521.html>

MOBILE- THE EQUALISING FORCE

During the India Mobile Congress, the most interesting thing being discussed was how the internet and/ or data are becoming the most valuable resource in the world replacing oil⁶.

The only challenge and task ahead is to help it reach where it still hasn't. Data and device affordability will help narrow this divide. There are more than 500 million feature phone users who are waiting to either change their redundant phone for an affordable smartphone or a smart feature phone⁷ that will help them participate in digital government services as well. Internet access through the mobile will help millions of Indians conduct business, participate in governance, and connect socially.

For the 'Digital India campaign' to become a bigger reality, we should look at addressing four key challenges regarding smartphone adoption in the country.

- The first and the foremost challenge is to bring down the price. Industry players are working together to bring down the price of 4G enabled smartphones to below INR 3000.



⁶Data is the new oil. India TV, 27 September 2017. Available at <http://www.indiatvnews.com/business/news-data-is-new-oil-and-we-don-t-need-to-import-it-says-mu-kesh-ambani-at-india-mobile-congress-403579>

⁷Telcos fight shifts to 500 mn feature phone customers. Business Standard. Available at http://www.business-standard.com/article/companies/jio-vs-airtel-telcos-fight-shifts-to-500-mn-feature-phone-customers-117101600856_1.html

⁸GSMA analysis estimates that over 134 million people in India are unable to afford one of the cheapest internet-enabled handsets on the market, because it exceeds an affordability threshold at 5% of income. Available at

<https://www.gsma.com/mobilefordevelopment/programme/connected-society/challenge-opportunity-accelerating-smartphone-ownership-emerging-markets>

- The second biggest challenge is the perception that the price of data is exorbitantly high for an average Indian consumer. Consumers perceive that even if they pick up a lower priced smartphone they will not be able to afford the cost of the data⁸. Micromax, in its endeavour to connect the unconnected, has recently introduced Bharat-1, a 4G enabled feature phone and partnered with the state telecom player BSNL to provide high speed data in rural areas.

- The third challenge is about the language barrier: also a herculean issue for the consumers. Fortunately, everybody in the ecosystem now recognizes the importance of removing the language barrier.

- The last but not the least is introducing a 'killer' use case. For many people, the switch to smartphone may not happen as they don't see a use case for it. Digital government services and broad range of attractive, local, online offerings such as easy banking opportunities, created in a local digital ecosystem stimulate engagement in the internet, because they resonate with people's everyday lives. The entire ecosystem must continue making consistent efforts towards this.

Growth in new categories will happen, and when it does, it can happen very quickly, but the industry needs to move NOW to drive its next phase of growth. The winners will be those who can work with their ecosystem partners to push disruptive innovation by connecting humans with technology in ways that meet their most fundamental needs.



Rahul Sharma is the co-founder and Managing Director of Micromax, one of the leading consumer electronic brands in the world.

With increase in the usage of the Internet, there has been an exponential increase in the use of online social media and networks on the Internet. Websites like Facebook, YouTube, LinkedIn, Twitter, Flickr, Instagram, Google+, FourSquare, Pinterest, Tinder, and the likes have changed the way the Internet is being used. In India, these networks have proliferated heavily, and India stands in the top 5 countries consuming content from these platforms. Various organisations, entities, and individuals are using these platforms effectively to do what they are interested in doing. For example, Politicians are effectively using it interacting with citizens, police organisations are using it for pushing content to citizens, NGOs are using it for collating help, etc. Given the nature and the history of the platforms, Facebook is very popular in India, especially vernacular languages being supported on Facebook. Large amount of content from India gets generated on Quora, and Reddit; there are also repercussions because of sharing information on these platforms. Overall, India is well penetrated in these platforms.

However, widely used, there is a lack of understanding of privacy and security issues on online social media. Privacy and security of online social media need to be investigated, studied and characterized from various perspectives (computational, cultural, psychological, etc.). It is important for various stakeholders of social media to understand the different facets, in particular, through this article, I would like to bring out some challenging and exciting problems that can be studied further. I teach a course on this topic and I have made all lectures on this topic on NPTEL platform public.^[1]

Here is an (incomplete) list of challenges / topics that are most exciting to work on:

- **FAKE CONTENT / MISINFORMATION ANALYSIS:**

A single most important issue that companies like Facebook, Twitter, Google, Microsoft are all grappling with is the misinformation campaigns on social media and the Internet. There is an increasing belief that Social Bots ^[2] control a large proportion of discussions or views on social media. There have been large body of knowledge created in this space, but still there is lot more ground to cover to be confident on the output from these algorithms, systems, and implements. Building algorithms to detect fake content, is one of the biggest challenges in the space of Online Social Media.

- **IN-ORGANIC USER BEHAVIOUR:**

Given that the online influence or network has become a mechanism or metric to measure the influence of the person in the offline world, it has become more and relevant for people to start finding ways to increase their online influence.

Metric like Klout ^[3] measure the online influence. Natural behaviour on gaining followers, gaining likes, gaining connections are all organic, i.e. it grows in a specific way depending on your network. While services like Fiverr ^[4] can help you gain inorganic likes, followers, and connections. Studying the inorganic behaviour of users and measuring the quantum of inorganic behaviour is important to differentiate the real influence vs. bloated influence.

- **CYBERCRIME ANALYSIS:**

Due to increase in use of technology, the Internet, mobile phones, there has been an exponential increase the cybercrimes in general and social media has helped in increasing the derivative of these crimes. It has been shown that social information, i.e. one's network on Facebook or Twitter helps in targeting the attack on users and the success rate for these attacks using social information more than traditional attacks ^[5]. Online crime can include malware, phishing, scams, terrorism, hate speech, bullying, etc. Understanding how these crimes propagate on the social media, characterizing these crimes can be very useful in building techniques to deter the effect of these cybercrimes. Build these technologies can be very challenging, given the quick changing nature of the cybercrime modus operandi and vectors.

- **PRIVACY ON SOCIAL MEDIA:**

Given that we cannot live without sharing what we are doing on Facebook / Twitter / Instagram, we sometime intentionally and sometimes unintentionally share information which can be used / misused again us. There have been many incidents where information that is posted online has been used again individual or people associated with the individuals. There is service www.pleaserobme.com which has been created to showcase how information that one post on Twitter can be used to say whether one is at home or not and use it rob his / her home. There are other pieces of work to use the Foursquare information to find out accurately home of an individual ^[6]. It is not only the issues due to sharing of information by individuals, there are also issues and challenges to study from the information that organizations collect, ISP infer from our online behaviour and how much privacy leaks happen because of this. Studying both the organization front, and the user side of privacy on social media is very exciting.

- **DISCRIMINATION AND BIASES ON SOCIAL MEDIA:**

There are many forms of biases and discrimination on the Internet which is also penetrated into the social media space.



Search bias is one of such biases on social media, i.e. the ranking of a particular post or a user is dependent on various features, one of them being page ranking technique. Spammers / Link Farmers use this technique to increase page rank, thereby increasing the probability of appearing on the search output. Characterizing these discriminations, and biases may help in developing better solutions or educate users about these, so decisions can be made accordingly.

Ponnurangam Kumaraguru ("PK") Associate Professor, is currently the Hemant Bharat Ram Faculty Research Fellow at the Indraprastha Institute of Information Technology (IIIT), Delhi, India.

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Indian outsourcing

SECURING THE DIGI.TRANSFORMATION JOURNEY FOR GLOBAL ENTERPRISES

NAGENDRA BANDARU

Market disruption. Now that is a phrase you hear everywhere since the new kid on the block – digital technologies – levelled the playing field for global businesses. Several large enterprises faced the heat of competition, while born-in-the-cloud startups took charge and changed the way customers experienced products. Today, digital business has a profound effect on the way business is done and how it is supported. No longer can large enterprises be secure in the legacy of their brand. Instead, they need to rethink the way they operate and embrace ever-evolving technologies to stay ahead of the curve. And, to stay secure!

There is no denying that while technology has been a boon to companies, in several instances it has also brought them to their knees. The collective gasp we heard from the business world earlier this year reverberated across the globe when the ransomware WannaCry walloped hundreds of thousands of targets, including public utilities and large corporations. It temporarily crippled several business-operations and created much chaos. Of course, while a particularly malicious ransomware or virus may create news, such instances are not new. For years, cybersecurity has been a key concern for organizations and it is only getting more serious owing to advancements in technology growing at a heady pace.

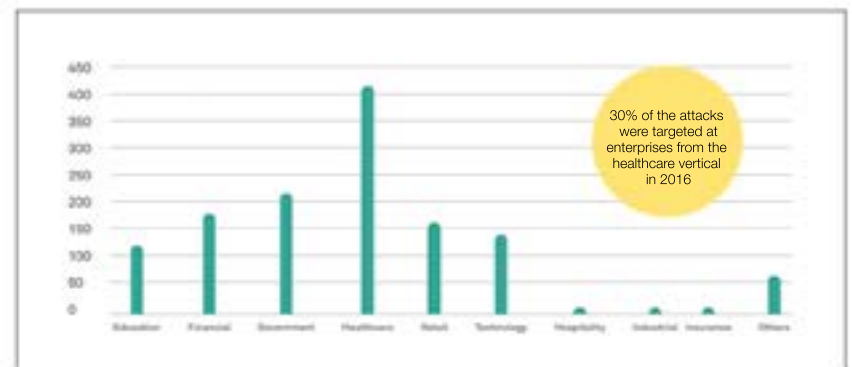
ENTERPRISES AT THE CENTRE OF THE TECHNOLOGY REVOLUTION

This is especially true in a world caught in the midst of a revolution—one where human and digital interactions are becoming more commonplace. From refrigerators that warn you if your groceries are running low to universities with intelligent learning platforms that supplement the work of instructors in the classrooms, we possibly interact more with technology than humans. Today, we see large industrial equipment companies automate production lines magnificently so that they can run unsupervised for weeks. Machine learning is aiding doctors in analysing patient data to determine what kinds of treatments are needed for different symptoms. Smart devices are monitoring personal health round the clock. Technology is indeed the core of every business in every sphere.

Also, technology and people together generate data. Industry experts predict that more than 5 billion people globally will have an active social media presence by the year 2020 with over 6 billion smartphones connecting them. The data this generates is beyond simple human comprehension. Brilliant “exascale” supercomputers with computing power of a quintillion floating-point operations per second (FLOPS) will be crunching nearly 370 trillion megabytes (MB) of data generated from 21 billion connected devices. Today, businesses are facing unprecedented challenges in managing the varied volume and velocity of digital

As digital business resolutely gallops past traditional business, conventional security approaches become ineffective.

Security and risk leaders can no longer ignore the threats associated with innovation; they need to adopt new ways to establish a secure, trusted enterprise. No wonder then that global enterprises are looking at trusted business process management (BPM) partners to help them maximize their gains during the journey of digital transformation. And, Indian BPMs are certainly geared up for the challenge.



INDIAN BUSINESS PROCESS SERVICES EMERGE DIGITAL TRANSFORMATION PARTNERS

As one of the largest destinations for outsourcing and offshoring, Indian companies have weathered several waves of change to remain profitable. While the early 1990s saw us transforming from basic IT offerings to functional IT services, a decade later, the Indian IT-BPS (business process services) industry has emerged as a global offshoring leader with scalable solutions. However, with digital technology-powered start-ups biting at the heels of large enterprises, the Indian IT-BPS industry is evolving faster than ever before. They are emerging as strategic growth partners for global businesses in their transformation journey into outcome-driven digital organizations.

¹WIPRO State of Cybersecurity Report 2017

²NASSCOM: Reinventing to Disrupt: Shaping a new identity for the Indian IT industry



Leading Indian IT-BPS companies have embraced disruptive changes brought on by the five major technology forces: automation and robotics; artificial intelligence and cognitive computing; the Internet of Things; cloud computing; and virtual and augmented reality. They are spearheading digital-led business process transformation with their collective understanding of the nature and implications of the shifting technological landscape. Their solutions development approach prioritises deploying new connected systems, migrating legacy systems, and leveraging insight from data analytics that supports business decisions. These analytics services help manage and capitalize on large amounts of data to not only save costs but also increase customer base.

However, as Indian IT-BPS companies build digital competencies to grow into the role of digital transformation partners, they will need to reinforce the industry's reputation as trusted global source for IT talent by ensuring solid risk management and corporate governance related to cyber security.

1WIPRO State of Cybersecurity Report 2017

2NASSCOM: Reinventing to Disrupt: Shaping a new identity for the Indian IT industry

DATA SECURITY – A KEY PRIORITY FOR IT-BPS VENDORS

Data security and privacy have always been of prime concern for IT-BPS companies as they are responsible for all stakeholders including vendors, suppliers and the client-companies. Data privacy and measures to prevent information leakage via Internet or other means is an absolute imperative for securing the trust of clients. As a vast majority of internet and data processing transactions are increasingly offshored, service providers are taking on liability for security breaches. IT-BPS vendors are enforcing strict internal adherence to information security policies to overcome data breaches. Internal measures are also being implemented to block any attempts to download data and prevent unauthorized access to company's systems. With data security on Cloud becoming critical, companies are responding by including the client's environment in their Risk Management process, thus going beyond internal security to take complete control over data security. The mounting risk of cybercrimes is being countered with IT-BPS vendors developing best practices for both internal and external networks to keep hackers at bay. That way, vendors are committed to data protection while ensuring compliance for its clients.

Further, IT-BPS vendors constantly monitor business functions to assess, evaluate and improve information security measures and align with industry standards. This enables them to foresee possible vulnerabilities and proactively block threats.

Leading research and advisory firm Gartner forecasts that spending on information security products and services in India will reach \$1.5 billion this year in constant currency terms, up 12 per cent over 2016 – it is expected to further grow to \$1.7 billion in 2018. Gartner adds that security services will continue to be the fastest growing segment, especially in IT outsourcing, consulting and implementation services. Given this scenario, regulators and policymakers are pressuring board members and senior managers to grasp the core principles of cybersecurity. Not only is the leadership expected to set the pace for the rest of the organization, it must create sufficient awareness of the threats and adopt a sense of urgency to respond.

Cybersecurity, including a hacking response plan, is a must-have for enterprises of all sizes. As cybersecurity becomes a companywide and worldwide concern that demands attention and direction from the boardroom and the broader community, the coming years will see the role of the chief information security officer (CISO) evolve into critical areas of risk and compliance management, corporate governance, operational efficiency, and embedding of analytics-driven automated security solutions.

For now, companies will do well to define and implement an enterprise-wide data governance policy that determines who owns the data, who interacts with it, and how. They need to look into the compliance, privacy, security, and other risk factors associated with the data. This will strengthen the company's core making enterprises more resilient to cyber-attacks. It will also set them securely on course for an enterprise transformation journey critical to meeting the challenges of market disruption.

Nagendra Bandaru is Senior Vice President and Global Head - Business Process Services, Wipro Ltd.

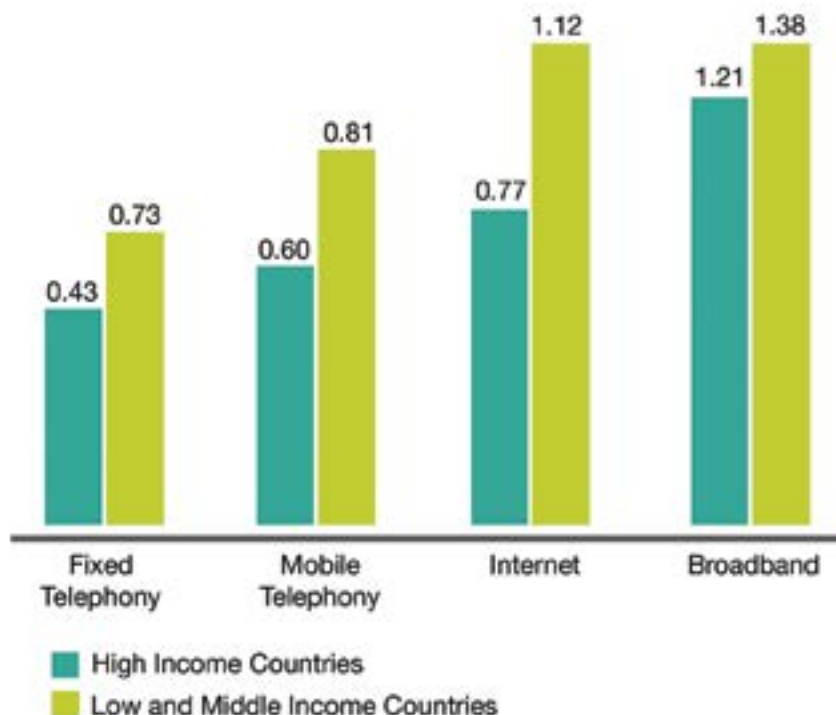
Enabling

ACCESS TO A SEA OF HUMANITY

ARUNA SUNDARARAJAN

India is already home to more than 400 million internet users and 300 million broadband users and yet it has a long way to go before it reaches the goal of broadband for all.

Multiple studies undertaken worldwide as well as in India have confirmed that by increasing access to quality internet for its citizens, a country can set itself firmly on the path of rapid and equitable economic growth. This impact is much more pronounced in the case of developing countries, where internet connectivity can enable access to basic services such as education and health. Thus, while a 2010 study by World Bank shows that a 10% increase in broadband access has an impact of 1.38% increase in GDP of developing countries, a study by Indian Council for Research on International Economic Relations (ICRIER) in 2012 finds that for India, the impact is even higher at 2.36% .



Source: World Bank Report on Broadband, 2010

The Indian Government has embarked upon provision of universal access to broadband as one of its priority initiatives. The focus is on bridging the digital divide by providing high speed broadband to rural and remote areas. Quite appropriately, creation of broadband highways has also been identified as the first pillar, amongst nine, under the Digital India programme.

In the context of developing countries, the provisioning and consumption of internet services can be analysed across three dimensions viz. infrastructure, services and users. Lack of consumption capability at local-user level, results in the lack of business models for creation of relevant online services and content, which in turn results in less than optimal utilization of infrastructure built for broadband services and less of a business case for all three dimensions. These three dimensions impact each other in complex ways, creating unique challenges for policymakers. In a diverse country like ours, local factors specific to each region add further to the complexity of planning and necessitate a varied approach within the overall strategy towards driving national internet usage. This complexity and variety is also reflected in the design of the BharatNet initiative with its ambitious target of connecting 2.5 lakh (0.25 million) village panchayats to high speed broadband and through them about 70% of the Indian population.

INFRASTRUCTURE

BharatNet is perhaps the largest rural broadband programme in the world. It will create high-speed optical fibre connectivity infrastructure in the rural areas, making broadband access possible for over 700 million rural Indians. The programme aims to more than double the optical fibre footprint in the country.

The BharatNet project has had to overcome several capacity-related constraints over the last few years, and is now on course to radically transform the digital-connectivity landscape of the country. The project is creating unprecedented opportunities not just for rural consumers and employment, but also for different organizations that hope to tap rural markets.

¹TRAI Performance Indicators Report, March 2017

²TRAI Telephone subscription data, July 2017

³Qiang, Christine Zhen-Wei, & Rossotto, Carlo M. (2009). Economic Impacts of Broadband. In Information and Communications for Development 2009: Extending Reach and Increasing Impact, 35-50. Washington, DC: World Bank.

⁴Kathuria, Rajat; Jaju, Mansi Kedia. (2012). India: The Impact of Internet. Indian Council for Research on International Economic Relations, Delhi.

Besides rural broadband, the creation of an overall robust telecom network remains one of the key priorities of the Government. The new telecom policy, slated to be released early 2018, would focus on revitalizing the telecom sector. The private sector has in the past played a critical role in the spread of telecommunications across the length and breadth of the country and the new telecom policy would focus on sustaining and enhancing the momentum of private investment to promote universal telecom penetration. Alongside, the Government would continue to support the creation of telecom infrastructure in the areas where, due to lack of a viable business case, private investment has not materialized. This includes providing robust connectivity in areas such as the North East and also the Left-Wing Extremism (LWE) affected areas, etc.



USERS

Broadband infrastructure, and online services provisioned on that infrastructure, are necessary but not sufficient to ensure local consumption by targeted or potential users. Even though these services are for the betterment of citizens, lack of their adoption both in terms of availability of relevant content and services, as well as the ability to use the same effectively, can and does remain an impediment. The enablement of users by way of providing them access to digital devices and making them digitally literate is another area where we need to focus. The Government's large scale Digital Literacy programmes, such as Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA), that aim to digitally educate 60 million households in the next 3 years and other schemes such as Sanchar Kranti Yojana (SKY) of the Chhattisgarh government are only a couple of examples of efforts being made to bridge the local digital capacity gap.

WAY FORWARD

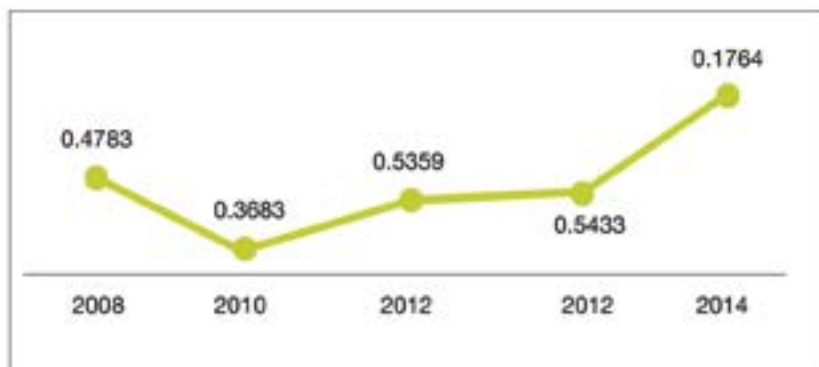
The intensity of government intervention required across the three dimensions of access will dynamically change over time. For example, at present in India, the Government must intervene strongly to create rural broadband infrastructure, whereas, as far as expansion of online services is concerned, it needs to act as a facilitator. As is evident above, the issue of providing universal and quality internet access cannot be addressed by focusing on just one dimension; all three must be carefully cohesively to create a lasting, positive impact. Further, at various stages of evolution of digital connectivity and technology, we may find that what has worked well in the past may not work well in the future. Thus, we would need to keep aligning our policy and programme initiatives and fine-tuning our approach as we move forward in our quest to realise the dream of a digitally empowered India, where every Indian is connected to what would be among the world's largest internet access networks.

Aruna Sundarajan is currently the Secretary, Department of Telecommunications and Chairperson, Telecom Commission.



SERVICES

Unless backed by a strong online and electronics services framework, broadband infrastructure by itself cannot bring about the intended benefits of connectivity. In India, the diversity in terms of languages, culture and other local elements makes the availability of useful content and services all the more challenging. However this is one area where we have improved consistently. A United Nations e-Governance survey has placed India in the top 25% of nations in terms of availability of online services. However, continuous effort needs to be made to address the issue of availability of localized, relevant and continuously updated content in vernacular languages. The Government is aware that it needs to enable an ecosystem that would see greater participation from multiple stakeholders in this area.



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Enabling access

A CASE IN POINT - AP FIBER GRID

AJAY JAIN

Developed nations around the world have added internet broadband access to their residents as a utility and strive to ensure that everyone – wherever they live, and whatever their circumstances are – has access to the benefits of high speed network. Innovations in this century are largely fuelled by the revolutionary power of broadband that helps in the socio-economic growth of societies. Large-scale adoption of broadband will not only make the internet service affordable to consumers but will also bring out innovative technologies that transform the fortunes of nations.

The International Telecommunication Union (ITU) has noted broadband's diverse economic effects. Broadband construction creates infrastructure jobs, and activates multipliers across the wider economy. Importantly, broadband investments generate externalities both on the supply side - boosting multifactor productivity across firms, and consequently accelerating GDP growth - and on the demand side, increasing household real incomes.

Public investments in broadband also enhance access to information, entertainment and public services - a very real benefit, the value of which may not be reflected in GDP data, but can be measured by the difference between what citizens would be willing to pay for broadband in order to access those benefits, and the price they do pay for broadband access¹.

To plan significant economic growth and productivity gains, access to broadband by general population plays a crucial role. The worldwide internet speeds that are available for the citizens of various countries are as follows:

	COUNTRY NAME	SPEED (IN MBPS)
1.	S. KOREA	28.6
2.	NORWAY	23.5
3.	SWEDEN	22.5
4.	HONG KONG	21.9
5.	SWITZERLAND	21.7
...	GLOBAL	7.2
89	INDIA	6.5 (GLOBAL RANK 89)

BHARATNET AND DIGITAL INDIA

To address the issue of low internet speeds and increase the penetration of internet, Government of India proposed to set up BharatNet (National Optical Fibre Network, NOFN), a Centre-State collaborative project of national importance: to establish a highly scalable network infrastructure accessible on a non-discriminatory basis; to provide on demand, affordable broadband connectivity for all households and on demand capacity to all institutions.

BharatNet aims² to provide broadband connectivity to ~ 250,000 Gram Panchayats. Once complete, BharatNet increases broadband penetration to 600 million subscribers by 2020. BharatNet project is funded by Universal Service Obligation Fund (USOF), which was set up to improve telecom services in rural and remote areas of the country.

BharatNet is setup under the Digital India initiative to ensure delivery of e-governance, e-health, e-education, e-banking, Internet and other services to the rural India.

BharatNet is a bold vision that could help address many of the challenges of Rural India. It can help foster social inclusion, deliver economic growth and enhance India's global competitiveness. **According to BCG & TIE report³, a 10% increase in internet penetration could uplift India's GDP by INR 16 Trillion (USD 245 Billion).**



¹International Telecommunication Union (2012). Impact of Broadband on the Economy. Available at https://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf

²See for example <http://www.bbnl.nic.in/index1.aspx?lsid=18&lev=1&lid=18&langid=1>

³The Boston Consulting Group and The Indus Entrepreneurs (TIE) Delhi NCR. (2017). The \$250 Billion Digital Volcano: Dormant No More. Available at <https://media-publications.bcg.com/BCG-TIE-Digital-Volcano-Apr2017.pdf>

EVOLUTION OF AP FIBER FROM BHARATNET

In pursuant to an early realization of the pivotal role of broadband connectivity to reach all the villages, Government of Andhra Pradesh recognized that re-architecting NOFN could achieve the vision of Digital Andhra Pradesh. Hence the Government of Andhra Pradesh came up with an ingenious idea of AP Fiber Grid under the guidance and leadership of Hon'ble Chief Minister of Andhra Pradesh Sri N. Chandrababu Naidu to provide rapid connectivity to households and enterprises. AP Fiber Grid utilizes aerial route to deploy optical fiber utilizing existing Electricity Poles and hence eliminating the expensive underground fiber laying process. AP Government created Andhra Pradesh State Fibernet Limited (APSFL) as the nodal agency responsible for undertaking the works of AP Fiber Grid.

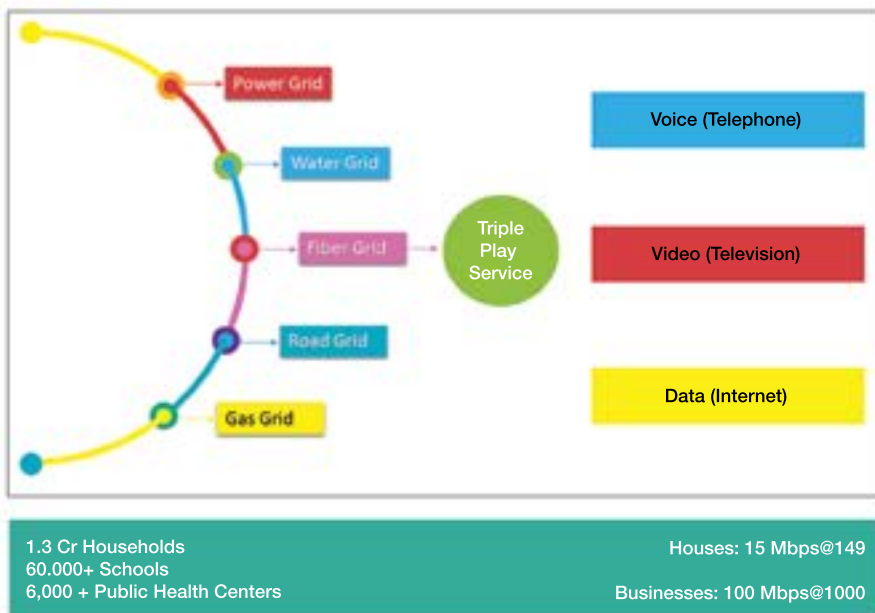
VISION OF AP FIBER GRID:

"To establish a highly scalable network infrastructure, accessible on a non-discriminatory basis; to provide on demand, affordable and end-to-end broadband connectivity of 15 to 20 Mbps for households and 100 Mbps to 1 Gbps for institutions & enterprises by 2018, to enable realization of the Vision of Digital AP, in partnership with the Government of India and the private sector"

AP Fiber provides Triple Play services⁴ - television (more than 200 channels), telephone (rental free), and internet (15 Mbps and 100 Mbps) - to households and Enterprises at a monthly affordable price of Rs.149 (\$2.3) and Rs.999 (\$15.4) respectively.

The implementation of AP Fiber Grid⁵ is redefining the broadband thresholds and experiences in India. Fiber Grid is one of the five utility grids identified to accelerate the infrastructure build and growth in the State of Andhra Pradesh.

AP Fiber Grid has set up a high-speed Aerial Optical Fiber Cable spanning 23,800+ Kms across 13 Districts in the State connecting 2,464 Substations.



SIGNIFICANCE OF AP FIBER GRID

Andhra Pradesh Fiber Grid – the first State Government sector telco – is the largest greenfield optical fiber network infrastructure taken up by any state government agency as on date, and the largest roll out of interactive IPTV services. It will provide a high-speed communication backbone accessible to every common man, leveraging the infrastructure to drive a host of innovative digital services and applications, and an ecosystem with more than 12,000 multi service operators (MSO) and local cable operators (LCO).

AP FIBER IN NUMBERS



SERVICES DELIVERED THROUGH AP FIBER GRID

- State-wide surveillance connecting more than 20,000 cameras, 16 Integrated District Command Control and Data Centers
- State-wide Wi-Fi linking 5,000 Access Points spanning cities, towns and villages
- State Wide Area Network (SWAN) connecting Government Offices located across the state
- Powering Digital Classrooms in more than 4,000 Government Schools
- Delivering Telemedicine at more than 6,000 Public Health Centers
- Video-on-Demand Services
- TV ATM Services
- Triple Play Services
- Network-as-a-Service
- Powering Smart Cities
- Connecting Mobile Towers
- Offloading Mobile calls to Wi-Fi Access Points

⁴<http://apsfl.in/wp-content/uploads/2016/01/APSFL-English-Brochure.pdf>

⁵<http://apsfl.in/network/>

AP FIBER GRID AND BHARATNET INTEGRATED NETWORK

Andhra Pradesh State is uniquely positioned to collaborate and generate value with Bharatnet by integrating its AP Fiber network with proposed Phase II network of BharatNet and hence providing a delivery mechanism for Quad Play services.

ADVANTAGES

The proposed network, would have an advantage over the competition, due to its reach, trust factor of the consumers, ability to provide multiple services over a single network, and affordability.

a. Statewide Network: The ubiquitous presence of the network across the state provides AP Fiber unparalleled access to the consumer base located even in rural areas.

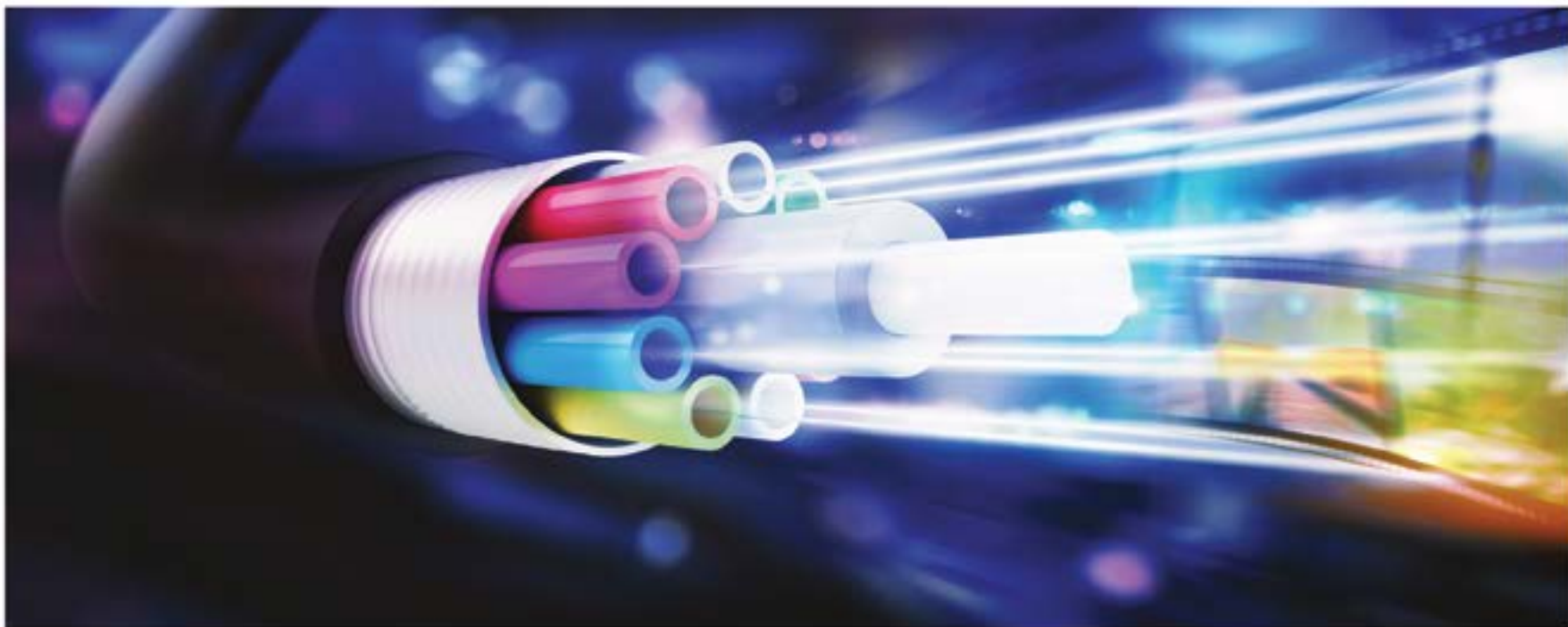
b. Owned and operated by a State PSU: Being owned and operated by a state-owned entity, the trust factor of the consumers is much higher on AP Fiber than on alternative service providers.

c. Triple Play on a single network: The project provides voice, video and data or in other terms, telephony, Internet Protocol Television, and high-speed internet access to the population of Andhra Pradesh. The billing for all three services would also be unified, thus creating efficiency of operations for the service provider, as well as less of a hassle for the subscriber.

d. Service Cost at a fraction of Private Sector Peers / Competitors: AP Fiber delivers triple play services to the subscribers at very affordable rates of Rs.149 and Rs.999 to domestic and enterprise customers respectively.

STAKEHOLDERS

The project has been planned and executed sensitively, keeping in view the interests of existing players in the market. The multi system operators and local cable operators' interests have been safeguarded and they have been included into the delivery model as channel partners. These MSOs/LCOs will connect their existing/new last mile fiber optic networks to 2,464 points of presence (PoPs) established across the state, and form part of the delivery of the services to the end customer / subscriber. Apart from the downstream channels, the project also is supported by Broadcasters, Telecom Service Providers, ISPs, Content Providers, etc.



⁶<http://apsfl.in/network/> <http://apsfl.in/network-technology/>

⁷APSFL ongoing and planned projects – (Technical Team, APSFL)

⁸Considering Indian market rates of INR 200 for CATV/IPTV/DTH services, INR 1000 for 5GB (FUP Limit) @ 15 Mbps and Telephone Service (No rental and free calls within APSFL Network) – domestic connections. High Speed Internet of 50GB (FUP Limit) @ 100 Mbps for enterprise connections.

Ajay Jain serves as Principal Secretary to Government of Andhra Pradesh, currently steering Energy, Infrastructure & Investment Department. He is also Chairman to APSFL Board.

Enabling access

TOWARDS ONE OF THE LARGEST INTERNET ACCESS NETWORKS IN THE WORLD

ASHOK JHUNJHUNWALA

EARLY WIRELESS SYSTEMS TO DE-BOTTLENECK TELEPHONY ACCESS

Some 25 years ago, people in India struggled to get telephone access. With 900 million people, India had less than 7 million telephone lines and was adding a million[1] in a year to cater to a waiting list, where people had to wait for 8 years. Most rural areas did not have telephone. Then came wireless in Local Loop (WiLL), where the last mile (or miles) connectivity was made possible by wireless instead of wired-line. India developed its own WiLL called corDECT at a price point which was much lower than deployment of wired-line telephony. The wired-line telephone did not make business sense, when people would spend less than INR 1000 per month on connectivity; even a middle-class household could barely afford to spend more than INR 300 per month on it. In 1995, corDECT made possible to break-even at INR 300. Many more systems followed and by 1999, wireless telephony in India could break even at monthly average revenue per user (ARPU) of INR 250. There has been no stopping since then.

EARLY INTERNET AND ITS PROMISES

The Internet had started emerging in early nineties, and was looked at by many as a powerful tool for not just communications, but also to empower people. It could help in education, healthcare, financial inclusion, livelihoods, agricultural production etc. besides providing entertainment and communications. The problem was that Internet-access so far required a landline and a modem. In 1996, CorDECT WiLL was modified to include a 35 kbps data communication link which could be used for Internet; the link speed was later enhanced to 70 kbps. Thus, wireless became a means to get Internet to people in India. corDECT WiLL was also used extensively to connect villages. As individuals could not afford Internet connection and computers, a concept of an Internet kiosk was developed and by 2000, Internet services were being provided in villages. These kiosks would also provide Internet based education and health-care as well as a whole variety of other services. Set up on a model of public call offices (PCO), which had made a mark in towns and cities and brought basic telephone services and long-distance calling (called subscriber trunk dialling, STD in India) to a large number of people, the Internet kiosks would provide not just telephony but Internet in villages.

FIRST EXPANSION OF WIRELESS ACCESS

In the meantime, wireless mobile services using global system for mobile (GSM) was making a mark. As costs came down, it started in 2000 providing mobile telephony services to a whole lot of people.

Soon low bitrate (13.6 kbps) data connectivity called general packet radio service (GPRS) was introduced, which could provide data communications in addition to voice on the mobiles. GPRS got enhanced to Edge and the data-rate started climbing. GSM towers started getting established in rural and remote areas and voice and low-bitrate data connectivity was now available widely. Three to four mobile services operators were now providing services and the number of telephones in India soon crossed 100 million.

THE SECOND WIRELESS EXPANSION IN LATTER HALF OF LAST DECADE

The telephone lines grew slowly from here-on to about 200 million. The average revenue per user (ARPU) that the mobile operators were aiming for was upwards of INR 200 per month. [2] Most people could not afford such ARPU. The operators then had formed a cartel and would not bring down the costs further. Somewhere later in the decade, new operators were given license to introduce more competition in the market. These operators slashed prices and within a year, India had about 700 million mobile subscribers. Many of them were providing a revenue of INR 50 per month, but telephone connectivity was reaching everyone. Gradually the number of subscribers rose to 900 million.

INTERNET ACCESS WAS STILL IN ITS INFANCY

Internet access was, however, still limited. While prices of mobile telephones had tumbled down such that many Indian could now afford to buy a new handset; others managed with an older one. While this provided voice communications, using the Internet required one to buy a computer or a tablet, which was still beyond the reach of most people. In the early 2010s, low-cost computing and tablets started emerging and the wireless Internet access started showing up amongst the urban students. But the number of people using these technologies was still too low. Email communications and some browsing was still the main applications for Internet. While these technologies were powerful, especially for business and student-community, their usefulness for ordinary citizens – even in the lower middle-class – was limited. Internet based empowerment was still to begin.

EMERGENCE OF 3G WIRELESS AND SMART-PHONES

Things started to change about four years ago.

EDGE had given speed to wireless communications. 3G wireless communications was getting introduced, further driving up the internet bitrates.

At the same time smartphones with touch-screen started emerging. This would provide Internet access on mobile phones itself and owning a computer, tablet, or laptop was no longer essential. Initially these smartphones were expensive. But Moore's Law was already in action, and the emergence of low-cost smartphones was a matter of time. These would give high-speed Internet usage on mobile handset itself.

But the appeal would still not have been widespread, unless the right tools and applications emerged. It is at this time Facebook was making a mark. And then came WhatsApp and sharing messages, information, songs and even video-clip would become commonplace. Listening to online music became a major driver of wireless Internet. The emergence of 4G last year accelerated this. Social media apps became a powerful tool, which gripped the imagination of common people. This had unusual implications: on the one hand, one saw the emergence of 'Hinglish' and 'Tinglish', as Indians wrote Hindi and Tamil written using English alphabets; on the other hand, Indian language characters appeared on the screen.

Media and social-media apps made full use of this. Along with 4G came video-communications – playing movie songs on the phone became a great attraction. The handsets were now equipped with powerful cameras; taking selfies became a craze, and one could take a short video of events around oneself and post it to any of one's contacts using applications like WhatsApp. Internet connections grew rapidly, as show in Figure 1.0.

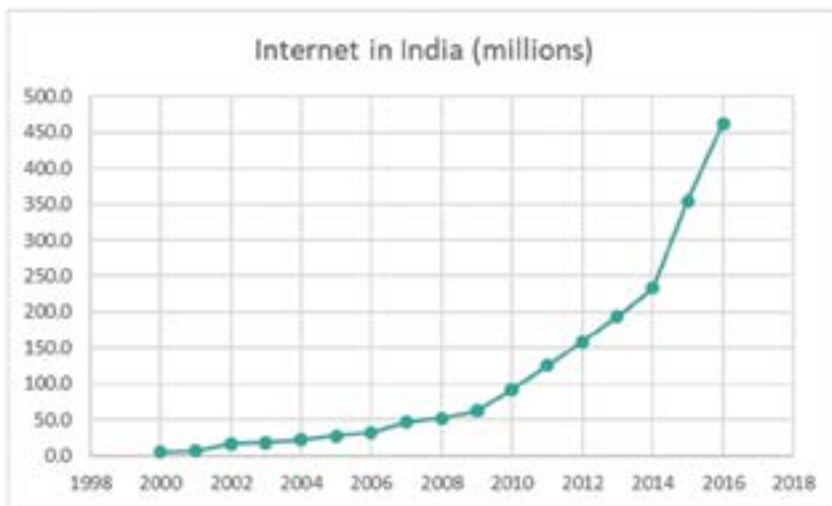


Figure 1.0: Internet Connections in India

READY FOR UNIVERSAL INTERNET ACCESS

The emergence of 4G has given us wireless communication at sufficiently high data-rates to provide access to everyone in India. Smartphones have provided devices with which to access the Internet to citizens with limited literacy, and applications have emerged for people to use wireless data-connectivity in a meaningful manner. Last year a certain 4G operator dropped the price of wireless access to a level where, by and large, the affordability issue is addressed. We are therefore ready for universal Internet Access.

But there are challenges. Let us begin with connectivity. First, 4G has not yet been deployed in significant parts of the country, especially in small towns and rural areas. The 2G wireless available cannot be used to provide the data-rate that today's applications demand. Second, there is a lack of backbone connectivity to deploy high-speed wireless access in many villages. The backbone for 4G needs high data-rate links, which is normally provided by using optical fibre. The state of fibre connectivity in rural areas, however, limits the wide-spread 4G deployment; India's BharatNet programme, financed by the Universal Service Obligation Fund (USOF), is intended to take fibre to each village, but must progress in a satisfactory fashion. Further, clear-cut policy is needed provide this rural fibre to various telecom operators to provide wireless service. Universal 4G access is still some distance away.

The affordability of smartphones is an issue especially very low income groups; that being said, the competition amongst different telecom operators has lead several of them to purchase these handsets in large volumes, and provide these handsets to their customers at very low costs. Accordingly, as the connectivity issue is resolved, it is likely that we will move closer to universal access.

THE FUTURE

As applications demand higher and higher data-rates, 4G will become a bottleneck at some point of time. We need to prepare for 5G wireless. Over the few years, researchers in India has made great strides in contributing new ideas (and associated patents) for 5G standardisation. The Telecommunications Standards Development Society, India, has been driving this. This will ensure that 5G wireless standards especially reflect requirements generated by high population density in rural India. Further, having our patents as a part of the standard will enable us to pay little to nothing for patents from the rest of the world, making the wireless services even more affordable.





The other important thing that we need to pay attention to in future is to harness the Internet of Things (IoT). In the future, wireless Internet will read our meters and control our electricity and water-access, and will manage many of our devices at homes, office and industry. The data-rates required are unlikely to be high, and latency will rarely be an issue; however, reliability will become more important. Wireless standards and services must pay special attention to these.

To conclude, the journey of wireless in India over the last twenty five years has been fascinating. It is enabling access to a sea of humanity. Truly empowering this sea through wireless communication is now indeed a possibility.

[1]Internet Live Stats, www.InternetLiveStats.com
<https://www.digit.in/mobile-phones/india-s-telephone-subscriber-base-goes-past-900-million-trai-17212.html>

[2]<http://www.thehindubusinessline.com/opinion/columns/slate/what-is-arpu-in-indian-telecom/article9562345.ece>

Ashok Jhunjhunwala [Professor, IIT Madras (on sabbatical)] is Principal Advisor, Ministry of Power and New and Renewable Energy.



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Affordable F T T H

BROADBAND FOR A FAIR, FREE, POWERFUL INDIA

LALITESH KATRAGADDA

With India's powerful set of social services transforming atop the India Stack, while global systems of business, finance, commerce, education, healthcare become digital and as computing systems turn primary drivers of global economy, access to high speed internet for everyone is no longer important, it is a national imperative. This is particularly so because only about a 100 million people in India enjoy true broadband while the rest of them can barely send photos. These 100 million constitute more than 80% of India's disposable income, representing a divide that will only grow higher in the upcoming automation era.

All of this is true for most of the world. Ubiquitous broadband is perhaps the only means for this 'billion outside the gate' to be truly free, truly global and truly empowered. While it is often celebrated that every 10% of expansion of broadband in a country increases its GDP growth by 1.4% (World Bank study)[1], this study overlooks critical factors that apply to India making broadband even more critical. For one, broadband is perhaps one of the very few ways (if not the only immediately feasible one) the illiterate and under-trained can overcome their handicaps. For another, fuelling Digital India and India Stack with broadband that reaches everywhere is the way forward for fairness, dignity and freedom for every Indian.

WHY BROADBAND FOR ALL

Broadband needs to be defined as 2-way 10 Mbps per person. This is due to the interesting apparent contradiction that (as is said) every ten years of education reduces bandwidth needed for the same task tenfold. This means that a task that an English-fluent Indian can accomplish with a 1 Mbps connection needs a 10 Mbps connection for the less educated vernacular speaker to do the same. Indian policymakers, with immense foresight, already recognized this need.

In 2012, India – via the National Telecom Policy (NTP-2012) notified that year – declared affordable universal broadband a key focus area, and set the ambitious goal of 600 million connections reaching 100 Mbps by 2020. In my opinion, such speeds can only be achieved by fiber connections to every home. The home (along with small retail) is critical as for the billion Indians to be unshackled including most women and children, the home is where they are truly free and need to access all services, education, health and run their businesses from. Now that India has created a visionary Universal Services Obligation Fund (USOF) with a significant resource of funds[2], it is time to make this dream of broadband for all a national priority. This single act will accelerate every aspect of India, from social services, to increase of farm income to topline economic growth. This single act done right and completely can transform the 15 million new job seekers entering adulthood yearly to self-sufficient job creators.

We need to set the immediate goal of two-way 15 Mbps per household growing to two-way 100 Mbps medium term and 500 Mbps long term. The technical reasons are that high definition internet usage necessary for strain-free, long-term usage by children, the quasi-literate and illiterate takes about 8 Mbps. This bandwidth need will first quadruple to deliver 4K or 3D experiences, necessitating 100 Mbps. However newer immersive augmented reality (AR) and other technologies will then grow this need to about 125 Mbps per person in a decade. Most critical services including education, health, businesses will move from HD to always-on VR.

The monthly target cost a household can afford apart from an initial cost of INR 3000 is about INR 120 per month, close to the telecom average revenue per user (ARPU) today. The following specifications define the target service costs necessary to reach the NTP goals as well as to bring all of India's citizens and small and medium businesses (SMB) to parity with global class access at home and work:

Bandwidth, consumption and cost specifications: with consumption limits having to quadruple over five years once international lines come online, along with the raising of bandwidth limits to NTP-2012 target levels;

10 Mbps, 100 GB, INR 120 per month;

100 Mbps, 500 GB, INR 1000 per month;

1 Gbps, 4000 GB, INR 8000 per month.

TECHNICAL SPECIFICATIONS

All hardware would be Open Hardware or Open Software Defined Networking (SDN) components

IPv6

L1 (with multiple carrier clock frames for 4G, 5G), L2, L3 layers present to every level in the fiber network

Open Standards: Openflow 1.4, MPLS-TP (L1, L2), IP-MPLS (L3)

Scalable Software: All software including OSS, BSS must be written on top of OpenFlow 1.4 or higher

Configurable: 500+ QoS Levels, ad-hoc VPN ability

Secure: DNS Sec, vulnerability/ bug policy, DOS/ Hack prevention firewalls

Latency: Cross India latency to be less than 20ms and proportionally less as distances reduce

Service Quality: Carrier grade requirements, including jitter, packet loss and

Robustness: All equipment except N/SHQ (National, State Head Quarter) equipment to be hardened to Indian heat, dust and power fluctuations

Service Level Agreement specifications: 99999 end-to-end reliability, capacity expansion at any node within 1 working day and meet the above technical, price and service coverage specs.

One may ask: why are such stringent specifications needed? The answer lies in the fact that openness is essential for Indian ecosystem of local innovators to become providers and global leaders in telecom hardware and services. The Bharat Broadband mission (which seeks to connect 250,000 rural gram panchayats, or village councils, with high speed broadband) will allow them to gain strength and experience necessary to do so. To this end, it is vital to buy technology as far as possible from sources where most of the value add will enrich and fuel Indian economy.

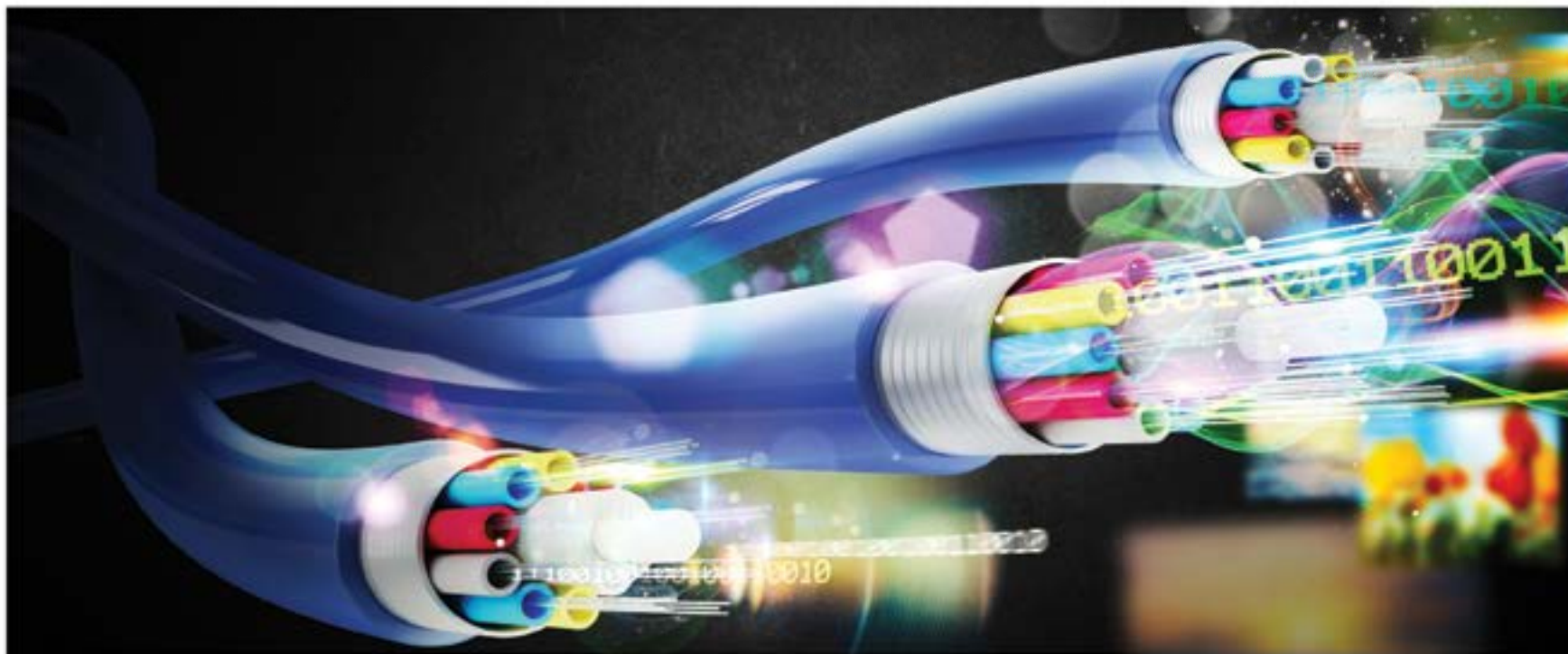
The quality of the network and reliability is essential if we are to deliver mission critical citizen services over this network and use it to build critical development infrastructure like education, healthcare, banking, law and order and so on.

Even in developed internet economies where wireless 4G, citywide WiFi – and, soon, 5G is emerging – every WiFi hotspot, 4G tower, and (because towers cannot serve so much) micro and pico towers in every building are connected by fiber. This is worth noting: it is fiber that is providing all this bandwidth to both towers and homes.

The other big difference is population density. Indian cities and towns are denser than even the densest cities in the West. For example, the population density of Vijayawada, a Tier II city in Andhra Pradesh State exceeds the population density of New York, the densest city in the US. And this density of every Indian city is likely to double, as rising development increases population concentration. In dense environments, the per capita bandwidth over airwaves drops dramatically due to contention and noise.

Finally, the real limitation is physics. There is a maximum limit to what we can push through a given band of airwaves. For example, Indian 4G towers with 20 MHz spectrum are able to transmit 500 Mbps per tower. On the other hand, fiber is cheap, and a fiber pair can carry several gigabits per second using cheap hardware for tens of kilometers, and when necessary 100 to 1000 times more.

Importantly, all this should be viable under existing systems and budgets such as the USO fund. And if the exercise of the laying of core fiber loops to every block and village is carried out by private, competitive entities using a modern, open architecture, and if we then allow both national and local telecom, media and internet entrepreneurs open access to this network under open, common, highly reasonable terms, Indian entrepreneurs and companies together would be able to provide the services our citizens need profitably, which then translates to acceleration of broadband for everyone along with sustainability of this network.



In parallel, embarking on the large scale digging projects to lay fiber for Phase II could proceed, which understandably will take longer. Such an approach brings the benefits of Digital India and the internet much faster to most people, while the substantially longer lasting, complementing infrastructure takes its time to arrive. From an engineering perspective, this is sound practice - as by spending a fraction, we mitigate all technical, operational risks except underground laying of fiber which is a well understood low risk operation. Bringing the states along, even encouraging them to lead this effort recognizing that right of way as well as powerlines are state domains, aligns the effort to administrative execution structures, allowing it to happen faster and better. State pride is a powerful motivator.

These costs could be further reduced by a combination of policy and technology innovations. By calling for advanced Software Defined Network components using open standards and open designs, by enhancing national and state policies around all road, rail and waterway designs to automatically include open access fiber lines, we reduce costs in both electronics and civil works substantially. Recognizing that civil work constitutes the majority of the total costs, this is not only a one-time reduction, following this policy perpetually for both public and private works means that this network will naturally keep expanding and strengthening. Technology innovations like using TV whitespace to deliver to remote areas, robotic research to make laying fiber at scale cheaper and less invasive, refinement of Open Hardware systems for India, all can reduce cost and improve capability even further. The point is we need a deeper technical thinking, national mission and will, money will not be the barrier.

ECONOMIC ACCELERATION

Both the exercise of building broadband for a billion Indians and consequent benefits of the internet are large economic opportunities.



However, imports of digital hardware (e.g. cell phones), software and services like search, advertisements, eCommerce and shared economy, seem to have grown from a USD 5 billion to USD 60 billion, indicating a digital deficit. And this will only accelerate.

The solution is, in theory, known to everyone - free up India's entrepreneurs to be on par with a Singapore or Israel; market making by government to buy from those companies that keep most of the resulting value, jobs and profits in India; and be clever about import duties, while preventing predatory practices from global monopolies. Any modern economist and industry expert worth their salt can specify what is needed. But what is also needed is to embrace our innovators and then redirect their energies to defend them on the global stage. We need to ensure we keep moving towards becoming a technology leader, as is our destiny, and keep course-correcting whenever and wherever we see indications of us becoming a technology colony.

With broadband to everyone in short order, a billion young, enterprising Indians and 100 million small and micro enterprises will come online, accessing the planet's resources and 7 billion customers worldwide. India's true strength is its people. Indians globally possess the unprecedented combination of excellence in technology, extraordinary entrepreneurship and a natural global outlook. This energy is tremendous, and with these 100 million entrepreneurs coming online, a billion empowered Indians coming online will be a planetary event. The world, not just India will stand transformed; similar to how the US catapulted itself using its natural resources during the Industrial Revolution.

[1] http://siteresources.worldbank.org/EXT/IC4D/Resources/IC4D_Broadband_35_50.pdf

[2] <http://www.usof.gov.in/usof-cms/home.jsp>

[3] http://www.dot.gov.in/sites/default/files/2016_10_20%20ANL%28E%29%20STT_0.pdf

Dr. Lalitesh Katragadda has co-authored India's Open API policy and is the architect of the AP Fiber Grid. He founded Google India, and created Google Mapmaker.

The pace at which India has been leapfrogging into the digital future via cyberspace is rather stunning, thanks to the unstoppable juggernaut of digitalization. The Digital India programme is a step towards transforming the country into a digitally empowered knowledge economy and accomplishing an inclusive ecosystem wherein the services are delivered seamlessly and efficiently, while also ensuring safety and (cyber) security of transactions and operations. A few leading indicators of India's digital momentum: India has more than 450 million internet users¹, 1200 million telecom users², and 200 million plus IoT devices³ as cited by various research reports in 2017. The economy is enroute to embracing the cashless paradigm, this transformation ably supported by regulatory regime, exponential smart phone availability and technology trends such as the Internet of Things (IoT), artificial intelligence (AI), cloud and mobility. The country has also embarked on its Smart Cities mission which will deploy leading edge technologies and be ready to serve its citizens with heightened connectivity and robust e-infrastructure. With over a billion digital identities, Aadhaar has also uniquely positioned India with an online authentication platform enabling both government to citizen (G2C) and business to consumer (B2C) services.

Digitalization is not only about facilitating service delivery to the citizens. It is also about paving the way for automation and creation of next generation factories, industries, supply chains, products and services. Shifting gears and examining how far Indian industry has advanced in this journey would be an important consideration while evaluating the overall safety and security of cyberspace. A three-pronged approach of risks, opportunities and capabilities might help put things in perspective. Industry 4.0 ushers in an era of smart manufacturing, responsive supply networks, and customised service and products; merging the digital and physical worlds through its use of smart, autonomous technologies. Organizations are also proactively leveraging artificial intelligence, machine learning and deep learning (under the bigger umbrella of cognitive computing) to disrupt the way the businesses are run, and solutions are developed. The limitless potential of algorithms is being realized both by industry front runners and also by vibrant start-ups.

The path to digitalization is exposing infrastructure to the internet, and to interconnection with other infrastructure systems. While this opens new and better avenues, it also engenders cyber security risks. New threat scenarios – never encountered before, and unanticipated – are emerging and confronting industry today; taking a toll in the form of business risks, reputational damage, disruption of services and potentially public safety. And let us be unequivocal about the fact that it is not just the banking and financial services industry (BFSI) and critical information infrastructure (CII) sectors that are bearing the brunt of these threats; across the board, industry sectors are feeling the heat of these vicious cyber-attacks. After recent cyber-attacks such as 'Wannacry', 'Notsopetya' and 'Equifax', there cannot be a clearer message to industry to beef up its cyber security preparedness. For this to happen, the only way is investing the right amount of effort in developing and honing capabilities on all fronts, including (but not limited to) research and development (R&D), talent and co-creation.

The risk story is just one part of cyber security that has been an ongoing concern of one and all. The other part of the house is the green lawn of enormous opportunity provided by this realm. A recent study by the National Association of Software and Services Companies (NASSCOM) and consulting firm McKinsey, *Perspective 2025: Shaping the Digital Revolution*⁴ forecasts that Indian outsourcing industry will achieve a size of USD 350-400 billion by 2025⁵. The report also identifies cyber security as one of the four prominent service lines that will contribute significantly to this industry growth. Cyber security is particularly expected to grow swiftly in domains including wearable devices, machine-to-machine (M2M), identity and security, cloud security solutions and services, security and privacy compliance, mobile devices and applications security, security analytics and intelligence, forensics and e-discovery, and ICT security and certification.

Given the existing status and the possibility of rapid growth, India can aspire to build a cyber security product and services industry of USD 35-40 billion by 2025; generate a skilled workforce of one million in the cyber security sector to cater to the rise in global and domestic demand; and build around 1000 start-ups that can furnish top-notch solutions in various sub-domains of cyber security. This is the vision of NASSCOM-DSCI Cyber Security Task Force (CSTF) which released an actionable roadmap for making India the global hub of cyber security products and services.

¹<http://bestmediainfo.com/2017/03/internet-users-in-india-projected-to-cross-450-million-by-june-2017-iamai/>

²<http://www.livemint.com/Industry/GWbJDKVd1a3aYkVy1TeyvK/Telecom-subscriber-base-in-India-crosses-12-billion-mark.html>

³[http://meity.gov.in/sites/upload_files/dit/files/Draft-IoT-Policy%20\(1\).pdf](http://meity.gov.in/sites/upload_files/dit/files/Draft-IoT-Policy%20(1).pdf)

⁴<http://www.nasscom.in/knowledge-center/publications/perspective-2025-shaping-digital-revolution>

⁵<https://www.dsci.in/content/cyber-security/cyber-security-task-force>

The demands from the digitalization ecosystem are ever increasing. With that, the strategy to secure cyberspace continues to evolve rapidly, propelling innovation in the realm of cyber security capability development.

The indicative list of next generation cyber security strategy elements includes, but is not limited to:

1. Security of Recognition Technologies
2. Extended Perimeter Security, with a focus on supply chain
3. Context Aware Security
4. The Shift from Detection to Response
5. Protecting Machines
6. Providing Resiliency to e-Infra (VI) Converging Security Disciplines.

These elements and many more are expected to be the driving force of cyber security landscape in the era of the 'Digital India'.

A strong fabric of capability-building capacity may enable a safe and secured cyberspace. India's capability landscape has evolved from services, through desktop products, to advanced cyber security appliances. Indian organizations are heavily invested in developing cyber security capabilities are based on artificial intelligence and machine learning. Some of the capabilities that are witnessing a lot of traction include advanced forensics, content-aware computing, security automation protocols, malware analysis, and supervisory control and data acquisition (SCADA) security, amongst many others. The role of capability development is critical due several factors: indigenous technological capability provides an added layer of assurance in securing nation cyberspace, and increases impact of domestic players – who can help in building newer sets of services around innovative sets of product lines – in the global market. This will expand Indian industry's presence with a global footprint Indian IT services companies are working towards this mission: serving global customers on security research and development projects, and building robust security research functions. Global security technology firms are also establishing cyber security R&D units in India, and global in-house centres (GIC) are setting up security operations to experiment with security engineering. Emerging Indian cyber security product R&D firms are also contributing to security R&D.

Start-ups and product companies have also been contributing significantly to R&D capability building, with Indian security product companies showing a great potential in recent past. There are more than 100 cyber security product companies in India, some of which have had success in international markets as well. Firms that were until recently located in academic incubation centres have been able to reach self-sustenance rapidly; in some cases, branching out and capturing market share across geographies. Promoting Indian cyber security entrepreneurship and innovation is vital to building robust national cyber security capabilities, and strengthening our national cyber security posture; in turn, access to data sets that can help identify use cases is essential to developing new technological capability. As the multitudinous cyber threats become challenging and increasingly sophisticated, funding for continued fundamental and applied research is imperative for cyber security capability development. This will stimulate research initiatives to be undertaken nationally through an efficient government-private-academia collaboration, thus, promoting innovation in cyber security.

The thrust areas which may need special focus going forward, for cyber security capability development. are capacity development of the system integrators, enhancing DevOps security in national projects, Identity and IoT Security, aggregation of threat mitigation strategies and building partnerships for cyber security start-ups growth. Promoting Indian cyber security innovation is one of the imperatives to build robust capabilities for strengthening cyber security posture of the country. Though Indian cyber security industry is emerging and nascent, there are many success stories of our industry players winning in the global markets. As the Indian cyber security industry continues to face challenges in market access, it is important that government and investors extend a helping hand to support them at different stages of their journey. Having talked about several dimensions of cyber security and capability development in it, I would like to end this piece with some food for thought: With so much going on technology wise, can we afford not to have a safe and secured cyberspace?



Rama Vedashree is CEO of Data Security Council of India (DSCI), a not-for-profit industry body established by the National Association of Software and Services Companies (NASSCOM).

INTRODUCTION

1. Cyberspace is acknowledged as the fifth dimension of the physical world, alongside land, sea, air and outer space. Our dependence on cyberspace for social, economic, governance, and security issues is directly proportional to the exponential growth of internet. Unfettered access to information through a globally inter-connected internet empowers individuals and governments, but simultaneously poses new challenges to their privacy.

2. This article has been written against the backdrop of challenges nations are facing, not from formidable armies, but from non-state actors, cyber criminals, hackers, etc. who have the capability to breach individual privacy, networks, communication and critical information infrastructure; and cause considerable damage. Seeing the gravity of threats in cyberspace, major world leaders and organisations are rolling out multiple initiatives to enhance security in cyberspace.

3. Hon'ble Prime Minister of India Shri Narendra Modi, in June 2015, described cyber-related risks as a global threat of "bloodless war," and called upon the nation's IT community to serve the entire world by building credible cyber security systems¹.

CYBER THREAT LANDSCAPE

4. The advent of internet in our lives has changed how governments work, businesses operate, and societies communicate. E-governance programmes across the world have positively impacted every aspect of governance. However, while cyberspace is a boon, its anonymity is exploited by cyber criminals, terrorists and state actors to carry out anti-social and anti-state activities, spying operations, espionage, critical information infrastructure disruption, and cyber-warfare.

5. The internet has created a virtual world for our economic as well as our social progress. Its borderless character has made it an extraordinarily powerful tool for knowledge-sharing, freedom, innovation and growth. The increasing proliferation of internet-based technologies globally has brought significant advantages to connected societies such as ours. The security of cyberspace concerns one and all – individuals, corporates, research organisations, defence, and governments across the globe.

INTERNATIONAL AND REGIONAL ORGANISATIONS

6. Against the backdrop of this menace, many existing international and regional

organisations have included cyber-security in their charters or mandates, and some new organisations have also come up with security in cyberspace as their only mandate. Some of these organisations include United Nations Group of Government Experts (UNGGE), European Union (EU), Association of South East Asian Nations (ASEAN), Council of Europe, BRICS, Shanghai Cooperation Organization (SCO), Organisation for Economic Cooperation and Development (OECD), the Organisation of American States (OAS), the G8/G20, the Internet Governance Forum etc.

CODE OF CONDUCT IN CYBERSPACE AND REGIONAL COOPERATION

7. The first step in the direction of evolving the code of conduct in cyberspace was taken by Russia over a decade ago, advocating the necessity to define rules and protocols for both cyber security and information security at the state level. In pursuit of this, the first draft of the International Code of Conduct for Information Security² was submitted to the United Nations Secretary General in 2011 by Russia and its partners in the Shanghai Cooperation Organisation. The Code of Conduct laid down the objectives of the cooperation, and incorporated the three dimensions i.e., politico-military, cybercrime and corporate infrastructure. This was for the first time a group of countries submitted the principles of responsible behaviour of states to secure both information and cyber security. The code of conduct revolved around the following issues:

- (a) Hostile use of ICT
- (b) Proliferation of cyber weapons
- (c) Cybercrime and terrorist activities
- (d) Respecting the freedom of speech, but complying to national laws
- (e) Multilateral and democratic Internet governance
- (f) Supply chain integrity issues

8. The United Nations General Assembly adopted the non-binding Resolution 68/167, which emphasizes the protection of the rights to privacy against unlawful surveillance. The Resolution stated that the same rights that people have offline must also be protected online. Pursuant to this, a group of individual experts representing 25 countries named the United Nations Group of Governmental Experts was created in 1990.

¹Prime Minister's Office, Government of India. (2015) PM's remarks at the launch of Digital India week, 01 Jul 2015. Available at

http://www.pmindia.gov.in/en/news_updates/pms-remarks-at-the-launch-of-digital-india-week/

²United Nations General Assembly. (2011). Letter dated 12 September 2011 from the Permanent Representatives of China, the Russian Federation, Tajikistan and Uzbekistan to the United Nations addressed to the Secretary-General.

https://codcoe.org/sites/default/files/documents/UN-110912-CodeOfConduct_0.pdf

The group drew attention from Western states in 2013 when it talked about the applicability of international law to cyberspace.

9. The United Nations Group of Governmental Experts on Developments in the Field of Information and Telecommunications in the Context of International Security (UNGGE) gradually has started identifying the issue which are at the core of responsible behaviour in cyberspace. Its 2016-17 meeting was organised by the Federal Department of Foreign Affairs of Switzerland in cooperation with the Geneva Internet Platform to address the issues of a Secure Cyberspace via Regional Cooperation. The role of regional organisations in the implementation of UNGGE recommendations on cyber security was discussed. Awareness raising, confidence and capacity building were identified as comprising the triad of international cyber security policy.

EMERGING CYBER DEFENCE COLLABORATIONS

10. BRICS. In July 2015, during the Seventh BRICS Summit at Ufa, a joint declaration was made by the BRICS member states, Brazil, Russia, India, China, and South Africa, to continue work on the measures to prevent conflict in cyberspace and further develop norms, standards and principles of responsible conduct. In this regard, it is especially important to that US-China-Russia has seen three bilateral agreements in the past to establish mutual confidence building measures, and responsible conduct, in the cyber domain.

11. NATO and EU. Multinational cyber defence initiatives have begun to emerge within the North Atlantic Treaty Organisation (NATO) and European Union. Bulgaria, Estonia, Poland, Slovakia, Turkey, the United Kingdom, and the United States have signed agreements with NATO to cooperate in the event of a cyberattack. NATO is also strengthening the Cooperative Cyber Defence Centre of Excellence, established in 2007, based in Tallinn, Estonia.

12. ASEAN is considered one of the world's fastest growing regions and has been proactive in the efforts to tackle cyber security challenges and has undertaken various confidence building measures.

ASEAN adopted the Singapore Declaration in 2003 which stressed upon the efforts to establish an ASEAN Information Infrastructure with a view to enhance security, integrity, and interoperability of cyber systems. ASEAN has also set-up a Network Security Action Council (ANSAC) and ASEAN Regional Forum for integrating regional cyber security initiatives have meetings on counter terrorism and cyber-crime.

13. Cyber security activities in Africa are synergised by the eight-member African Union Convention on Cyber Security and Personal Data Protection.

INDIAN PERSPECTIVE

14. India holds the third largest internet users after USA and China. We have, it is estimated, approximately 1035 million mobile phone users and over 450 million internet users, a figure that is believed will grow. The dynamic nature of internet has catalysed and accelerated the rate of change of economic growth. It has enabled extended governance outreach and has influenced every aspect of human life, the way we live, the way we think, our time and space by redefining our perceptions and value systems.

15. India and the United States have signed a Memorandum of Understanding (MoU) for close cooperation and exchange of information in the field of cyber security; the MoU was signed early in 2017 between the Computer Emergency Response Teams of both countries. Hon'ble Prime Minister Narendra Modi's visits to Israel, France and many other countries will go a long way to strengthen the ties and instruments for security of cyberspace.



¹<http://brics2016.gov.in/upload/files/document/5763c20e72f2d97hDeclarationeng.pdf>
²Robinson, Neil. (2013). Cybersecurity Strategies Raise Hopes of International Cooperation, Rand Corporation, Available at <https://www.rand.org/pubs/periodicals/rand-review/issues/2013/summer/cybersecurity-strategies-raise-hopes-of-international-cooperation.html>
³North Atlantic Treaty Organisation. (2008) NATO opens new centre of excellence on cyber defence. Available at <https://www.nato.int/docu/update/2008/05-may/a0514a.html>
⁴Saravde, Nand Kumar. (2016), 'International and Regional Responses to Cybersecurity Challenges', In Samuel, Charian and Sharma, Munish (2016) Securing Cyberspace. Institute for Defence Studies and Analysis, New Delhi.

⁵Press Trust of India. (2016) India's Mobile User Base Touches 103.5 Crore: Telecom Regulator. 09 September 2016. Available at <https://www.ndtv.com/india-news/indias-mobile-user-base-touches-103-5-crore-telecom-regulator-1456845>
⁶Chopra, Arushi. (2017). Number of Internet users in India could cross 450 million by June: report. Livemint, 02 March 2017. Available at <http://www.livemint.com/Industry/QWzIOYEsfQJknXhC3HiuVI/Number-of-Internet-users-in-India-could-cross-450-million-by.html>
⁷<https://telecom.economicstimes.indiatimes.com/news/india-us-sign-mou-in-cyber-security-cooperation/56491574>

HOW CAN WE PROCEED? (THE AUTHORS' SUGGESTIONS)

16. Cyber security is an issue that must be handled deftly at regional and sub-regional levels. India can play a pivotal role in this evolving world order. On the background of these initiatives, we might consider the possibility of enhancing our outreach, partnership and engagement, both at the international and regional level, to develop practical and implementable frameworks to address global cyber security challenges, and contributing to global fora to protect its strategic interests. ICANN-57, which India hosted in November 2016, offers an example of a progressive step in its participation in global internet governance process.

17. Our role as a pivotal player on the international scene could conceivably evolve, alongside our cyber economy and IT capabilities. We offer below a set of suggestions on the axes along which this role could evolve:

- Enhancement of infrastructures and capabilities to further enhance our understanding of complex issues like Internet protocols, requests for comment (RFCs) and Internet Drafts of the IETF, etc., so to help us play a decisive role in defining the rules of engagement in internet playing field
- Greater participation in almost all international cybersecurity processes
- Enhance the role played in formal Internet governance fora and processes
- Collaborating with regional and global players to enhance international

cooperation, and develop interoperable arrangements and implementable proposals

- Working with like-minded nations and global institutions to develop cyber norms and acceptable behaviour for operating in cyberspace.
- Ensuring that strategic and economic interests are addressed by ascertaining the implications of security aspects in bilateral and multilateral trade dialogues
- Strengthening participation in existing mechanisms and enhancing cooperation amongst law enforcement agencies at international level to improve attribution and solution of cybercrime cases
- Further developing cyber security capabilities, indigenous hardware, and supply chains for improving assurance of information systems within the country
- Adopting international standards, frameworks, skill-building and research and development as required to enhance indigenous capabilities.

TO CONCLUDE

A more deliberate effort is required to be synergised for developing behaviour norms in cyberspace. Capacity building is the need of the hour, not only in technical aspects but beyond, in domains like governance, economics, politics, and law.

Rakshit Tandon & Lt. Col. Naresh Chaudhary are cyber security experts.





Mangalyaan, primarily an indigenous 'Make in India' product, an exceptional and amazing engineering feat based on frugal engineering concepts is India's Mars Orbiter Mission. On September 25, 2014, it made history by being the cheapest interplanetary mission ever undertaken by the world and also by ensuring that India became the first nation to successfully enter Mars's orbit on its first attempt. It transmitted photographic and atmospheric data to the Indian Space and Research Organisation (ISRO) command centre through cyber space.

This is an example of astute governance focusing on precision engineering and project management to deliver a quality product on extremely tight schedule on a shoestring budget while being connected as well as communicating with its command centre through cyber space. It followed six operating principles as listed in the article "What the West Can Learn from Jugaad", by Navi Radjou, Jaideep Prabhu, and Simone Ahuja – "seek opportunity in adversity, do more with less, think and act flexibly, keep everything about the business simple, tap the margins of society for employees and customers, and follow your heart". Using the same rigour and discipline, India's first lunar mission Chandrayaan-1, successfully launched in October 2008, provided the first proofs to the world regarding the existence of water on Moon. Both these examples show how India has responsibly and innovatively used cyberspace for the benefit of the society at large.

Cyberspace (as defined by ISO / IEC 27032-2012) is a complex environment consisting of interactions between people, software and services, supported by worldwide distribution of information and communication technology (ICT) devices and networks.

Just as adoption and innovation of natural resources helped in the evolution of the industrial revolution, it is data which is fuelling the current information revolution. The successful innovative usage of cyberspace and mature use of ICT by developed nations is helping them and their society to prosper in the digital economy also known as the knowledge / information / wired / Internet economy. McKinsey Global Institute estimates that global cross border flows would be "up to USD 85 trillion flow of goods, services, and finance by 2025, three times the value in 2012" and that there would be "growth in knowledge-intensive goods trade 1.3x as fast as in labour-intensive goods".

For the economy, industry and trade to grow in such proportions in the digital world there is a need to focus on the aspect of cyber security as a quality (zero defect) factor for the benefit of the society at large. As per a press report from marketsandmarkets.com "the cyber security market is estimated to grow from USD 95.60 billion in 2014 to USD 155.74 billion by 2019, at a Compound Annual Growth Rate (CAGR) of 10.3% from 2014 to 2019".

Further, csoonline.com in 2017 has estimated that cybersecurity spending would exceed USD 1 trillion from 2017 to 2021.

Today almost 9 million devices are connected to the internet in cyber space and by 2025 the estimated number of devices would be 50 billion with the proliferation of Internet of Things (IoT). Increasingly, data or information generated from these devices would be handled, processed, transported or stored in digital systems thus making it a pervasive critical asset. Hence this critical asset, which is data or information, needs to be safeguarded and protected. Cyber security has implications at the individual, organization, sectoral as well as the national level.

In the light of the growth of IT sector in the country, ambitious plans for rapid social transformation and inclusive growth and India's prominent role in the IT global market, providing right kind of focus for creating secure computing environment and adequate trust & confidence in electronic transactions, software, services, devices and networks, has become one of the compelling priorities for the country. The Government of India has launched an ambitious 'Digital India' programme with the goal to transform India into a digitally empowered society and knowledge economy. While making efforts to achieve Digital India, the Government is striving to make "Digital Safe and Secure India" by focusing on securing Indian Cyber Space and connected digital infrastructure in the country which are utilizing the internet.

The Government has embarked upon various ongoing activities and to address the cyber-security challenges which have significantly contributed to the creation of a platform that is now capable of supporting and sustaining the efforts in securing the cyber space.

The Government has adopted a holistic approach towards securing the country's cyber space encompassing multiple initiatives like Security Policy, Compliance and Assurance, Security, Incident – Early warning & Response, Security Training, Security specific R&D, Enabling Legal Framework and Collaboration.

Government has put in place a robust cyber security policy and architecture for building a secure and resilient cyber space for citizen, businesses and Government through a multilayer approach. The Policy is aimed to protect information and information infrastructure, build capabilities to prevent and respond to cyber threat, reduce vulnerabilities and minimize damage from cyber incidents through a combination of institutional framework, people, processes, technology and cooperation.

The Government has enacted the IT Act 2000 including its amendment in 2008 so as to provide a comprehensive legal framework to boost e-commerce in the country and also to create an enabling environment for e-Governance in the country. It also addresses various cyber offences and crimes and protection measures against them. Some of the key provisions include measures for data protection, punishment for identity theft, e-commerce frauds like phishing, frauds on online auction sites, sending offensive emails and multimedia offences, cyber terrorism, pornography including child pornography, video voyeurism, breach of data etc. The Act has also created institutions like Indian Computer Emergency Response Team (CERT-In), National Nodal Agency for protection of critical information infrastructure (NCIIPC), Controller of Certifying Authorities (CCA), Adjudicating Officers etc.

With the increase in the proliferation of Information Technology and related services through the use of internet providing numerous benefits for the society and citizens, there are also challenges such as the rise in number of cybercrime and cyber security incidents involving malicious state and non-state actors. It is well established that the ICT infrastructure and network connectivity has also increased the vulnerability of businesses, society, individuals and Nations at large. The rapidly evolving threat landscape exposes the increased attack surface of the networked systems making them vulnerable and difficult to separate or secure any particular area within the overall system. It exposes the ICT dependent critical information infrastructure systems and users to dramatic risks. It is estimated by Zurich Insurance Group and Atlantic Council that by the year 2030, an insecure Internet would reduce the global economic net benefit by USD 90 trillion while a completely secure Internet would result in a global net gain of USD 190 trillion. Risks arising due to cybercrime and cyber security incidents have a multi-fold impact on the nation and need to be mitigated.

The Government set up the Indian Computer Emergency Response Team (CERT-In) in 2004. It operates on a 24 X 7 basis and has been designated to serve as the national agency for incident response, as per the provisions of section 70B of the Information Technology Act 2000. All organizations have been mandated to report cyber security incidents to CERT-In expeditiously. CERT-In is mandated to perform the following functions in the area of cyber security:

- collection, analysis and dissemination of information on cyber incidents;
- forecast and alerts of cyber security incidents;
- emergency measures for handling cyber security incidents;
- coordination of cyber incidents response activities;
- issue guidelines, advisories, vulnerability notes and whitepapers relating to information security practices, procedures, prevention, response and reporting of cyber incidents.

Considering the need for real time situational awareness and rapid response to cyber security incidents, Government is setting up a Centre to generate necessary situational awareness of existing and potential cyber security threats and enable timely information sharing for proactive, preventive and protective actions by individual entities.



The Government has formulated a Cyber Crisis Management Plan (CCMP) for countering cyber-attacks and cyber terrorism for implementation by all Ministries/ Departments of Central Government, State Governments and their organizations and critical sectors. Cyber security mock drills are being conducted regularly by CERT-In for assessment of cyber security posture and preparedness of organizations in Government and critical sectors. CERT-In has empanelled security auditing organisations to support and audit implementation of Information Security Best Practices.

The technology security skills shortage is leaving all of us at increasing and alarming risk of cyber-attacks. It is estimated that the Group of Twenty (G20) economies have lost 2.5 million jobs to a wide range of nefarious cyber activities including counterfeiting, piracy and cybercrime, and that governments and consumers lose USD 125 billion annually, including losses in tax revenue (Hathaway, Centre for International Governance Innovation). According to an article in csoonline.com, cyber-crime will more than triple the number of unfilled cybersecurity jobs, which is predicted to reach 3.5 million by 2021. This is a concern as well as a great opportunity. Hon'ble Prime Minister of India Shri Narendra Modi, at NASSCOM's silver jubilee celebration event on 1st March 2015, called upon the Indian IT Industry to focus on meeting the global challenge of cyber-security. Seizing this opportunity, the NASSCOM-DSCI Cyber Security Task Force in its report has set a target for India wherein it plans to create a cyber security product and services industry of USD 35 to 40 billion by 2025, and at the same time generate a skilled workforce of one million in the security sector, to address domestic and global demand. By focusing on capacity-building in the area of cyber security, governments will partially achieve their goals of creating and generating employment.

The Government has initiated the Information Security Education and Awareness programme to train persons in various formal / non-formal courses. As part of cyber-crime awareness and capacity building in cyber-crime investigation the Government has setup Cyber Forensics Training Labs for the Law Enforcement Agencies. The Government is regularly conducting trainings / workshops to train officials of Government, critical sector, public / industry sectors, financial & banking sector, Internet Service Providers (ISPs) and Judiciary on various contemporary and focused topics of Cyber Security, for example CERT-In has conducted 32 training sessions covering almost 900 Chief Information Security Officers and security administrators across sectors in the last two years. In addition, CERT-In has also conducted workshop on security of digital payments systems for stakeholder organisations covering 110 participants. CERT-In has also recorded cyber security awareness sessions under the DigiShala Awareness Campaign, a free Doordarshan DTH TV channel, for educating citizens and create awareness amongst internet users so that they do not fall prey to online frauds. To address the emerging problem of cyber security to sustain the digitalisation momentum in the country CERT-In has issued alerts and advisories regarding latest cyber threats/vulnerabilities along with countermeasures to create awareness among stakeholders to take appropriate measures so as to ensure safe usage of digital technologies. Regarding securing digital payments, 25 advisories have been issued for users and institutions. Digital India being a citizen-centric programme, creation of 'trust and confidence' in cyberspace is considered as one of the key aspects for the overall success of Digital India. Hence, there is a need for 'promotion of digital safety and responsible user behaviour' by way of continuous engagement of citizens for sensitisation through sustained efforts over a period.

Botnets and bots are used for spam, phishing, click-fraud, DDoS and other malicious activities. To address this issue of bots and malware, which is contributing to unhealthy cyber ecosystem, CERT-In has extend the 'Swachh Bharat' campaign to the online world by establishing the Cyber Swachhta Kendra (the Botnet Cleaning and Malware Analysis Centre) for the benefit of the citizens to practice cyber hygiene in the online world and remain secure. This facility is set up for detection of systems infected by malware/botnets in the country and to notify, enable cleaning and securing systems of end users to prevent further malware infections. The centre is working in close coordination and collaboration with ISPs, Academia and Industry. The centre is providing detection of malicious programs and free tools to remove the same for citizens and Banks.

The Government has undertaken Research and Development programme for development of skills and expertise in areas of cyber security by facilitating basic research, technology demonstration and R&D test bed projects. Under these projects, efforts have been made to nurture institutions and capacity enhancement. Some of the areas where efforts have been put are in creating mass cyber security awareness among schools, colleges and government employees through appropriate training and campaign mechanism in North-Eastern States of India, enhancement of cyber forensics lab for advanced training to law enforcement agencies to handle emerging cyber-crimes and capacity building, establishment of an anti-spam coordination centre, design and development of opinion mining and sentiment analysis of social media content, etc.

Since the internet is a global trading platform, it needs to be available 24x7 for trade to flourish. Online trade demands information and data should be able to move confidentially without hindrance or loss of integrity. While internet as a platform and internet technologies help enable these, it is cybercrimes, cyber security incidents, mass scale digital data surveillance and intelligence gathering which expose the vulnerabilities and dual use of these technologies. This then needs to be addressed by appropriate regulations and maturity among people, policy makers and Nations to understand the risks and mitigate them appropriately. Today trade negotiators are grappling with various complex issues in the digital economy. For example, the General Agreement on Trade in Services (GATS) agreement, Taxation, Wassenaar Arrangement on Export Controls for Conventional Arms and Dual-Use Goods and Technologies. We are moving towards a data driven diplomacy and democratisation of diplomacy where cyber security is vital to the stability and safety of the cyber space.

There is a need to enhance global cooperation by promoting shared understanding and leveraging relationships, both with ICT dependent Nations as well as industry, for furthering the cause of security of cyberspace. Strategic cyber security cooperation with the other countries enables creation of a security ring of like-minded and ICT dependent nations around the world that can help safety and security of cyber space. In view of the need for international relationships and cooperation issues, the Government is making concerted efforts to determine the ways and means of expanding the international collaboration as well as exploring the possibility of commonality of approach between nations.

In order to create collaborative mechanisms for dialogue related to technical and operational aspects among CERTs and also with industry in order to facilitate efforts in recovery and resilience of ICT systems regular information sharing, including obtaining advance information on cyber threats as well as bilateral and

multilateral cyber security exercises between the Computer Emergency Response Teams are carried out.

It is clear that the economic growth of nations is increasingly dependent on the availability of the internet (global data networks) as a global trading platform for the purpose of a network of global trade. Thus, in today's globalization era, international trade, investments and technology are connected inseparably within global supply chains. Globalization is a complex mega phenomenon integrating world economy without precedence with multiple effects, as pointed out by Zoran Stefanović in the paper Globalization: Theoretical perspectives, impacts and institutional response to the economy. It is the progress of technology which is now a driving force transforming the functioning of borderless and virtual cyber space economic systems by being noticeable in foreign trade, international investment and international finance.

From a socio-economic relevance perspective India is focusing on cyber security as it would help in

- improving productivity (by reducing downtime and improving availability of ICT systems) and thereby performance and competition,
- technical and business innovation including commercialization of research and development,
- ability to move data confidentially without hindrance or loss of integrity,
- optimized operations within the government,
- improved service delivery for the citizens,
- building trust in ICT systems among the society at large,
- informed and improved risk taking by policy makers in the government,
- entrepreneurship drive among people based on new stable and sustainable business models,
- creating opportunities for entire new industries to support an innovative ecosystem,
- creation of jobs and highly skilled cyber security workforce,
- FDI and opportunities for mergers and acquisitions,
- economic competitiveness and hence improved globalization.

The time is ripe for India to focus on cyber security for National Security, economic growth, public safety and competitiveness while laying out a robust roadmap for tapping the immense global trade opportunity estimated to be US\$1 trillion by 2021 in this space so as to create a safe and secure cyberspace for all.

Dr. Sanjay Bahl is Director General, Indian Computer Emergency Response Team.



Privacy paramount

FOR PERSONAL DATA IN CYBERSPACE

PAVAN DUGGAL

India as a nation has been always committed towards protecting privacy. Privacy protection is an integral part of ancient Indian culture.

Over a period of time, different regimes and rulers in India upheld the rule of law and privacy. The advent of the East India Company and English rule in India saw a period where privacy as a phenomenon did not get the kind of importance that it ought to have had. This was understandable, given the principles on which the British colonial empire was founded. After India became independent, India enshrined its hopes and aspirations in the Constitution of India.

In the landmark case of Justice K. S. Puttaswamy (Retd.) and Anr. vs Union Of India and Ors., the Preamble of the Constitution of India has been interpreted and used in the sense of providing “dignity to an individual”¹. The Supreme Court has held that due to the nature of the words of the Preamble, and its relationship with the Constitution², there should be an active involvement of the Courts to achieve the objects enshrined in the Preamble. In such a situation, the apex court of India has categorically held that privacy of an individual is to be considered an integral part of dignity, life and liberty, which is enshrined in the Preamble.

It is interesting to note that the Indian Constitution did not come up with a dedicated stipulated right to privacy. However, judge-made law in India has been remarkably contributory towards the growth of privacy jurisprudence. The Supreme Court of India in various cases has upheld that the fundamental right to life includes the right to privacy. In the case entitled “Justice K S Puttaswamy (Retd.) and Anr. vs. Union of India”, the Supreme Court of India held as under:-

“The right to privacy is protected as an intrinsic part of the right to life and personal liberty under Article 21 and as a part of the freedoms guaranteed by Part III of the Constitution.”³

India is committed towards privacy being paramount for personal data in cyberspace. That is the reason why India has in place various parameters in its existing legal frameworks. Way back in 1885, the Indian Telegraph Act, 1885 was enacted which had provisions including prevention of unauthorized persons to tap or to access information.

Indian cyberlaw is a good starting point to examine the legislative frameworks in this regard. The Indian Information Technology Act, 2000, being the Indian Cyberlaw, was enacted on the turn of the century and was amended in the year 2008. The Information Technology Act, 2000 enacted Section 43 which dealt with the concept of privacy of data resident on computers, in an indirect way.

Section 43A talked about protection of data privacy in respect of sensitive personal data resident on computers.

Section 43A of the Information Technology Act, 2000 devised an ingenious methodology for prescribing reasonable security practices and procedures as a way of protecting data privacy of sensitive personal data. Of particular importance is the manner in which the Indian cyberlaw defined the ambit and scope of reasonable security practices and procedures. The law defines “reasonable security practices and procedures” to mean security practices and procedures designed to protect such information from unauthorised access, damage, use, **modification**, disclosure or impairment, as may be specified in an agreement between the parties or as may be specified in any law for the time being in force and in the absence of such agreement or any law, such reasonable security practices and procedures, as may be prescribed by the Central Government in consultation with such professional bodies or associations as it may deem fit. These reasonable security practices to protect data privacy, in the context of cyberspace have since been defined.

Under Rule 8 of the Information Technology (Reasonable Security Practices and Procedures and Sensitive Personal Data or Information) Rules, 2011 has identified the International Standard IS/ISO/IEC 27001 on “Information Technology- Security Techniques- Information Security Management System- Requirements” as one such standard fulfilling the parameters of reasonable security practices and procedures. Continuous adoption and implementation of such standards contribute for the privacy protection of personal data, both in the actual world as well as in cyberspace.

Further, Section 72 of the Information Technology Act, 2000 deals with making the breach of confidentiality and privacy as an offence, punished with imprisonment for a term, which may extend to two years, or with fine which may extend to INR 100,000/- or with both. Further, Section 66E of the Information Technology Act, 2000 also is an implicit recognition of protecting the personal privacy. Section 66E makes the intentional or knowing publication or transmission of the image of a private area of any person, without his or her consent, under circumstances violating the privacy of any person, as an offence punishable with imprisonment with may extend to three years or with fine not exceeding INR 200,000/- or with both.

¹Justice K.S. Puttaswamy v. Uoi, WP (Civil) No. 494 of 2012, p. 13

²Kesavananda Bharati v State of Kerala, (1973) 4 SCC 225

³Justice K.S. Puttaswamy v. Uoi, WP (Civil) No. 494 of 2012, p. 546



There is distinct clarity in the Indian legal system that privacy is paramount for personal data protection in cyberspace. This, despite the fact that India does not have in place either a dedicated law on privacy or on data protection.

A Group of Experts headed by (Retd.) Justice A. P. Shah, Former Chief Justice, Delhi High Court submitted a report to the Planning Commission on the subject of data privacy .

Their recommendations inter-alia included a proposal for the adoption of the following National Level Privacy Principles:

(a) Notice: A data controller, which refers to any organization that determines the purposes and means of processing the personal information of users, shall give simple to understand notice of its information practices to all individuals, in clear and concise language, before any personal information is collected from them. Such notices should include disclosures on what personal information is being collected; purpose for collection and its use; whether it will be disclosed to third parties; notification in case of data breach, etc.

(b) Choice and consent: A data controller shall give individuals choices (opt-in/opt-out) with regard to providing their personal information, and take individual consent only after providing notice of its information practices.

(c) Collection limitation: A data controller shall only collect personal information from data subjects as is necessary for the purposes identified for such collection.

(d) Purpose limitation: Personal data collected and processed by data controllers should be adequate and relevant to the purposes for which they are processed.

(e) Access and correction: Individuals shall have access to personal information about them held by a data controller and be able to seek correction, amendments, or deletion of such information, where it is inaccurate.

(f) Disclosure of Information: A data controller shall only disclose personal information to third parties after providing notice and seeking informed consent from the individual for such disclosure.

(g) Security: A data controller shall secure personal information using reasonable security safeguards against loss, unauthorised access or use and destruction.

(h) Openness: A data controller shall take all necessary steps to implement practices, procedures, policies and systems in a manner proportional to the scale, scope, and sensitivity to the data they collect, in order to ensure compliance with the privacy principles, information regarding which shall be made in an intelligible form, using clear and plain language, available to all individuals.

(i) Accountability: The data controller shall be accountable for complying with measures which give effect to the privacy principles. Such measures should include mechanisms to implement privacy policies, including training and education, audits, etc.

This report has not been implemented but continues to be the torchbearer of the leading, cutting edge thought in the jurisprudence of privacy and protection of personal data.

⁴Report of the Group of Experts on Privacy, October, 2012, http://planningcommission.nic.in/reports/genrep/rep_privacy.pdf

In light of the increasing importance of data protection, regulation and privacy in today's world, the Reserve Bank of India (RBI), has come up with a guideline, no. RBI/2-17-18/15, on July 6th, 2017. The RBI, in the said guideline, has stated about Board Approved Policy for Customer Protection as thus:

"11. Taking into account the risks arising out of unauthorised debits to customer accounts owing to customer negligence/ bank negligence/ banking system frauds/ third party breaches, banks need to clearly define the rights and obligations of customers in case of unauthorised transactions in specified scenarios. Banks shall formulate/ revise their customer relations policy, with approval of their Boards, to cover aspects of customer protection, including the mechanism of creating customer awareness on the risks and responsibilities involved in electronic banking transactions and customer liability in such cases of unauthorised electronic banking transactions. The policy must be transparent, non-discriminatory and should stipulate the mechanism of compensating the customers for the unauthorised electronic banking transactions and also prescribe the timelines for effecting such compensation.... The policy shall be displayed on the bank's website along with the details of grievance handling/ escalation procedure. The instructions contained in this circular shall be incorporated in the policy."

Thus, we find that the Reserve Bank of India has put the onus on the protection of the consumers' data onto the banks themselves to develop individual policies, which would be compliant with their own internal settings. This is yet another example of adopting innovative approaches for protecting people's privacy in their personal data, which is being used for the purposes of doing transactions in cyberspace.

As more and more Indians are realizing that privacy is paramount for personal data in cyberspace, the government of India has seized thought leadership in this regard. The Government of India has already set up the Justice B N Srikrishna Committee which is looking for coming up with legal frameworks for data protection.

India is committed towards protecting personal and data privacy. The Government of India is taking various steps in this direction. Several nations are now looking towards India on what India's policies and strategies would be on privacy and data protection. This is a strong indication that India is being seen as a thought leader in the digital world. The approach that India adopts for protecting personal data and related privacy in cyberspace, is likely to be analyzed and also followed by nations which seek to learn from the Indian experience.

India as a nation is a land of unity in diversity. It believes in the philosophy of Mahatma Gandhi of keeping the windows of our home open so that the air from the four directions can come in, bringing along whiffs of freshness. It will be interesting to see how the developments in the direction of protection of privacy in the context of personal data in cyberspace take place in India in times to come.

Pavan Duggal, Advocate, Supreme Court of India, is a leading expert and authority in the country on Cyberlaw, Cyber Security Law & Mobile Law; and also acknowledged as amongst the top cyber lawyers in the world.





25

Railways

A PRIME MOVER IN COMPUTERISATION

PITAMBER VERMA & S. J. SINHA

1.0 INDIAN RAILWAYS AND COMPUTERISATION OF ITS OPERATIONS INITIATIVES

Indian Railways (IR), the country's largest public sector undertaking and the world's largest Railway Network, carries 11 million passengers in over 6000 trains daily.

IR's Central Railways Information System (CRIS) was established the Ministry of Railways to be an IT organisation for all computer activities on Indian Railways. It has focused on avoiding duplication of effort; standardising the Railways' computer hardware and software; designing and developing major Railways' applications requiring advanced expertise; accelerating decision-making and system-wide applicability; and developing specialised expertise to keep pace with the fast-changing technology.

The Railways' work currently covers a number of functions, such as passenger ticketing, freight operations, train dispatching and control, crew management, e-procurement, management of Railways' fixed and moving assets, and production of rolling stock. Our information systems provide services in the remotest of locations. Currently, systems are being developed to cover emerging needs of the Railways including the protection of Railway assets, energy management, management of the overhead electrification system, parcel management, employees' health management, and a comprehensive financial management system.

CRIS has developed a number of applications, across these various functions. These are outlined below.

2.0 PASSENGER APPLICATIONS

Over 800 crore (8 billion) passengers originate journeys on Indian Railways every year. CRIS has developed a range of applications to manage and serve this traffic.

- **Passenger Reservation System (PRS).** Each day, over 10 lakh passengers are booked at 11,127 PRS terminals at 3,107 booking locations and over 6 lakh passengers through Internet booking. Tickets worth about INR 85 crore are sold daily.
- **Unreserved Ticketing System (UTS).** Approximately 2 crore passengers are booked daily in the UTS, which covers more than 90% of all unreserved tickets. Tickets worth about INR 55 crore are sold daily at 10,763 terminals at 5,798 booking locations.

Tickets are also issued from more than 1,000 self-service automatic ticket vending machines (ATVMs) installed in stations with high volumes of ticket sales.

- **The National Train Enquiry System (NTES) and Integrated Coaching Management System (ICMS)** applications provide train running position and monitor the coaching stock and running of more than 8,500 passenger-carrying trains daily.
- **The Indian Railways Portal with Retiring Room booking, and Complaint Management System** manages almost 39,000 retiring room bookings made each month, at over 400 stations through the Internet and station counters, earning over INR 1 crore monthly. Complaints in trains or at stations can also be logged and tracked through the portal. Retiring Room Application is now running over 400 stations.
- **SMS Gateway.** More than 1.5 lakh SMSs are being sent daily to passengers to inform them about change in their reservation status.

3.0 Freight/Operations Applications

Over 110 crore (1.1 billion) tonnes of freight originate journeys on Indian Railways every year. CRIS has developed several applications to manage and monitor this load.

- **Freight Operations Information System (FOIS), Terminal Management System (TMS) and E-Payment-** About 2.9 million tonnes of freight are booked daily in FOIS. Nearly 1,600 Railway Receipts (RRs), amounting to about 255 crore, are generated, constituting 99.9% of freight booked; approximately INR 191 crore (75% of total) is collected through e-payment every day.
- **FOIS Rake Management System (RMS).** About 4,353 rakes are monitored on a daily basis. Consignments in transit can be tracked by the customers on FOIS-Web. The Rake Allotment System also provides optimum allocation of rakes for efficient freight movement.
- **Control Office Application (COA) and Timetable Management System.** About 5 lakh arrival/ departure events of 14000 trains are recorded each day in 77 control offices through COA. Time table Management software assists in the preparation of train timetables to optimize running of trains.
- **Crew Management System (CMS).** 362 lobbies are provided with CMS. The system serves 47,000 calls daily via SMS, enabling train crews to sign on and sign off at CMS locations.

¹Indian Railways. (2017). Statistical Summary 2015-16. Available at http://www.indianrailways.gov.in/railwayboard/uploads/directorate/stat_econ/IRSP_2015-16/Summary%20Sheet_Eng_pdf.pdf

- **Locomotive Management System (LMS, for diesel locomotives) and Software for Locomotive Asset Management (SLAM, for electric locomotives).** These applications, presently implemented at a few sheds, will ultimately be able to manage the maintenance of over 10,000 locomotives.

- **Coaching/Freight Maintenance Management System (CMM/FMM).** These applications, presently implemented at pilot locations, will be able to manage the maintenance of 60,000 coaching vehicles and 2.5 lakh wagons. These applications currently provide convenience and enhanced transparency for the Freight Customer.

CRIS-developed applications also ease the work of the Railway staff, improving the overall efficiency and performance, in the following ways:

1. The Control Office Application helps reduce fatigue and stress on section controllers;
2. The Crew Management System application optimizes crew rotation and allows automatic mileage calculations, easing the burden on running staff ;
3. The Track Management System application makes it easier for track maintenance staff to maintain records;
4. Locomotive maintenance staff can receive information at fingertips through SLAM and LMS applications;
5. Planners are assisted in optimal rake allotment through the Rake Allocation System of FOIS.

4.0 OTHER IMPORTANT APPLICATIONS

CRIS has also designed a set of applications to manage other core Railway functions.

- **E-Procurement System (EPS) including e-Auction and Reverse Auction.** Nearly 15,000 tenders are issued each month through the EPS. Till date, over 5.67 lakh tenders have been issued. 21,776 vendors are already enrolled. Scrap worth INR 4,339.61 crore has been sold through the e-Auction sub-system till now.

- **Parcel Management System (PMS).** Booking, delivery and tracking of parcels is possible through this system, presently covering Delhi – Howrah corridor. A pilot project for computerization of the Parcel traffic on Indian Railways has been successfully running at 10 stations of New Delhi– Howrah corridor. Four more stations have been covered. Extension of the System to cover all major corridors involving 228 stations (Golden Quadrilateral and its diagonals) is under progress. This system is being expanded to 200 stations in a phased manner.

- **The FOIS Data Warehouse** will enable analysis of data from FOIS by making ad-hoc reports and assisting in strategic decision making.

- **I-PAS (Accounting Management System).** I-PAS is centralized Financial Management software, presently being implemented in phases in Zonal Railways and Production Units on entire Indian Railways.

- **WISE (Workshop Management System).** This system is under roll out in Railway Workshops, to be implemented in 34 workshops.

- **ERP systems in Production Units.** ERP system has been implemented in the Integral Coach Factory, Chennai.

- **Energy Management System,** which is part of a project under the United Nations Development Programme focused on enhancing energy efficiency in the

the railways, targeting 15% energy saving by 2020.

- **Track Management System.** Asset management, rail and track monitoring and maintenance, ultrasonic testing, track renewal, patrolling, tunnels and bridges are part of this system implemented over 28 divisions.

5.0 FUTURE PROJECTS

The Railways is now planning a range of projects based on state-of-the-art technologies. Projects under execution include development of ticketing mobile applications, linking tickets to Aadhaar, using radio frequency identification (RFID) tags to track rolling stock, real-time train tracking systems using global positioning systems (GPS), setting up a geospatial database for the Railways, and establishing a state-of-the-art data centre to host the Railways' IT system.

Many more such initiatives are in the pipeline, which will over time lead to significant improvement in the functioning of the Indian Railways.

Numbering Systems: 1 Crore (Indian) = 10 Million = 100 Lakh (Indian)



²Ibid

Pitamber Verma, currently serves as Chief Project Engineer in the Web Applications Group at Centre for Railway Information System (CRIS).

Sudhendu J. Sinha oversees web applications and passenger reservation systems at CRIS.

The Ministry of Road Transport & Highways (MORTH) is the nodal ministry in the Government of India for development, upgradation and maintenance of national highways in our country. MORTH also acts as a nodal organization for laying guidelines, specifications and stipulations for overall development of roads and transportation systems in the country. It has also played its part in developing IT platforms that can help in integrating vast swathes of data and mitigating the demand-supply gaps of road users. Some of the recently developed technology platforms are ePACE, INFRACON, INAMPRO, and ITS, all of which are, in so many ways, roads to good governance!

ePACE

MORTH has a large number of capital works being done by multiple agencies with no single platform for accumulating and integrating data. Historically, every report entailed fresh acquisition of data, thereby tiring out the giver and the recipient. There was also no single central repository for project-related documentation. And then there was the inability to track projects through their lifecycles, leading to inaccurate measurements of physical and financial progress. Because of this, no project related information was in the public domain. There was a clear need for an integrated information system that addressed this problem and ensured effective and real-time tracking of the projects. ePACE (Projects Appraisal & Continuing Enhancements) has been designed as one such online platform.

The platform envisages data-entry at the top level for basic project data and target setting covering the entire lifecycle from project identification, pre-project activities and construction period. The data pertaining to physical and financial execution details can be entered at the field level, resulting in a single source of truth with validation checks.

ePACE has provision to obtain reports in multiple formats with graphical interface for round-the-clock monitoring. It has also been provided with GIS interface to enable easy geo-tracking of the projects. The application has a data export engine for feeding into other applications. The architecture of the application is scalable and customizable.

ePACE, as a platform, can be used for monitoring projects pertaining to any ministry or state in the country and can improve governance of such projects.

INFRACON

MORTH undertakes the development and upgradation of highways and other infrastructure projects.

For this, it procures and uses the services of consultancy firms and other domain experts (known as 'key personnel') in various fields related to highways and engineering, both for project preparation and supervision.

In order to make the evaluation process during procurement more objective, user-friendly and transparent, "INFRACON" has been developed as a comprehensive national platform for infrastructure consultancy firms and key personnel. The platform has the facility to host firms, personnel CVs, and credentials online, and has linkage to Aadhaar and Digilocker for data validation and purity.

The portal also enables the agencies within the MORTH facility to receive technical proposals through INFRACON. In order to do so, firms and key personnel are required to register on the portal online. This has resulted in significant reduction in paperwork during bid submission and also brought in transparency and accountability in the process. The information being captured on the portal and the input forms are so designed that it aids in automating the evaluation process and is leading to quick and effective decision-making. INFRACON as a common platform for both service providers and clients has also opened a window of opportunity for professionals engaged in the infrastructure domain to showcase their experiences and contribute to nation-building.

INAMPRO

This is a web-based application for Infrastructure and Materials Providers. It acts as a common platform for infrastructure material providers viz. cement companies, infrastructure providers, Ministry of Road Transport and Highways, and other stakeholders.

It has enabled contractors/cement buyers engaged in executing the central/state-funded roads and highways/ bridge construction projects to place cement orders online with the registered cement companies offering cement at competitive rates near project execution locations.

Cement companies can update their offers (stocks) with prices on the portal with prices. They get instant intimation about the orders placed and approve the delivery schedules as requested by the cement buyers without hassles and delays. This has helped cement companies plan their annual production in advance and schedule deliveries with better precision. Cement companies also have the facility to increase the cement stock offerings based on market demand and reduce prices to attract more buyers. Using INAMPRO, companies can also track orders, add more products (grade/ type), add cement offerings, view listed buyers, and submit their complaints/ suggestions to the Ministry.

Buyers can view and track the orders placed with different companies and also submit their suggestions/ complaints.

The Ministry is able to track and monitor the activities of buyers and suppliers, and remove impediments, in effect, accelerating the execution of infrastructure projects in the most cost-effective manner. INAMPRO has enhanced transparency and allows the buyers and material providers to have fair understanding of stocks, prices and orders placed.

Considering the success of INAMPRO, MORTH has decided to bring in all other materials required for infrastructure construction on this platform making it a comprehensive e-marketplace for infrastructure providers.

INTELLIGENT TRANSPORT SYSTEMS (ITS)

The use of advanced technologies including information and communication technologies (ICT) or telematics, data collection and storage, navigation systems and others, fall under the aegis of intelligent transport systems (ITS). The chief aim of using such technologies in road, traffic and transport sector is to alleviate existing concerns including traffic congestion, air and noise pollution, by enhancing data collection for addressing the transport-related concerns.

Use of such technologies can be both at a vehicular and infrastructural levels. Some broad categories of ITS technologies are:

- Automated Speed Enforcement
- Incident Management
- Electronic Toll Collection
- Traveler Information
- Vehicle Control Technologies

KEY BENEFITS ARE

1. User/ Passenger/ Driver Safety & Experience e.g. road safety, alerts & information, traffic congestion etc.
2. Road and related asset operations & maintenance for increased productivity, efficiency & environmental sustainability e.g. Road Maintenance, Highway Lighting & Digital Signboard upkeep, Air Quality etc.
3. Increased revenue streams from road and surrounding ecosystem e.g. Toll collection; connectivity hotspots; surrounding real estate for retail, eatery & leisure etc.

OUTLOOK

The success of the above platforms should pave the way for the development of other platforms for road users in the country.

Sanjay Jaju serves as Director (Finance/ Admin), National Highways & Infrastructure Development Corporation Limited.



The evolution and development of Information and Communication Technology (ICT)-based digital infrastructure in India started gaining momentum in the last decade of the last millennium. A few future-looking states implemented scattered and islanded initiatives on electronic governance, by deploying localised client-server based technology and applications, and with very limited use of Internet per se.

In real terms, the digital revolution in Indian government ecosystems started in the late seventies of the last century, with the National Informatics Centre (NIC) within the then Department of Electronics leading from the front. NIC developed and deployed many computerized applications using client-server and local area network (LAN) technologies for selected government services in the states. NIC also tele-connected all the districts and selected central government offices, with a combination of leased lines and very small aperture terminal (VSAT) based network named NICNET, essentially to facilitate video and data communications. Since that time other major triple-play (voice, video and data) countrywide government networks, like Education Research Net (ERNET) connecting educational and research institutes; State Wide Area Network (SWAN) connecting all the state capitals, district and block headquarters; and Knowledge Net (an enhanced version of the erstwhile ERNET) connecting around 1650 premier institutes of the country with as high as 1 Gigabit speed, were put in place with the support of the Central Government's Department of Information Technology. All these networks utilized, wherever necessary, the pan-India telecommunication backbone network (copper and optical fibre) established by Bharat Sanchar Nigam Limited (BSNL).

Development of soft and hard digital infrastructure in India went almost hand in hand with the development of Internet connectivity in the country. In other words, the digital infrastructure evolved following the Gartner maturity model for electronic governance. As in the first phase of the model, soft infrastructure of websites for most of the entities in the government and private sector got created, to provide the 'informational' services to the stakeholders. NIC was again loaded with the task of developing websites for all the government departments and their attached agencies all over the country.

The second phase of the infrastructure build-up started in the late nineties, when the static websites started getting converted into 'dynamic' 'web portals' to provide 'interactional' services to the stakeholders. At this stage, erstwhile hardcopy forms, templates etc, for service delivery and applications related to government and private agencies, were becoming uploadable or downloadable 'intelligent' e-forms, to facilitate two-way communication between the stakeholders.

At this stage, erstwhile hardcopy forms, templates etc, for service delivery and applications related to government and private agencies, were becoming uploadable or downloadable 'intelligent' e-forms, to facilitate two-way communication between the stakeholders. This became possible because of growing presence of internet in the country, thanks to the opening-up of the telecom ecosystem for private participation by that time.

The next (third) phase of 'transactional' services, brought in infrastructure for payment gateways established by government and private sectors, to facilitate financial transactions or e-payments across the country. In the course of time, the Government founded the National Payments Corporation of India (NPCI) in 2008, to facilitate large-scale e-payments across the country. The commercial banks, by that time deployed core banking solution (CBS) applications and related captive infrastructure, to carry out their businesses. National Security Depositories Ltd. (NSDL), through its sister agency NSDL e-Governance Infrastructure Limited, has also created another national-level supporting infrastructure in the country for Indian capital finance market for doing financial transactions digitally. Further, Securities and Exchange Board of India (SEBI) created its captive, highly secured, and internet-based pan-India network and data centres, to provide their various commercial products and services.

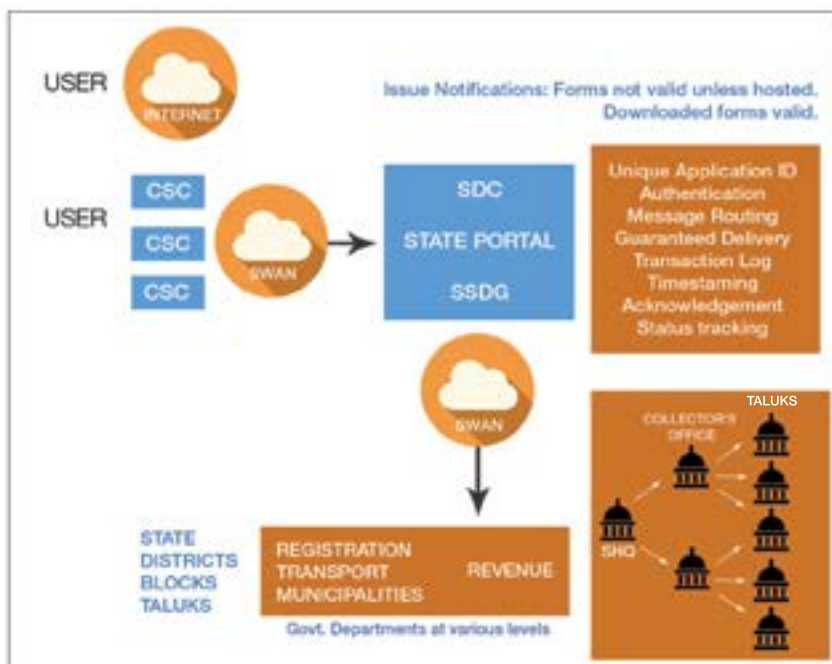
The fourth and the last phase of the e-governance maturity model defined by Gartner as 'transformational' services by a 'connected' government, is being implemented currently, in which citizen would see only one face of the government, and the services would be sought through a 'single window'. Implementation of this phase requires humongous digital infrastructure, which interconnects each and every department of the state and central government seamlessly, and integrates the business processes in such a manner that the government-to-government (G2G), government-to-citizen (G2C or C2G) and government-to-business (G2B or B2G) activities are carried out with automated workflows and minimum human intervention.

The Department of IT (now Ministry of Electronics and IT), in 2006, took Cabinet's in-principle approval for the National e-Governance Plan (NeGP), which outlined 27 Mission Mode e-governance Projects or MMPs (the number of MMPs now stands at 44) and 8 components of core and support infrastructure, to be used by most of the MMPs. Components of core infrastructure were designed in 3-tier architecture with the State Data Centres (SDCs) at the highest tier, the State Wide Area Networks (SWANs) in the middle and the Common Services Centers (CSCs) as the service delivery outlets at the lowest tier of panchayat headquarters.

SWAN was created as a secure closed user group (CUG) government network to deliver G2G and G2C services with minimum 34 Mbps speed (with some states going as high as 100 Mbps). It has a gateway to NICNET at state headquarters, to facilitate central services and inter-connectivity to other networks. SWAN also has connectivity to state and national data centres, and disaster recovery centres (DRCs). For many SWANs in the states, a public private partnership (PPP) build-own-operate-transfer (BOOT) business model has been adopted, with private network operators adhering to various provisions of a pre-defined service level agreement (SLA). State Data Centres consolidate various support infrastructure, services and applications, to provide efficient electronic delivery of G2G, G2C and G2B services. Common Services Centers (CSCs) at the village panchayat level, work as the front-end delivery points for government, private and social sector services to rural citizens of India, in an integrated manner.

A key support infrastructure element for the NeGP, the National e-Governance Service Delivery Gateway (NSDG), was established as a standards-based messaging switch. Its purpose is to provide seamless interoperability and data exchange across government departments. The State Service Delivery Gateways (SSDGs) ensure scalability, inter-operability between heterogeneous systems, authentication, assured delivery, message routing, transaction logs, audit trails, time-stamping etc. SSDGs are hosted in the respective SDCs.

With SDCs, NSDG, SSDGs, SWANs and CSCs positioned in a tiered architecture, local, state and central government departments provide integrated service delivery: the first step of a joined-up government, which is the fourth phase of the e-governance maturity model. The entire architecture routes service requests from a service seeker (service access provider – which could be a CSC or an internet kiosk etc) to a service provider (typically a back-end government department that offers its services by electronic means), and in turn, sends the response back to the service seeker through the gateway.



Ultimately, the aim is to provide citizens the facility to obtain the services online through different delivery channels, such as, home PC, mobile wherever applicable, interactive TV, internet-enabled kiosks and so on.

The India portal www.india.gov.in constitutes important soft infrastructure being developed and hosted by NIC and currently providing informational services for various ministries, departments and government-aided agencies to the citizen. This portal can be a digital gateway to our country for all types of services and transactions including financial transactions from any part of the world.



BharatNet (formerly the National Optical Fibre Network, NOFN), providing high-speed optical fibre connectivity to 2,50,000 panchayats, is being established by BSNL, PGCIL and RailTel (and, in BharatNet Phase II, by some State Governments). Optical fibre for hundreds of thousands of route-kilometres is being laid under the project, to facilitate implementation of the e-government projects in the social sectors like, education, health, public distribution, social security, financial and banking services, all fostering inclusive growth for the country. It would also provide a great fillip to the private sector, enabling private players to provide other services in remote places through commercially viable business models.

The recently planned Smart City programme of the government also promises creation of large scale state-of-the-art ICT-based infrastructure, laced with state-of-the-art front-end sensors, back-end secured data centres hosting AI, machine learning and other analytic software for automated workflow and processes to cater to city affairs. Further, the unique identity programme with its huge front and back-end infrastructure; the private sector increasingly creating infrastructure using the technologies of cloud computing, CPU sharing, thin client, edge computing, virtualization; the Government's 'Meghraj' cloud infrastructure for its national and state data centres, humongous mobile infrastructure increasing from current 4,50,000 mobile towers to a predicted number of over 5 lakh towers by 2020 (as per a study by Deloitte¹): all would be very significant components of the digital infrastructure for a connected society of the present and future Digital India.

¹Deloitte Touche Tohmatsu India Ltd. (2015). Indian Tower Industry: The Future is Data. Available at <https://www2.deloitte.com/content/dam/Deloitte/in/Documents/technology-media-telecommunications/in-tmt-indian-tower-industry-noexp.pdf>

Creating state-of-the-art digital infrastructure for a digital nation is a journey and cannot ever be a destination. With perpetually changing versions of hardware and software, and a constantly shrinking period of the currency of technology, this is one of the premier exciting journeys the nation has undertaken for public good.

Ashis Sanyal was formerly Senior Director in the Ministry of Electronics and Information Technology, Government of India. He is currently working as independent consultant in the areas of e-Governance programme design and management, capacity building, and ICT for development.



In view of the relevance of financial inclusion as a policy initiative to promote equitable growth, the Government of India has been taking various initiatives to provide access to finance especially for the poor, and to promote products and services which can be easily delivered to this segment. It is well understood that lack of financial products and services leads to social exclusion and, therefore, there is a need for special policy interventions to meet the expectations of a vast number of people, especially those living in rural India. The major components of financial inclusion are easily accessible points and centres, financial literacy and convenient financial products and services to support and meet the requirements of all sections of the society.

Traditionally, access to financial services has been provided through bank branches. The scheduled commercial banks including Regional Rural Banks have about 50,000 rural branches. In India we have more than 6 lakh villages and 2.5 lakh million panchayats. The existing rural banking branch network is inadequate to provide access points for financial services to every citizen, close the place of her residence. The number of branches per hundred thousand (100,000) population in rural areas is still less than half to that in urban areas. Aside from this limited number of access points, there is significant regional variation. The penetration of number of bank branches (traditional access points) in rural areas is often very low which lead to regional imbalances.

There has been an effort to promote business correspondents (BC) as an alternative to bank branches for providing financial service to people, especially those living in rural areas. The success of BC model in meeting rural communities' expectations of access to financial inclusion products and services is in consideration; there have been technological and commercial viability constraints in enabling a sustainable banking correspondent model.

The Government has been promoting the Jan Dhan, Aadhaar and Mobile Number (JAM Trinity) as an ideal opportunity to promote innovative delivery channels for financial services to citizens. Mobile tools including the Bharat Interface for Money (BHIM; using the Unified Payment Interface) have made significant progress in enabling people to access financial services in recent times.

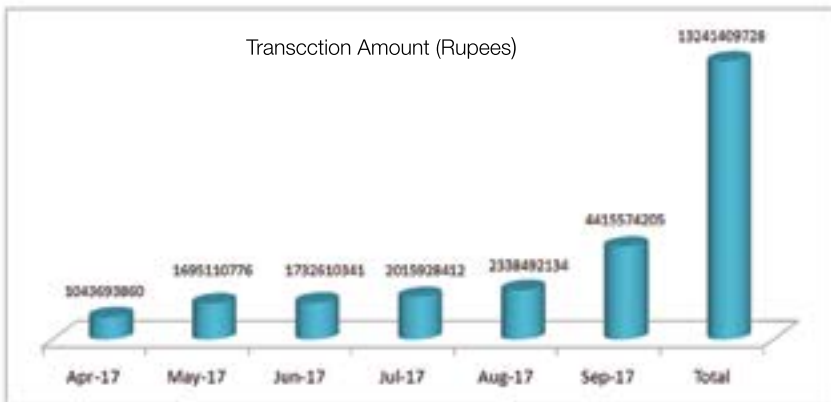
The other significant development in India has been the Aadhaar digital identity for every citizen which can be promoted and effectively used for creating financially inclusive society. The National Payment Corporation of India (NPCI) has promoted Aadhaar Payment Bridge System (APBS) which can be used by various financial entities for payment settlement. APBS has been validated as an important instrument for promoting financial inclusion.

The advantage of APBS for the population especially those living in rural India is that it is interoperable, uses biometric identification for transactions and is thus less prone to fraud; its technology is also very cost effective. Access point using the Aadhaar-enabled Payment System (AEPS) can be set up with a biometric device costing less than USD 50. However, the access point needs to have a computing device to support the Aadhaar transactions. AEPS provides the advantage of easy accessibility for a large section of the community. A citizen with an account at any bank can do transaction using his biometric authentication. Services that can be provided through the access point include deposits, withdrawal, balance enquiry, mini statement and fund transfer which meet the basic banking requirement of the citizens.

Over a period of time the facility can also be used for extending small credit to the needy including farmers, shopkeepers and other sections of the society which are hitherto uncovered under the formal sector of the finance.

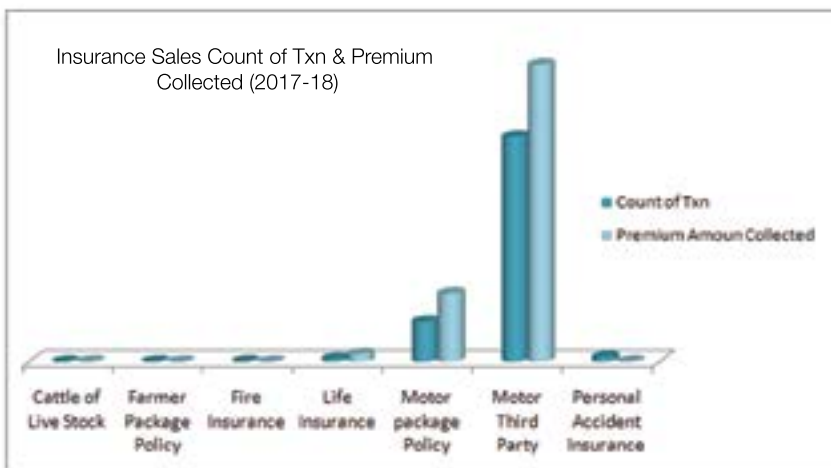
Common Services Centres (CSC) promotes Aadhaar access points operated and managed by local entrepreneurs and are integral part of "Digital India" initiative of the Government. It is envisaged to promote atleast one CSC in every gram panchayat – creating 2.5 lakh centers. Presently there are 2.7 lakh CSCs across the country, out of which 1.7 lakh are in the panchayat. These digital access points enable delivery of government to citizen (G2C) and business to citizen (B2C) services to the citizens close to their place of residence. Delivery of financial inclusion services is an important component of the bouquet of services identified for delivery through CSCs. All these CSCs are being promoted to use AEPS for providing banking services to the citizens. The progress of enabling the banking services through CSCs using AEPS has shown significant growth during the last six months. The details are as in Figure 1.





The availability of AEPS services through 2.5 lakh digital access points would create the geographical equity and remove regional imbalances in providing access point for a financially inclusive society. With the Government of India's emphasis on delivery of subsidies and incentives to citizens, the access point of CSCs using AEPS can enable appropriate utilization of the subsidy disbursements. CSC-AEPS system can help in disbursement of amount at the place of residence and solve number of issues relating to access. There are many examples of VLEs operating CSC who provide these services using AEPS to weaker, underprivileged, old, sick, infirm and backward sections of the society. As these are local entrepreneurs belonging to the same community or village, their acceptability in providing such services is greater in comparison to other modes of service delivery.

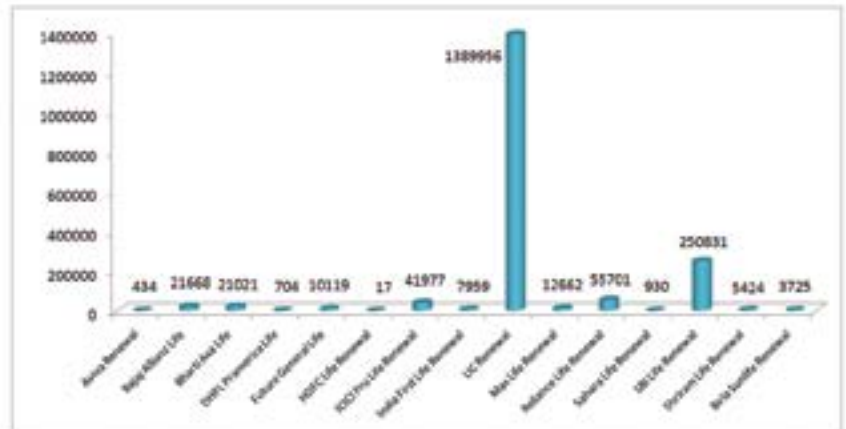
In addition to banking services there is also a need to provide insurance to rural citizens. Insurance Regulatory and Development Authority of India (IRDAI), recognising the vast network of CSCs, has released specific guidelines for enabling promotion of insurance products and services to citizen through CSCs. The progress in sale of specific products and services of insurance to citizens through CSC is depicted in Figure 2.



Insurance Sales at CSCs

The digital access points of CSC would significantly enhance the insurance penetration in rural India. The progress over a period of time has shown significant growth.

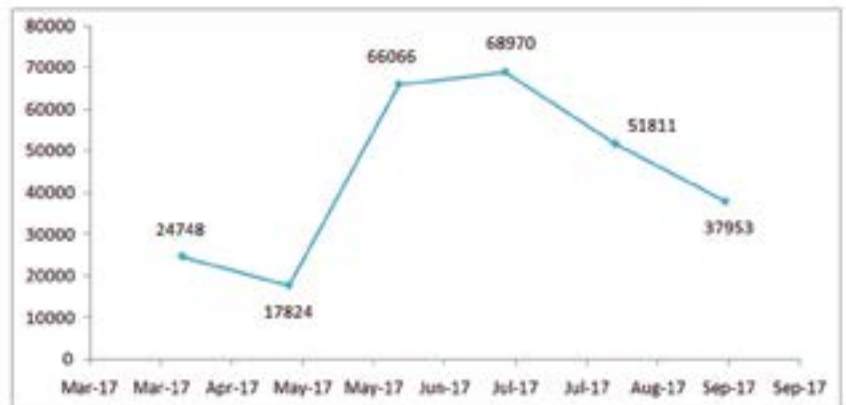
It is well known that India has a low insurance policy renewal rate, owing to the fact that the access point for enabling premium payment is not easily available to people living in rural India. CSCs enable collection of insurance premium for almost all insurance companies in India. The progress of insurance premium collection is as in Figure 3.



Total Renewal Premium collected (April -Sep 2017) - In Thousands

CSCs not only help the citizen in purchase of insurance product and services, but also support activities like the deposit, withdrawal, and renewal of premiums. This enhances the insurance penetration especially in rural India and meets the expectation of risk coverage for such population promoting financial inclusion.

Besides banking and insurance, the CSC also promote pension for unorganized and uncovered section of the society. The National Pension Scheme (NPS) is promoted through CSC to citizen especially for those living in rural India. People in rural India are also provided access for withdrawal of pension amount provided by State and Central Government under various schemes and programmes.



Monthly Trend of Transactions under Pension Services Apr 17 -Sep 17



Thus the unique feature of CSC as an access point is that it not only provides banking related services but also covers insurance and pension which are integral part of enabling a financially inclusive society. This has been possible due to Aadhaar, which has proved to be a unique instrument for promoting financial inclusion thereby leading to growth and equal opportunity for every citizen; and has significantly transformed the process, mechanism and delivery channel for financial products and services in India leading to an empowered society.. In doing so, CSC has become a unique example of creating access points for delivery of financial services and products to citizens in a geographical equitable manner across the country.

Dr. Dinesh Tyagi is Chief Executive Officer (CEO) of CSC e-GOVERNANCE SERVICES INDIA LIMITED (a Special Purpose Vehicle promoted by Ministry of Electronics and Information Technology). He was earlier CEO (CSC Scheme) with Infrastructure Leasing and Financial Services Limited.

Ref : <https://www.csc.gov.in/>

Our transformation

TO E-SERVICES - A TURNING POINT

R. CHANDRASHEKHAR

For decades on end, citizens have spent millions of hours standing in long queues, making innumerable appearances to get their legitimate dues or be served in some manner. The envisaged USD 1-trillion digital economy is an ambitious plan and a realm where there is no place for serpentine queues, lack of transparency or accountability and forced intervention of obsequious intermediaries.

At the heart of the matter is inclusivity. We want to build a society aided by technology which addresses digital divide, sustains development in a safe and secured manner, and upholds partnerships and collaborations through digital democracy. And finally, it should advocate dialogue to enable digital diplomacy between nations and weed out the unwanted elements that infest cyberspace. A cyberspace that is open, interoperable and unregimented.

Good governance is the key to a nation's progress, and it is also the fundamental promise of elected governments to its people. A little over 10 years back, the announcement of the National e-Governance Plan (NeGP) saw the country embark on a journey towards eGovernance in a programmatic way: a far cry from the ad hoc approach seen earlier. The "customer-first" mantra had witnessed its formulaic success in boardrooms earlier which arguably was the harbinger to the "citizen-first" approach that unfolded with the umbrella programme of Digital India three years ago, championed by our Hon'ble Prime Minister.

The Jan Dhan, Aadhaar and Mobile (commonly known as JAM) trinity has enabled this revolution in India. The common man today has a bank account, a unique identity and mobile connectivity. It does not matter if he is hundreds of miles away from the government. Almost all government schemes and benefits can now be availed online without queuing up or greasing the palms of intermediaries, thereby rendering the whole process far more transparent, stakeholders accountable and leakages plugged in the process. Just to give an example of the massive change, Aadhaar-based Direct Benefit Transfer (DBT) has been rolled out for 393 schemes of 56 Ministries/ Departments on-boarded which has led to Rs 57029 Cr (USD 8.77 Billions) being saved through weeding out of fictitious beneficiaries.

To reach the unreached or to bank with the unbanked is a challenge of gigantic proportions for a huge and diverse nation such as ours, one in which nearly 70% of the population is based in rural areas. Needless to say that it can only be achieved if access to infrastructure is ubiquitous. Towards this end, BharatNet has been the beacon of hope – more than 251,240 kms of optical fibre cable have been laid, covering more than 110,769 Village Panchayats against the targeted number of 250,000.

That "Last Mile Connectivity" is a rather slippery customer is now common knowledge. The Common Services Centers (CSC) network can be credited with addressing this issue, and in the last 3 years alone, the number of CSCs has trebled to exceed 3 lakhs or thereabouts today. Here, even the marginalized sections of society can take up entrepreneurial roles and provide critical services to rural citizens.

Since we are on the subject of rural India, it is noteworthy that technology has already made deep inroads into the agricultural sector. Tech-enabled solutions empower the farmers and enable extended market outreach. Farmers are better equipped today to know the true value of their yield and can access superior soil management techniques. The technology is quite complex and sophisticated which involves the Internet of Things (IoT), satellite-based solutions and the like. But, access to most of the information has been made fairly simple – through that humble palm-held device.

A developing nation faces many challenges. Well, that's one way of looking at it – staid and clichéd. But what if one were to suggest that these are billion-dollar opportunities waiting to be tapped – financial inclusivity, healthcare, education etc. to name a few. In almost all these areas, demand for services far outweigh the supply. Too few doctors, fewer trained teachers, insufficient banking infrastructure (physical), the list is endless.

Fintech startups augment the traditional banking, financial services, and insurance (BFSI) sector rather well. They leverage deep-tech like artificial intelligence (AI) and machine learning to offer personalized solutions. Financial inclusion is one of the pillars of the government's vision, and so the opportunities are rife. Though the competition is healthy, yet, there's a whitespace for collaborative approach with the incumbents alongside. Similar narratives can be woven for health-tech and edu-tech startups too. Online discovery of doctors, telemedicine, health e-Commerce, tech-enabled diagnostics are some such examples. Inasmuch, massive open online courses, popularly known as MOOCs, are making steady progress and helping students and professionals who do not have access to the best of teachers and teaching environment. Technology is being put to the forefront to bridge the gap between haves and have-nots. A whole new breed of young entrepreneurial startup founders are making dreams come true. Today, this ecosystem is powerful enough to claim its own at third position globally and doing the country proud.

The true marvel of technology is felt in its ease of use. However, easy as things seem at the foreground, there's always a very complex digital mechanism that's working feverishly at the back end to make it look all-so-easy though 'clicks'.

The array of deep technologies available can overwhelm the most scientific of minds today – social, mobile, analytics, and cloud (SMAC); IoT; AI; robotics; 3D printing; and blockchain; to name a few. If data is the new oil then arguably, analytics is the new refinery. The sheer volume, velocity and now the conspicuous third dimension – variety of data which is being generated, must be made sense of. Once again, billion dollar opportunities await us and this time seen through the lens of technology adoption. Each is transformative in its own way. But for now, and just touching the tip, suffice it to say that the cloud market in India is expected to be approximately USD10 billion; the IoT market, USD 15 billion; and AI, perhaps, USD 5 billion; in the next 3–5 years. All these technologies are galloping at high double-digit growth rates, as NASSCOM studies indicate.

The single, most pressing need before the IT industry today is about re-skilling the workforce with relevant skills in digital, and to ride a wave which is radically different from all others that we have successfully negotiated in the past. Re-skilling is a global imperative and it is not merely restricted to the Indian scenario though some overzealous arm-chair theorists would have us believe otherwise. NASSCOM Sector Skill Council has identified 55 new job roles in 8 technology areas that will be relevant for the future. The other aspect of training is about making the common man also digitally literate. Towards this, the National Digital Literacy Mission (NDLM) – launched in 2014 – has made steady progress towards empowering at least one person per household with crucial digital literacy skills by 2020.

The internet economy in India is one of the fastest growing; the last bastion of goods and services tax (GST) roll-out challenges is being conquered and the mammoth-sized machinery is well underway; the nation continues to be a very high consumer of electronic goods – can it finally establish itself as a global electronics research and development hub?

The USD 154 billion Indian IT business process management (BPM) industry which employs 4 million people directly, has achieved both breadth and depth; so the possibilities are vast. However, there are certain caveats that should be mentioned. Firstly is the threat of cybersecurity that looms large and ransomware attacks are but a wake-up call. Without further ado, we need to have data privacy laws firmly in place. Secondly, it is about the criticality of talent. This cannot happen in silos and requires the concerted efforts of the government, industry and academia. The delivery method has favourable options too. For example, setting up of centres of excellence, proliferation of company and government supported initiatives towards re-skilling, and, (who can undermine the importance of) self-learning in a graded manner. The common thread here is a collaborative approach and fostering an ecosystem for which all of us are responsible as equal stakeholders. The present government dispensation has already initiated business-friendly policies; and as NASSCOM, we continue to share our views. This is a journey or work-in-progress where all of us are co-travellers, constantly striving to address the challenges and any excuses of size, complexity, inequality and diversity.

With that and sustained agility, a USD 1 trillion digital economy, or a USD 350 billion IT BPM industry, are not only rightfully ours, but also well and truly within sights.

R Chandrashekhara is the current president of NASSCOM and former Secretary, (the then) Department of Information Technology, as well as former Secretary, (the then) Department of Telecommunications.





30

Enabling, linking & SUSTAINING E-ECOSYSTEMS

A S RAMASASTRI

Though the word ecosystem is closely associated with a biological community of interacting organisms and their physical environment, it can be generalised to be any complex network or interconnected system. With that extended definition, an e-Ecosystem can be conceived as a collection of government agencies, regulatory bodies, technology companies and start-ups working together to usher in digital era.

In countries like India, the major player in the development of good ecosystems, like banking, postal or legal, has been the State itself, especially during the early days of independence until mid-nineties. In the nineties, with the unfolding of a series of reforms leading to privatisation and globalisation, the role of the private sector has increased particularly in the financial sector. Simultaneously, there has been an unprecedented growth in two major industries – computing and communications, popularly referred to as information technology.

The degree of adoption of information technology since then has been phenomenally high across the sectors, mainly due to the free climate created by reforms. Government cleared the decks and paved the way. Entrepreneurs have taken the journey on a mission mode. A new ecosystem evolved. The growth story has been like a fairy tale.

After about two decades, during the past couple of years, the Government has stepped in again to take the country further on digital path. The rapid digitisation of all sectors requires development of a new order – new ecosystem. There are a few ecosystems to be developed to build a robust e-Ecosystem. The related such ecosystems are Innovations, Start-ups and Security.

INNOVATIONS ECOSYSTEM

Although it is difficult to define or describe what exactly an innovation is, most of us can recognize an innovation. An innovation is initially an excitement in the neurons of the human brain, which may later get translated into a design on paper and subsequently into a working model. When the model reaches a significant size of population in a usable form, then the innovation has reached its final stage of adoption. There can be slips at any stage during the journey from a flash in the brain to final adoption. The ecosystem should be such that the slips are minimized so as to ensure that a good number of useful innovations are not lost. A major reason for losing an innovation is the fear of failure. The organizations – both private and public – should learn to tolerate genuine failures. They should usher in innovative culture by encouraging the fresh and thinking minds to question the existing systems, come out with alternative solutions. Less inhibitive the employees, more innovative the organization.

Hunt for innovative ideas and solutions is an ongoing process. Innovation contests and hackathons can help a great deal. But identification of good solution alone is not an end by itself. Nurturing the ideas and providing necessary support that help the ideas to transform into products and services is very important. It is here the system of incubators play a major role.

It is essential to bring together academicians, who have been trained to question the existing systems and build alternatives as well as the practitioners, who have been trained to convert the lab models and usable solutions. Innovations ecosystem is based on the close collaboration between academia and industry professionals.

START-UPS ECOSYSTEM

There has been considerable discussions and deliberations on start-ups across the globe and equally so in India. It has also been observed that a large number of start-ups are dying even before they are fully born. There may not be dearth of thinking brains. But there may be a gap in converting ideas into solutions.

Most of the start-ups do not have adequate skills to market their product. They may not even get an appointment from both government and private sector. In a competitive market of tenders, they may not have the status to even submit the bid. Even if they do, they may not have skills to prepare responses to tenders.

Unless an ecosystem is developed which will ensure start-ups are encouraged with open arms for their ideas, they may wither away gradually. There is a need for guidelines from government agencies and regulatory bodies to help the start-ups.

There is a responsibility for major tech companies in this regard. In the overall interest of improvements in the digital products and services, they need to create a friendly environment around themselves to attract start-ups to supply their products and services to ultimate consumers through them.

The situation is akin to small and medium sector industry. As long as big companies take their support by sub-contracting their work, the small and medium sector industry is sustainable. A big steel plant in a city used to attract several small and medium scale industries around them, creating an eco-balance between big, medium and small.

Today the start-ups are to a great extent dependent on large tech companies. Support in the form guidance, sub-contracts, assured business alone can sustain start-ups. And start-ups ecosystem is no doubt an important constituent in the total E-Ecosystem.



CYBER SECURITY ECOSYSTEM

The more digital the country goes, the more cyber threats it faces and hence the need for greater cyber security systems. A country cannot afford to digitize all its transactions unless it assures the users reasonable degree of security.

Over the past few years, the need for building effective cyber systems has been recognized, especially by financial sector regulators and financial institutions. There has been considerable progress, though it is not possible to say at any point of time that the systems are perfectly secure and breach proof.

The attackers are motivated, young and talented. The defenders can never afford to be complacent.

Nations, over centuries, have learnt to build good physical security ecosystems in the form of military, police, judiciary and individual measures. While military protects the nation, police ensure security on roads and public places. Individuals build strong houses, security alarm systems and employ security personnel. Judges have acquired necessary knowledge and experience to deal with physical crime.

Cyber crime is a new challenge to most of the players. In India, several organizations have emerged at national level in the form of CERT-In and NCIIPC to take care of threats at national level and protect critical information infrastructure. Similarly, state police departments have been setting up cyber police special branches. But their scale of operations is still not adequate to meet the large scale growth in digitization and associated cyber threats.

There is a need to enhance redressal system through appropriate cyber judiciary mechanism. The system should be quick and effective. Digital forensics play a crucial role in resolving cyber crimes. We have a long way to go in this space. Individual organizations, like banks, building their own cyber protecting solutions may not be fully effective unless the entire cyber security sub-ecosystem develops well and fast.

DIGITAL ECOSYSTEMS

Development of an efficient depends on all the major players – Government Agencies, Regulatory Bodies, Technology Companies and Start-ups. The table below summarises the roles of enabling, linking and sustaining to Government Agencies, Regulatory Bodies, Technology Companies and Start-ups.

Dr. A. S. Ramasastry is Director of the Institute for Development and Research in Banking Technology, and was previously the Chief General Manager-in-charge of Department of Information Technology at Reserve Bank of India.

Leveraging technology is a potent way to solving India's problems, and indeed those of many other countries. Being a rather generic enabler, information technology (IT) is particularly well suited for this role. IT can bring about fundamental changes in everyday life, even with respect to problems partly rooted in semi-social and cultural aspects, through raising public awareness, helping citizenry visualize the positive overall impact of adhering to a societal code, monitoring the degree to which they do so, performing uniform and transparent evaluation against norms, and encouraging adherence through wide accessibility of this information. Indeed, these effects may be more pronounced in less developed countries, leading to greater public empowerment, economic growth, etc.

To realize this societal potential of IT, Government of India's Ministry of Electronics and IT (MeitY), has been conducting an experiment in India, called Information Technology Research Academy (ITRA). ITRA activities are focused on research and educational institutions, to help with: (1) building a good IT workforce, which is a valuable resource by itself, with a large and growing need worldwide; and (2) raising IT penetration in daily life. If IT professionals in various areas could recognize and harness the power of IT for problem solving and societal development in their own domains and ways, this could lead to higher societal productivity.

Below we summarize some aspects of the ITRA approach.

1. THE BASIC MODEL

1. Overall Objective. ITRA is designed to serve as a resource for advancing the quality and quantity of research and development (R&D) in IT, at a steadily growing number of academic and research institutions, while strengthening the academic culture of IT-based problem solving and societal development. Institutions are teamed up to form large centres of excellence and make an impact by solving major problems while performing necessary basic research, in specific focus areas chosen to respond to high priority needs in (i) IT or (ii) applications of IT in other engineering and non-engineering disciplines. The choice of problems is driven by societal needs and priorities, thus helping direct education and activities of the vast pool of national talent to nation building.

2. Definition of Quality. ITRA defines quality through four, quantitative measures

- a. Research: problem identification, formulation and solving
- b. Impact of research activity on enhancing curriculum and instruction

- c. Outreach, or deploying solutions and technologies to impact society
- d. Concomitant development of societal sensitivity, and thus a resonance to societal needs – to act as a powerful multiplier of the impact made by the measures above

3. Desired Attributes of Quality Enhancement to Address Identified Challenges. ITRA seeks to build

- a. Scalability: to include a very large number of institutions, from across India
- b. Intra- and Inter-Institutional Teamwork: to have institutions work in teams
- c. Inclusion of Diverse Institutions: so, institutions from many levels can play fulfilling and self-esteem building roles in the teams, and all move up the quality chain
- d. Research Drive: to instil a quest for research and deriving contentment from it

4. ITRA Model to Realize the Desired Attributes

The ITRA model builds the desired R&D culture in the institutions where it is active, by identifying important focus areas, developing a roadmap for them, defining and financially supporting large research projects, carried out by teams of ITRA institutions (IIs), in ways designed to help them meet the challenges and attain the attributes listed above:

- a. Towards 3(a), a team starts as a group of pyralets (2-layered pyramids) of IIs, each with a Lead II (LIN) at the top and 2-3 Partner IIs (PINs) below – PINs slightly trailing the LIN in quality. Each PIN improves in quality by learning from its LIN, and raises quality of its own PINs. After about 2 years of induction, each PIN in turn adds 2-3 PINs of its own, serves as their LIN, while continuing to be a PIN of its own original LIN. By adding one layer every 2-3-year-cycle, the number of IIs in each pyramid grows exponentially. Through the omnipresent activities of each II simultaneously mentoring as well as being mentored, each pyramid rises in quality while adding fresh IIs at the bottom.
- b. Eminent researchers are included as mentors, and mandatory parts of the teams.
- c. Eminent industrial experts are included as translators, and mandatory parts of the teams.
- d. Concrete programmes aimed at 2(d) and opportunities through 2(c) and 4(b) naturally lead to 3(b,d).
- e. Team based targeting of 2(c), and 4(c), enable IIs to excel in different roles, which helps achieve 3(c).
- f. Strengthening of 2(a) along with 4(b,c) are well known to directly lead to 2(b).

5. A SUSTAINABLE ECOSYSTEM TO IMPLEMENT THE MODEL

ITRA proactively and continuously works with the teams to maximize their performance metrics. It identifies the teams' needs and available opportunities, and arranges for necessary resources and pyramid-wide access to them. It provides an administrative, technical and financial ecosystem for effective and sustainable R&D.

- a. Encouraging ambitious goal-setting through awards for out-of-the-box proposals
- b. Attracting undergraduate students to advanced R&D (Masters, PhD, etc.) programmes through project internships
- c. Attracting fresh PhDs or senior researchers from around the world to join ITRA teams as faculty
- d. Attracting world renowned experts to get involved with ITRA teams as members, mentors, collaborators, thesis guides and translators while implicitly serving as a source of inspiration
- e. Enabling exposure of teams to global researchers and practices through international programmes
- f. Organizing frequent intra-team as well as inter-team meetings - 4 times a year.
- g. Recognizing faculty, students, experts, teams, etc., annually with major awards for notable advances (self-improvement) with respect to ITRA Quality Metrics and Desired Attributes
- h. Involving less advanced IIs in a team for field implementation of team's ripe solutions
- i. Facilitating outreach by helping connect government, industry, NGOs and others having problems and domain expertise, with existing focus area communities or forming new ones
- j. When relevant, encouraging projects to solve local problems, e.g., within easy reach

6. EXPECTED OUTCOMES

ITRA seeks to generate measurably steep and steady increases in:

- a. Quality of all IIs in the pyramid
- b. PhD, MS enrolment
- c. Capacity to produce quality faculty, other researchers and industrial innovators
- d. Societal impact of BS, MS, PhD work
- e. Ability, enthusiasm, engagement and satisfaction of IIs in spotting and solving societal problems
- f. Publications, patents, recognitions and engagement in professional societies
- g. Innovative solutions, startup /transfer technologies
- h. Global standing of each IT or Non-IT activity as a centre of excellence
- i. Rise in world rankings of the IIs
- j. Academic opportunities for late bloomers
- k. Diversity of available career paths
- l. Geographical spread of development

For IT and IT-enabled problem solving, ITRA is designed to simultaneously act as: an IT knowledge bank and think tank; a catalyst for raising generations of IT-equipped, technology-proficient, societally-sensitive researchers; and an engine of economic activity, driven by the vitality of action, intellectual prowess, emotional energy, and ultimately, the societal empathy of the researchers.

2. RESULTS OF THE PILOT IMPLEMENTATION THROUGH JUNE 2016

a. Pilot's Scope. ITRA identified four pilot focus areas of R&D and associated problem solving. Two of these, namely, (a) Mobile Computing, Networking and Applications, and (b) IT Innovations in Sustainability of Water Resources, were launched in January 2014. The other two, (c) IT Based Transformations in Indian Agriculture and Food and (d) Human Simulator for Amyloids Related Diseases, developed in collaboration, respectively, with Indian Council for Agricultural Research (ICAR), and Department of Biotechnology (DBT), are under development. Initiating a new area entails launching 3-year activities of multi-institutional teams.

b. Results from Pilot Focus Areas (a-b): The pilot-ecosystem has:

- a. 55 research groups/institutions
- b. 100 faculty/researchers
- c. 43 Mentors (eminent researchers and Translators (research to industry) from India and abroad
- d. 135 PhD students
- e. Led to 290 papers at reputed venues, 40 new/modified courses, 58 workshops, 11 researcher visits abroad
- f. About 17 technology prototypes in various stages of transfer-readiness.

g. Overall Performance/Impact of ITRA Model. The performance of the teams was measured with respect to each of the four original quality measures, in terms of about 25 detailed parameters. The team performance data for these parameters was collected over the 3-year project period. Impact of the ITRA model on the team quality in each parameter's area was estimated by comparing the combined team performance data with those for the 3-year period just preceding the project period, and calculating the gain in each parameter. Representative impact was then considered as the median of the about 25 gain values (i.e., the gain value which has equal number of gains above and below it).

The data collected through June 2016 shows that the median gain in team performance is 1.75, i.e., in half the parameters the teams have made higher gains than 1.75 and in the other half of them less. The smallest two gain values are 1.06 and 1.13, and the largest two are 4.62 and 8.50.

c. Results Expected from all Four Pilot Focus Areas on Completion: The ecosystem formed by all four focus areas is expected to amount to:

- a. 160 research groups/institutions
- b. 220 faculty/researchers
- c. 100 domestic and international Mentors and Translators
- d. 300 PhD students
- e. About 30 technology prototypes

3. MODEL FEATURES THAT REMAIN TO BE FULLY IMPLEMENTED

1. Transfer/Startup technologies: Demonstrations and discussions continue to be held with a number of industrial organizations, government departments, VCs, Angels, potential CEOs, ultimate users, etc., to identify the exact enhancements needed to take the current lab prototype to field prototypes ready for conversion to deployable solutions.

2. Deepening the Pyramids: Addition of the first new layer of institutions to the initial pyramids is yet to be implemented.

3. Execution Mechanisms: ITRA's features involving recognition of team performance, international activities and interacting with external organizations are yet to be implemented.

4. BEYOND THE PILOT - NEW FOCUS AREAS

There are numerous nationally important problem areas (e.g., those overseen by various domain ministries in the government) in which there are well recognized, IT-hungry needs, but the ministries/departments may be unable to provide the required IT expertise. These may be chosen as new ITRA focus areas in collaboration with the domain ministries. ITRA model could thus be used as a cookie-cutter, to develop vibrant communities in all significant areas, with the quality and attributes of the model. These communities may serve as resources of domain excellence, knowledge exchanges or think tanks. They may already possess answers to unanticipated questions, or may be able to quickly find them. Our experience of working with ICAR has shown that such domain based intense collaboration is not only very productive in addressing real problems but also feasible within the government system. There is much alignment of such views with, e.g., Ministries of Power, Water Resources, Human Resource Development, Petroleum and Gas, Defence, Health, Railways, and Textiles, and the National Disaster Management Authority.

To illustrate, if 20 focus areas were to be implemented (say, realistically, one per quarter), then based on the results of the two focus areas to date, the 20 areas will yield an estimated minimum of:

- a. 600 active research groups/institutions
- b. 1000 active researchers
- c. 1500 PhDs
- d. 150 transfer/start-up technologies

The solutions arising from these 20 areas may be expected to form a critical mass, capable of demonstrating the influence 'IT-in-X' research may wield on the state of affairs in many societally important sectors. Simultaneously, domain ministries would find better solutions to problems in their sectors. Since startups are designed to target important problems, they would be well aligned with the Digital India, Startup India Standup India, Make-in-India and Skill India initiatives. As suggested by the quality of pilot activities, the proposed plan may be realistically expected to put a large number of advanced Indian institutions on the world map as centers of excellence in education/research, and more importantly, greatly strengthen a culture of developing and deploying solutions to Indian problems, with the graduates becoming job providers instead of job seekers.

Prof. Narendra Ahuja is Director, Information Technology Research Academy, Ministry of Electronics and Information Technology, Government of India; and Research Professor at the University of Illinois at Urbana-Champaign, USA.



The world is truly transforming into a global village: one in which frontiers hardly matter, especially for goods and services. Today, boundaries are relevant mainly for people, and even in this, there is free movement between some countries. As far as trade is concerned, barriers are mostly minimal. Apart from global compacts made through the World Trade Organisation, there are Free Trade Agreements between countries or amongst groups of countries. With little or no border taxes added to imports, products made in one country have to compete with those manufactured elsewhere. As a result, competition is now global.

In such a situation, companies and countries are always looking for ways to keep their products or services ahead of others. In the past, this competitive edge came from cost, speed or quality. This is what propelled India's IT industry to become the unquestioned world leader for outsourced services. Our magic mantra was "cheaper, quicker and better", and we continue to deliver this extraordinary combination even today. While some countries may compete with India on cost, others on quality, and a few on speed (which requires large talent pools), none of them is quite able to match India's unique capability of delivering on all three together.

The world of technology is, however, changing. Automation, artificial intelligence, machine learning and robotics are making rapid advancements, taking on ever more complex functions, and replacing humans not only in routine tasks, but also at higher levels of the value chain. As a result — thanks to both technology and its decreasing cost — wage rates no longer matter, and the traditional cost advantage of getting work done in India as opposed to, say, Europe or the US, may be disappearing.

Further, automation ensures speed and quality that is at least comparable, if not superior, to what humans can deliver. Thus, with these new technologies, one can ensure the same quality and speed, at the same (possibly lower) cost anywhere in the world. Consequently, any competitive edge that was location-specific may not last for long. This does not mean that AI, robots and other synergistic technologies are going to immediately take over all existing tasks and displace the entire workforce. Quality, cost and speed will continue to depend on the availability of talent. India's triple advantage will continue to propel a large part of the country's IT industry for quite some time, maintaining its competitive advantage.

Though yet small, a rapidly growing proportion of all work will, however, see the use of new technology, and this will pose a challenge to the present paradigm of the tech industry.

The importance of location will start decreasing as ever greater amounts of knowledge transitions into machines, so that "talent" becomes machine-embedded, and far more portable than human talent. This will also make costs substantially location-agnostic.

What, then, are going to be the differentiators in this new world? The answer has been visible for a while now. As technology creates a "flatter" world with little spreads in cost or quality, the true competitive advantage will lie in innovation. Innovations in processes and business models, along with innovation in products and services, will be the differentiators that will attract customers and matter to them.

Innovation has been the buzzword since long, and its seemingly unending shelf life is a measure of the substance and seriousness behind the concept. Little wonder, then, that it continues to be a hot topic everywhere from corporate boardrooms to government conference rooms. Boards everywhere are formulating and reviewing innovation strategies. Governments in many countries have an innovation policy and some even have ministries of innovation. In academia, innovation is now a hot topic for research, and bookshops around the world are well stocked with 'innovation' titles.

Clearly, innovation is no passing fad. It has become a core factor of production: an input whose importance is increasing rapidly. The world transitioned from land-labour-capital to labour-capital-technology during the Industrial Revolution, and later to talent-capital-technology. Now, it is talent-technology-innovation that acts as the primary driver. The "knowledge economy" is widely spoken about, but we are now entering the era of the "innovation economy". The most visible evidence of this is any current list of large and fast-growing companies.

If the future is about innovation, who are the likely leaders, the winners that outcompete others? Almost certainly, it will be those countries in which innovation blossoms and who have the capability of converting innovative ideas into products or services that can be scaled for global markets. This requires an ecosystem that encourages, nurtures and supports innovation; an innovative society. It also needs to have the requisite human and other resources to operationalize and scale-up innovative products or services. It is in this context that India is well placed. It has the potential of being a major global innovation hub and of capitalising on innovation as an engine for accelerated economic growth. (Innovation could have an even bigger impact in the social sphere, but that is not the theme here.) Many factors give one the confidence to assert India's advantageous position, and some of these are outlined below.



India has already won wide recognition as a base for innovation, belying its ranking in the Global Innovation Index (up 6 places, but yet at 60 in 2017). Such indices are very useful, but have their limitations. In many ways, the market is a far better indicator and it clearly sees India as a great bet for innovation. Already over 100 of Fortune 500 companies have set up innovation centres in India.

Spanning the range from improvisation to invention, India has a wide spectrum of creative capabilities. "Jugaad" has now become a known word in the global lexicon. Though often identified with innovation, it is typically a non-scalable, "band-aid" improvisation which solves an immediate problem. Yet, the phenomenal amount of Jugaad in India – especially at the grassroots level – is indicative of highly creative minds that can come up with great ideas for solving a pressing problem. Jugaad is primarily the result of one of the major drivers of innovation: adversity. Given that this is, unfortunately, yet common in India, it results – fortunately – in fostering a lot of creative ideas.

While adversity is not uncommon across the globe, India has an almost incomparable advantage in that other big driver of innovation: diversity. India's huge diversity, across almost any dimension one can name (language, ethnicity, cuisine, religion, culture, appearance, etc., as also its geography), means that people are used to all kinds of differences; therefore, thinking "differently" is also acceptable and taken in one's stride.

Diversity is but one dimension – albeit a somewhat uncommon one – of India's 3D advantage apropos innovation. The second is democracy, which, through its acceptance of dissent and free thought, facilitates the freedom to think differently, to question the conventional and the "given". This is certainly the starting point for creative thinking and is facilitated by the country's diversity, which makes "different" thinking acceptable and even natural. The third "D" is demography: India's large and yet-growing young population (about 45% under 25 years by 2020) enables the energy, dynamism and natural rebelliousness of youth to be a vast reservoir of innovation.

India is already a major entrepreneurial power, with the third highest number of tech start-ups. A majority of these have necessarily to be innovative, otherwise they will be in no position to take on existing players. Many of them are working on completely new products or services.

The government's Start-up India initiative has given a huge boost to this entrepreneurial movement through funding and more relaxed regulations. The overall ecosystem too has evolved over the years, with angel funding, VCs, mentors, incubators, accelerators and co-working spaces greatly facilitating the setting up, sustenance and growth of such ventures.

Adding to this is another government programme: Make in India. This provides the impetus to manufacturing that may emerge from innovative ideas. Underlying all this, is the vital base of human talent, which includes the capacity of graduating 1.5 million engineers a year. This adds each year to the existing stock of experienced technologists already in the field, and a very extensive network of R&D institutions in a very wide range of disciplines. Marrying this to India's known strengths in the creative sector (especially cinema, dance and music) and design makes for an unbeatable combination for innovation.

As businesses across sectors adopt the new digital technologies, with AI, machine learning, social media, big data analytics, cloud and robotics entering the mainstream, it is those who can deliver in these areas who will be the winners. This certainly poses challenges to the tech industry, but also throws up vast opportunities. Capitalising on these will require a large pool of high-order talent and a great deal of innovation.

The ambience of adversity, the advantage of its three Ds, a strong industrial, creative, technological, and R&D base, and a well-developed ecosystem, position India very well. In a short time, it will certainly become a global innovation hub, especially for technology.

In the world of tomorrow, where innovation and talent are going to be the biggest differentiators, India has a competitive edge that is both unique and sustainable. If it plays its cards well, as doubtless it will, it is well placed to be a winner.

Kiran Karnik, an independent strategy and policy analyst, is ex-President, NASSCOM. He is the author of 'Crooked Minds: Creating an Innovative Society' (Rupa, 2017).

¹The SAGE Handbook of International Higher Education edited by Darla K. Deardorff, Hans de Wit, John D. Heyl

THE TECHNOLOGY AND BUSINESS CONTEXT

We live in a hyper-connected world. Everything and everyone that can communicate through the network will communicate through the network: person-to-person, person-to-machine and machine-to-machine. Our current era is ‘the fourth Industrial revolution’ where there is a growing interplay of the physical, digital and living worlds. If the earlier industrial revolutions were driven by steam power, mass production and the advent of computing respectively, ours is being shaped by multiple digital forces and their network effect.

This is profoundly affecting businesses, and society at large. We in TCS are helping our global clients through the journey into ‘Business 4.0’. Today, ‘the born digital’ industries and specific companies are able to leverage technology, to tailor and mass-customize experience for hundreds of millions and sometimes billions of customers. They are able to create exponential value, by leveraging ecosystems and having a nuanced view of business risk. Most importantly, they have a mind-set of abundance – removing constraints with an abundance of resources.

From being a tool that drives efficiency in business, technology has become the business driver, shaping the business model. This is a disruption with many consequences: It has accelerated cycles of technology change and advances; it makes greater demand on networks in terms of connectivity, bandwidth and increased complexity. From the perspective of end customers, it has created the possibility of extreme personalization; expectation of 24 * 7 availability through multiple channels. This has forced businesses to stay agile and completely customer focused. While process maturity will do a lot for global businesses, Business 4.0 demands more. The levers for success today depend on a digital backbone and the quality of insights that data can bring. With the volume of data that is being spewed, self-learning systems and automation become critical. These help businesses focus on delivering the best customer experiences.

INDIA'S COMPETITIVE EDGE

Since India is both a market and an exporter in this changing world, how well are we equipped to perform in a hyper-connected world?

Historically, we have done well. Information Technology has played an important part in India's growth story in the past four decades. It contributes approximately 9% to the GDP¹. We have a 55% share of the USD 150 billion global IT and BPM sourcing market². We have a robust local market, USD 48 billion³, with rapid growth potential. Indian IT Industry is still posting double digit growth.

We have maintained a competitive edge in the global IT services space with respect to cost and increasingly with value. As a sector, we are a large employer, offering around 3.7 million jobs. We have over 600 offshore development centres (ODCs) catering to business from 78 countries. The sector accounts for the largest share in total services exports (38%).

We have a well-articulated vision. National Policy on Information Technology 2012 aims to increase the revenues of IT and BPM industry to USD 300 billion by 2020. The policy also seeks to achieve the twin goals of bringing the full power of Information and Communication Technology (ICT) within the reach of the whole of India and harnessing the capability and human resources of the country to enable India to emerge as the global hub and destination for IT and BPM services by 2020. Simultaneously, the Digital India vision seeks to make: digital infrastructure as a core utility to every citizen; governance and services on demand; digital empowerment of citizens.

India has shown great capability in building technology excellence. Apart from established players in the technology space, about 15,000 firms⁴, we have a vibrant entrepreneurial ecosystem that boosts the country's competitiveness. Start-ups tend to be involved in cutting edge technologies, innovative and with a young workforce, NASSCOM-Zinnov Report (2015)⁵ states that India is the “third largest base of technology start-ups in the world (2015)”. The report also records a big jump in incubators (numbering 110) with a USD 5 billion funding, just in 2015. With eight out of ten investors coming from outside India, global investors are betting on Indian start-ups. Established players have also adopted open innovation, providing market and technology diligence to start-ups.

However, being a populous country, where agriculture has been the backbone for centuries, moving to a fully digital economy will take concerted effort. Areas that need attention are rightly outlined in the theme of the GOCS-2017 conference: inclusion, safety, security and sustainability.

¹<http://meity.gov.in/content/fact-sheet-it-bpm-industry>

²NASSCOM-BCG “India-Tomorrow-Transformed-by-Innovation-n-Technology” Report, 2015; http://www.nasscom.in/sites/default/files/uploads/temp/India_Tomorrow_Case_Study_2015.pdf

³ibid

⁴<http://meity.gov.in/content/fact-sheet-it-bpm-industry>

⁵http://www.nasscom.in/system/files/secure-pdf/Startup-India-2015-report_0.pdf

INCLUSION

Digitized identity in terms of Aadhaar, growing coverage of eGovernance and the Government's effort in increasing digital transactions (the BHIM app for instance), increase transparency and prepare Indians to participate in the digital economy. TCS has partnered a number of banks to take digital services to the doorstep of the unbanked to increase inclusion. While financial inclusion is the biggest task on hand, digital technologies can drive further inclusion of the differently abled with mainstream processes by adopting universal design in technology. The "Sugamaya Pustakalaya", an online library for persons with visual disabilities, is one such effort supported by TCS. The library houses publications across diverse subjects and languages and multiple accessible formats. Over 2 lakhs books in diverse languages. Integrating libraries across India and the globe, including the largest international library, 'Bookshare'. A visually disabled person can access all the books in the library at a click of a button and can read the publications on any device of choice: mobile phone, tablet, computer, DAISY player or even in braille.

Inclusion at another level – technology innovation for the people, by the people – is being demonstrated in India.

SAFETY AND SECURITY

Cybersecurity becomes paramount in a hyper-connected world. Online crime can trigger anything from harmful gaming and data thefts to cyber-attacks on critical national infrastructure. The Global Cybersecurity Index puts India in the 23rd place⁶ in cyber-preparedness, clubbing it with nations that are maturing with respect to cybersecurity. Assessing the country across multiple pillars of cyber security: legal, technical and organizational capacity building, multiple assessments place India among the "countries that have developed complex commitments, and engage in cybersecurity programmes and initiatives." India has developed its cyber security policy in 2013 and it offers a framework for cyber security. Recent partnerships with countries with expertise in this technology will hopefully fortify the country's cyberspace.

On the positive side, Indian IT firms have been providing cyber security services to global clients. We have expertise in providing managed security services, identity and access management services, implementation services, enterprise vulnerability management and governance risk and compliance management services. We also have a large pool of experts who are trained in security management services.

To enhance safety, educating users on safe use of the web and protecting data will go a long way. Similarly helping professionals understand IPR protection and respect for copyrights will increase our credibility in the global market.

SUSTAINABILITY

Disruptions shake up status quo and threaten sustainability of businesses. Business 4.0 is no exception. With automation, machines gaining the ability to learn and exhibiting "cognition", what of the industry's competitiveness?

I would like to observe that the Information technology industry has seen, not one, but quite a few inflection points in its existence.

The Y2K opportunity, the eBusiness boom and the financial crisis in the USA have all seemed like make-or-break moments threatening sustainability of the industry, or have offered new opportunities. The industry has grown stronger by meeting each of these challenges. Not with complacency; but with agility and preparation.

As for other dimensions of sustainability such as social and environmental, digital technologies can play a significant part. Prime Minister has himself said "Social media is reducing social barriers. It connects people on the strength of human values, not identities."⁷ E-governance programmes, computer-based adult literacy applications, cloud-based learning and assessment platforms, cloud-based healthcare applications and financial inclusion applications have a large social impact. In conserving the environment, digital technologies can make a big difference. Precision agriculture, energy management, water management and leakage prevention, disaster management, wildlife inventory and conservation are proven areas.

CONCLUSION

Several factors make me feel optimistic and enthusiastic about our local competitive edge in the global market: as a nation we have a vision for Digital India; we will continue to improve infrastructure and security frameworks.

We have a huge pool of educated youth; we have many budding entrepreneurs who would like to take risk and create radically new applications; and investors are willing to bet on our industry.

While technology is changing, contextual knowledge that established players in our country have, will create an edge over competitors. Technology is the single biggest demand driver all over the world, in every industry. We have the capability to deliver this, with excellence.

Rajesh Gopinathan is the Chief Executive Officer and Managing Director of Tata Consultancy Services (TCS).

⁶ https://www.itu.int/dms_pub/itu-d/opb/str/D-STR-GCI.01-2017-R1-PDF-E.pdf

⁷ <http://indianexpress.com/article/india/india-news-india/full-text-pm-narendra-modis-speech-at-digital-india-dinner-in-silicon-valley/>

1. THE CHANGING FACE OF INDIA'S ELECTRONIC MANUFACTURING INDUSTRY

1.1 After the twin revolutions in IT and telecom sectors, the story of electronics manufacturing in India is attracting global attention. India's emergence as an electronics manufacturing destination is an important component of "Make in India", and cannot be ignored. A large number of major electronics manufacturers have invested in India in the last few years. But more importantly, when any major electronics manufacturing decision is being taken in any part of the world, India is increasingly and invariably featuring as an option.

1.2 The situation a few years back was very different when India had become largely an importer of electronics products. Due to the onslaught of various unfavourable forces for manufacturing in India, like zero import duty, poor manufacturing ecosystem, high costs of power and finance and high transactional costs, the domestic industry, unable to face competition from global majors, had withdrawn or was in the process of withdrawing. The import bill for electronics was growing at alarming proportions resulting in critics saying that electronics would become the single largest item of import in the country, ahead of oil.

2. INDIA'S ELECTRONICS OPPORTUNITY

2.1 The growth opportunity for electronics manufacturing presented itself due to high growth rate of electronics products in India in the new millennium. Propelled by young demography of India, growing incomes, growing middle class, and increasing adoption of technology with growth in IT/ITeS and telecom sectors, India witnessed growth rates of nearly 20 to 22 percent for electronics demand. This trend has largely sustained over most part of this millennium. Digital India has been a big driver of growth in electronics demand in the country. With 1.18 Billion Aadhaar, 1.19 Billion mobile phones and 1.06 Billion bank accounts, the foundation for inclusive digital society has been made. Aadhaar has led to big push in authentication devices. Digital payment has given a fillip to PoS devices. The 180 GW solar energy production agenda has created a huge demand for solar cells and modules. India's plan to promote e-vehicles and develop 100 Smart Cities, 50 new metro sub-urban train networks, high speed Bullet Train, are other Governmental initiatives which are driving the electronics demand.

2.2 The 'India opportunity' also became more attractive with global pressure on population. For a two trillion dollar plus industry and growing, the human resource requirement for workers is large.

With the world experiencing an aging population and growing wage levels, many companies started looking at destinations where the future of electronics manufacturing could be housed, apart from China, which was already accounting for over one-third of global electronics manufacturing. India, with over 800 million people in the working age group, wage rates which were nearly half of that in other parts of the world, presented an attractive alternative.

3. EMPHASIS ON QUALITY

The revival of electronics manufacturing was started with the National Policy on Electronics 2012 and was strengthened under the "Make in India" and "Digital India" programmes of the Government. Under "Make in India" Prime Minister Narendra Modi gave a call for "Zero Defect, Zero Effect" and India hallmarked itself as a manufacturer of good quality electronics products with top quality electronic manufacturers including the likes of Samsung, LG, Apple, Bosch Panasonic, GE, to name a few started manufacturing in the country.

4. ATTRACTIVE INCENTIVES FOR INVESTORS

4.1 India offers attractive incentives for potential investors in electronics manufacturing. These include capital subsidy for investments made under its Modified Special Investment Promotion Scheme (M-SIPS). This capital subsidy is 25 percent of investment made in domestic area and 20 percent of investment made in the Special Economic Zones. For ensuring that state-of-the-art infrastructure is available for world class manufacturing is available, under its Electronics Manufacturing Clusters scheme, 50% of the cost of common infrastructure is provided by Government. The amount available for this purpose is subject to a ceiling of INR 50 crores (approximately USD 8 Million) for every 100 acres. Under its skill development scheme, support is provided to train people for the specific skillsets which a manufacturer may require. Under the Electronic Development Fund, support is provided to Venture Funds and Angel Funds looking to support start-ups in the area of electronics, IT and Nano-electronics etc.

4.2 Ease of doing business has been a great enabler in making India the next big emerging electronics manufacturing destination of the world. Recently, World Bank announced that India climbed 30 positions in last one year in its Ease of Doing business rankings, the largest jump in one year by any country. In the last 3 years, India has climbed 42 positions in this global world ranking in ease of doing business. Starting a company, getting permissions to start a business, opening bank accounts, and in multiple other areas, the companies find India a hugely improved country.

Apart from generic ease of doing business, the Government has also rationalized the tax structure. Previously, the tax structure was inverted. Components were imported at higher tax and end products at lower tax for several products. The rationalization of taxes further added to creating a favourable environment for manufacturing in the country.

5. SUPPORT FROM INDUSTRY

The manufacturing of electronics manufacturing was aided by proactive support from industry associations in the area including sector specific industry associations like the Indian Cellular Association (ICA), Indian Electronics and Semiconductor Association (IESA), Consumer Electronics and Appliances Manufacturers Association (CEAMA), Electronics Industries Association of India (ELCINA), Manufacturers Association of IT (MAIT), and many others who I do not mention for want of space. These industry associations collaborated actively with the Government's efforts and reached out throughout the world and facilitated entry of new investments in India. 'Invest India' also played a pivotal role in handholding first time entrants into India, resolving their issues by reaching out to concerned authorities on behalf of the investors. Several industry bodies came forward to set up Electronics Manufacturing Clusters and Common Facilities Centre for the units. These initiatives helped give fillip to the industry in the area.

6. PARTNERSHIP WITH STATES

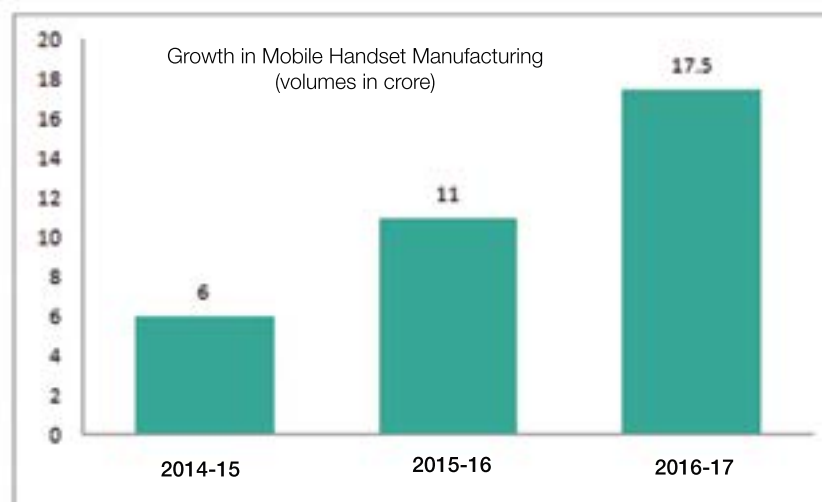
The efforts of the Government of India were actively supported and enhanced by the State Governments. States throughout the country saw the potential of this sector and announced their State specific policies, made land available for setting up electronics clusters and provided incentives for investments in the county. While well-established locations like Delhi NCR, Pune, Bengaluru, Hyderabad, Chennai, Aurangabad, Bhiwadi were well known electronics manufacturing locations, the momentum of the sector resulted in various new destinations for electronics manufacturing emerge. Without being exhaustive, these included Tirupati, Vishakhapatnam, Raipur, Jabalpur, Bhopal, Gandhinagar, Nagpur, Bhubaneswar, Coimbatore, and Kochi. 18 electronics manufacturing clusters (16 greenfield, and two Common Facility Centres) are coming up in India in 13 different states. An extent of 3030 acres of land is readily available in these clusters for any potential investor seeking to invest in electronics manufacturing. A dedicated investment promotion cell in Invest India as also in Ministry of Electronics and IT (MeitY) is available 24 by 7 to provide hand-holding support to the investors.

7. INDIA AS A HUB FOR MOBILE MANUFACTURING

The growth of electronics manufacturing in India is best reflected in the mobile manufacturing growth in the country. Mobile manufacturing has benefitted from the Phased Manufacturing Programme for mobile manufacturers. The programme targets fiscal and financial incentives for manufacturers of mobile handsets and sub-assemblies. These incentives are annually sequenced to target sub-assemblies with steadily increased value-addition: starting with chargers, battery packs, and headsets in 2016-17, to supporting display and cover-glass assemblies by 2020. Using transparent timeframes for support in each sub-assembly category, India is enabling its manufacturers to systematically plan investment and capacity addition – and, consequently, their own rise to higher value production.

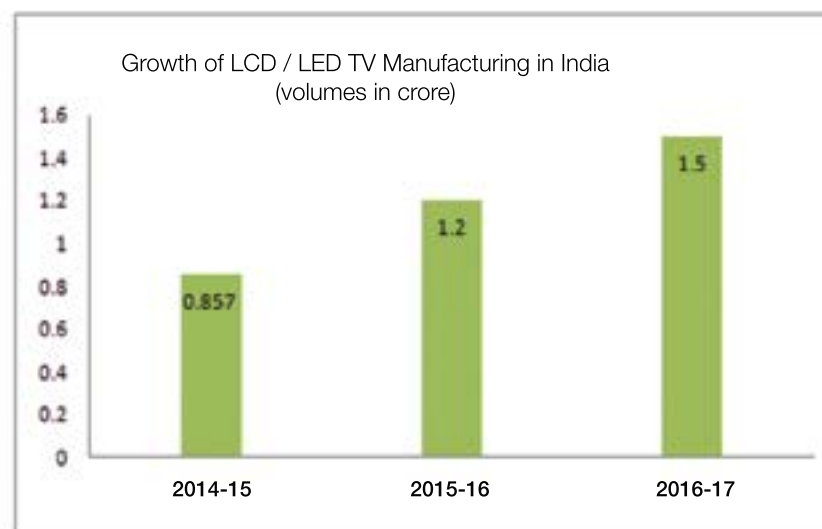
In the last two and half years, 104 units have been set up resulting in multi-fold growth in mobile phone assembly. Most of the mobile majors including Samsung, Apple, LG Micromax, Lava, Oppo, Xiaomi, and Vivo have set up assembly plants or are manufacturing through contract manufacturers in India. Indian brands like Lava and Micromax have made significant impact in many countries. Lava mobiles are sold in over ten countries and Micromax in over seven countries.

GROWTH IN MOBILE HANDSET MANUFACTURING (VOLUMES IN CRORE)

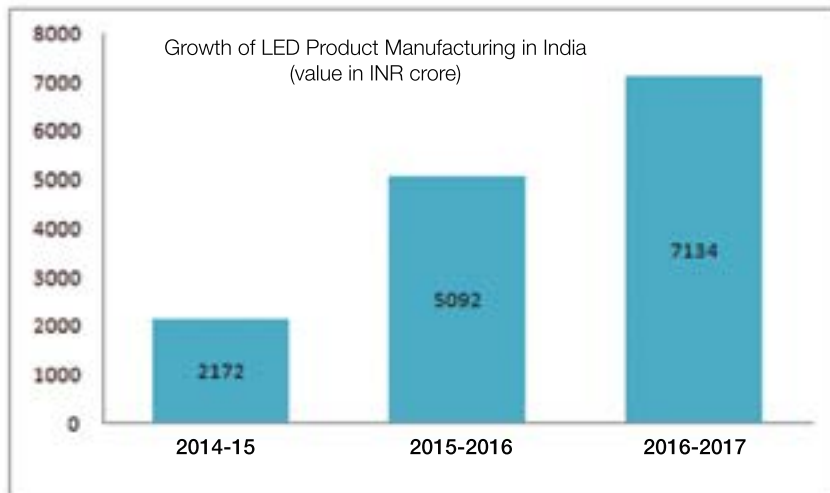


8. GROWTH IN SEVERAL ELECTRONIC PRODUCTS

8.1 The growth of LED/LCD TV manufacturing also has witnessed similarly impressive growth. Companies like Panasonic, Samsung, LG, Videocon, Onida, and Dixon are among leading TV manufacturers in India.

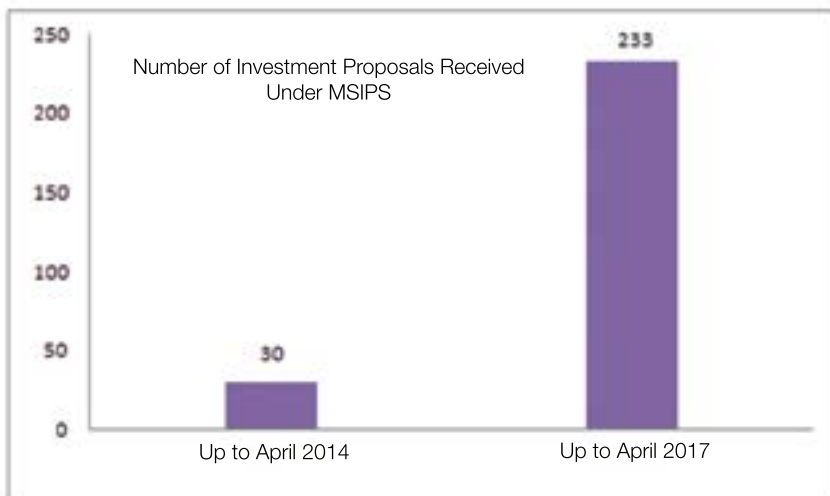


8.2 LED lights manufacturing has witnessed quantum growth as well. Companies like Syska, Jacquar, Orient, EoN, FIEM, Eveready, Delta, HQ, Panasonic, Osram, HPL, Halonix, Havells, Bajaj, Wipro, Crompton, Surya, and Philips are among the major producers of LED lights in India.

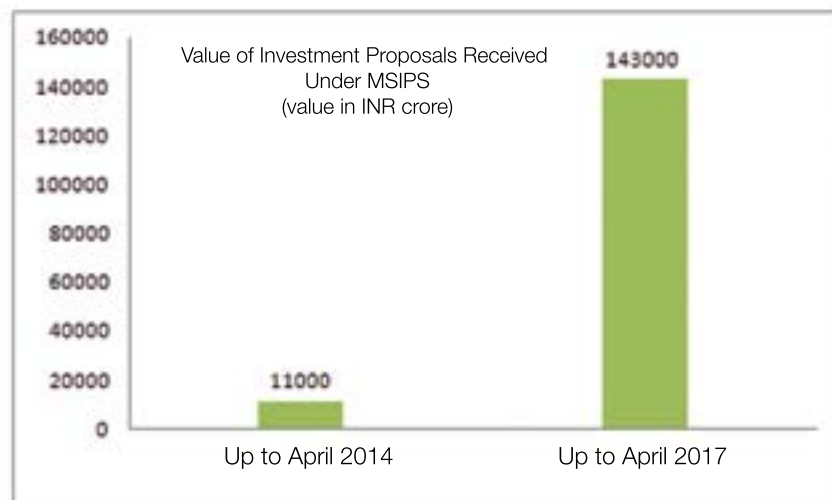


8.3 Several other electronic components including solar cells and modules, set top boxes, surveillance devices like cameras etc. have also seen significant growth in manufacturing.

8.4 The overall interest in electronics manufacturing is reflected in spurt in the proposals received for investment under the MSIPS subsidy scheme. While several proposals especially in chip design and other design activities are not reflected in this data, the investment proposals in pipeline reflect the sentiment in the sector.



8.5 The overall growth of electronics manufacturing has outpaced the growth in demand. This reversal of trend has led to import in many high demand electronic products coming down for the first time in last two decades. While these are early green shoots of the electronics industry beginning to happen, the progression has a clear story to tell.



9. INNOVATION AND STARTUPS IN ELECTRONICS

9.1 Startup India programme has kindled a new wave of innovation in India. Electronics is riding on this wave of startup and innovation and several new Incubators have been set up with support from MeitY and many of these have created new technologies and products in this sector. Electropreneur Park in Delhi has been set up in collaboration with IESA and Delhi University (DU). It has created new products which are already in the market, like IOT based distributed asset automation solutions; fast charging solutions and charging stations for electric vehicles, and systems to monitor energy usage in a distributed grid; medical equipment accessories for endoscopy and laparoscopy products; ESDM learning kits for school and skill development institutes; and IoT-based energy audit and control systems. CoE in IoT has been set up jointly with NASSCOM and ERNET in Bengaluru and has developed IoT products which are in the market. These products include offerings cloud-connected solar grid-interactive inverter which allows users to generate, consume, sell, and store energy; network-connected electrocardiogram can be installed in public health centers, with health reports accessible through tablets, computers, and smartphones; wearable device tracks the heart rate and sleeping pattern of pregnant women; multi-functional wearable electronic products that can be used as a smartwatch, or clipped to clothing for alerts and interaction with mobiles; predictive maintenance based monitoring solutions; and new incubators have also been set up at IIT Patna for medical electronics, at Kochi with Indian Institute of Information Technology and Management Kerala at Kochi and fabless chip design at IIT Hyderabad. These are in initial stages of parenting startups.

9.2 MeitY has initiated supporting industry for developing new technologies proactively. Conditional Access System (CAS) for Set Top Boxes has been developed by a company in Bengaluru with MeitY support.

Prior to development of the Indian CAS, all Set Top Boxes sold in India were dependent on imported CAS. Today over 1 million licenses of Indian CAS are in the market in less than 2 years and is now entering export market as well. Again, with MeitY support, new technologies in the area of medical electronics have been developed by industry partners. These include devices for screening of hearing for new born babies, life saving devices like hand-cranked defibrillator, hexapod computer controlled patient couch for LINCA machine, XRayto3D cloud based 3D Surgery planning software among others.

9.3 National Centre of Excellence in Flexible Electronics at IIT Kanpur and National Centre of Excellence for Technology for Internal Security at IIT Bombay have been set up to drive technology development in these frontier areas. Both these Centres are working closely with industry in identifying problem areas and finding solutions to their problems.

9.4 A big difference has been created in the field of innovation through Electronic Development Fund (EDF). EDF is a Fund of Funds which invests in other Venture funds supporting startups and businesses in electronics, IT, Nano-electronics etc. EDF has approved participation in 22 funds with total targeted corpus of INR 10,906 crores (USD 1.6 Billion). Out of the aforesaid funds, 12 funds have completed their first closure and are in market for funding companies.

9.5 The innovation and R&D agenda has been further strengthened by giving a quantum push to the number of PhDs produced in the country in electronics and IT. Under the Vishveshwaraya PhD scheme, 970 full-time and 190 part-time PhD scholars across 96 leading Engineering Colleges, Universities, and institutions of national importance have been supported by MeitY in areas of current interest.

10. DECLINE IN IMPORTS

Various steps taken for promotion of electronics manufacturing ecosystem has led to increase in domestic production and decline in imports as is reflected from the figures below.

COMMODITY	2015-16 (MILLION USD)	2015-17 (MILLION USD)	DIFFERENCE IN %16-17-15-16
Mobile Phones	5922.51	3739.95	-37%
Set Top Box for TV	642.90	367.37	-43%
Monitors	401.82	281.66	-15%
Personal Computers etc	2232.19	2148.75	-4%
Electric inverters	206.67	180.57	-13%
Printers and MFDs	83.51	59.13	-13%
Automatic Data Processing Machines	258.23	240.04	-3%
Video game consoles & machines	21.00	5.64	-26%
Audio-frequency amplifiers	20.72	16.41	-21%
Microwave ovens	57.28	53.13	-7%

11. ELECTRONICS MANUFACTURING: OPPORTUNITY FOR MNCS AND DOMESTIC COMPANIES

Electronics manufacturing is allowing 100 percent Foreign Direct Investment through automatic route. Therefore, the growth story of “Make in India” in electronics has been scripted jointly by multinational companies and domestic companies. While over 50 global companies have invested in the area over the few years, many Indian industry groups have invested to support this agenda like the Tatas, Adanis, Hero Group, Vedanta Group, Lava, Micromax, Dixon, Tejas, Centum among others. Encouraged by the success, several domestic companies have successfully raised funding from public through IPOs.

12. NEW ELECTRONICS POLICY ON THE ANVIL

12.1 Building on the developing ecosystem, Government of India is in the process of formulating a new Electronics Policy which would help advance the agenda of electronics manufacturing in the country and provide further impetus to the momentum generated.

Dr. Ajay Kumar is Additional Secretary, Ministry of Electronics and Information Technology.



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Emergence

OF A GLOBAL M-MANUFACTURING HUB

PANKAJ MOHINDROO

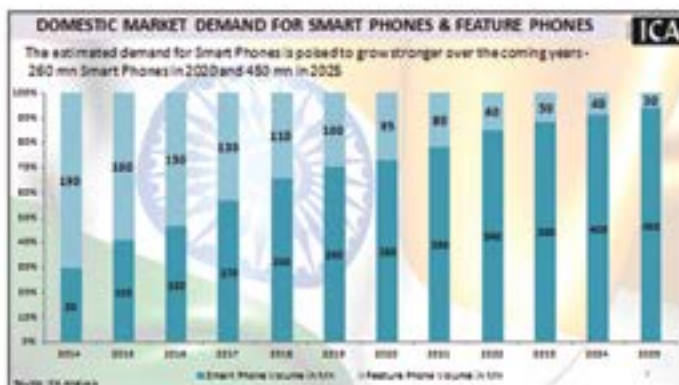
1. BACKGROUND

One of the shining successes achieved under the "Make in India" initiative of the Government is the stupendous growth recorded by the mobile handsets and components manufacturing eco-system during the past 2 years. Over 100 new factories have already been set up and this new manufacturing activity has generated approx. 0.4 million employment.

Needless to mention, mobile handset and components manufacturing is considered to be a champion category under the "Make in India" initiative of the Government. The production of mobile handsets which reduced to approx. 60 million units in the year 2014-15 valued at approx. \$3 billion has witnessed staggering growth over the past couple of years. Production of mobile handsets in the year 2016-17 reached 180 million units valued at approx. \$14 billion. There is a manufacturing target of 500 million handsets and employment of 1.5 million by the year 2019.

The demand for mobile handsets in India especially the smart phone demand is growing at a rapid pace. The estimated demand for mobile handsets in India in the year 2017-18 is estimated at 300 million, which includes demand for approx. 170 million smart phones. The demand for smart phones in India is envisaged to grow stronger in the coming years due to greater dependency of citizens on various social media platforms, ability to access various e-Governance services, usage of various gaming platforms by the predominant youth population and the Government's increasing focus to popularize digital payment services.

The estimated growing demand for Smart Phones in India is highlighted as –as under:



2. FACTORS INFLUENCING GROWTH IN MANUFACTURING ACTIVITY

The Government of India in sync with the "Make in India" initiative has adopted a differential duty regime in order to encourage domestic manufacturing of handsets by way of a tariff protection for domestic manufacturers of handsets vis-à-vis importers. Over 50 new mobile handset manufacturing units have been set up.

In order for deepening and widening the components manufacturing eco-system in India with the objective to enhance value addition, generate employment and save foreign exchange, the Ministry of Electronics and Information Technology (MeitY) has notified the Phased Manufacturing Programme (PMP) in April 2017.

Establishment of PMP was considered to be a landmark development in the history of Indian electronics manufacturing sector with the Government's underlying push for domestic manufacturing. Notification of the PMP by MeitY provides the necessary lead time for investors, both from India and abroad, to plan and execute the projects. The PMP roadmap is as under:

YEAR	SUB- ASSEMBLY
2016-17	1) Charger/ Adapter, 2) Battery Pack, 3) Wired Handset
2017-18	4) Mechanics* 5) Die cut parts* 6) Microphone & Receiver 7)Key Pad, 8) USB cable
2018-19	9) Printed circuit board assembly (PCBA) 10) Camera Module 11) Connectors
2019-2020	12) Display Assembly 13) Touch Panel/ Cover Glass assembly 14) Vibrator Motor/ Ringer

Over 50 new component manufacturing units have already been set up in India during the past one and half year's time which are producing components such as chargers/ adapters, battery packs, wired headsets, mechanical parts, USB cables, etc.

A list indicating the number of manufacturing units which have been established for producing mobile handsets and components is given below:

FACTORIES - MOBILE HANDSETS & COMPONENTS	
Total Manufacturing Units	
Mobile Handsets	52
Adapter/ Chargers	22
Battery Packs	16
Wired Headsets	4
USB Cables	3
Mechanical Parts	7
Total	104

Apart from establishment of a tariff structure favouring domestic manufacturing activity for mobile handsets and components vis-à-vis imports, the Government also provides various fiscal and non-fiscal incentives such as M-SIPS, which provides for 20% - 25% of capex subsidy. Apart from the sops provided by the Government of India, several State Governments also provide attractive fiscal and non-fiscal incentives such as additional Capex subsidy over and above the M-SIPS, rebate on land cost, incentives to cover expenses incurred on account of skill development initiatives, concessional power tariffs, etc.

3. ESTIMATED FACTORIES AND EMPLOYMENT

While approx. 104 new factories have been established so far to produce mobile handsets as well components during the past 2 years or so, it is envisaged that the mobile manufacturing journey has just begun.

As per ICA analysis, the estimated total number of factories and employment which are expected in India up to 2025, based on establishment of the PMP roadmap of MeitY, is given below:

Total no. of Factories	1,400
Employment	4,700,000

4. ESTIMATED PERCENTAGE SHARE OF "MADE IN INDIA" MOBILE HANDSETS OVER THE TOTAL GLOBAL DEMAND

India is emerging as the manufacturing hub for handsets. As per ICA analysis, the percentage share of "Made in India" handsets over the total Global demand is poised to grow stronger over the coming years. While in the current year the percentage share is estimated to reach 13.3%, it is estimated to reach over 45% by the year 2025.

% Share of Made in India Mobile Handsets over the Total Global Demand

Year	Global Demand for Handsets (Mn. Units)	Handsets Produced in India (Mn. Units)	%Share of Made in India Handsets over total Global Demand
2018	2246	352	15.7
2019	2287	520	22.7
2020	2319	605	26.1
2021	2345	715	30.5
2022	2366	850	35.9
2023	2386	980	41.1
2024	2405	1115	46.4
2025	2429	1245	51.3

5. INTENSE FOCUS FOR ENHANCING SKILL DEVELOPMENT, EXPORTS AND ESTABLISHMENT OF A ROBUST R&D ECO-SYSTEM

a) Development of a robust R&D infrastructure and enhancing skill development for manufacturing job roles

While mobile manufacturing eco-system in India has attained preliminary success during the past 2 years, one of the fundamental challenges this sector faces currently is due to absence of a robust indigenous product development and R&D ecosystem.

In order to address this anomaly, the Government in partnership with the industry, is spearheading efforts to set up a National Design Centre which is aimed at minimizing this gap and promote innovation and ensure adequate availability of talent for indigenous product development.

In order to achieve the enormous manufacturing targets to establish India as the Global manufacturing hub for mobile handsets and components, there is an urgent requirement for enhancing skill development of workers in various manufacturing processes. In order to respond to these challenges the Government of India, State Governments and industry stakeholders have come up with several initiatives to work towards minimizing skill gaps.

b) Enhance Exports

Export of Mobile handsets had crashed to almost nil in the year 2014-15, after the closure of Nokia plant. However, considering the appreciable growth witnessed in manufacturing of mobile handsets during the past couple of years, it is expected that exports will kick start from India in the near future. The vision for 2019 is to achieve 120 million export of mobile handsets.

India's geographical proximity to various emerging markets such as the Middle

Middle East, Africa, Latin America compared to other competing manufacturing hubs such as China, Indonesia and Vietnam, provide a natural advantage in favour of India.

The estimated year wise export targets is given below:

% Share of Made in India Mobile Handsets for Exports over Total Production			
Year	Total Production	Production for Export	%Share of Made in India Handsets over total Global Demand
2018	352	70	19.9
2019	520	120	23.1
2020	605	280	46.3
2021	715	375	52.4
2022	850	475	55.9
2023	980	575	58.7
2024	1115	680	61.0
2025	1245	790	63.5



6. INDIA'S EMERGENCE AS THE GLOBAL MANUFACTURING HUB FOR MOBILE HANDSETS AND COMPONENTS - THE MARCH TOWARDS ACHIEVING THE TARGET NET ZERO IMPORT

One of the important pillars under the “Digital India” initiative of the Government is to achieve Net Zero Import. It is quite heartening to note that the growing manufacturing activity related to mobile handsets during the past couple of years has drastically reduced India's dependency on imported handsets. It is envisaged that the dependency on imports to meet the country's domestic market requirements will be further reduced over the coming years.

A chart given below depicts the estimated decline in handset imports into India and the possibility to reach near Zero Import status by the year 2025.

Percentage share of Imports over Total Market Demand of Handsets				
Year	Domestic Market Demand (Mn. Units)	Domestic Production to meet Domestic Demand (Mn. Units)	Import of Handsets into India (Mn. Units)	Import as percentage share over Domestic Market Demand
2015	270	110	160	59.3
2016	280	170	110	39.3
2017	300	260	40	13.3
2018	320	282	38	11.9
2019	340	310	30	8.8
2020	355	325	30	8.5
2021	370	340	30	8.1
2022	400	375	25	6.3
2023	430	405	25	5.8
2024	460	435	25	5.4
2025	480	455	25	5.2

Pankaj Mohindroo is the founder and current National President of the Indian Cellular Association (ICA).

Data presented in the article may be ICA's own estimates.

A few years back, cybersecurity left the rooms of hobby hackers and computer science whiz kids and arrived at the national security and defence scene. One of the earliest attacks in late 1980s was done by a graduate student at Stanford University exploiting a buffer overflow bug in a popular service in the early Unix operating system. By early 2000s, email borne worms, exploitation of bugs in database servers, etc., was taking the Internet by storm, often debilitating it for hours. In some cases, the cleaning up took days together. Still, those were relatively better days, because of lower number of attacks as well as intermittency. Engineers in the United States Computer Emergency Response Team (US-CERT) hosted in a university campus, could very quickly identify signatures and mitigation techniques, and send alerts to IT administrators – allowing fast service restoration.

Then came the menace of the botnets. Infecting millions of computers with clandestine malware that report to command and control centers – more often in another country, in a completely different jurisdiction. Botnets are still a huge problem. Criminal gangs initially masterminded such botnets to use them for email spamming, but soon transformed themselves – using these botnets – into financial fraud networks. Some of the first instances of international law enforcement cooperation were in tracking these botnets, and arresting criminals running them.

In the field of Computer Science, international cooperation has been common among researchers; indeed, the adoption of the ARPAnet technologies into internetworking the entire world to create today's Internet has been a notable example of international cooperation. However, due to the open nature of the technology, it hardly ever needed bilateral agreements or any kind of international agreements except that some of the Internet protocol (IP) addressing and naming were delegated to an international body such as the Internet Assigned Numbers Authority (IANA). Also, the Internet Engineering Task Force (IETF), Institute of Electrical and Electronics Engineers (IEEE), the International Standards Organisation via the Open Systems Interconnection (OSI) model, international task forces, and standardization bodies cooperated internationally¹ to evolve technology standards².

Cybersecurity threats evolved in the last 10 years or so in multiple distinct ways –

(i) Large scale data theft including financial information – leading to breach of privacy, massive financial crimes, and embarrassing emails and other sensitive or classified information leakage;

(ii) Botnets and trolling based social media manipulation to spread rumours, fake news, and fake construction of publicity (both positive or negative) which created riots, subversion of democratic decision making process, or defamation;

(iii) Attacks on critical infrastructures such as industrial control, nuclear plants, dams and sewage control, power grid, banking, and defence; and

(iv) Ransomware-based attacks to deny critical information and demanding ransom to release locks on critical information.

These threats are evolving at a lightning pace; every single day we find new attacks occurring somewhere in the world. A few examples: the Stuxnet worm attack on an Iranian uranium enrichment plant³; the BlackEnergy malware attack on Ukraine's power grid⁴; the Petya ransomware affecting one of the world's largest transportation companies which affected a port in India⁵; the Mirai botnet based distributed denial of service attack on domain name service root servers maintained by a company causing Internet outage⁶; massive credit card data breach from a video gaming platform⁷, and from a departmental store chain⁸.

While a substantial percentage of cyber-attacks seem to be due to disgruntled insiders, or insiders who have been innocuously socially engineered by external entities, more and more cases seem to be orchestrated by nation states against other countries⁹. It appears that some countries have developed cyber armies whose job is to automate penetration testing of targets abroad, find vulnerable systems – of which there may be plenty – and then attacking those¹⁰.

¹M. Ohta, "IETF and Internet standards," in IEEE Communications Magazine, vol. 36, no. 9, pp. 126-129, Sep 1998

²<http://www.xoc.net/works/tips/standards.asp>

³D. Kushner, "The real story of stuxnet," in IEEE Spectrum, vol. 50, no. 3, pp. 48-53, March 2013

⁴BlackEnergy Used as a Cyber Weapon Against Ukrainian Critical Infrastructure.

<http://resources.infosecinstitute.com/blackenergy-used-as-a-cyber-weapon-against-ukrainian-critical-infrastructure/>

⁵Maersk Group Hit by Cyber Attack.

<https://www.maritime-executive.com/article/maersk-group-hit-by-global-ransomware-cyberattack>

⁶<https://dyn.com/blog/dyn-analysis-summary-of-friday-october-21-attack/>

⁷Sony Playstation suffers Massive Data Breach.

<https://www.reuters.com/article/us-sony-stoldendata/sony-playstation-suffers-massive-data-breach-id-USTRE73P6WB20110427>

⁸Target Store hit by data breach.

<http://www.cbc.ca/news/world/target-stores-hit-by-data-breach-affecting-40-million-cards-1.2469895>

⁹Main Cyber Threats Coming from Governments as State Actors.

<https://www.europeaninstitute.org/index.php/136-european-affairs/ea-november-2011/1464-main-cyber-threats-now-coming-from-governments-as-state-actors>

¹⁰See for example Clarke, Richard and Knacke, Robert. (2012). Cyber War. Ecco Publishers.

Using honeypot and honey net technologies here at the Indian Institute of Technology (IIT) Kanpur, we find a massive amount of such penetration attempts originating in other countries. The problem in thwarting these is not just that the attacks are originating in a foreign jurisdiction but also attribution is difficult. Some of these attacks are not originating from countries where the source IP is located – they are being reflected through many proxies as they reach us, rendering attribution of the source of the attack to a country is often next to impossible.

So cyber security and defence against perpetrators of cyber-attacks is not just a technology problem; and, hence, cannot be solved by technology alone. Of course, standard techniques such as strong perimeter defence, use of vulnerability detection tools, routine penetration testing of one's own cyber assets, regular audit of cyber defence posture of institutions and business entities, intelligence gathering through various feeds collected by many companies, collection of attack intelligence through honeypots and darknet monitoring, making use of intelligence to adaptively change cyber security protection measures, monitoring of network, and systems, use of machine learning techniques to detect anomalies in the system behaviour, and many such technological tools must be deployed to reduce the attack probabilities. But in an environment where we use vendor provided software, often use libraries developed elsewhere, use hardware and software that are manufactured and developed elsewhere; the chances of finding a 100% cyber-attack proof system may be very low.

The situation is even more complicated as different countries are at different levels of maturity in terms of technology, technology deployment, and use of cyber security tools and methodologies, leading to massive asymmetry.

Countries even with the most advanced in cyber security technology and research continue to get attacked. It is the need of the hour to actively seek diplomatic cooperation internationally. In terms of manpower development, training, and technology R&D too, the value of international collaborations cannot be overstated.

In 2016, Indian Institute of Technology Kanpur founded the Interdisciplinary Center for Cyber Security and Cyber Defense of Critical Infrastructure (C3I Center)¹¹, funded by the Science and Engineering research board of the Department of Science and Technology, Government of India. Our center has signed memoranda of understanding (MoUs) with the Interdisciplinary Cyber Research Center at Tel Aviv University in Israel, and with the Center for Cyber Security at the New York University in the US. IIT Kanpur also signed an MoU with the State University of New York at Buffalo wherein joint PhD offering is one of the objectives. We already have students and faculty traveling to these centres, working for weeks to months with researchers there, and have students train there. We have also learnt the successful incubation and start-up models some of these centres have around them, which we would like to replicate here to develop further indigenous cyber security technologies.

It is also important to address cyber security not just as technology challenge, but also take into account its social, regulatory, legal, policy and human aspects; which are often as important as technology innovations and practices. Here, international collaboration can play a very important and positive role. Another dimension that holds a lot promise and potential is non-aggression pacts between countries.



¹¹<https://security.cse.iitk.ac.in>

Prof. Sandeep K. Shukla is the head of the Computer Science and Engineering Department at IIT Kanpur, and co-founder of the Interdisciplinary Center for Cyber Security and Cyber Defense of Critical Infrastructure at the institute.

In today's digital era, the demand for a flexible Information Technology (IT) infrastructure calls for speed, scalability, convenience, and a “gee whiz” factor that encourages the deployment of innovative applications for enhanced user experience.

A classic example is the advent of streaming devices that enable communications between computers, smartphones, and television sets linked to cable and satellite networks. The beginning of this new digital era began with the focus to drive accessibility and convenience in the entertainment industry through the streaming of television shows, films, and other content aimed at individual users or groups. This infrastructure now serves as a prototype for innovation in other industries such as education, healthcare and finance, with a goal to empower marginal populations that currently have little or no access to technology with connectivity.

This is why in India, successive governments have continuously pushed the development of IT infrastructure. The government has recently accorded its Digital India programme the highest national priority. Launched two years ago, the initiative detailed the development of IT infrastructure, including the delivery of high-speed internet services in urban and rural areas as a core component¹.

The future of IT infrastructure in India will involve innovations in technology through artificial intelligence, data analytics, cloud computing, and open-source platforms in efforts to upgrade all existing legacy systems. The IT industry in India is expected to grow at a rate of 12 to 14 per cent from 2016 to 2017². As government programme takes hold, the sector is expected to triple its current annual revenue to reach USD 350 billion by 2025². The IT industry will continue to evolve as we progress further into a digital economy, making it tougher for organizations to keep up with rapid pace of technological innovation. It is more important now than ever to future proof IT investments. Here's how it can be done.

CUSTOMER INSIGHTS: MINING FOR THE NEW GOLD

Just as the entertainment industry leveraged technology and innovation to deliver a unique customer experience, the financial industry followed suit. Earlier this year, the Prime Minister of India launched the Bharat Interface for Money (BHIM) app, an Aadhaar-based mobile payment application that will allow users to make digital payments without the need for a credit or debit card. The app saw over 10 million downloads in a span of just 10 days after its launch³. The innovation of this portal has resulted in accessibility to financial services country-wide.

The widespread adoption of the application has also harnessed the data of millions of consumers into one integrated system providing organizations with access to insights that can be leveraged for information-driven business decision making.

However, data will always grow, and customers' demands will always change. So how can business leaders ensure that they upkeep the large volumes of data while being able to derive accurate, real-time insights to deliver better offerings for customers?

One of our local customers, YES Bank, deployed Cloudera's Enterprise Data Hub to ingest data from any source across any environment into a centralized data hub. This provided YES Bank with the capabilities to mine large volumes of data from financial transactions and develop machine learning algorithms to create new cross-sell and up-sell opportunities for the business⁴.

India ranks among the top five countries in terms of digitalisation maturity with the opportunity to grow and scale up digital platforms by 2020⁵. To further support the Indian government's initiatives to become a digital economy, organizations must invest in scalable and robust data management platforms. Such platforms enable real-time analytics to use data in ways not possible before and continuously innovate business strategies for the future.

CYBERSECURITY IS THE NEW CHARTBUSTER

If 2017 has taught us anything, it is that cyberattacks and data outages are inevitable. Future proofing your IT investments also means guarding them against these attacks in the best way possible, and retaining the ability to respond and recover efficiently should an attack occur. In 2013, the Indian government announced a National Cyber Security Policy aimed at protecting the public and private infrastructure. The objective is to create an ecosystem designed to generate trust and confidence in transactions in cyber space, to encourage the adoption of information technology and to address fears of privacy⁶.

¹Digital India, Government of India, 8 August 2014

²IT-BPM Industry in India: Sustaining Growth and Investing for the Future, NASSCOM, 22 June 2017

³PM delighted over 10 million downloads of BHIM App, Times of India, 9 January 2017

⁴Cloudera Empowers YES BANK's Digital Strategy to Deliver Enhanced Business Insights, Cloudera, 6 July 2017

⁵Majority of Businesses and Economies Are Not Ready for Digital Platforms, Accenture Research Shows, Accenture, 14 September 2016

⁶National Cybersecurity Policy, Ministry of Electronics and Information Technology of India, 2013



A fitting example of technology that will support such an ecosystem is Apache Spot, a community-driven cybersecurity project that brings advanced analytics to all IT telemetry data on an open, scalable platform. One key factor that will encourage collaboration in the battle against cyber attacks is Spot's capability to consolidate all enterprise security data into a comprehensive IT telemetry hub based on open data models⁷. The open data model strategy not only aims to support a wider set of cyber security use cases, but it encourages knowledge-sharing and creates a unified effort to strengthen cyber defences as a nation.

India's evolving cyber security framework is based on an assessment of threats from espionage, warfare, terrorism and crime⁶. Cyber attacks have become so common that all organizations are starting to think of what to do when instead of if they get hit. The fact that cyber threats are evolving at a rapid pace makes it all the more important that your equipment and software are also kept up-to-date. Here's where automated cyber security solutions work best.

The implementation of Machine Learning (ML) and Artificial Intelligence (AI) to detect and respond to cyber attacks has become increasingly common. Apache Spot also uses ML to expedite threat detection, investigation, and remediation while supporting an entire ecosystem of other ML-based applications. This enables maximum analytic flexibility, leading to better and faster threat detection.

Apache Spot for Cybersecurity, Cloudera

ADDRESSING THE PROBLEMS OF TODAY WITH TECHNOLOGY OF TOMORROW

The Indian government is working hard to drive accessibility across the nation while safeguarding the economy from cyber threats through IT solutions. Efforts of this nature benefit from the implementation of strong regulation for risk reduction, investment in human resource development, forging public and private partnerships, as well as creating a strong international partner network that will support research and development programmes. There will always be a need to prepare for the future as the economy and competitive landscape will continuously and inevitably change.

The need for infrastructures that manage the growing volumes of data will never change, but the technology used to leverage data will continue to evolve. Embracing and deploying the right kind of technology can help to shape the future, ensuring that your IT investments will stand to reap the benefits from improved efficiencies, lowered costs and greater revenue. At the end of the day, future-proofing your IT investments also means future-proofing your organization and its success.

Mark Micallef is Vice President of Asia Pacific and Japan, Cloudera.

RAGHAVENDRAN KANDASWAMI

Rules in the technology world are set by dynamic adaptation to changing demands. This applies particularly in the era of cloud computing, and the transformation it has wrought in the information technology market and the digital value chain. Social, Mobile, Analytics and Cloud (SMAC) – an acronym coined first in a 2013 Forbes article – is a near reality; corporations and governments now look beyond the data conundrum, and are keen to exploit software technologies that offer real solutions to their problems. The Asia Cloud Computing Association (ACCA) 2016 Cloud Readiness Index¹ places Hong Kong, Singapore, New Zealand and Australia above markets such as Germany, the United Kingdom (UK) and the United States (US) showing that Asian economies are indeed leading the world in cloud readiness. India ranks 12th in the Index, and is particularly impacted by this trend in the most progressive way; with cloud rapidly altering the country's IT landscape, and companies allocating significant shares of revenue to cloud innovation.

While the positive outlook towards cloud readiness in India is here to stay, adoption rates across the last ten-year window were slow, gradually increasing in the last five years.

Despite gathering reasonable speed now, cloud adoption in India had generally been subject to much – albeit unwarranted – inhibition on information security and data protection, which may have initially slowed public cloud infrastructure development. However, today, the market opportunity for public cloud has leading cloud players competing in one of the world's fastest growing cloud markets, with other providers not lagging far behind in aiming for small (and large) chunks of what is perhaps truly one serious market.

Private cloud in India has always shown promising growth rates: industries across the board have widely adopted the deployment model, allowing for horizontal capacity build-up of IT Infrastructure and allowing dynamic scalability, while reducing operating costs through shared resourcing models across companies, applications and IT services. Public cloud deployments across Software-As-A-Service (SaaS), Infrastructure-As-A-Service (IaaS) and Platform-As-A-Service (PaaS) have gained wide acceptance today.



Available at <http://www.asiacloudcomputing.org/research/2016-research/cr12016>

Fuelled by the Digital India initiative, many agencies today look to deploy SMAC solutions on the cloud. Some may even use cloud platforms for departmental portals and citizen engagement apps. Today, service distribution through e-Governance, e-delivery of services, public internet access, and information for all have become real reasons for governments to invest in cloud infrastructure, as a means to future-proof computing-needs that will arise with increased Indian digitalization. As demand for infrastructure supporting digital applications grows, there is an increasing need to future-proof the supply of the infrastructure through adoption of hybrid cloud models, allowing for greater flexibility. Big Data today poses this very challenge; and also provides the encouragement towards adoption of Big Data technologies in cloud platforms.

In developed markets, even data-sensitive departments like law enforcement and criminal justice chose to adopt enterprise hosting services to address this very challenge. These agencies can be constrained from coordinating information to enhance public safety by increased data volume, archaic information systems, and constrained resources. For example, law enforcement and criminal justice officials in the US state of North Carolina needed to swiftly receive a comprehensive record of individuals with prior criminal records from multiple systems, while minimizing the risk of overlooking critical data. The North Carolina Office of the State Controller worked with SAS Institute to develop the Criminal Justice Law Enforcement Automated Services (CJLEADS) application²: an on-demand, web-based application that integrates criminal offender data to provide judicial and law enforcement agencies with a comprehensive profile of a criminal offender. The system also places offenders on a watch list, allowing officials to monitor changes in their status (including arrests, future court appearances, or releases from custody).

Today, organisations like the SAS Institute and its peers are mobilising their research and development (R&D) arms to steer the market (particularly SMAC) towards innovative cloud models. These models do not just provide SaaS, but go a step further to provide non-subscription, pay-per-use models that allow customers to benefit from services when they need it. Multi-tenancy is key to such innovative models, becoming an integral backbone to facilitate information- and resource-sharing across a large number of customers. This is particularly relevant to analytical solutions for criminal justice and law enforcement, where information sharing between key agencies sharing the same platform ensures quick and efficient information flow, reduces IT operations costs, and improves collaboration and partnerships.

In India, we can expect to increasingly see a Cloud First Policy. As technology companies propagate new architectures and applications, departmental alignment with IT will provide greater impetus to cloud adoption, particularly in the solution and apps space. This will result in increased software company participation in developing solutions for the Government. High-speed internet across India's rural landscape is a fast progressing reality that asserts itself in the sheer spread of mobile and net banking across India's villages. As more and more industries such as manufacturing, automotive, telecommunications, etc. look to reduce over-head costs, down-time and automate infrastructure development, cloud technologies seem the most efficient way for them to fulfil their objectives. The additional impetus provided by players that bring cutting edge analytics, social and mobile capabilities; encompassing them into packaged solutions made available through innovative cloud adoption models only make the day brighter, despite the cloud looming large – for the first time maybe, not so gloomy after all.



²https://www.sas.com/en_us/customers/nc-office-of-state-controller.html

Raghavendran Kandaswami heads the Public Sector Practice for SAS Institute.

A quote by Jane Addams, a pioneer American settlement activist/reformer and social worker, is worth remembering while we discuss security. "The good we secure for ourselves is precarious and uncertain, until it is secured for all of us and incorporated into our common life."

The World Economic Forum's 2016 Global Risks Report estimated that crimes in cyberspace would cost the global economy USD 445 billion in 2016, rising at 30% per annum, in the next two years. According to another report by Hewlett Packard and the U.S.-based Ponemon Institute of Cyber Crime, hacking attacks cost the average American firm USD 15.4 million per year, double the global average of USD 7.7 million. In recent times, we are also aware of hacking of the National Bank of Bangladesh for a USD 100 million in a very sophisticated operation. Wannacry, NotPetya etc. are all still fresh in our memory making their presence felt in our country.

Obviously, such attacks will cause loss of access to the computing network, loss of confidentiality, integrity, availability of valuable organizational information and personal electronic data further resulting in lawsuits, loss of public trust, prosecution, internal disciplinary action or even termination of employment or contracts.

Security policy, regulatory compliance, user awareness programmes, access control, security audit, incident response, encryption, firewall and finally anti-virus, are all important aspects of security and are highly technical in nature. Learning, training, re-training on a regular basis, therefore becomes cardinal.

IT and ITES are all pervasive today. Security threats are equally pervasive. Government departments and their e-governance initiatives, IT-development/ services, SW/System houses, HW-Production, IT-Consulting, Net-Providers, SMEs, financial services organizations, banks, insurance companies, hospitals, educational institutes, power sector, railways, automotive manufacturer/ supplier, aircraft/ aerospace-industries, hospitality, aircraft/ aerospace-industries and virtually any other utility will be a potential attackers' paradise.

A cyber-security strategy is needed today because of the heightened security threat that is based on use of technology for crime and the thrust towards creating and sustainable digital economy. Cyber-security remains a cross-cutting thread across every other infrastructure and is the underlying foundation for the operation of every business and government function. Unlike physical vulnerabilities, cyber security vulnerabilities and threats can change in seconds. The protective measures can also become obsolete just as quickly.

I strongly feel that it is imperative that we have a national cyberspace security response system, a national cyberspace security threat and vulnerability reduction programme, a national cyberspace security awareness and training programme. This will ensure secure government cyberspace and lead the country to embark on an effective international cyberspace security cooperation model.

A good way to begin would be to create a registry of cyber-security experts at operational level. The programme divided in four levels would create trained professionals at each level, accredited with either a white belt, blue belt, green belt or a black belt. A 240-hour training at each level with real time hands-on learning would populate the registry.

At the entry level, Computer Basics, Network Basics, Internet Technologies, Information Security, IT Acts & Cyber Laws, Virtualization, Email Security, System Security, Password Security and Mobile Security would create a white belt. The next level would include System Hacking, Operating System Cracking, Cryptography & Steganography, Administration of Windows & Linux, Android and iPhone Security, and Reverse Engineering. Going further the next belt would include Web Application Attacks & Security, Honeypots, Google Hacks and Social Engineering. Finally, the black belt would gather expertise in Wireless Security, Network Scanning, Metasploit Exploitation, Buffer Overflow Attacks & Preventions, Operating System Attacks and Security and Content Filtering Techniques.

A registry would keep tabs on the trained personnel since today's experts could easily become tomorrow's hackers in an ever expanding and innovative world. A registry that has experts logged in at different levels can then be used to depute to address different classes of vulnerabilities and intrusions simultaneously populating the expert data, vulnerability and the security solution.

Besides creating a pool of experts for this country and other countries as well, a registry of security breaches and trouble shoots would be available which will help in identification of future breaches. This will spin off several new job opportunities not to speak of the immense benefits accruing for research into cyber security threats and even prediction of future attacks.

A new security doctrine would need to be understood which will be a part of a larger strategy. Whereas cyberspace was seen as a supporting infrastructure, thought of as only defence and no attack back or pre-emptive attack possible, defending the entire network to the same degree was also a done thing. Blaming and harassing the end user and defending against yesterday's attacks was the norm.



The new doctrine should recognize that the cyberspace is a war-fighting domain on par with land, sea, air and space, and that all is fair in love and war. Defending selectively and dynamically, making the user a part of the solution being proactive, getting ahead of the curve, and being future-proof should all be a part of the new thinking.

It is extremely important that all present security initiatives are created as business cases. The cost of poor security must be measurable and measured. Large policy changes must be supported with a robust, targeted communications plan, supporting services and documentation. Patch management, communications, incentives and mass communications must be shared with the private sector including owners and operators of the critical information infrastructure. The plan should also include developing innovative mechanisms for information sharing on cyber security threats, vulnerabilities, best practices, emergency response, and solutions. Improving performance on cyber risk assessments and remediation activities must include a plan for Internet-related recovery in the event of a disaster or coordinated attack, and work closely with cyber first responders across the Nation, State, local, and private sectors.

Finally, the strategy must also support research and development and educational activities to improve cyber security products and services that are user friendly and keep pace with risk and technology. We also need to create a cyber security knowledge database and develop an expert system that promotes alerts on possible cyber-crime threats based on heuristics, statistical models etc.

A security debate would probably not end without remembering what Benjamin Franklin, one of the founding fathers of the United States said on liberty. "Those who would give up essential liberty to purchase a little temporary safety, deserve neither liberty nor safety"

Dr. S. S. Mantha is former Chairman, All India Council of Technical Education (AICTE).



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100 Smart Cities

ON THE ANVIL: MOVING TOWARDS SMARTER, MORE LIVABLE & HAPPIER CITIES

M. NAGARAJAN

The concept of Smart Cities is not alien to India. Smart-cities are part of the ethos of India: ancient Indian university towns like Takshashila and Nalanda were Smart Cities of those times. Modern-day urbanization seems also to take inspiration from the urban planning and culture of the Indus Valley Civilization.

Cities accommodate nearly 31% of India's current population and contribute 63% of GDP, according to the 2011 Census. By 2030, urban areas are expected to house 40% of India's population and contribute 75% of India's GDP¹. This requires comprehensive development of physical, institutional, social and economic infrastructure: all of which are important in improving quality of life, and attracting talent and investment, to set in motion a virtuous cycle of growth and development.

The Government of India's Smart Cities Mission is an innovative initiative to activate that cycle. It aims, inter alia, to drive economic growth and improve the quality of life of urban citizens by enabling local development and harnessing technology as a means to create smarter outcomes for citizens. Launched in 2015, the Mission encompasses 100 cities, and aims to provide residents with efficient and reliable infrastructure, enhanced quality of life, and economic opportunity.

While Government-driven attempts towards urban renewal are not new in India, the country's Smart Cities Mission is designed with certain unique features, and offers unprecedented opportunities. The criteria and strategies followed in identification of smart cities include a bottom-up approach; demonstrating social media as tool for citizen empowerment; reflecting, in the design and execution of strategies, the collective conscience of citizens; fostering an increased sense of ownership amongst them; and superimposing different layers of city needs.

Across the world, Smart Cities would be designed to offer service baskets optimised to their own operating contexts, and to what their citizens most need. While these would naturally vary from context to context, they may offer services that include the following examples:

- Smart City Management and Maintenance Systems, which will allow citizens to notify city officials about damage to, or problems with, public infrastructure, using mobile applications and SMS, email, and so on;
- Smart Grids and Smart Meters, which will maximize power efficiency by matching supply and demand dynamically, supported by advanced monitoring and management systems;

- Smart Urban Lighting, which will leverage technologies like the Internet of Things (IoT) - using automatic light sensors and centralized control and management facilities - to adjust the intensity of the light to the number of people on the street who need it;

- Smart Waste Management Systems, built around (for example) smart containers, advanced fleet management system, SMS- and mobile-based reporting, smart dumping stations, and so on;

- Intelligent transport: allowing for different modes of public transport – for example, the Metro, electric vehicles, smart-card based city transportation, and more – to be coordinated in real time, allowing citizens to travel seamlessly.

The various initiatives of the 90 winning smart cities in India will impact over 95 million people with an investment of around INR 1,90,000 crore (equivalent to USD 27 billion) over the next five years. Of the total investment, 80% will be spent on Area Based Development and the remaining on Pan City Solution. Each selected Smart City is planning to increase the efficiency of its services and enhance the experience for its citizens by building a digital platform for better urban livability. Each is preparing a blueprint to improve how local administrations **manage** civic infrastructure, respond to rising service demand, and catalyze growth.

Surat, to quote our own example, is attempting to resolve urban governance challenges through a range of Smart City projects. The Surat Municipal Corporation has deployed a Smart City (or SMAC) Centre, to serve as an integrated command and control centre (ICCC) for managing and delivering municipal and allied services to citizens at an appropriate standard. The Centre engages core urban governance functions: allowing city operations to be monitored through a closed-circuit television (CCTV) network; supporting **supervisory** control and data acquisition (SCADA) systems for water and sewage treatment plants; and delivering services related to property tax, health surveys, and complaint management. The Centre would also cover intelligent transit management systems, the Swachh Bharat cleanliness and sanitation programme, and monitoring of door-to-door garbage collection using global positioning systems (GPS). The Centre would also manage Surat's Adaptive Traffic Control System (ATCS), which will automate all the signals within the city, detect red light violations (RLVD), and deploy automatic number plate recognition (ANPR) systems.

¹Ministry of Urban Development, Government of India. (2015). Smart Cities: Mission Statement and Guidelines. Available at [http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines\(1\).pdf](http://smartcities.gov.in/upload/uploadfiles/files/SmartCityGuidelines(1).pdf)

This will lead to reduction of road congestion, improve traffic awareness for city law enforcement and the public. The system will also use big data to optimize signal operations across the city. By providing a 360-degree view of the key functions for managing the city, the SMAC Centre will help city officials proactively manage the factors that affect their citizens' quality of life: allocating resources more appropriately, and implementing preventive maintenance measures.

Similarly, Surat is deploying an Automated Fare Collection System (AFCS) to enhance operational capability, citizen's satisfaction, reliability and ease of operations for its services offered through various transit modes in Surat's upcoming public transport system, including integrated ticketing between city buses and the Bus Rapid Transport System (BRST). AFCS implementation is designed to advance a number of goals: deploying integrated fare management process for transit services within Surat city; introducing open/closed loop based electronic ticketing platform; and simplifying fare policy and ability for smart and integrated pricing. Such systems would offer Surat's citizens a unified riding experience by integrating mobile ticketing with other applications for trip planning, real time arrivals, etc. Similarly, a range of excellent Smart City projects are also being implemented in other cities across India, transforming India's urban governance ecosystem.

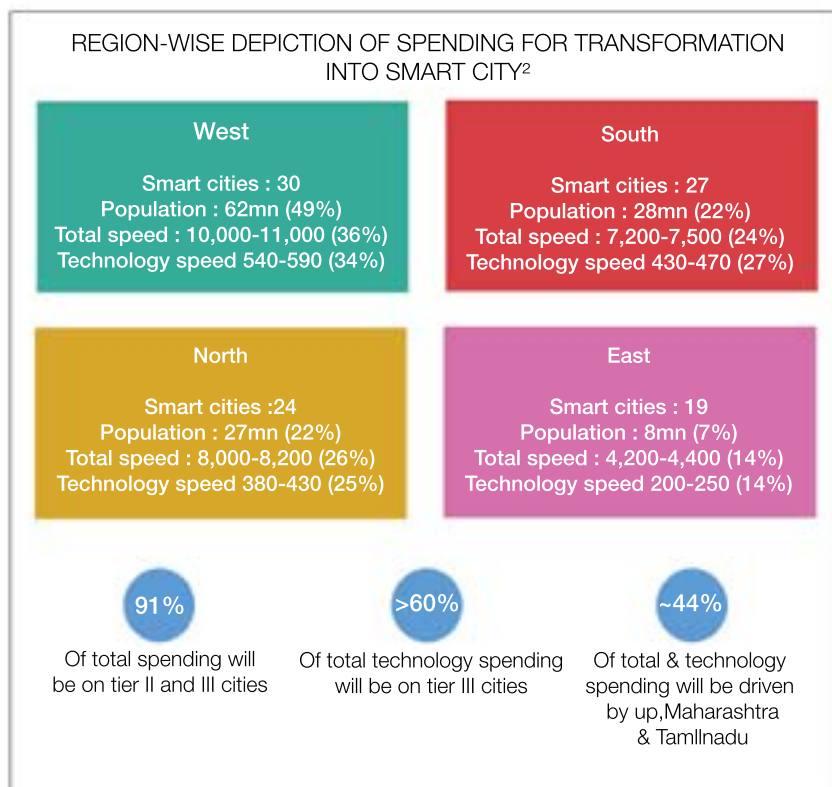
Adding icing on the Smart City cake is the Surat Money Card. It is a pioneering initiative in the country – based on open loop technology, it will not only allow citizens to use Surat's public transport system, but also integrate access to non-transit services such as property card details, library membership, swimming pool membership, and such other municipal services.

Surat will therefore be one of India's first cities to combine Open Loop payment services and municipal services access in a single card: soon realizing the vision of One City, One Card covering transit, municipal services, retail and e-commerce. This will set the path forward for a future of One Citizen, One Card across the nation.

Transformation to a Smart City requires an integrated and holistic approach with technological intervention. Internet of Things (IoT) and blockchain technology will soon surface across Indian smart cities. A multi-pronged approach is necessary, which will incorporate technology standardization and data liberation through data sharing by practicing Open Data strategies. This will support efficient decision making and planning, and enhance citizen awareness and engagement – leading to effective and efficient service delivery. Fig. 1 depicts the region-wise spending in technology in various smart cities in country.

The Smart Cities Mission complements – and will converge with – several other sectoral government schemes; something that is ensured at the planning stage itself. Cities will seek to converge their proposals with key urban revitalization programmes, including Atal Mission for Rejuvenation and Urban Transformation (AMRUT), which seeks to bolster sewage and water supply infrastructure; the Swachh Bharat Mission's (SBM) national campaign to clean up our cities and villages; and the National Heritage City Development and Augmentation Yojana (HRIDAY) which seeks to revitalize heritage assets such as monuments, ghats, and temples, and also certain intangible assets. Cities will also converge their Smart Cities programmes with major government initiatives beyond urban development: including Digital India, Skill India, and Housing for All. This convergence will consolidate the social, economic and physical infrastructure of these cities.

As their Smart Cities programmes transform India's urban landscape, cities are addressing some key challenges. These include integration with former legacy infrastructure, the limited availability of long term development plans, financial sustainability, constraints around technical capability and talent, and varying levels of inter-department coordination within the city. Civic departments often lack a unified perspective of the technological implications of smart cities, which can add to operational inefficiencies. Accordingly, to enable effective decision-making despite multiple overlapping authorities, each city in this mission is creating a Special Purpose Vehicle (SPV) registered under the Companies Act 2013. With a dedicated CEO and Board of Directors, this entity will not only be responsible for coming out with desired frameworks, but also for monitoring the implementation of identified projects. The Smart City SPV will have to put in place a management framework that can resolve these issues, to unlock the urban development potential that the concept promises – and the economic growth that accompanies it.



²Zinnov Consulting. (2016). Technology Opportunities in Smart Cities: India. Available at <https://www.slideshare.net/zinnov/smart-city-opportunity-india>.

The Mission has also engaged this challenge by establishing a competitive process for the cities to engage in. It has set a broader framework for cities to develop their strategic plans and allowed them to innovate, depending on their institutional, administrative and financial capacities. At the same time, it has allowed cities with varying (or weaker) capacities to engage in a larger pool of collaborative learning, with hand-holding by the Ministry of Urban Development. This allows solutions to these challenges to be learned and shared more swiftly.

While there is no doubt about the profusion of opportunities for all stakeholders, major concerns pertaining to the prevailing civic governance structure need to be resolved to achieve the optimum potential of Indian urbanization.

Implementing information governance, deploying next generation technology, optimizing digital platforms to maximize citizen experience, mandating selected transactions to be digital-only, partnering and collaborating with all stakeholders, greater thrust on public private partnership (PPP) models, marketing digital services to citizens, enhancing administration responsiveness and using citizen forums to create communication between government and others are determinants to the success of the smart cities initiative. We must act simultaneously on several fronts in a focused manner to ensure that India achieves the key goals of a mission-transformed nation.

M Nagarajan is Chief Executive Officer of Surat Smart City Development Limited, and Deputy Municipal Commissioner to the Surat Municipal Corporation.



Towards a trillion

DOLLAR DIGITAL ECONOMY

SEEMA GAUR

The term 'Digital Economy' was first used by Don Tapscott in his 1995 best-seller "The Digital Economy: Promise and Peril in the Age of Networked Intelligence". It basically refers to an economy based on digital technologies and characterised by hyper-connectivity. However, it is not the same as "information economy" or "network economy." It permeates all aspects of society and has significant potential for scientific breakthroughs, job opportunities, and economic growth. It comes with risks such as unauthorized access to data, cyber-crimes, and cyber-attacks, which may result in violation of privacy, disruption of operations, system shutdowns and financial and reputation losses, etc.

Digital technologies have spread rapidly in much of the world with traditional economy giving way to new age digital economy. India is no exception to these trends and is fast emerging as one of the global leaders in digital adoption, despite remaining gaps and uneven progress across regions. Harvard Business Review (HBR)'s Digital Evolution Index (DEI) 2017 for 50 countries has bracketed India in the list of 'Break Out' countries along with China, Brazil, Mexico, Indonesia, etc. These countries have the potential to develop strong digital economies as they are improving their digital readiness quite rapidly. India's digital economy potential lies in its large population, increasing adoption of technology, and the rise of skilled and global language-speaking youth. As per HBR Report, India is moving towards the digital economy path with a fair number of initiatives and innovations. However, staying on this trajectory means confronting challenges like improving supply infrastructure and nurturing sophisticated domestic consumers. To accelerate the digital momentum, growth drivers for digital economy must be identified and amplified.

In May 2017, Hon'ble Minister of Electronics and Information Technology, Shri Ravi Shankar Prasad announced the aim of making India a "One Trillion Dollar Digital Economy" by 2022. The Ministry partnered with McKinsey & Company (management consultants) to create the vision and roadmap of the project to communicate to the world the massive scale of digital transformation underway in India, and a roadmap of how India could become a global digital leader. A 50+ member Digital Council comprising private and public-sector leaders with varied expertise and experience was set up to advise on the project. A two-day workshop was also organized by the Ministry to consult the industry leaders to discuss the potential of the project.

The Government's strong commitment and the myriad of initiatives to digitise key aspects of the economy as a means of achieving national objectives are driving the rapid digital adoption in India.

They are being complemented by private sector investment, disruptive innovation and intense competition (enabled by falling costs) promoting digital access and usage at affordable prices. In 2014, with the aim of broad-basing financial inclusion, the Pradhan Mantri Jan Dhan Yojana was launched to open millions of bank accounts linked to mobile phones and authenticated using Aadhaar. In 2015, Hon'ble Prime Minister launched the flagship Digital India initiative to transform India into a digitally empowered society and knowledge economy. This is an ambitious programme focusing on three key areas — digital infrastructure for all the citizens of India; taking governance to people digitally and providing services online; and the overall digital empowerment of the people. The real push has come from using the JAM trinity, comprising of Jan-Dhan account, Aadhaar identity and Mobile phone to enable citizen participation in the digital and finance space. India is the only country in the world with 99 % of its adult population having a verifiable biometric identity. This is enabling crores of poor people otherwise living in the shadow of informal economy, to become active participants in the global economy. Internet connectivity, the key to digital adoption, is growing exponentially in India. Driven by availability and affordability of smartphones, about 65% of internet traffic is coming from mobile. India has now the second largest mobile consumer base as well as the second largest Internet subscriber base in the world.

Direct Benefit Transfers (DBT) in more than 390 welfare schemes covering over 41.8 crore beneficiaries, enabled by the JAM trinity have made the transfers efficient and transparent and saved more than INR 57,000 crores (570 billion) over the last three years. About 2.86 lakh Common Services Centers with nearly 1.88 lakh of them at Gram Panchayat level with wide coverage across the country are taking e-services to every corner of the country. This implies that citizens need not travel long distances for services related to Aadhaar, passport, Permanent Account Number (PAN) card, banking, and, many other services. Post-demonetisation, to transform India into a modern cashless society, the Government is promoting the digital payments ecosystem, which allows service delivery at a lower cost and promotes financial inclusion. The launch of IndiaStack applications such as DigiLocker, eKYC, eSign, Unified Payments Interface (UPI) and other open APIs as well as large-scale investments in the Bharat Bill Payment System are catalysing the digital adoption.

Digital India programme has laid a robust foundation for India to move on a steep acceleration path and become one of the leaders in digital transformation. With over 120 crore mobile phone users, 43.1 crore internet users, 30.6 crore Jan Dhan accounts, and Aadhaar authentication platform with details of over 120 crore people, India is very much on its way to becoming a digital economy.

The winning combination of the JAM with Digital India has kick-started a major disruption in banking, payments and the like, as never before. Further, a whole range of start-ups, working in almost every sector, are contributing to the process of digital transformation. Now, India is the third hottest start-up nation in the world— just behind the US and the UK, with over 4,000 start-ups. Be it healthcare, banking, insurance, travel, agriculture or even education, start-ups have become the platform on which various services are available which were earlier not within the reach of common citizens.

With increasing reach of digital access and services, the lives of millions of Indians are starting to improve in terms of greater connectivity, inclusion, convenience, choice, and financial savings. Most sectors in the Indian economy are facing challenges as well as opportunities through digital disruption. Further, the pace of change brought upon by digitization has accelerated significantly in recent times, necessitating new job roles and skills requirements. India can leverage its natural advantage in digital technologies to improve efficiency and lower costs in health care delivery, power distribution, payments, and a number of other infrastructure and social development areas. There are several other challenges, which include issues relating to infrastructure—physical and digital, skill gaps including need for re-skilling, innovation ecosystem, public-private partnership, support for MSMEs, data security and privacy, standards-based interoperability and a conducive regulatory framework. The Government is relentlessly working to tackle these challenges through various initiatives such as drafting a new industrial policy with focus on Industry 4.0 and a robust Data Protection Act. The trillion-dollar digital economy is an ambitious new initiative of the government aiming to amplify the ongoing digital revolution and spread it to all the sectors of the economy by identifying unlocks and growth drivers and implementing them.

McKinsey & Company have engaged with the members of the Digital Council as well as government ministries/ departments and other organizations. The project covers several components, viz, a) creation of indices to understand India's digital access and adoption relative to other emerging and mature digital economies; b) value to be created by 2022 as per national priorities through digital ecosystems, highlighting opportunities for all segments including MSMEs, rural/farm workers, less developed areas, and poorer income groups, c) a broad roadmap for what it would take to enable the digital economy in terms of private and public sector innovation, partnerships, investments, new-age digital platforms, ecosystem enablers and supportive policies and regulation; and d) a set of iconic lighthouse projects that will have transformational impact on India in the digital arena.

India's digital transformation is accelerating and has the potential to raise productivity, unlock efficiency, remove barriers to growth, and improve the quality of life of especially the disadvantaged sections. Leveraging India's start-up momentum is a pre-requisite to integrate innovation into the fabric of the country, while working towards the trillion-dollar digital economy. There is also a need to encourage better integration of automation, data, and new technologies into the legacy economy. Introduction of skills required to thrive in a digital economy at early levels, specifically at schools is vital. Therefore, collaborative efforts by the government, industry, academia, research and financing institutions are the need of the hour to ensure leveraging of the digital revolution for inclusive growth in India. Together, a wider ecosystem can be created, where next-gen technologies are mainstream, connectivity is seamless, and quality of life is improved via e-governance, online education and training, smart healthcare, digital market connectivity and even precision agriculture, amongst other things. Vision for the digital economy is to reach out to citizens in the remotest corner of country, and make them a part of India's growth story and transform their lives.



CITATION

- 1-http://www2.johnson.cornell.edu/alumni/enterprise/spring2014/index.cfm?action=feature&feature_id
- 2- <https://www2.deloitte.com/mt/en/pages/technology/articles/mt-what-is-digital-economy.html>
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Dr. Seema Gaur is Senior Economic Advisor, Ministry of Electronics and Information Technology

India's quest

FOR LEADERSHIP IN CYBERSPACE

VIJAY KUMAR SARASWAT

The last couple of years have clearly marked the advance of cyberspace and its relevance in contemporary geopolitical discourse to an extent as being referred as the fifth domain of warfare. While this realm has been in limelight for its strategic and geopolitical relevance especially in warfare, it also brings with it opportunities with regard to social and economic relevance. India, in its quest to be a new global power, should also take seize of these opportunities and should aim at capitalizing them especially in view of a sizable cyber-literate, skilled and relatively young demography. The nation needs to re-strategize and organize to capitalize cyberspace in rather unconventional terms i.e. from an existing paradigm of software services and development aspects to the domain of strategic cyberspace technologies and specifically cyber security.

To orchestrate this strategy, India needs to strategically develop long term capability in certain niche areas of cyberspace which the author believes will be the disruptions with strategic effects and which will in-hitherto shape the next century effecting almost every aspect of life. These three strategic domains of cyberspace are the domain of artificial intelligence (AI), Internet of Things (IoT) and, most important of all, quantum applications in cyberspace – specifically quantum computing and quantum communication. These three domains will be the **primary** triggers in shaping cyberspace in particular and society in general in this century. India needs to plan and orchestrate its research institutions, industry and academia to develop a stable and sustainable ecosystem for these three domains to germinate and evolve, thus reshaping India's cyber economy, heralding it to be a new global leader in cyber space.

Research and development in computer science has given rise to advanced technologies like AI, IoT and quantum computing and communication. These technologies are no longer part of the laboratories; instead they are rapidly becoming interwoven in societies and are delivering services across a wide spectrum of applications. A new era is on the rise in the cyber world and its security where artificial intelligence is reducing human intervention while productivity has increased multi-fold. The world is becoming more connected. IoT **enables** even otherwise 'dumb' devices get services over the Internet. This has resulted in the devices becoming smarter and able to handle variety of complex problems. Quantum computing holds the key to the perfect security, even as classical techniques of cryptography can no longer guarantee confidentiality, integrity, and authenticity. Considering the advances seen all over the world, primarily as applicable to cyber world, India needs to move in these domains or else risk being swamped.

ARTIFICIAL INTELLIGENCE

Ever since humans inhabited this planet, they were in search of techniques which would aid them to conduct their daily work in an easy manner. In this era of high end technology, artificial intelligence (AI) is sought for the same reason. Although the history of AI is fogged with myths and rumours, the gestation period of AI was 1943-1956^[1] and it included the introduction of three noted factors. These three factors are: the introduction of artificial neuron by Warren McCulloch and Walter Pitts in 1943^[2]; the proposal on the topic "Computing Machinery and Intelligence" by Sir Alan Turing in 1950^[3]; and coining of the term "artificial intelligence" by John McCarthy, an American computer and cognitive scientist. AI was included in the field of research and development in 1952^[1]. Today this term encompasses several technologies, such as robotic process automation, machine learning, machine vision, and natural language processing. AI has been deployed in various aspects of daily life, right from large industry operations to basic home routines. AI has been applied in healthcare, business, education, finance and **manufacturing**.

The rise of AI has helped mankind take a giant leap. AI has rapidly progressed from voice based assistance to self-driving cars. AI has now attained an appreciable ability to encompass a spectrum ranging from search algorithms to autonomous weapons. As of now, AI is widely known as narrow AI or weak AI in which it is only designed to perform a narrow task like searching the internet, driving a car and so on. Researchers have set a long-term goal of creating a strong AI or general AI which would outperform humans on cognitive tasks. AI has brought about a drastic change in the cyber domain. Chatter bots are very good examples of the incorporation of AI in the cyber world. Chatter bots – also known as artificial conversational agents, artificial conversational entities, conversation agents, or chat bots^[4]- are computer programs used to conduct conversations using text or auditory messages. Currently chatter bots are a part of virtual assistants. Assisting applications are also installed in computers and other cyber devices that would assist the user to perform their routine tasks, such as sending mails, setting reminders, and auto replies for unattended calls. All these are results of research into, and the implementation of, machine learning (ML), deep learning (DL) and natural language processing (NLP).

Machine learning is an application of AI based on the concept that machines should be able to learn from data fed to them. Technically, ML is the ability provided to computers to learn without being explicitly programmed^[5]. The term machine learning was coined by Arthur Samuel, a pioneer of computer gaming in 1959^[6]. ML has evolved from the study of pattern recognition and computational learning theory in AI^[7].

Given samples of data (input-output pairs) that represent the behaviour of a real-world system, an ML algorithm builds a model that is capable of behaving like the real-world system. That is: given the same input data it will provide the same output data, as provided in the samples. This model also can provide reliably accurate output data for previously unknown inputs. For any such model to be realized correctly, the provided data needs to be representative of the real-world system.

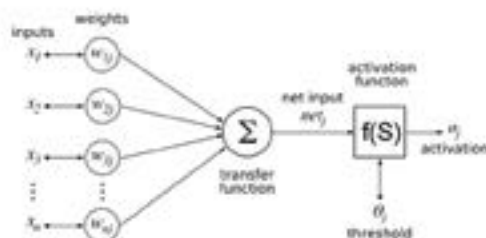


Figure 1: Training a neural network by supplying representational data

ML has been applied alone and in conjunction with AI. It has shown plenty of possibilities that would provide an edge to the new technologies of computation and communication. Decision tree learning, artificial neural networks, and genetic algorithms are some of the approaches employed by ML.

Neural network algorithms emulate the ability of human brain to learn from experience. As shown in Figure 1, instead of executing explicit code for classifying data, the neural network analyses sample representational data (i.e. input and output pairs) and models the real-world system based only on simple mathematical functions and multiplicative factors called weights.

Similar techniques are followed in other approaches to ML like deep learning. DL is a kind of neural network algorithm and a part of the broader family of machine learning algorithms which are based on learning from data representations [8].

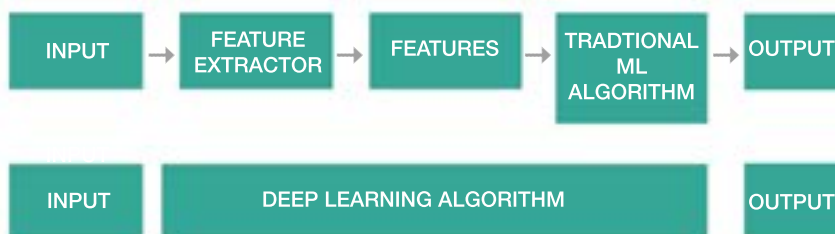


Figure 2: Deep learning compared to traditional machine learning

A DL algorithm accepts metadata as input and processes data through multiple layers of non-linear transformation [9]. The process of learning can be supervised, partially supervised or unsupervised [9][10][11]. The DL algorithm automatically grasps the required features to solve the problem. DL differs from traditional ML in that, unlike in ML, feature extraction, feature analysis and classification are all done by a learning algorithm like a neural network. When utilizing neural network algorithm in DL, the algorithm has hidden layers which will compute the unique set of features. An increase in the number of hidden layers would cause an increase in abstraction and complexity of the neural network. A hierarchy is formed from low-level to high-level features which in turn make the DL algorithm capable of solving complex problems using layers of non-linear transformations.

Other important application of AI is in natural language processing. NLP can be defined as the ability of a computer program to understand human language [12]. Recent approaches to NLP are based on DL where understanding of a program is improved by using patterns in data. NLP can be employed for interpreting free text and making it ready for analysis. This feature allows analysing the information available in free text such as medical records.

AI has evolved from a pure theoretical computer science subject to a contemporary applied variant, with its numerous applications are being developed and productionized. Some of them include virtual personal assistants, smart cars, and the chat bots mentioned earlier. Now days, everyone has smartphones with AI assistance (systems such as Google Now, Siri and Cortana) on various platforms (IOS, Android and Windows, respectively). These assistants help in finding location, giving commands to other apps, telling stories, setting reminders etc. Alexa is also AI- powered; it works like other personal assistants, but can also purchase products from Amazon website. Similarly, AI is used here to drive cars using deep learning i.e. the smart cars. Just like humans, smart cars need sensors (camera, and ultrasound) to understand the world [14]. Google auto drive cars and Tesla's autopilot are examples of ongoing development of smart car technology.

One of the most important application of AI is in cyber security. Using traditional defensive mechanisms, it may take a long time (sometimes up to a month or even a year) to detect intrusion. AI systems can be designed and trained to detect intrusions in the smallest time period after the incident. Although AI increases efficiency and precision with which to meet the challenges of today's organizations, human interaction is still required so that along with human interaction it may be possible to produce results in less time. When government introduced cashless economy and Digital India, the importance of cyber security increased. Creating an AI for autonomous cyber bug hunt will increase the speed with which zero-day exploits could be identified and addressed. AI-based advance intrusion detection systems and self-healing platforms are some of the palaces where AI would drastically change the contemporary cyber security domain. Similarly, the quantum of data being generated every second itself has resulted in a pertinent need for analysing huge amounts of data – in other words, Big Data. It is not possible for humans to process large amount of information. AI-based applications are needed for handling Big Data – for example, for identifying and forecasting potential vulnerabilities, identifying anomalous cyberspace activity, and orchestrating an automated response to prevent such activities before they happen.

AI will be one of this century's great game-changers, reshaping it. Russian president Vladimir Putin has warned that the nation that leader in AI "will become the ruler of the world". Tesla chief executive Elon Musk has also warned that AI could be humanity's greatest existential threat, this time by leading to a third world war [13]. Hence, this one domain is where India needs to strategically define a roadmap; and synergise its industry, academia and research institutions to capitalize on the opportunities provided.

INTERNET OF THINGS

Another game-changer of this century will be the domain of Internet of Things. The term "the Internet of things" was coined by Kevin Ashton of Procter & Gamble (later the Massachusetts Institute of Technology's Auto-ID Center), in 1999 [15].

The Internet of Things (IoT) is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and network connectivity which enable these objects to collect and exchange data ^[16]. Each 'thing' is uniquely identifiable through its embedded computing system but is able to interoperate within the existing Internet infrastructure. Experts estimate that the IoT will consist of about 50 billion devices by 2020^[17]. In other words, IoT is a system in which different dedicated devices are able to communicate and exchange data over the Internet (or even a network restricted within a campus) in order to deliver better services to end users.

Popular consumer applications include smart home systems, wearable technology, connected health monitoring and emergency response systems and so on. Industry applications include industrial process automation, environment regulation, energy management etc., while IoTs are also proving useful in business by understanding customer needs and delivering customized service. The power of IoT is really seen when combined with other technologies like AI. Elon Musk's Tesla vehicles comprise one of the better examples of such a technology. Packed with features [18] like automatic entry and exit from garage, keyless locking and unlocking, regulating speed as per traffic conditions, and a partial autopilot system, Tesla's technology is able to upgrade the experience of driving a car. IoT has a significant impact on cyber world. A network and a protocol for exchanging data are crucial to IoT implementation. Due to these two factors, IoT enters the cyber domain by utilizing the existing Internet infrastructure and protocols.

As IoT devices are necessarily small in size, they are limited in terms of resources like energy, computational power and bandwidth ^[19]. Such limitations open these devices to a large number of bugs which can be exploited with malicious intent. Similarly, its applications also have implications on privacy and security. Continuing with the example of Tesla car: while IoT technology does make it better in many ways, the fact remains that software is involved at some level of control. As vulnerabilities may exist in such software, it is possible to exploit and cause harm as was demonstrated at Keen Security Lab by taking remote control of Tesla Model S in both parking and driving mode ^[20]: Specifically, researchers were able to remotely control the sun roof, indicators, seats and car lock in parking mode, wing mirrors and brakes in Driving mode.

Another case of security failure of IoT is that of Mirai botnet. Mirai is a malware which scans for and infects IoT devices like routers and IP cameras. The purpose is to turn infected IoT devices into "bots" for use in Distributed Denial of Service (DDoS) attacks ^[21]. Mirai was involved in a cyber-attack against the Domain Name System (DNS) provider Dyn on 21st October, 2016 ^{[22],[23]} causing disruption of services like Netflix, Amazon.com, Airbnb, HBO, The New York Times, CNN, Quora, Twitter, PayPal, GitHub, BBC, The Boston Globe, Electronic Arts and more.

Privacy concerns are integral to IoT as the technology relies heavily on data collection and data exchange. Due to the nature of services that can be provided using IoT devices, companies not only collect data but also analyse it.



Since companies are restricted by their privacy policy on why, what and how of data utilization, corporate transparency is desperately needed [24], [25]. “Data brokers” – people or organizations – can sell collected data for financial gain. While stringent privacy policies can aim to restrict data brokering, in reality, such policies may not be as strictly followed as is claimed. Back door selling and buying of data is also possible [26]. Mass surveillance is also possible – and can be made even easier – using IoT devices [27],[28].

IoT has and will drastically change the way in which contemporary cyberspace operates, with serious cybersecurity and privacy ramifications. Indian academia and industry should join hands to create a stable workforce and environment where research can be carried out in technology areas such as the standardization in IoT protocols, and in the technologies, that form the building blocks of IoT [29]: addressing, Machine to Machine (M2M) protocols such Message Queue Telemetry Port (MQTT), Constrained Application Protocol (CoAP), Open Mobile Alliance Light Weight M2M (OMA LWM2M), and their applications in cyber-physical systems.

QUANTUM COMPUTING AND QUANTUM COMMUNICATION

The third and probably the most important disruption in cyberspace will arise from the application of quantum physics in the domain of cyberspace: specifically, quantum computing and quantum communication. Quantum computing has evolved a lot since its inception in early 1980s, when Nobel laureate and physicist Richard Feynman thought of a computer that would yield the quantum mechanics effects for its own advantage [30]. The concept of a quantum computer was considered only on the basis of theoretical research until in 1994, when Shor’s algorithm which proposed to break the existing cryptographic techniques in few seconds. Although quantum computing would not replace classical computing entirely, its ability to solve classical problems influenced researchers and physicists to dive deep into this technology. The superposition and entanglement concepts enable quantum computing to process varied number of calculations simultaneously [31]. The ability of quantum networks to transmit quantum information between quantum processes which are physically separated paved the way for communication between multiple quantum processes. An important feature of unbreakable security is that the communication technology proposes a secure communication channel by implementing quantum key distribution [32].

The keys for encryption are sent in forms of photons distributed evenly to sender and receiver. Due to the entanglement feature (highly correlated particles), it is impossible to intercept the communication without disturbing the system. Such actions would be promptly noted by the two parties. This promising security feature has resulted in multiple implementations around the globe starting from the DARPA Quantum Network in early 2000 to the successful operation of Micius, China’s quantum satellite, recently this year. The transfer of unhackable codes from the Chinese satellite to earth has opened a new chapter in the field of communication [33]. Apart from China, US, Canada, Japan and the European space agency are also working on minor projects in this filed. Considering the communication in the cyber world, the trial run by china would bring about a secure communication network.

From the cyber-attacks that have occurred till date, it is evident that the Government, armed forces and financial networks are the primary targets of hackers.

The implementation of quantum encryption promises to thwart any intrusions or interceptions for those networks along with an impeccable method to detect any such attempts. Stored data in databases faces the issue of illegitimate leakage by adversaries. The quantum computers are able to falsify digital signature, change the code and even permit access to outsiders. To answer this, Russian Quantum Centre has proposed a quantum block chain which allows using a quantum cryptography system and quantum data transfer system to secure databases from attack. Reports indicate that certain Indian enterprises have been exploring the quantum physics based technologies that would mould the future of cyber security [34].

Although the quantum technology provides imminent security, further implementations are still unexplored. Mainstream IT giants are already operational in quantum computing. The implementation could be enabled in scores of scenarios, including credit card data transfer, health care, etc. A paper [35] published early this year proposes the idea of implementing quantum cryptography in cloud computing to provide a secure cloud environment for data transfer. In the field of cyber security, quantum cryptography would provide an invulnerable channel for communication.

Quantum computers pose a threat to the current cyber security infrastructure for its capability of computing power to crack the security measures that are currently followed. The budding quantum computers could create havoc by harvesting sensitive data. In order to reduce this threat, quantum technology provides quantum cyber security [36] capabilities that would enhance data security against existing attacks and future quantum computer attacks. In addition to these, methods are being proposed by researchers for preventing susceptible attacks on quantum key distribution. New algorithms are being sought out to prevent classical and quantum computing attacks; however, these algorithms, too, would require updates as new quantum algorithms emerge. Quantum computing and quantum communication technologies are shaping, and will continue to shape, the way in which classical cyberspace operates.

Quantum computing, in essence, renders classical cryptography – rather, cyber confidentiality measures – useless, and hence opens a Pandora’s box of new threats and opportunities. The key aspect is that, as these technologies evolve, the entire cyberspace will be affected which in-hitherto changes the way in which classical notion of computing, communication and security behaves. It is for this important fact that it becomes imperative for India to take on these challenging problems right at their inception, building a solid research foundation which may be capitalized by the industry resulting in a sound ecosystem for next generation systems.

WAY AHEAD

India, with its aspirations to become a global leader in cyberspace and cyber security, needs to take into account contemporary dynamics involved in these strategic domains of cyberspace. The domains of artificial intelligence with key areas of focus in machine learning, deep learning neural networks etc.; Internet of Things with sub-domains such as the standardization in IoT protocols, Machine to Machine (M2M) protocols such Message Queue Telemetry Port (MQTT), Constrained Application Protocol (CoAP), Open Mobile Alliance Light Weight M2M (OMA LWM2M) etc.

and their applications in cyber-physical systems; and quantum physics based quantum computing and quantum communication systems and technologies, provide niche areas where the nation can take leadership.

In order to achieve this goal, there is a need to strengthen policy and regulations, initiate skill developing programs, promote R&D and innovations and give funding to business incubators for cyber security solutions through tax relief and financial incentives. Creating a technology cluster approach where appropriate research institutions, incubator industries, startups, academia and individual researches both from India and Indians abroad may be identified as technology domain cluster. These clusters need to be strategically funded and steered by Government and private actors in a public-private partnership model. The outcomes of these strategic technology clusters need to be provided with research grants primarily for academia; easy and interest free loans for startups; and preferential market access specifically in government procurements for industry. These clusters will prove important to promote growth of cyber security startups and small and medium sized enterprises (SMEs) as well. Each of these clusters need to be monitored and steered by a strategic advisory group primarily consisting of academia, industry and government.

India has the required intellectual capability, a vibrant young demography, strong academia and evolving cyber industrial complex with emerging startups. We have all the requisite ingredients to develop a strategic and focused roadmap to orchestrate all these factors in pivoting India to become a global leader in cyberspace and cyber security. It is indeed time to leapfrog by capitalizing on these strategic and high impact technologies to become a global leader in cyberspace and cybersecurity.



Dr. Vijay Kumar Saraswat, is former Secretary, Defence R&D, and presently Member NITI Aayog. He has been credited with development of Liquid Propulsion Rocket Engines and missiles namely PRITHVI, DHANUSH, PRAHAAR indigenously.

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Annexures

A COUPLE OF INDIAN VOICES
ON GLOBAL MATTERS

1. SCIENCE, TECHNOLOGY, ENGINEERING, APPLICATIONS, MANAGEMENT

First, we discuss the issues related to the technical aspects of cyber security: its science, technology, engineering, applications, and management (STEAM).

SCIENCE

The science behind securing the web spans many domains of mathematics, statistics, computer science, electronics and communication engineering. Within computer science, information security covering data-at-rest, and data-in-transit pose many challenges to the designers of operating systems, database systems, and network protocols. These provide many opportunities for new ideas drawing upon basic sciences for the design, analysis and verification of algorithms, programs in software hardware. The advent of quantum mechanics-based computational algorithms and communication schemes has spurred much recent excitement about the possibilities of secure computing and communication.

The science of privacy-preserving search and retrieval operations on digital databases has led to many useful results. Statistical methods, algorithmic schemes and cryptographic techniques can all be invoked to develop sophisticated methods satisfying the requirements of the owners and consumers of data. There is a new trend in developing methods for controlled release of personal information by an individual owner. These methods provide privacy and security and also provide a share to the individual in the monetization of his personal information. These methods utilize contemporary developments in the area of blockchains and cryptocurrencies.

Technology

The technological issues of digital security relate to the end-usage conditions. Many innovative adaptations suitable for different application scenarios are produced by industries. There is an increasing reach of digital technologies from corporate IT businesses to all human activities. With the coming of ubiquitous computing, cloud platforms and Internet of Things (IoT) the digital tentacles are growing rapidly to touch every human and every human-made artefact. Clearly, in such a networked world, the cascading effects of local actions on the global scale will be far-reaching. The scientific and technical ideas of information security need to be reshaped to cope with these new kinds of local-global paradigms.

Engineering

Many of the issues above are handled effectively by engineering software and

and hardware that takes note of security right from the design phase through the development, manufacturing and installation phases. Many inventions in programming languages, computer communication hardware, are utilized to give robust shape to the basic scientific algorithms. An example of this phenomenon is in the domain of cryptographic algorithm design and engineering, where the modern emphasis is, on implementation, resistant to information leakage or side-channels. However, these interventions need controls – the absence of which can lead to wilful misuse.

APPLICATIONS

There is a wide range of existing and future applications of digital technology products and services. The balance between societally relevant usage versus mala fide and inappropriate usage lies in the hands of the individual and the state. This balance is also tempered by the interests of the corporate business world. The web demands collaborative audits and checks imposed by the service providers.

MANAGEMENT

Closely related to the world of applications are the issues of operations and management of systems riding the web. These include trusted platforms, trusted security management practices, trusted dispute resolution and arbitration mechanisms. A broad spectrum of security issues, impinging on the principles enunciated in all the other sections, need to be addressed by states and enterprises.

2. SOCIOLOGY, PSYCHOLOGY, INFOMEDIA, ECONOMICS, LINGUISTICS

The digital age, just as other ages of civilization, brings a host of competing issues impacting the human condition. We consider various cyber security issues pertaining to sociology, psychology, information-media, economics, and linguistics (SPIEL).

SOCIOLOGY

Human users have a special disposition toward technology. They exhibit unpredictable levels of acceptance or rejection of the products of human creation. This has been noted across cultures, geographies and time. Today, communication and computing technologies and their congruence have been embraced as a way of life by almost all societies.

Education and awareness of cyber security issues need to be escalated from national considerations to global perspectives.

PSYCHOLOGY

There is a growing need for regulations in the generation and dissemination of digital content over the social media, by individuals and collective groups. The basic socio-cultural fabric of human beings consists of several checks and balances. The advent of the ephemeral, dark, hidden, virtual, world provides easy avenues for errant behaviour which defy the norms observed in the real world. The ensuing conflicts in the minds of individuals and groups, leads to virulent, anti-social cyber havoc. Monitoring the web for digital signals using techniques, such as machine learning, has been successful to limited extents. This needs to be strengthened.

INFOMEDIA

The digital age has brought information access within the reach of all. The enablers of this access mechanism include the content providers, the media services and the end-device manufacturers. A safe and secure digital web has to address issues of interest to all these agents and the citizen end-users. Amidst the many advantages of education and entertainment the contentious issues are digital rights, social media misuses, data privacy, dark web, propaganda ware. Coping with these require newer processes of instilling cyber-ethics in a natural, universal manner.

ECONOMICS

The economics of cyber security is about threats and returns on investment. We touch upon a recent new phenomenon of private cryptocurrencies. Since the initial entry of Bitcoin, many companies have announced new cryptocurrencies. These are cryptographically secured, privately generated sequences of publicly verifiable distributed, digital ledger entries. The inexplicable rise of this form of product, owes its success to the human speculative nature, and relies on its financial volatility rather than its transactional convenience. The future of money depends on the growing digitization of financial transactions, and products, trading protocols, exchange agreements and most of all on the security of the underlying substrates of algorithms, software code, digital operating systems, trusted hardware and the ubiquitous internet.

LINGUISTICS

In the digital age, data flows seamlessly across borders. The semantics of the language of bits and bytes covers – representation (text, image, audio, video), content (email, news, publications, propaganda material), user entities (individuals, rms, government, law enforcement agencies), languages and cultural contexts. A safe, secure world requires utmost diligence and empowerment on the part of the international oversight systems. The imperative, for a secure web, is a good understanding of the underlying socio-political, socio-linguistic and socio-economic fabric of different peoples, polities and societies.





3. GOVERNANCE, LEGISLATION, ACCORDS, DIPLOMACY, ENTENTE.

Cyber security issues require the examination from the perspectives of governance, the city-state and international agencies. We consider the issues pertaining to governance, legislation, accords, diplomacy, and entente (GLADE).

GOVERNANCE

A secure and safe cyberspace is required not only by citizens and corporates, but also for the smooth conduct of governance processes since almost all critical infrastructure is becoming heavily dependent on the information technology substrate. Hence the state needs to establish and sustain institutions such as the computer emergency response systems, cyber evaluation and certification systems.

LEGISLATION

The advances in computer and communication systems necessitate many revisions of thinking with respect to many decade old IT processes and systems. Major structural changes and adaptations need to be considered to accommodate the technological changes. Some examples are policies on public key infrastructures, data mining and privacy protection, blockchains and cryptocurrencies.

ACCORDS

The seamless integration of the information networked world generates many contentious and fractious issues. The issues require prudent examination of the implications and suitable agreements need to be worked out.

Some examples of potential future instruments are digital intruder extradition treaties, digital insurgency elimination protocols, and digital anti-terrorism acts.

DIPLOMACY

The integration of the cyberspace across sectors of governments and businesses requires policies on multi-national diplomatic relationships. These will also enable the formulation and containment, of the effects of future cyber-warfare, through principles of digital embargoes and digital-disarmament.

ENTENTE

Grand challenge technological projects on a global scale are harbingers of friendly uses of technology. A couple of such projects are (i) a constellation of international quantum satellites for secure, high throughput communication (ii) secure, international financial disaster warning systems. Such projects will kindle and sustain the human spirit in the modern digital era. Hence the resolution of cybersecurity issues requires a global understanding and entente, with regard to a few international projects.

Prof. C E Veni Madhavan is Professor at the Department of Computer Science and Automation at the Indian Institute of Science.

1. PERSPECTIVE

Artificial Intelligence (AI) is the field of Computer Science and Engineering (CSE) that aims to make computers intelligent. Alan Turing, the Father of Computing, gave the Turing Test for AI back in 1950s, which highlights the long-standing pre-occupation of the computing community with AI. It is interesting to note that in the absence of fixed and unique definition of intelligence – an impossible task per se – AI has always suffered from identity crisis, ever-shifting mileposts, and even mistrust for lack of concrete evaluation criteria. However, like all areas asking **foundational** questions, AI too has challenged CSE with deep questions and thus has pushed the frontiers of computing.

Efforts to make computer intelligent have co-existed with efforts to make computers faster – the so-called numerical computing and symbolic computing dichotomy symptomatic of the machine intelligence and human intelligence dichotomy. Scientific computing has benefited immensely from number crunchers that process at the speed of trillion bits per second. These machines have ameliorated the human frailty of dealing with numbers. For example, multiplying two 24 digit numbers is cake walk for such machines, but uphill task for humans. Conversely, recognizing faces, understanding sentences and interpreting images have been cake walk for humans, but uphill task for machines. Humans are excellent with patterns, but terrible with numbers, while computers are just the opposite. AI purports to resolve this weakness of computing machinery, viz., processing and making sense of symbols. AI's main methodology has been symbolic computation, working with patterns. It is now a cliché to state that computers have not been able to emulate the abilities of even a toddler who effortlessly recognizes its mother, in spite of her dressing, expressions and even perfume being different.

1.2. NATURAL LANGUAGE PROCESSING

Natural Language Processing (NLP) is a sub-field of AI concerned with endowing computers with language ability- of understanding and generating language. Linguistics is one of the oldest disciplines, purporting to place study of language on a scientific footing, discovering the laws governing language analysis and production. Discovery of computer, and later, advent of internet introduced a completely new dimension in the study of language, viz., Computational Linguistics (CL). Like other fields of Artificial Intelligence, CL sought to sieve apart the drudgery component of language analysis and generation from the creative component, and delegate the former to mechanical processing. That is why CL is also called Natural Language Processing (NLP).

Availability of huge amount of textual data in electronic form, engendered NLP-ML, the use of Machine Learning (ML) techniques to process language. Until huge amounts of text data in e-form became available, rules were embedded in computers to do, for example, translation from one language to another, automatic question answering, and summarization and so on. Rule based systems are characterised by high precision and low recall. They are brittle too. For example, the accuracy of traditional Part of Speech (POS) Taggers fall by at least 20% when applied to noisy text like tweets and social media postings. The reasons for the failings of rule based systems are not far to seek. Rules are products of human understanding of phenomena. When these phenomena are of language, arbitrariness and exceptions confront the rule-framers more often than not, derailing theories. So, NLP – like many other fields of AI – is by necessity a mixture of neat rules and rote-learned patterns, the latter many times overwhelming the former, so much so that, NLP is sometimes uttered in the same breath as machine learning.

Extracting and weighing text patterns with probability is the modus operandi of ML-NLP. Parts of text (e.g., N-grams) and properties of text (e.g., parts of speech) provide features for machine learning systems to make decisions, for example, to decide if the text contains positive, neutral or negative opinion; or, for example, out of 25 answers to a question which one is the most appropriate. It is agreed that such decisions are shallow, and based on assumptions of underlying distributions which may be completely off the mark. But such statistics based approaches have 'delivered' more often than not, worked by producing 'something' at least, instead of coming a cropper. ML-NLP has been found to be useful and is here to stay.

1.3. FEATURES

However, the crux of ML-NLP is the set of 'features', the driver of the learning machine. Features are needed to train a machine. They are again needed when a new input arrives. For POS tagging, for example, suffixes of words are one of the important features. Features are also uncovered by ANNOTATION, enrichment of text by meta information. For POS tagging, annotation produces POS tags on training data. This POS tagged data is used to do parameters setting in HMMs/MEMMs/CRFs/Neural-Nets. Huge amount of annotated data is typically needed for solving complex NLP tasks like machine translation or sentiment analysis.

This article is on Sentiment Analysis (SA) which is a sub-field of NLP that makes heavy use of machine learning. Written texts and spoken utterances often have sentiment associated with them.

Such sentiment is expressed explicitly (“that was a terrific movie”) or implicitly (“go see the movie only if you want to have a nice sleep in AC”). Fundamentally it is a 3-class problem- positive polarity (as in the first example) or negative polarity (second example) or neutral polarity (“the movie runs for 3 hours approx.”). Given an input text the sentiment analysis program should place the text in one of the three polarity classes- positive (+1), negative (-1) or Neutral (0), which amounts to hard decision (hardmax) or should assign a number, say, between 0 and 1 (a probability, if the numbers add to 1) which amounts to soft decision (softmax) of placing the text in one of the three classes. An allied problem- more complex and involved- is the problem of emotion analysis (EA) which is a multi-class problem, tracking the emotion expressed in text.

2. FORMAL DEFINITION OF SA

Sentiment analysis is defined by a quintuple:

$\langle oj, fjk, soijkl, hi, tl \rangle$,

Where,

oj is a target object,

fjk is a feature of the object oj,

soijkl is the sentiment value of the opinion

of the opinion holder hi

on feature fjk

of object oj

at time tl

Each component of this quintuple is necessary, since definiteness is critical about

(a) What is the actual entity (product/performance/person/organization etc.)

(b) What the actual sentiment is about an entity (positive/negative/neutral)

(c) Which aspect of the entity is meant (for a movie cast/dialogue/music etc.)

(d) Who holds the opinion (speaker/another person referred to by the speaker etc.)

(e) When is the opinion held (at the time of utterance/before the utterance etc.)

Take for example the sentence:

S1: I loved the songs in the movie, though only the cast was liked by my brother who said the director was of the opinion that the story line which is from a drama by Shakespeare will be lapped up by the public.

From the sentence, we get:

Entity: movie

Aspects: songs, cast, story line

Opinion holder: I, brother, director, public (not Shakespeare!!)

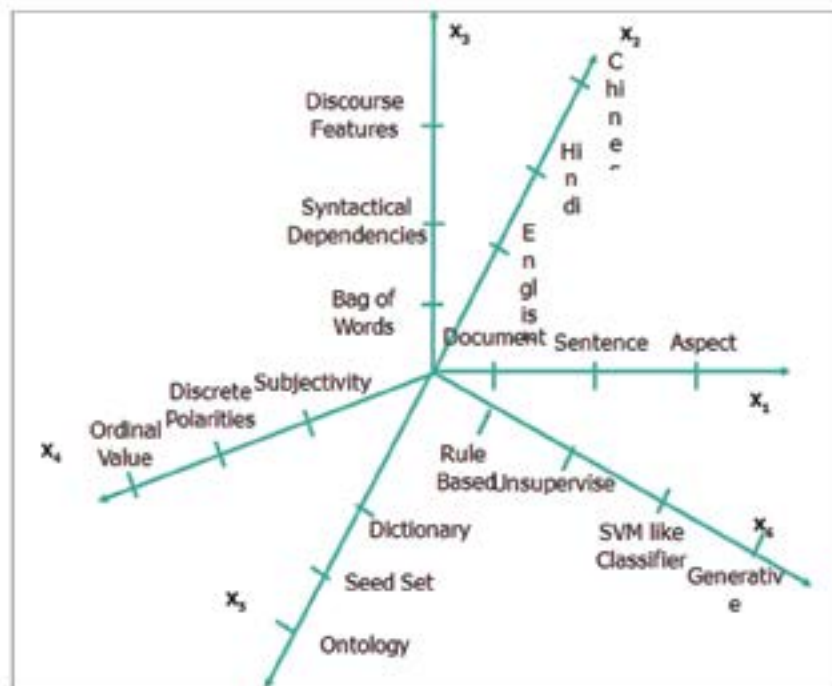
Time: present (I), past (brother), present (director), future (public)

Opinion holder-sentiment-aspect triple: I-love-song, brother-like-cast, director-like-storyline (indirectly), public-lap_up-storyline

It is necessary to correctly establish the sentiment, entity, aspect, sentiment holder, and time relationship. Otherwise the SA system’s output may lead the bigger NLP system that uses the SA module to believe that Shakespeare liked the movie!

3. SA AS A MULTIDIMENSIONAL PROBLEM

Figure 1 below depicts sentiment analysis to be a multidimensional problem. There are 6 dimensions bringing out the 6 different aspects of sentiment analysis. As far as SA as an ML problem is concerned, the granularity of the text is important (dimension - X1). Is the sentiment to be deciphered for the whole document or for a sentence or for a phrase referring to an aspect of the entity? Then comes the language dimension X2.



SA is a multidimensional problem

This point is important, since cultures express sentiment in varied ways. The same intensity, therefore, may be expressed by moderate or strong adjectives in different settings (“the performance was good” vs. “the performance was amazing”). Cross lingual and multilingual sentiment analysis are very active areas of research these days. Researchers are trying to create, for example, neural systems wherein a single deep network is trained with sentiment annotated corpora of multiple languages; or a network is trained with English sentiment annotated corpora and is applied to Japanese text. The latter is bound to give wrong decisions, since the adjectives chosen by two languages are of differing intensity.

Dimension X3 is very important from the point of view of machine learning. ML based SA makes use of features of text to make a decision about the polarity of the text. These features can be words, phrases, dependencies found by parsing, and discourse features like pronominal reference, ellipsis (text drop) and connectives (while, if, until etc.). It is the feature extraction part that makes SA an NLP problem. Dependency features will need parsing, discourse features will need coreference resolution and phrases will need constituency parsing.

A pertinent question here is that of return on investment (RoI). After applying heavy duty NLP (like parsing+coref), do we get sufficient gain in accuracy over the situation where very simple features like Bag of Words (BoW) are used? This question applies not only to SA, but to whole of AI. Theories of diminishing return, submodularity etc. are to be used to tackle this question.

The role of dimension X4 is to express the output as per the need of the user of sentiment analysis system. The output can indicate subjectivity, i.e., whether the text subjective or objective (e.g., “the movie is wonderful” vs. “the movie is set in urban locale”). This decision is important for opinion mining wherein the subjective content of the document needs to be separated from the objective content. The output can be in the form of discrete polarity – positive, negative and neutral- as already discussed. Finally the output can be in the form of ordinals like 2-star, 4 star etc., typically used in movie ratings.

Dimension X5 is for lexical resources. Dictionaries, ontologies, wordnets, knowledge bases etc. are called language resources which are heavily used in NLP systems. SA being a sub area of NLP is no exception. Bag of words – also called unigrams – are the most primitive features used in SA systems. These features may be augmented by referring the words in sentiment dictionaries like SentiWordNet, AFINN, WordStat Sentiment Dictionary, the MPQA Subjectivity Lexicon and so on, to obtain the polarity of the words. For example, the word “disgust” has negative polarity and that information is important for sentiment analysis.

Ontologies play a very important role in organizing concepts as hierarchies. Assisted by word sense disambiguation, ontologies can make the polarity of words precise. Consider these two examples:

S1: Shane Warne was a deadly leg spinner. (Sports domain)
 S2: That forest has deadly snakes. (Travel domain)

The word “deadly” has two different polarities – positive for S1 and negative for S2– in two domains which the use of ontology can help show. Consequently, the word polarity information given to the ML system will be more precise.

The final dimension X6 is for the classifier techniques. Wide variations exist, starting from human created rules to classical ML algorithm like SVM to modern Deep Learning techniques. The choice of the ML technique is dependent on the taste of the system designer, amount and quality of training data available and the form in which the output is desired.

3.1. ON FEATURES AGAIN

Does adding more and more sophisticated features lead to higher and higher accuracy? The answer is no. It is somewhat of a mystery in NLP that increasing the number and sophistication of features often does not bring in expected commensurate gain. Striking examples of this fact are word sense disambiguation, IR and even machine translation. Serious reflection leads one to believe that more features and more complex features most likely introduce drift which takes away from the benefit accruing from augmented and more complex features. Take for example query expansion. Adding topic relevant words to the original query improves recall, but may bring down precision, thereby lowering the F-score.

The reason is that the added words have their own ambiguity, causing topic drift. Thus if one adds the word “case” to the query “law suit against illegal immigration”, which is very related, the ambiguity of “case” as “container” can retrieve irrelevant results.

Table-1 shows representative accuracy figures for sentiment analysis. Over the years similar accuracies have been reported in SA literature. The table is a features vs. classifier matrix, with features as rows and classifiers as last 3 columns (Naïve Bayes, Maximum Entropy and SVM).

Features	# of features	Frequency or Presence?	NB	ME	SVM
Unigrams	16165	Freq.	78.7	N/A	72.8
Unigrams	16165	Pres.	81.0	80.4	82.9
Unigrams+bigrams	32330	Pres.	80.6	80.8	82.7
Bigrams	16165	Pres.	77.3	77.4	77.1
Unigrams+POS	16695	Pres.	81.5	80.4	81.9
Adjectives	2633	Pres.	77.0	77.7	75.1
Top 2633 unigrams	2633	Pres.	80.3	81.0	81.4
Unigrams+position	22430	Pres.	81.0	80.1	81.6

Representative SA Accuracy with different features and classifiers

The combination of very simple features like Unigrams and very simple classifiers like Naïve Bayes produces an accuracy of 78.7, and all other accuracies reported are close. The point this observation brings home is that very simple features and classifiers can produce accuracies that are difficult to beat by more sophisticated features. Unigrams have persisted as indispensable attributes of ML-SA.

3.1. CHALLENGES OF SENTIMENT ANALYSIS

Computationally speaking, sentiment analysis faces the following challenges:

(a) Thwarting: there are large number of positive sentiment bearing features and words, but one final damaging sentence reverses the polarity.

S3: The movie has the nicest actors, a talented music director of worldwide acclaim and the most expensive set one has ever seen but it fails to impress

Here there are many positive sentiment-bearing words or phrases like “nicest”, “talented”, “acclaim”, “expensive” and so on. But the final sentence with the negative phrase “fails to impress” seals the overall sentiment as negative.

For machine learning, thwarting is a challenge, since the features are mostly of one polarity, but the decision is of opposite polarity! Thwarting can be tackled only by weighting the features as per their position in the text (initial and final sentences are often very important for the whole text) and their position in an ontology or concept hierarchy that is specific to the entity. For example, we can create the “part-ontology” of a camera, wherein the parts are placed in a hierarchy with respect to one another with “camera” being the root node. Parts closer to the root are more important than those closer to the leaves. This fact can be used to give weights to words in the BoW based ML.

(b) Noisy text: sentiment is often expressed- especially on social media, blogs, tweets etc.- using non-standard text, i.e., text that is often ungrammatical, has spelling errors and uses slangs. For example:

S4: keeps you on the edge of your seat', 'Tim Tam. \m/
For such sentences, the main problem is data sparsity. ML has to deal with words in the test corpus, that were not encountered in training. Many times the text also has emojis.

(c) Domain influence: we have already seen this case above in discussing the word “deadly”.

(d) Implicit knowledge: world knowledge that is difficult to encode in the automated system. For example:

S5: the batsman falls 284 runs short of what would have been a fourth first-class triple-century

The batsman made only 16 (=300-284) runs! But the negative sentiment is detected through the knowledge of subtraction and the significance of a century in cricket.

(e) Sarcasm: next section.

4. SARCASM

We are ending this article with discussions on sarcasm which is a particular case of sentiment analysis that has proven to be extremely hard to deal with computationally. The problem of sarcasm is a real one and needs attention, since sarcasm is ubiquitous in the world of blogs, social media and tweets. Political tweets abound in sarcasm. Public opinion about personalities, organizations and online services, more often than not make use of sarcasm.

The fundamental problem with sarcasm is that the surface information on the text is exactly in contradiction with the intended meaning. “I love being ignored”- the mirthless utterance of a frustrated guest to her host who never paid any attention to her during the party, is exactly in opposition with the intent, “I have been ignored, and I have NOT liked it”. On the face of it the text does not convey the frustration, but the body language of the speaker is a give-way, the eye is an indication from which a sensitive host will know that she has not exactly done her job. When a machine is called upon to decide if a piece of text or utterance is sarcastic, it often fails badly. Traditional sentiment detection systems show at least 10% fall in accuracy when called upon to decide the sentiment polarity of a sarcastic text.

The origin of the word “sarcasm” is in Greek: ‘sarkasmós’: ‘to tear flesh with teeth’. The equivalent in Sanskrit is ‘vakrokti’: ‘a twisted (vakra) utterance (ukti)’. The Greek etymology makes the intent of sarcasm clear. Sarcasm is always negative and meant to hurt. The opposite phenomenon may be called humble bragging, like in “Oh, I am tired with my life; I have to sign so many autographs everyday!”. The Sanskrit etymology makes it clear that sarcasm originates in irony which arises when the surface meaning is in opposition with the intent.

The author, with his students, has tackled sarcasm with the innovative use of the instrument of incongruity spotting. Incongruity may be explicit or implicit:

S6: stranded in pouring rain and biting cold – so much fun!! (Explicit)

S7: I liked the research article so much that I made a toy boat out of it (Implicit)

In S6, the incongruity arises from the simultaneous presence of the positive sentiment word “fun” with the negative sentiment word “stranded”. In S7, incongruity originates in the simultaneous presence of positive “liked” and implicitly negative “made a toy boat out of the research article”.

4.1. FEATURES FOR SARCASM DETECTION

Table-2 shows the set of features for sarcasm detection. The first row- “unigrams”- is very standard as was discussed in the context of table-1. Unigrams cannot be ignored for SA, as has been repeatedly reported through feature ablation studies in sentiment analysis. The next row is that of pragmatic features. Though sarcasm is a difficult problem, there are clues that are give-aways:

(i) Use of laughter expression

S8: haha, you are very smart xD

S9: Your intelligence astounds me. LOL

(ii) Heavy Punctuation

S10: Protein shake for dinner!! Great!!!

(iii) Use of emoticons

S11: i LOVE it when people tweet yet ignore my text X-(

(iv) Interjections

S12: 3:00 am work YAY. YAY.

(v) Capital Letters

S13: SUPER EXCITED TO WEAR MY UNIFORM TO SCHOOL TOMORROW !! :D lol.

ML must make use of these clues.

Lexical	
Unigrams	Unigrams in the training corpus
Pragmatic	
Capitalization	Numeric feature indicating presence of capital letters
Emoticons & laughter expressions	Numeric feature indicating presence of emoticons and lol's
Punctuation marks	Numeric feature indicating presence of punctuation marks
Implicit Incongruity	
Implicit Sentiment Phrases	Boolean features indicating phrases extracted from the implicit phrase extraction step
Explicit Incongruity	
# Explicit incongruity	Number of times a word is followed by a word of opposite polarity
Largest positive/ negative subsequence	Length of largest series of words with polarity unchanged
# Positive words	Number of positive words
# Negative words	Number of negative words
Lexical Polarity	Polarity of a tweet based on words present

Features set showing use of incongruity for automatic sarcasm detection

The next two rows are the contributions of the present author and his research group working on sarcasm. Incongruity is captured and embellished with other information like text position, frequency, distance between incongruous phrases and so on. Using these factors involve huge implementation challenges, and we have been able to create state of the sarcasm detection systems (Figure 2).

Features	P	R	F	Approach	P	R	F
Original Algorithm by Wolff et al. (2013)							
Ordered	0.774	0.798	0.737	Wolff et al. (2013) (Best reported)	0.61	0.44	0.52
Unordered	0.799	0.837	0.819	Reynard and Greenwood (2014)	0.44	0.38	0.41
Our system				Our system (all features)	0.71	0.55	0.63
Lexical Baseline	0.82	0.967	0.892				
Lexical + implicit	0.827	0.887	0.857				
Lexical + Explicit	0.807	0.885	0.847				
All features	0.854	0.976	0.915				
Tweet A				Tweet B			
Features <td>P <td>R <td>F <td></td> </td></td></td>				P <td>R <td>F <td></td> </td></td>	R <td>F <td></td> </td>	F <td></td>	
Lexical Baseline	0.645	0.508	0.568				
Lexical + Implicit	0.688	0.595	0.638				
Lexical + Explicit	0.512	0.762	0.582				
All Features	0.685	0.514	0.64				

State of the art sarcasm detection accuracies on tweets and discussions for

State of the art sarcasm detection accuracies on tweets and discussions for The F-score in the range of 0.6-0.9 is better than any reported in the literature

5. CONCLUSIONS

The chain of AI à NLP à Sentiment à Sarcasm needs to be taken seriously in today's connected world of internet and social media. Opinions are freely expressed, and cases and anecdotes are broadcast with unimaginable speed and reach. Sentiment, emotion and opinion mining, therefore, assume huge importance. In spite of extreme activity in this field, there are still peaks to be scaled.

Prof. Pushpak Bhattacharyya is Director of the Indian Institute of Technology, Patna; and Vijay and Sita Vashee Chair Professor in the Department of Computer Science and Engineering, Indian Institute of Technology, Bombay.





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