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VOL 27 ISSUE 08 AUGUST 2020

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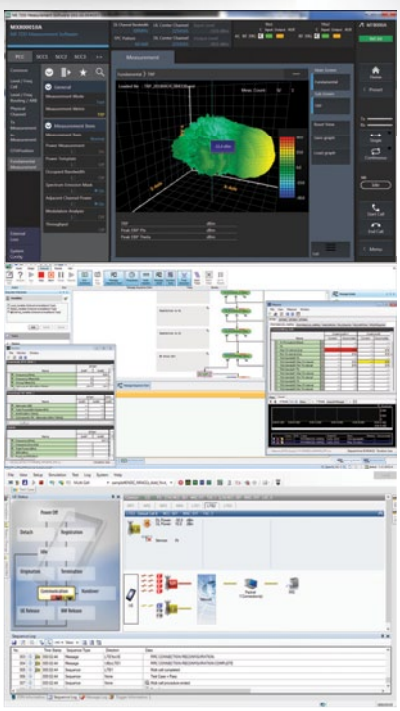

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Voice&Data is printed and published by Pradeep Gupta on behalf of Cyber Media (India) Ltd, D-74, Panchsheel Enclave, New Delhi - 110 017, and printed by him at Ratna Offset, C-101, Okhla Industrial Area Phase—I, New Delhi – 110 020. Editor: Pradeep Chakraborty

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All Payments Favoring: CYBER MEDIA (INDIA) LTD
Distributors in India: IBH Books & Magazines Dist. Pvt. Ltd, Mumbai.

Corporate Website: www.cybermedia.co.in
www.ciol.com (India's #1 IT Portal)

August 2020

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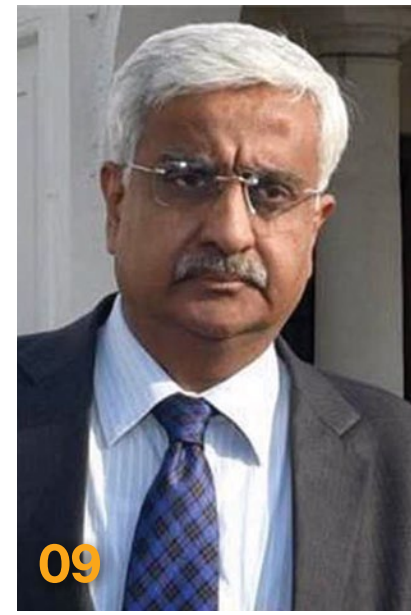

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RIDING HIGH ON THE AD TECH WAVE

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SHUBHENDU PARTH

[OPENING NOTE]

Let us think impossible, unknown

A team of scientists announced that they have figured out a way to keep a quantum computer system operational – or "coherent" – 10,000 times longer than before. According to reports, though the team at the University of Chicago tested their modification technique on solid-state qubits, the solution can be applied to other quantum systems and revolutionize quantum communication, computing, and sensing.

"The broad applicability of this discovery, coupled with a remarkably simple implementation, allows this robust coherence to impact many aspects of quantum engineering," lead author David Awschalom said, adding that the breakthrough lays the groundwork for exciting new avenues of research in quantum science since the approach does not actually eliminate the vital noise, but instead "tricks" the system into thinking it doesn't experience the noise.

My fascination with quantum computing owes its genesis to the transporter from Star Trek universe that could dematerialize matter into energy patterns, beam it to a target location, and reconvert it in the original form.

The binary system used in computers have been able to achieve something similar by breaking the digital assets into packets, transporting it electronically, and reconstructing it bit by bit at the user end. The fatter the pipe, the easier it is to transport bigger files.

However, transporting a matter is different from transferring digital information. This is where quantum computing can play a big role. While theoretically, quantum teleportation is possible, the maximum we have achieved so far is the teleportation of a tripartite unit of quantum information, across 1,400 km. This was achieved by a team of scientists from Austria and China using entanglement-based quantum-key distribution, via Chinese satellite Micius.

Mobile telephony and internet in India turned 25 in August 2020. The period can be marked as an era of metamorphosis. Over the year, the terms IT and communication have converged into digital, driving transformation at a much faster pace. 5G is expected to take connectivity to a different level, enabling billions of machines and objects to transfer information, learn, and operate autonomously. Beyond the enhanced mobile broadband, the mantra is ultra-reliable low latency and massive machine type communication.

Earlier in February this year, scientists from the US Department of Energy's Argonne National Laboratory and the University of Chicago achieved a quantum entanglement over 83.7 kilometer quantum-loop network. The entanglement enabled scientists to link the behavior of two particles in a way that their states became identical. Researchers believe that this could be an important step in the development of a new, vastly more powerful "quantum internet".

In India, we love to live in the past and pat ourselves for achievements "despite the magical mistakes" and policy paralysis. Twenty-five years is a good reason to celebrate, but it is also a time to retrospect, look beyond the obvious and create enabling environment for achieving the impossible and creating the unknown.

Can Aatmnirbhar Bharat walk the talk?

shubhendup@cybermedia.co.in

RAVI SHANKAR PRASAD

LET US BUILD AATMANIRBHAR BHARAT

The telecom sector has to play a major role in achieving the goal. The government and industry need to work together to make India self-reliant

Telecom has emerged as a real savior during the ongoing pandemic, becoming a major driver of the economic engine of the country. In the last 25 years, the telecom sector has witnessed tremendous transformation – in connecting a billion citizens by 2G, 3G, 4G, and 5G, ushering in several disruptive technological developments such as innovative mobile apps, mobile payments, connected devices and wearables, IoT, and m-commerce.

Today India is the second-largest telecom market in the world and it has surpassed China and the US to be the largest data consuming economy that too with the lowest tariffs in the world. The transformation is moving India towards becoming a knowledge society riding on digital communications in true sense.

Prime Minister Narendra Modi has given a clarion call for Aatmanirbhar Bharat – a self-reliant India. This does not mean India in isolation but India as a contributor to the global supply chain. The PM has also set a goal of making a USD five trillion dollar economy. The telecom sector has to play a major role in achieving the goal. The government and industry need to work together to achieve these goals.

Based on the message from Ravi Shankar Prasad, Union Minister, Communications, Electronics and IT, and Law and Justice at the COAI-IMC online event on 25 years of mobile telephony in India

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> The Prime Minister has given a call for self-reliant India. This does not mean India in isolation but India as a contributor to the global supply chain.

ANSHU PRAKASH

PROPELLING HIGHER TRAJECTORY GROWTH

India needs to prepare, invest, and be ready for reaping the benefits of 5G technology opportunities and applications across all sectors

In the journey of two-and-a-half decade beginning 1995, we have witnessed phenomenal growth, adoption of new technologies, penetration, and proliferation of mobiles across India. Mobile telecommunication has become central to India's development story and all stakeholders responsible for this growth deserve to be congratulated for their efforts, relentless pursuit of the goal, and remarkable achievements.

At times like this when India is under lockdown due to the pandemic, the telecommunication sector has played a stellar role in keeping India connected. It is the telecommunication network that helped each one of us to stay connected with our friends and relatives. During the lockdown when there was no flight, trains, and road transport, it was telecom that connected us.

Healthcare workers and doctors, law enforcement agencies, essential services, and government authorities, among others, were able to deliver effectively due to the voice, data and video connectivity enabled by telecommunication networks. Despite the surge in data

> While we have every reason to be proud of the telecom sector's success, we also need to realize that the period ahead is full of challenges.

consumption, the Indian telecom network did not fail even once during this period.

I recall the mid-1990s when the mobile phones being used by us were heavy and clumsy. They were essentially used for voice communication in a mobile setting. The rates per call were unaffordable, especially for roaming calls. Both incoming and outgoing calls were charged. But that is history. What we have achieved since then is unimaginable.

Today, the mobile density in India is over 85%. The data usage per month, per subscriber, is over 10.5 GB, one of the highest in the world while the cost of data is one of the lowest at just about a quarter of a dollar. With the fast adoption of 4G technology, we also witnessed a great leap in the quality of service; a high-speed download and high-quality voice, data, and video connectivity.

The telecom infrastructure industry has also faired with distinction. India has led the world with the concept of tower sharing. Today, India has over six lakh towers and is rapidly expanding. Mobile phones have become both vital and central in our daily lives. The role of mobile phones has changed in the last 25 years. From an alternative to fixed-line voice communication, today they are the backbone of e-governance, e-commerce, value-added services, and most importantly, empowerment of citizens.

Mobile phones, today, are without a doubt necessity. They are a basic requirement in the list of essentials – water, food, fresh air, followed by access to and availability of mobile and smartphone coverage. The internet and broadband revolution rides on telecommunication networks. Smartphones are our link to the world.

While we have every reason to be proud of the telecom sector's success, we also need to realize that the period ahead is full of challenges. Telecommunications is capital intensive and requires continuous investments in maintenance and renewal of networks, as also for the adoption of new technologies. This, in turn, entails capital infusion. India also requires a larger network of wireline communication and wireline broadband. The tower density needs to be majorly enhanced. Fiber use per capita also needs to increase. Towers need to be fiberized. FTTH connections and internet leased lines need to proliferate.

The rural areas that have shown a huge appetite for data consumption require better telecom connectivity. There should not be, and cannot be a digital divide between regions, urban and rural areas, as well as haves and have nots. The right of way issue requires resolution.

Certain reforms in telecom policies will have an impact on the industry. The telecom policy has evolved from the year 1994, 1999, 2012, and in 2018; we now have a futuristic National Digital Communications Policy (NDCP). Concerted efforts are a must to achieve the goals and objectives of the new policy. Provision of broadband for all, enhancing the contribution of communications' contribution in GDP, employment, and increasing our ranking in the global ICT Development Index are some of the challenges that we need to address.

India also needs to prepare, invest, and be ready for reaping the benefits of 5G technology opportunities and applications across all sectors including health, education, agriculture, disaster management, industry, and commerce, etc. Enhancement of our capabilities and capacities in the core ICT sector must be a focus area.

The Prime Minister has already indicated the country's focus on Aatmanirbhar Bharat. With the active efforts of all stakeholders, the telecommunication sector in India will emerge stronger and meet the expectation and aspiration of propelling the country to a higher growth trajectory with major enhancement in the quality of life of all citizens.

Based on the speech made by Anshu Prakash, Secretary (T) and Chairman DCC, Department of Telecommunications at the COAI-IMC online event on 25 years of mobile telephony in India

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MUKESH D. AMBANI

THE ERA OF A REVOLUTIONARY DISRUPTION

Mobile telephony has become a catalyst for enrichment, and empowerment of common Indians in ways that were unthinkable 25 years ago

There are rare moments in history when fiction becomes fact, constraint makes way for freedom and necessity becomes the proverbial mother of invention. The birth of fixed-line telephony was one of them. However, it provided only partial freedom of communication. It did not completely remove the constraint of distance, people needed to communicate from anywhere to anywhere 24x7. It was both their need, and their dream. Technology answered their dream and entrepreneurship satisfied this need.

The transition from landline to mobile was undoubtedly a revolutionary disruption. However, in the past 25 years, mobile telephony itself has undergone many disruptive and transformational changes. I can count four fundamental ways in which mobile telephony has changed, and has in turn changed, India.

First, mobility has become affordable beyond all expectations. In 1995, the cost of per minute call from a cell phone was Rs 24 – Rs 16 for the caller and Rs eight for the called. Now, voice calls are free, without any time limit.

Second, because mobility became affordable it also became democratic. It ceased to be a rich man's monopoly, long ago. Indeed, no other technological tool in human history has erased the rich and poor divide the way mobile telephony has done.

Third, from uni-functional, cell phones have become multifunctional because of the mobile internet. The combination of the connectivity revolution and the computation revolution has opened the floodgates of human creativity.

Fourth, and most important with data becoming both abundant and affordable, mobile telephony has become a catalyst for enrichment, and empowerment of common Indians in ways that were unthinkable 25 years ago.

People are now, accessing and exchanging knowledge on their phones. They are receiving news on their phones, watching and making videos, buying and selling goods and services, making payments, and working from home or studying from home on their phones. They are also participating in virtual meetings.

The ongoing COVID lockdown has provided the best examples of how mobile phones are empowering people. They have kept the nation connected, and they have kept the wheels of the economy running. What all this goes to show is how digital mobility is realizing Prime Minister Narendra Modi's vision of improving the ease of living for common Indians.

While we take legitimate pride in the achievements of mobility in the last 25 years, this is also an occasion for us to look at the obstacles that have prevented Indian consumers and Indian society from fully benefiting from the digital revolution. Here I specifically refer to the fact that India still has 300 million mobile subscribers trapped in the 2G era. Their feature phones, keep them excluded, even from the basic uses of the internet at a time where both India and the rest of the world are standing at the doorsteps of 5G telephony. I think necessary policy steps should be taken with the utmost urgency to make 2G a part of history.

It is obvious that the next 25 years will bring even more breathtaking changes in mobility. 25 years ago, India was behind the developed world in mobility. Now the time has come for India to be ahead of the rest of the world in key areas of technology. Let's all work together to realize this vision and mission.

Based on the speech made by Mukesh D. Ambani, Chairman and Managing Director, Reliance Industries Limited at the COAI-IMC online event on 25 years of mobile telephony in India

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SUNIL B. MITTAL

A FORCE MULTIPLIER FOR THE ECONOMY

The government should not consider spectrum as a source of income. It is a resource that is vital to drive India's industrial and social growth

Telecommunication is the Digital Spine of the country. It has played one of the key frontal roles in our society at a time when everyone is going through extremely difficult times during lockdown, keeping them connected and keeping them calm, and most importantly, ensuring that the economic engine continues to move forward. All these would have been impossible without a robust telecom network in place.

Today, over a billion people are connected in India, not just in cities and small towns, but deep in villages and rural areas. In this story of a billion people connected on the mobile network, of which nearly 600 billion people on broadband internet is a story which is unparalleled anywhere in the world. The tariffs are also the most affordable ones in the world. Customers are enjoying over 15 GB of data usage per month at the most affordable rates compared to other countries across the globe. With a mobile plan of less than Rs 200, people can consume music, movies, games, entertainment; run multiple applications, and access vital government services on their mobiles including the ones for financial inclusions.

However, like all other industries, the telecom industry has also gone through its ups and downs, but the taxes, in general, have been very high on the sector so far. Hence, it is time that the telecom industry gets its due attention from the government and the tax and levy structures are reviewed.

Telecommunication resources like spectrum, levies, etc. should not become a source of income for the exchequer, but should become a "force multiplier" in ensuring that the economic momentum becomes faster and gets accelerated so that the government can earn its dues from the industries, which are going to be riding on the back of the progress of the telecom industry.

Telecom, especially the mobile industry has played a vital role in fulfilling the government's ambitious 'Digital India' vision and has also been a key contributor to India's economic growth. Now the same success story can be repeated once again with the Prime Minister's vision of Aatmanirbhar Bharat by focusing more on the mobile telephony backbone of India, including mobile devices, and even accelerating software abilities.

Going forward, the telecom sector will continue to play a vital role in ensuring India's digital visions are met with a superior and cutting-edge telecommunication network. The telecom operators remain at the forefront in connecting all the things that are required.

Based on the speech by Sunil B. Mittal, Founder and Chairman of Bharti Enterprises at the COAI-IMC online event on 25 years of mobile telephony in India

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> It is time that the telecom industry gets its due attention from the government and the tax and levy structures are reviewed.

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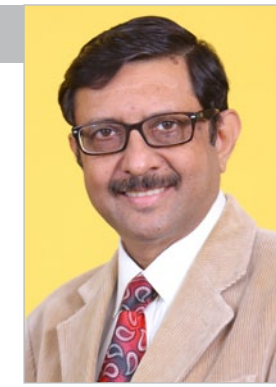

LOOKING BACK, LOOKING AHEAD

India's telecom journey, like elsewhere, has been that of convergence with telcos evolving as digital service providers. Here is the A to Z of the years gone by

Voice&Data has been witness to the remarkable journey of the telecom sector – from few months after the NTP 1994 when the magazine was launched to this date when the sector has emerged as the strongest pillar of India's digital economy. Few months after the launch of V&D, India embarked on its mobile telephony path and the 25-year journey has helped it evolve from being a DoT-centric service to a customer-driven sector. Over the years, the sector has evolved from a being a provider of voice-only service to offering everything-as-a-data service and becoming a digital service provider.

As India's first telecom industry magazine, Voice&Data continues to focus on this convergence between telecommunications, computing, and broadcasting, a general trend that is now emerging as the new norm. And this got represented in different forms.

Technical convergence in the way information is communicated. Computing was the first to store information in digital form. Broadcasting was the last – High Definition Television (HDTV).

Functional convergence is the way services would be consumed. Back in 1995, there were three distinct networks. Today, 25 years later this functional convergence is clearly manifested in the cell phone – with voice, data, and video.

Corporate convergence in the way services is supplied. Already telephone companies are positioning themselves to be able to supply software (information content) as well as just supplying the hardware (information carriage).

Whether they choose to do so through strategic alliances or through outright mergers and acquisitions is a secondary issue that will depend largely on the regulatory position in the country. However, what is most important is to gain a piece of the action.

Of course, convergence implies not only the entry of telecommunication companies into computing and broadcasting but also the entry of firms from these markets into telecommunication. And the impact of convergence has been positive – it has brought new ideas, investment, and innovation. No doubt then, cellular has been an important manifestation and has benefitted the consumer.

Here is the A to Z of India's telecom sector journey.

A – Airtel

In an interview with Voice&Data 25 years ago, Sunil Bharti Mittal had said, "If the floodgates open, we are ready". Bharti Telecom at that time had revenues of Rs 45 crore. But he promised that by the year 2000, Bharti would be a big company – with varied products and services. Today, Airtel is one of the key players in the Industry.

B – Big business

After years of protectionism and bureaucratic control, when the sector was opened for private participation – several big business houses – Aditya Birla Group, Reliance Industries, Tatas, RP Goenka – to name a few, showed keen interest. Bharti was not considered a big group then.

C – Chinese checkers

Even 25 years ago, we were tracking the Chinese. Officials at DoT used to say, do not compare us with the West, China maybe. China had 620,000 mobile phones then, we were starting out.

> While the growth in mobile has been great, rural and remote areas still need to be covered. The pandemic has highlighted its importance even more.

It certainly is not a question of numbers alone, it is a question of enabling a nation's growth, that of access to the people. Today access has grown, but the COVID-19 crisis has also highlighted the divide.

D – Digital divide

Earlier, when the country was starting out on its mobile journey, the divide was with other Asian countries. Today, while the growth in mobile has been great, rural and remote areas still need to be covered. The pandemic has highlighted its importance even more.

According to recent reports, 39 school students in Tsuruhu village of Nagaland have been taking online exams inside a dense forest. While a moderator dictated questions to the students from a smartphone – one of the only three in the remote village – the students write answers on sheets of paper, which is then clicked and uploaded to the school.

E – Empowering

I was talking to DOT officials in 1995 and they said there is not much demand for phones. "There are some waiting lists, but we can meet them."

Today, mobile is a means not only to see (reading the news, watching videos and listening to music), but also to search (researching topics of interest – such as health tips, recipes, and ideas around home décor), socializing (interacting with others), selling (selling goods and services online, for personal or professional reasons), saving (managing personal finances through online banking, trading and investing), studying (accessing study materials and other resources and taking online courses), and shopping (through e-commerce).

F –Financing

In 1995, Dr. N Seshagiri, Director-General, National Informatics Centre had advised the industry to do an impact study on the conditions laid down by DoT for private sector entry into value-added services (VAS). Mobile was a VAS. The study would enable them to identify ROI – before investing in the sector.

He warned against infrastructural bottlenecks and monopolistic tendencies of DoT, which would put hurdles in way of private sector participation. It was also pointed out that DoT network – a combination of digital and analog – would render difficult, superimposition of value-added networks.

While financing continues to remain an issue even today – the viability of mobile players – apart from a few, face challenges. However, the bigger irony is the viability of BSNL and MTNL in its current organizational form.

G – GSM

GSM was the European digital standard and was being touted as the most suitable technology for India as far as WILL (discussed under W) was concerned. It provided a very good speech quality, national/international roaming facility, and promised error-free transmission and encryption facility.

It also promised efficient spectrum usage and better handling of heavy traffic. So, it was considered better suited for metros like Mumbai and Delhi back then. However, despite its technical superiority, it was expensive. This was a concern for India. Balancing its technical advantages with economic ones was important.

GSM was the cellular technology being deployed by companies like Ericsson and Nokia.

The GSM handset in 1995 was priced in the range of USD 800-1,000, comparable to what was available in other Asian countries like Thailand and Malaysia.

H – Healthcare

In August 1995, Dr. Mahesh Mangal, Consultant Plastic Surgeon in Delhi, in an interview said, "In our profession – pagers and cellular phones are a must. It is a question of saving a life if the doctor can be reached faster. We just can't do without these".

Back then, mobile phones were an urban phenomenon – more for the metros. Today, that has changed. The

integration of medicine with mobile – telemedicine is a key driver for strengthening the healthcare infrastructure in the country.

I – Infrastructure investments

In 1995, investments for infrastructure were being planned for the two western states, four southern states, and NCR. Significant private sector participation was expected to happen in the coming year, including over USD 22 billion investments by 2000. The industry expected USD 35-40 billion in revenues from services. The optical fibre transmission system was meant to be a major area of growth.

Today, the question is – bandwidth or mobility?

J –Jio

Reliance had been involved in the industry, right from the early days. It had submitted an ambitious proposal in August 1994 – Project Win 2000 to DoT. This was to build and operate a nationwide telecom network. The company aimed to provide 10 million telephone lines over the next ten years that would have helped meet 60% of the country's demand for new telephone lines within three years.

Reliance has always demonstrated ambition. With Jio today, it is the company to watch – not only its services across the spectrum but also the stock price.

K - Knotty challenge

Mobile communication networks have always been a knotty challenge. Communication networks have been new railways.

Kabuliwala is a reference one reads a lot in Tagore's works. It was the railways set up by the British that allowed traders from as far as Kabul to come and conduct business in Calcutta, the hub of commerce at the turn of the 20th century in India.

Communication networks are the new railways. As the services sector is driving the economy, phones are required to drive the increasingly digital economy, in the global marketplace. But putting up that network is no mean task. There are many balls in the air. Untying the knots is imperative even now.

L – Leap into the future

Twenty-five years ago liberalization brought a leap into the future. From a telephone density of 0.8 per hundred, India was planning dramatic improvements. The country intended to add three million lines every year for the next three years. In other words, from eight million lines in 1994 to 17 million lines in 1997.

The focus was that if India is to stay globally competitive, its communication infrastructure needs a quick fix. Just providing a connection was not enough and it was important to a basic level of service to the customer.

Value-added services – of which mobile is a part – would help in greater call competition, and therefore, more revenue for DoT. But there was silence on this in 1994-95. There was talk of a higher license fee for these services, which would eventually be passed on to the consumer.

M - Metamorphosis

The launch of cellular services 25 years ago were the beginning of a metamorphosis. It brought in competition – which means choice for the Indian customer. It encouraged the entry of Indian, foreign and JV operators – which brought in new technology, embraced entrepreneurship, and professional management. And most importantly saw Indian telecoms, not as an end in itself – but important to power India's economic growth.

Cellular phones have been getting smaller and smaller – technology has enabled "miniaturization".

N – Network economics

Network economics have driven the implementation of mobile. There have been two divergent trends having a major impact on the nature of supply and demand mismatch.

Mobile communication system was initially developed as a complement to the fixed-link network, but increasingly as a substitute or competitor to it.

Increasing investment in fibre in the basic transmission network, initially in the international and long-distance network, but increasingly now in the local loop – delivered directly to home or desktop.

The evolution of these two trends fundamentally changed the nature of the supply-demand equations in several different ways – network access, network provisioning and network pricing.

O – Optical fibre

Transmission systems represent the major fixed asset of most telecommunication network operators, and therefore their main source of competitive advantage.

> Reliance had been involved in the industry, right from the early days. It had submitted an ambitious proposal in August 1994 – Project Win 2000 to DoT.

Increasing use of fibre optics within both public and private networks that started at the inter-exchange and international level trickled down over time to the backbone networks and to the local loop.

One sees an increasing deployment of optical fibre as data exchanges and the number of subscribers increase – cellular/mobile and the internet.

P – Policy

The Government of India (GoI) had with the new policy tried to promote growth, from a culture of monopoly to a culture of competition, from a culture of scarcity to a culture of plenty.

In our country, the focus was to try and utilize our resources in an optimum and appropriate manner. Try and avoid waste

GoI continues to be a major factor – it does control the clock – Tik Tok, Tik Tok. But Indian consumers are emerging as major influencers.

Q - Quality of service

Even when there was general agreement on much-required reform, nothing worthwhile was done by DoT to improve the quality of services, and facilities offered to the consumers. Poor bill collecting system of the DoT caused great inconvenience to the consumers. The long queues of people lined up for paying their phone bills spoke loud and clear of the inconvenience.

R – Regional developments

Balanced growth has been GoI's favourite concept. In the future, as in the past – it is likely to remain just that – a concept. In 1995, the government continued to talk about balanced growth. Back then when we were fast changing into a market economy – we must accept the realities – prices, shortcomings, or whatever one might call them. The fact was that some states had much more unmet demand than others. It was not surprising that private operators were all vying for those states – Maharashtra, Gujrat, Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Punjab, Haryana, and the National Capital Region.

Today, twenty-five years later, the regional imbalances are more urban and rural.

S – Supreme Court

Cellular Services experienced several stumbling blocks – areas of operation, tariff and revenue sharing, manpower, technology and quality of service. In August 1994, a three-member bench comprising Chief Justice MN Venkatchaliah had asked the government to reconsider the licensing scheme for operating cellular services.

Sterling Cellular and BPL Systems in New Delhi, Usha Martin in Calcutta, Skycell in Chennai and Hutchinson Max in Mumbai was shortlisted. Bharti had an interesting case. Their bid for Mumbai was challenged by Tata Cellular on the basis of their experience claim. But they were hopeful of eventually getting the license for Delhi.

Courts had been the catalyst in moving the process along. And it holds true to date.

T – Technological change

Changes in the telecommunication equipment sector characterized by digitization of exchanges, new transmission techniques, computerization, and miniaturization have greatly enhanced the capabilities and capacity of communication networks.

As a result of technological advances, new services – value-added services, cellular services, and image-based services have become available. Infrastructure costs have declined – due to increased capacity and functionality. This has benefitted the customer.

U – Unauthorised calls (Spams)

India was the fifth most spam-affected country in the world in 2019 according to a True-caller Insights Report 2019. However, the number of unwanted or spam calls has gone up 15% in two years with users receiving 25.6 additional calls per month.

Nearly two-thirds of these unwanted calls are from telecom operators. Interestingly, telecom operators happen to be the biggest spammers globally. The rest

> In 1995 Dr. N Seshagiri had warned against bottlenecks and monopolistic tendencies of DoT, which would put hurdles in the way of private sector participation.

include telemarketing calls (17%), communication from financial services (10%) and scams (6%).

This was obviously not something one had to contend with, back in 1995.

V – VSATs

January 1995 saw the launch of the VSAT network in the country. DoT conditions limited VSAT data network usage to a closed user group – with further limitations on voice. It also insisted on allowing VSAT operators access only to the extended C band frequency – the direct result of idle capacity on INSAT 2 series – A and B satellites.

Launching a satellite in 1995 cost USD 300 million, while a shared hub VSAT network service cost Rs nine lakh per remote site. Key demand drivers were the financial services sector and corporate users.

Today VSATs and their smaller cousins, USATs, have proliferated.

W – Wireless in Local Loop (WILL)

The shift from fixed wire systems to wireless networks can be compared to the shift from gaslight to electric bulbs, and from trains to airplanes. In WILL, the wired connection between the telephone exchange and the subscriber's instrument is replaced by radio links.

But WILL is not synonymous with radio links. Most of the communication is through the wire, just like an ordinary phone call. It is only in the last mile – that the call is transmitted via radio. Demand was getting identified in industrial clusters in states like Maharashtra, Gujrat, Karnataka, Tamil Nadu, and Haryana.

These systems also played an important role in providing access to phones in rural areas. Their importance continues.

X – Factor

N Vittal, the former DoT Secretary was a key influencer in driving the liberalization process. The 1994 Telecom policy was a vindication for what he was trying to achieve, although a partial one.

The policy was a logical extension of the structural reforms initiated by the Narsimha Rao government to revamp the Indian economy – and integrate it globally. If India wanted to compete – a state of the art communication infrastructure was mandatory.

In that respect – the policy was a letter of intent - a welcome beginning. The policy was about bringing in liberalization – and Vittal was seen as a friend of the Industry. He wanted to quicken the process, while the Minister wanted to go slow. He was keen to corporatize DoT, bring in competition and professional management.

Today the numbers speak for themselves. For example, from April to December 2019, the public-sector BSNL recorded a loss of Rs 39,000 crore; two and a half times more than the corresponding year.

If only Mr. Vittal had not been dispensed with, when and in the way he was – the path and pace might have been different.

Generation Y and Z

With elevated awareness and usage of the internet, mobile devices, and social media – they will drive mobility to newer heights. And help introduce and improve new services.

The next 25 years

Digital connectivity has been an enabler of multiple kinds of mobility – social, economic, and informational. Companies in the mobility ecosystem have done tremendous service during these COVID times.

The next 25 years will be about IoT connectivity, low latency connectivity, 5G enabled network across the country, ensuring that digital payments, online activities, e-commerce, health services, agricultural services, government subsidies going into mobile accounts are all effectively done through a robust mobile network.

The network will get better. And so shall mobility.

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- Edu-Tech Leaders, Academicians Educationists
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25 Years of Mobile

1994

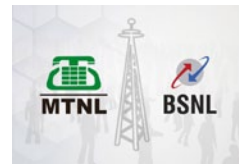
- India unveils National Telecom Policy 1994 (NTP 94); opens telecom sector to private sector participation
- First spectrum auction held for four metros: Delhi, Mumbai, Kolkata, and Chennai

1995

- Modi Telstra sets up first mobile telephony network in Kolkata
- India's first mobile call on 31 July 1995 between West Bengal Chief Minister Jyoti Basu and Union Telecom Minister Sukh Ram
- STL sets up optical fibre plant In Aurangabad
- First mobile telephone service started on non-commercial basis in Delhi on 15 August
- Spectrum auction for 19 telecom circles. Bidders needed a foreign partner to be eligible.

1997

- India setup Telecom Regulatory Authority of India (TRAI) as an independent regulator
- Government enters mobile telephony sector with public-sector BSNL and MTNL



1999

- New Telecom Policy (NTP-1999) unveiled
- Mobile telcos get an option to shift from fixed-licence fee to revenue-sharing model

2000

- Government amends TRAI Act to set up Telecommunications Dispute Settlement and Appellate Tribunal (TDSAT)
- Private operators in India given permission to provide National Long Distance Service beyond the service area

2010

- 3G Spectrum allocated to all private operators

2011

- Mobile number portability allowed across networks and nation

2012

- Airtel launches India's first 4G service in Kolkata
- Supreme Court cancels 122 spectrum licences that were given between 2007 to 2009
- Huawei brings 4G smartphones to India

2013

- India allows 100% FDI in telecom sector
- Unified Licensing (UL) regime unveiled enabling operators to provide all telecom services under one licence

2014

- Indian brand Micromax becomes the largest mobile phone supplier in the country for the first time

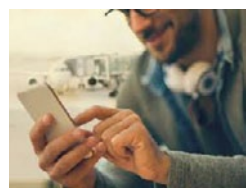
Telephony in India

2002

- Reliance Infocomm started its CDMA mobile services with the launch of Rs 500 phone

2003

- Calling Party Pay (CPP) adopted in India making incoming calls on mobile free across all cellular networks



2004

- Mobile phone subscriber base crosses fixed-line connections

2008

- India enters 3G era; MTNL launches 3G service in Delhi & Mumbai
- CDMA players were allowed to enter GSM mobile service
- Access Deficit Charge (ADC) abolished in the country

2009

- Telecom sector faces the heat of Rs 1,76,645 crore 2G Scam
- HTC brings smartphones to India

2016

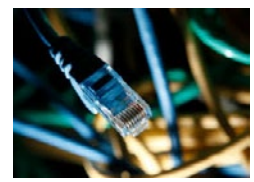
- Reliance Jio launches operation, triggers price war
- India enters VoLTE era

2017

- India abolishes roaming charges on data and calls
- Jio launches cheapest 4G VoLTE feature phone

2018

- Government swings to Net Neutrality and amends the UL norms



2019

- SC directs operators to clear AGR dues

2020

- Around 25% surge in demand for mobile data during lockdown
- TRAI reports 114.952 crore wireless subscribers as on 30 April 2020

DR. RS SHARMA

MAKING TECHNOLOGY EQUITABLE

The task before policymakers in India is to ensure that the benefits of upcoming 5G technology are made accessible to all at an affordable cost

Mobile communication in India has gone through a series of phenomenal changes over the past 25 years. Having achieved the stature and size of this magnitude, the telecom sector in India has kept a legacy and model before other developing economies of the world of a vibrant policy and regulatory environment.

From the time of the first mobile call made on 31 July 1995 to the present, as the world's second-largest mobile market, India has come a long way. From now on, the mobile sector and the ICT space are ready to embrace many technological innovations related to 5G, artificial intelligence (AI), machine-to-machine (M2M) and beyond. When that historic first mobile telephone call was made 25 years ago, very few would have realized that this will make an indelible mark in the history of Indian telephony and would transform our lifestyle, behavior, the conduct of business activities, etc. forever. Now it is hard to imagine life without a mobile phone.

The evolution of the Telecom sector started in earnest, with the adoption of National Telecom Policy 1994 (NTP-94), which was the first effective step towards deregulation, liberalization and private sector participation in the telecom service sector. The NTP-94 defined certain important objectives, including the availability of telephone on demand, provision of world-class services at reasonable prices, ensuring India's emergence as a major manufacturing/export base of telecom equipment, and universal availability of basic telecom services to all villages.

> The 5G economy will introduce a new level of complexity to policymaking and regulation as new business models emerge.

The opening of the telecom sector to the private sector has led to a huge investment in the sector. The NTP-94 envisaged providing world-class quality of telecom services and the development of telecom services, as well as increasing accessibility of telecom services. It also emphasized to provide the widest permissible range of services to meet the customer's demand at reasonable prices. The uptake of mobile phones in our country was rather quick and in a short span of few years, say by 1997, the number of mobile phone subscribers grew to 14.5 million, which was in a way started the process of achieving the goal of "telephone on demand" envisaged in NTP-94.

The entry of private service providers brought with it the inevitable need for independent regulator. The Telecom Regulatory Authority of India (TRAI) was, thus, established with effect from 20 February 1997 by the Telecom Regulatory Authority of India Act, 1997 to regulate telecom services, including fixation and revision of tariffs for telecom services that were earlier vested with the central government. The Authority is empowered to make recommendations to the government on various issues related to the telecom sector such as the need and timing to introduce new service provider; measures to facilitate competition and promote efficiency in the telecom services to facilitate growth in services; technological improvement in services; type of telecom equipment to be used; measures to develop the telecom services and efficient management of available spectrum.

TRAI is also mandated to ensure technical compatibility and effective interconnection between the telecom service providers and lay down the quality of service benchmarks and ensures compliance of the same. The story of telecom sector growth in India is predominantly attached to the growth of mobile telephony. Technological evolution has hugely contributed to the mobile telephony and our journey from 2G to 5G – which is expected sooner than later – has been made possible due to favorable policy and regulatory initiatives of both government and the regulator.

After its inception, TRAI made several recommendations to the government on telecom related issues such as revenue share and unified licensing. These helped in the reduction of the telecom tariff drastically during the year 1999-2000. In 1999, New Telecom Policy was released, which aimed at the rapid expansion of tele-density. It focused on the provision of universal service to all uncovered areas, including the rural areas, and the provision of high-level services capable of meeting the needs of the country's economy. It also set the objective for the creation of a modern and efficient telecommunications infrastructure taking into account the convergence of IT, media, telecom, and consumer electronics, and thereby propelling India into becoming an IT superpower. It also allowed the migration of the licensees from a Fixed License Fee Regime to a Revenue Share Arrangement Scheme w.e.f. 1 August 1999.

In November 2003, the government introduced the Unified Access Service License (UASL) regime. The UASL permitted an access service provider to offer both fixed and/or mobile services under the same license, using any technology. The entry of new players, internet telephony, national roaming regulation, and calling party pay (CPP) regime also helped in growth of the mobile telephony in the country. Further, the Pan India Mobile Number Portability (MNP) in 2011, permission for 100% FDI in the sector in the year 2013, and launch of VoLTE by operators in the year 2016 combined with reduced data rates and the Smart Mobile Handsets have completely changed the mobile telephony landscape.

The mobile telephony, which started in India as voice telephony in the year 1995, has become more of a device running on data/internet and providing all the essential services such as mobile banking, education, medical, entertainment and educational services. The growth of mobile telephony in India has also been fueled by a mix of several important factors such as 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,

> The challenge for policymakers in the 5G economy is that they must be prepared to address the ubiquity of the new technology in everyday life.

infrastructure sharing and the introduction of enabling regulatory reforms are also widely acknowledged as being responsible for the exponential growth in the Indian mobile telecom industry. The vibrant, forward-looking regulatory policies were one of the catalysts for achieving this growth.

Through the combined efforts of the government, regulator and the service providers, mobile telephony crossed the 500 million mark in 2009 and touched the billion-mark in 2015. The telecom sector in India now boasts of over 1.17 billion subscribers today. Along with better connectivity, the quality of services has also improved; given the affordability. The phone device has now transformed from a "luxury" to a necessary utility good for social and economic mobility. Today we have 1.15 billion wireless or mobile telephone subscribers, including 629.44 million urban and 520.08 million rural subscriptions. Besides, 97.2% of the total 676.14 million broadband subscribers come from the wireless segment.

On the technology front, the country has upgraded to 4G and is readying for rolling out of 5G services. Overall, the network technologies have evolved to a level unimaginable in 1995, when the first mobile call was made. Today the mobile telephony is serving as a lifeline for the masses with the entire nation effortlessly working from home during the pandemic and resultant lockdown.

Looking ahead, with the implementation of 5G and associated technologies, there will be much higher broadband speeds available. The government has already decided to auction the spectrum and therefore, with the rollout of 5G, higher download speeds can be provided to the customers. The 5G economy will introduce a new level of complexity to policymaking and regulation as new business models emerge. The challenge for policymakers in the 5G economy is that they must be prepared to address the ubiquity of the new technology in everyday life without creating regimes that stunt the continued innovation that will be critical to the success of the 5G economy.

The task before India's policymakers is to ensure that the advantages of the new technologies are accessible to all equitably and affordably while securing them against existing and emerging threats. For achieving this goal, the government has released the National Digital Communication Policy (NDCP) 2018. This policy framework provides the right launching pad for realizing digital transformation aided by mobile telephony. This will ultimately unlock the transformative power of digital communications networks and enable us to achieve the digital empowerment goal and improve the well-being of the people. Areas where policy and regulatory modernization will be required for a future mobile-led growth will include cybersecurity, privacy, spectrum allocation, access to public infrastructure, small cell deployment, in-building access, cross-sectoral coordination, licensing framework, streamlined process for faster implementation and education, training, and development of digital skills.

Any discussion on the Indian telecom sector growth story will be incomplete without acknowledging the contribution of various stakeholders such as service providers, equipment manufactures and consumers, who have played major and constructive role in building the ecosystem of the mobile sector step by step and brought it to this level. This growth that was supported by all stakeholders has contributed effectively to the economy of our country.

As we stand today celebrating the 25 years of mobile telephony, we look forward with greater hope and confidence that we are in for exciting times ahead. No one can accurately predict the future role of mobile telephony for the next 25 years, but we can rest assured that this technology is here to stay and continue to take us to different levels of innovations and achievements.

The author is the Chairman of TRAI

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VOICE&DATA

25 Years of Mobile Telephony in India

Collector's Edition

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R CHANDRASHEKHAR

A MIND-BLOWING ROLLER-COASTER

As our dependence on telecom infrastructure grows exponentially, security and reliability of this infrastructure assumes ever greater importance

For the millennial and Gen Z of today, it may be hard to imagine that the first mobile call in India was made just 25 years ago on 31 July 1995. The mobile device is now an integral part of our social and economic fabric. One cannot imagine life without it. The advent of the COVID crisis has made us much more aware of this reality. COVID has been on the ascendant in India since March 2020 and shows no signs of retreating anytime soon. The monitoring of exposure to COVID infection risk is now done via the Aarogya Setu app on the mobile. Healthcare regulations have been relaxed to allow and even encourage telehealth services. Wadhwani Institute for Artificial Intelligence in India is working on an AI-based mobile application for preliminary screening of patients for COVID, based on cough sounds. Visits to hospitals for treatment with or without COVID have become the last resort with remote health services being the preferred and less risky mode for both patients and medical personnel alike. Schools and colleges have all resorted to virtual classrooms to the extent feasible. Organizations, governments, and courts are conducting their business almost entirely in the virtual mode.

Nothing could have underlined the criticality and urgency of ensuring countrywide availability of mobile broadband services as effectively and emphatically as the present crisis has done. Mobile connectivity was already important before COVID-19 struck. It has now become critical, not only to the economy and society but to healthcare, education, and literally life itself. Mobile telephony is a critical national infrastructure more than ever before. Protecting, expanding, and modernizing it is unquestionably a major national priority.

But how prepared are we for this mobile-telephony dependent future irrespective of the trajectory of the COVID pandemic? Before coming to that question, on this occasion of the silver jubilee of the first mobile call in India, it is fascinating to reflect on how we reached here before visualizing the exciting future that lay ahead.

No roller coaster ride can match the dizzying pace, the highs, the lows, the twists and turns of the mobile telecom services sector in India. The advent of mobile telephony and the private sector into telecom in the country set off a chain of events, which made history and has already re-scripted the future of India.

The start of the journey, like any roller coaster ride, was beguilingly slow. Against the backdrop of economic liberalization initiated by the Narasimha Rao government, NTP 1994 introduced mobile telephony and opened the gates to the private sector with two operators in each circle. But NTP 1994 belied expectations and did not exactly set the Ganga on fire. Services were expensive and handsets were unaffordable except to the rich. Consequently, uptake was low, and penetration minimal and largely confined to urban areas. Worse, the operators who succeeded in obtaining licenses through a fiercely competitive bid process discovered that they had grossly misread the market, bid way too high, and were afflicted by the winners' curse. They mounted pressure on the government to revise the contracts. These pleas were backed by International Financial Institutions like the WB and IFC. Soon, the Government too realized that the policy had become a constraint rather than an enabler and began looking for new solutions.

After protracted and tortuous reassessment, the Vajpayee Government came up with NTP 1999, which brought in revenue share instead of upfront payments and introduced 2 more mobile operators in each circle,

> No roller coaster ride can match the dizzying pace, the highs, the lows, the twists and turns of the mobile telecom services sector in India.

including the state-owned BSNL. The momentum started picking up thereafter as the operators began to understand the market better and were able to tailor their offerings, accordingly, using flexibility that the revenue share regime gave them. Still, growth was not quite meteoric. The Unified Access Services License (UASL) was introduced in 2003-04, which enabled operators to offer landline, mobile, and a range of other services through a single license.

The spread of mobile telephony in the country gathered greater momentum thereafter and by 2008, the country had nearly 300 million mobile subscribers. Then we saw the dramatic and hugely controversial expansion of 2008 when 122 new licenses were issued across 22 circles. The number of operators in each circle ballooned to an unimaginable 12-16. Cut-throat competition ensued. Telecom rates, which were already amongst the lowest in the world dropped to one-third of the earlier prevailing levels and became affordable to even low-income earners, including rural areas.

During this phase, the coverage grew by leaps and bounds and in just 3-4 years, trebled to 900 million. Meanwhile, the political, economic and business ramifications of the unbridled expansion were playing out. Relentless legislative (including PAC and JPC), media, and judicial scrutiny culminated in two epochal events. The first was the CAG report of 2010 which identified losses to the exchequer caused by the issuance of 122 licenses with bundled spectrum at administered prices. The loss was estimated at a mind-boggling Rs 1.76 lakh crore. Then there was the Supreme Court judgment of 2012, which canceled the entire set of 122 licenses issued in 2008.

Steering the sector during those turbulent years was incredibly challenging. A new policy was needed so that changes could be driven by an elevating vision rather than as mere remedial therapy. A triad of policies covering telecom, IT, and electronics was unveiled in 2012 offering an integrated view of the emerging digital future and what was needed to enable it. The mobile device was positioned as an instrument of mass empowerment providing access to services, employment, entertainment, and much more. The integration of mobile telephony with financial services and the banking sector was another path-breaking leap that has its roots in that period.

The seemingly impossible task of steering the sector to calmer waters was facilitated by presenting an enticing future and a road map to get there. At this distance of time, it is hard to imagine the challenge then of navigating a path to a new and exciting future amidst the looming threats of international arbitration, media warfare, judicial involvement, and political churn. Aadhaar created a digital identity for every resident. Direct Benefit Transfer brought together governance, banking, telecom, and IT on a mega scale. UPI enabled the integration of digital financial services across the entire financial sector. These developments enabled India to become a creator rather than a follower of global best practices. More importantly, they lifted telecom from being merely a convenient mode of communication to become the bloodstream of modern India.

The en bloc cancellation of the 122 licenses by the Supreme Court in 2012 triggered an industry-wide consolidation across the sector. Many of the new companies, which were focused more on subscribers and valuations than sound business plans, folded and merged into larger companies. However, the competitive environment still did not permit tariffs to be raised or companies to achieve healthy balance sheets. More importantly, from a subscriber perspective, investment in infrastructure could not keep pace with the growth of subscribers and usage, and quality of service dropped. At the same time, a heightened awareness of the health hazards posed by proximity to telecom towers made it difficult for telcos to find sites for installation of base stations. All these developments led to a decline in service quality, notwithstanding the fact that the number of subscribers had plateaued, having reached near saturation levels. Policy consolidation accompanied industry consolidation during this period. Policies allowing spectrum sharing and trading cleared the decks for business consolidation and more efficient use of spectrum. Unified License (UL) replaced UASL and

> The advent of mobile telephony and the private sector into telecom set off a chain of events which made history and re-scripted the future of India.

allowed operators to offer nearly all services through a single, integrated, and nominally priced license. Bundled spectrum was no longer a part of the license and so, much of the exclusivity and contentiousness relating to licensing was removed.

Despite industry consolidation and policy enablement, mobile operators were unable to find a path to financial health. The entry of Jio added a whole new dimension to the industry dynamic. Unburdened by legacy investments in 2G and 3G, a direct entry with 4G using newer, more cost-effective LTE technologies and equipment and bolstered by substantial investments in content, Jio disrupted the market, made the huge variation between voice and data pricing untenable and overall added to the business pressure that incumbents were already under. The consumer benefitted, even though the extension of coverage to rural areas and augmentation of infrastructure in urban areas still lagged. The coverage problem was compounded by the failure of USOF to bring the same speed into the expansion of coverage into uneconomic areas due to budgetary constraints, process bottlenecks, and inability to enforce contracts.

The Narendra Modi government's visionary Digital India programme and the huge thrust on digital services, especially DBT and digital financial services riding on the JAM trinity of Jan Dhan Bank Accounts, Aadhaar and the Mobile, combined with rising rural demand for audio and video content have already made India the world's highest per capita data consumer. India is also one of the highest-ranked in terms of the percentage of mobile Internet users with rapidly rising smartphone usage. The National Digital Communications Policy (NDCP) of 2018 lays the foundation and sets the direction for the next phase of industry growth. A key sentence in the Policy has not attracted as much attention as I thought it would. The Policy says: "Accordingly, this policy aims for Universal Coverage rather than revenue maximization." Universal coverage logically subsumes affordability. Past policies had always prioritized universal coverage/affordability on the one hand and revenue maximization on the other, without indicating which was the overriding goal. This deliberate ambiguity lies at the heart of many of the ills of the past.

The final Supreme Court judgment on AGR pronounced recently has settled an issue pending for about 15 years. However, it has led to a new reality with one of the three surviving private operators teetering on the brink of collapse. This poses serious issues regarding the resultant competitive landscape in the

> Massive investments needed to create ubiquitous broadband connectivity can only flow in if the sector remains a viable investment option.

sector that will need to be confronted head-on by the government. Political courage is needed to nurture the sector back to health with a well-thought-out intervention, as was done by the Vajpayee Government in 1999. Nothing less can achieve the dreams of NDCP and Digital India.

The future is an era of connected, intelligent devices. Businesses, financial services, governments and infrastructure sectors like power, railways, and airports will all be driven through and by such devices. Education, agriculture, healthcare will be heavily dependent on high-speed connectivity and connected devices. A vibrant telecom sector is a foundation on which the entire society, economy, and governance will increasingly rest. The current difficult phase through which the older surviving telecom service providers are passing through must be dealt with understanding and courage to ensure continued vigorous competition amongst financially viable TSPs. Massive investments needed to create ubiquitous broadband connectivity can only flow in if the sector remains a viable investment option. Competition is vital to ensure competitive pricing, universal coverage, and protection of consumer interest. Unfortunately, at the present time, especially after the recent Supreme Court ruling in the AGR case, all of these are not reasonably assured and will need focused attention of Government and bold remedial action.

As our dependence on telecom infrastructure grows exponentially, security, and reliability of this infrastructure assumes ever greater importance. The recent border confrontation with China has brought this issue at the centre stage. Sourcing of trustworthy and reliable core and even peripheral network components becomes especially important from a national security point of view. Raising domestic capability in telecom R&D, design, manufacturing, testing, and software by building strategic partnerships initially and progressively increasing domestic capability through win-win partnerships are critical. A carefully thought-through strategy and road map are a sine qua non for success. Inadequate groundwork before increasing local sourcing via carefully calibrated steps runs the risk of encouraging non-conformity to global standards, higher pricing due to lack of global volumes (leading to higher cost of service) or lower security and reliability apart from avoidable debate and litigation on what constitutes indigenous technology/products. This is not merely a technology battle. It is a techno-commercial battle with strong geopolitical overtones. Only when we recognize, allow for and manage all these elements simultaneously, can we find the right path.

These challenges can and must be overcome. Let us remind ourselves that the telecom sector has made us proud. It delivered the fastest growth ever in human history and has brought us to the doorstep of universal coverage. It has given us the lowest rates for usage anywhere in the world, despite there being no new underlying technological innovation – purely by business innovation. Let us take pride in all these achievements and savor those successes while dealing with some of the aberrations of the past and more importantly, laying the foundation for an even more exciting future that awaits us.

There is a tantalizingly attractive digital future beckoning us. We have all the ingredients to achieve the trillion-dollar digital economy by 2024: a vibrant IT sector with demonstrated world-dominating (not just world-class!) capability, a remarkably innovative startup eco-system that is growing at an explosive pace, the highest per capita digital consumption in the world, near-universal mobile coverage with a rapidly rising percentage of smartphones and a host of intractable economic and social problems that are amenable to breakthrough disruptive solutions using new technologies like AI, big data, and IoT. But to realize the dream, we need to ensure regulatory and policy interventions in telecom based on a single-minded pursuit of that lofty vision while keeping in mind the lessons of the past. That is the challenge of the coming decade.

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PRADIP BAIJAL

CHALLENGED WE RISE

No one had visualized the ubiquitous nature of mobile telephony; despite the odds, the sector leapfrogged to transform a billion lives and the economy

Mobile technology was introduced in the world in the mid-1980s, but our experts opposed it because they thought the technology was very expensive for the poor Indians. Hence, initially, mobile telephony was not introduced in the country. Ultimately the technology was introduced in the mid-1990s for fixed-lines only, since such installation did not involve any digging, etc. Later mobiles were introduced around the same time. They could not connect with other networks since there was no regulation or regulator to enforce interconnection between the private and public networks.

The work only started after the promulgation of the TRAI Act 1997 and the appointment of a regulator under a court order. Even then they were expensive due to heavy taxation and connectivity charges till 2003. The Act also had problems with regulation, dispute resolution, and appeals. They were sorted out through an amendment of the Act in 2000. But numbers did not grow due to high tariffs promulgated by the Regulator, who favored the incumbents' heritage networks, charging a heavy rental for their old networks. Consequentially, the number of mobiles only grew to 10 million by 2003. In a similar backward country China the number of mobile users had crossed the 300-million mark during this period.

The Regulator introduced Unified Access Service Licensing in 2003, and drastically reduced connectivity and other charges. It also decided to make tariffs forborne – to be fixed by operators in a competitive regime. This resulted in the tariffs coming down 50 times and massive growth in mobile subscribers, from 0.2 million to two million per month in 2004, six million in 2005 and 20 million in 2010. India's overall mobile subscriber base crossed the 1,000 million mark by 2010. This also led to a jump in India's global ranking on the mobile front: from 122 in 2002 to number 2 in 2010. The monthly growth of 20 million a month was three times that of China.

All good things come to an end and the telecom sector's dream run too ran into some rough weather. The industry faced many ups and downs after 2010 but continued to invest in new technologies like 3G and 4G and we are now on the threshold of adopting the 5G. However many problems continue, like the non-introduction of converged licensing in India, despite the new networks being digital. This problem has been dealt with by converged permissions being given for all new technologies through regulations, including broadcasting services. With all kinds of data also moving on to telecom works, another problem is data security, particularly on foreign networks. The government is seriously working out solutions for data security and privacy issues.

Telephone services were revolutionized in the period starting with 1950 with the Industrial Revolution 3.0. This revolution also led to higher GDP growth rates in backward countries. The new communication technologies are also working on the same medium. The networks therefore now carry most information and served as an infrastructure of growth. If these networks are handled intelligently, these services, operating on the same wire/wireless may lead to huge growth in GDP in backward areas. China has shown a great growth rate up to 2017, overtaking the USA's PPP gross growth rate.

India is still catching up but the future has a huge potential for the country. The country has done it in the past with its excellent service in the IT sector, and it can lead way in driving the digital economy again.

The author Pradip Baijal is former Chairman of TRAI and Secretary, Divestment with the Government of India

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LET US REDIAL

From telegraph to the round dialing toy and size zero-smartphone – telecom has evolved to become wireless. Here is a quick jog down the memory lane

BY PRATIMA HARIGUNANI

Imagine if Alexander Graham Bell was living in a submarine for the last seven decades. If he were to suddenly pop out on some remote beach in India, he would be a tad shocked to see that thing a fisherman is carrying around. He would look at the mobile phone and mutter – "Whoa! You have grown so 'small' kid!"

He would not be wrong to say that. They called it telephone perhaps due to some Greek factor again. They mixed the word "tele", for 'a far' and "phone", for "voice or voice sound". That has, incidentally, been pretty much the elevator-gist of the story of telephone in India too. It starts a century back.

The humble telegraph lineage

A lot of the initial pages of this history talk about the Britishers entering India. They, unlike, Europeans embraced the telephone with a lot of fervor and telephone lines. Colonialism spread these lines to India too.

It all started in Kolkata, somewhere in 1882. It began with the commissioning of a 50-line manual telephone exchange. But back then in 1850, the first electric telegraph Line that was instituted between Kolkata and Diamond Harbour was quite experimental. All we had for communication was the vintage 'The Posts and Telegraphs department' as part of the Public Works Department. Somewhere around 1853, we saw the construction of 4,000 miles of telegraph lines that connected various points in India. Like Kolkata and Peshawar in the north via Agra, Mumbai through Sindwa Ghats, and Chennai in the south, and Ootacamund and Bangalore. The pioneer here was Dr.William O'Shaughnessy and a lot of the initial infrastructure was laid down by the Britishers for their

> It all started in Kolkata in 1882. Then in 1850, the first electric telegraph Line that was instituted between Kolkata and Diamond Harbour.

own needs. During British period all major cities and towns in India were linked with telephones.

In 1854, thanks to efforts of pioneers, telegraph facilities were made open to the public and a regular Telegraph Department was set up with the enactment of the Telegraph Act. By the time we made it to 1880, the idea of telephone exchanges found its first flutter with the arrival of two companies - The Oriental Telephone Company Ltd and Anglo-Indian Telephone Company Ltd. Their requests were rejected because this space was still a Government monopoly. However, in 1881, the Government gave a license to the Oriental Telephone Company Limited of England for opening telephone exchanges at Kolkata, Mumbai, Chennai and Ahmedabad. The following few years saw a lot of momentum. The Indian Telegraph Department (ITD) found its first Superintendent in Dr. William O'Shaughnessy, who later became the first Director-General of ITD. In 1858, the first India-Ceylon cable was laid and in 1865, the first Indo-European telegraph communication was put in place. India embraced the first Duplex telegraphy in 1873 - introduced between Bombay and Calcutta. And in 1875, the ITD supplied the first private telephone line. The ITD transferred responsibility of the Ceylon Telegraph System to the Ceylon government in 1880 and the very next year, licenses were granted to private companies for operation of telephone systems in Madras, Bombay, Rangoon (Yangon) and Calcutta. Bombay saw a telephone exchange in 1882. The quadruplex telegraphy and provision of copper wire, instead of iron wire, happened soon enough – in 1885. Interestingly, it was in 1887 that the ITD started helping the India Meteorological Department (IMD) in communication of Storm Signals to all places.

The Indo-European Telegraph Department got merged with the ITD in 1888. Phonograms came in 1895. And by 1905 the control of the Telegraph Department was handed over from the PWD to the Commerce and Industry Department. In 1914, more administrative traction followed when the Postal and Telegraph Departments were amalgamated under a single Director-General while the P&T Department was reverted to the PWD.

But what was really pushing the space forward was the advent of new levels of technology. Like first automatic exchange at Simla (Shimla) that had a capacity of 700 lines and 400 actual connections. It was also an exchange that employed women operators for the first time, in 1919. In 1933, Radio telephone communications between England and India were opened. In 1937, deluxe telegrams with foreign countries saw the light of the day. And soon enough, the Bombay-Australian wireless telegraph service and Bombay-China wireless service and Bombay-New York Wireless Telegraph Service was switched on. By the time we touched 1944; we had a Hindi telegram in Devnagari script and an 'Own Your Telephone Scheme' in 1949.

One level to another, the space kept evolving in small and big sprints. But the most notable one was the first coaxial route between Delhi and Agra and the first Subscriber Trunk Dialing (STD) route between Kanpur and Lucknow. This was followed by the first microwave route, the first crossbar local exchange and then the first crossbar trunk automatic exchange. The country saw installation of the SPC gateway telex exchange and introduction of the international subscriber dialed telex service in the 1970s, and later, the optical fibre system for local junction in Pune.

The 1980s formed a critical period in many ways – the landscape met the first satellite earth station for domestic communications at Secundrabad, the first SPC electronic digital telex exchange, the first SPC analogue electronic trunk automatic exchange (Bombay), the setting up of the Centre for Development of Telematics (C-DOT) and also the advent of the first mobile telephone service, the first radio paging service, MTNL and Videsh Sanchar Nigam Ltd. (VSNL) along with the international gateway packet switch system. At the time of independence,

as estimated in some past data, India easily had about 82,000 telephone connections, which grew to 3.05 million by 1984.

From the 1850s to the 1980s: If this was the kindergarten age of basic telephony, the adolescence period was still waiting to happen – and that's where the real action and twists came in.

Opening up: From vintage to teenage

We know that in 1975 all we had was the Department of Telecom (DoT) that was responsible for telecom services in the entire country – especially after separation from Indian Post and Telecommunication. After some years the Mahanagar Telephone Nigam Limited (MTNL) was spun out from DoT – for telecom services of Delhi and Mumbai. This was the Black & White equivalent of telephone until the trunk-dialers got a taste of the Kodak Eastman and Dolby periods of telephony.

This began in a big way in 1990 with liberalisation waves. Once the telecom sector was opened by the government for private investment, Bharat Sanchar Nigam Limited or BSNL became a separate government outfit and private operators, such as Reliance India Mobile, Tata Telecom, Hutch, BPL, Bharti, Idea, etc., entered the scene, that was, hitherto, a government-territory.

Next to hit the space was the big turning point. The mobile cellular service (both CDMA and GSM) was introduced in 1994. Suddenly there were 19 telecom circles each with about three private service providers and one state-owned service provider. A massive trunk capacity was gradually added in the form of fiber-optic cable and domestic satellite systems, and Very Small Aperture Terminals (VSAT). The network kept expanding and deepening to five submarine cables, including Sea-Me-We-3 with landing sites at Cochin and Mumbai (Bombay), Fiber-Optic Link Around the Globe (FLAG) with landing site at Mumbai (Bombay), South Africa - Far East (SAFE) with landing site at Cochin, i2icn linking to Singapore.

It was a big change for India – from rotary phones and neighbourhood huddles, the very idea of communication became more stylish, simple and private. We were moving from clunky landline phones to pagers to push-button phones, STD booths and cordless chats.

As private competition bubbled forth in this space, and as cellular and basic services as well as National Long Distance (NLD) and International Long Distance (ILD) telephony came up for grabs, the Telecom Regulatory Authority of India (TRAI) was constituted in 1997 as a regulatory body for the sector.

It was in the 1990s only, that the sector saw a lot of other shifts – like the commissioning of the I-Net Exchange, introduction of the voice mail service in Delhi, and the unfolding of a National Telecom Policy, a new ISP policy, and later the setting up of the Telecom Disputes Settlement and Appellate Tribunal. Regulation and structural changes were deepened in the sector with more changes like the tabling of the Convergence Bill in Parliament, the announcement of policies for the GMPCS service, PMRTS and UMS, privatisation of VSNL and the advent of Internet telephony.

And how can we forget the big day, 31 July 1995. The first mobile telephone call - when the Union Telecom Minister Sukh Ram and the then Chief Minister of West Bengal Jyoti Basu talked to each other through a hand-held phone!

These years saw India embracing the cellular revolution in a big way. Operators moved from 900MHz bandwidth to 1800MHz bandwidth while CDMA operators moved to better bands and EVDO-based high-speed wireless data services. A lot of names were now part of the sector – as big and small players catering to different needs, regions and markets.

We had VSNL, BSNL for sure but we also had many more players and industry-handshakes:

1. Reliance Infocomm, Tata, Hutchison-Essar, Idea and Bharti, Aircel (South India) and Escotel (North and West)

2. Consolidation happened at a bigger pace and brought a new texture to the industry. Example: Idea Cellular, the three way joint venture of the Tata group, Aditya Birla group and AT&T, Hutchison- Essar, sale of the BPL Mobile Cellular stake, Hexacomm stake, Escotel stake and RPG Cellular stake.

3. Infrastructure and ecosystem builders: Nokia, Ericsson and STL

Almost mirroring the telephony journey of the country was the evolution of networking and supporting infrastructure. Players like STL networks, Nokia, Ericsson etc. have been witness to the early days of India's growth here. From nascent phases to the latest breakthroughs,

> The year 2007 was declared as "Year of Broadband" in India. With optical fiber technology we could move to better speed and communication.

many players have contributed to the wheels that helped to build the story of India's momentum forward and upward.

If we look at Ericsson, the story dates back to the British rule period. This company got its first order for a manual switch from the Indian government in 1903. Later in the 1970s, a jointly owned production company, Ericsson India Pty Ltd, was formed. This catered to the needs of manual switching equipment and then in 1996, the name Ericsson Communications came to the fore. This company also signed the first GSM contracts with India in 1994. This was for networks in Delhi, Bombay and Madras; and at one point Ericsson supplied about half of some 40 Indian GSM networks. Interestingly, India started out with the digital GSM system.

STL is another name that has a strong presence in the annals of telecom history. It exemplifies how optical fibre sprouted and spread in the sector in a span of 25 years. It has been evolving from one step to another since 1988 and has solidified India-grown innovation through home-built R&D, Centres of Excellence and over 300 patents in optic fibre production, storage and transmission. Pioneers like STL helped the industry develop strong roots with Centres of Excellence and core laboratories for strong research in helping India meet the challenges of higher data transmission speed and capacity demands. The company was riding the wave just at the point when India opened its eyes to the power of Internet and new-generation communications. It contributed by producing high-grade optical fibre for local and regional players.

These steps bolstered the country's capabilities with design and manufacturing of optical fibres and optical fibre cables. This was helpful for matching steps with the ever-increasing global demand for bandwidth. As the government rolled out the Nationwide Optical Fibre Project, the last mile of broadband connectivity got a strong impetus. Nokia was another company that was integral to the country's strongest phase of transformation for the telecom sector. It arrived just after liberalization, around 1995 and apart from being the phone on which the first GSM call happened, the company also added other turning points in its growth story. It slowly set up manufacturing presence, and deepened its handset ecosystem and innovation footprints India. As the sector opened up and strengthened more and more, this paved the way for companies investing in domestic manufacturing strengths, connecting mobile towers for 4G access, FTTX (Fibre to the "X") and other milestones of creating a 'Digital India'.

2000: Not just the 'wrong' number

As India moved into the 2000s, the country also saw the arrival of 3G, digital microwave, optical fiber, and satellite earth station. However in the initial period, we were still notorious for a minimum broadband speed of 256kbit/s. The year 2007 was declared as "Year of Broadband" in India. With Optical Fiber technology we could move to better speed and Fiber-optic communication (FTTx). Then around 2012, we also saw the sector change its dynamics with penetration of LTE (Long-Term Evolution) and WiMAX. From one thing to the next, we kept evolving to Next Generation Networks (NGNs), multiple access networks, IP technology, coaxial cable networks connected to fixed locations, Wi-Fi and better 3G.

Today, it is hard to imagine an average Indian person without a smartphone, without a streaming app and without a food/cab app.

So from now to where?

If we look at numbers, India is a very hot telecom market presently – with a subscriber base of 1.20 billion and a big contribution to India's Gross Domestic Product (GDP): as per a report by GSM Association (GSMA) in collaboration with Boston Consulting Group (BCG). We have also; apparently overtaken the US in number of app downloads. Internet subscribers in the country increased at a CAGR of 45.74% during FY06-FY19 and this figure grew to 636.73 million in FY19. Also, the total wireless data usage in India jumped 10.58% y-o-y to 19,838,886 terabytes between July-September 2019. Data usage

> The next five years would be even more exciting – a spurt in mobile-phone penetration and decline in data cost can add 500 million new internet users in India.

stood at about 55 million terabytes in 2019 – as per some estimates.

As of January 2020, our total telephone subscriber base and tele-density reached 1,177.02 million and 87.45%, respectively, while the gross revenue of the telecom sector stood at Rs 121,527 crore (USD 17.39 billion) in FY20 (April-September 2019). India had over 500 million active internet users (accessed Internet in the last one month) as of May 2020. And as of January 2020, more than 542 banks were allowed to provide mobile banking services in India.

As per the report by ResearchAndMarkets, over 600 million people became internet users over the last six years and another 600 million more internet users are expected to come online over the next six years by 2025. The report forecasts sustained revenue growth to 2025, despite the COVID-19 pandemic and the diminishing impact of declining legacy voice and SMS revenue. It also points out that the mobile subscriptions are growing faster than mobile service revenue – that is translating into ARPU decline after three years of intense competition with the market transitioning to 4G. The new National Telecom Policy also intended to attract investments worth US$ 100 billion in the sector by 2022.

A lot of long-sighted strategies are in progress. We have seen how infrastructure companies are helping this industry with networking technologies, especially as the country makes a big shift to Digital Infrastructure and Next-Gen Digital Network. STL feels that it's recently established 5G ecosystem can help digital network creators, specially with a distinct Make-in-India quality. It tells how it is investing in technology and assembling an ecosystem of partners in hardware manufacturing, cloud computing, and academia. The idea is to create a Next-Gen Digital Network by converging wired and wireless, software and hardware, connectivity and compute, and open source - all at the edge of the network.

It is being augured that the next five years would be even more exciting – with a spurt in mobile-phone penetration and decline in data costs that can add 500 million new internet users in India. As we move ahead, the demand, and capability, for low-latency and high-definition services keeps proliferating. Right now we are busy jumping to more and more fiberisation, 4G LTE infrastructure and 5G paradigms.

Who knows if Mr. Bell were to land from some spaceship ten years from now, and look at the phone in India – would there be one to look at? May be he will have to look inside a fisherman's skin or around at some invisible hologram before he can utter with utmost awe: Whoa! You are better than what those Aliens have there!

A lot can happen in a few years. We know that best.

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ABHAY KARANDIKAR

DRIVING FUTURE OF MOBILE COMMUNICATION IN INDIA

TSDSI has brought India on the world's standards map with a potential of altering the landscape of the telecom sector in the next 25 years

Since the first cellular phone call was made in India on 31 July 1995, the country has witnessed tremendous growth in the telecom sector. From less than 15 million telecom subscribers in 1995, today we have over a billion subscribers with an overall teledensity of 88%. This has been made possible primarily due to an exponential growth in cellular mobile communications supported by a liberalized market with regulatory reforms. While we have about 1.1 billion mobile subscribers, the number of wireline subscribers remains only 20 million. Despite this spectacular growth, where the urban teledensity has crossed 100%, the rural teledensity is still 58% as of this writing. Moreover, the number of broadband subscribers is about 700 Million. Undoubtedly, rural connectivity and broadband penetration will be the key focus areas for the next decade for achieving nationwide digital empowerment.

I have been fortunate to be associated with telecom research, technology development, policy and regulatory changes in the country for the last 25 years and would like to recapitulate my experiences and involvement in establishing Telecom Standards Development India (TSDSI) which brought India on the world's standards

> Enhanced focus on IPR creations and influencing global standards with standards essential patents would be paramount for making India self-reliant.

map with a potential of altering the landscape of the telecom sector in the next 25 years.

Though India emerged as the second-largest telecom market in the world most of this growth story has been scripted by the import of telecom equipment, with very little value addition made in the country. The cellular mobile communications industry is heavily driven by global standards such as Third Generation (3G) Partnership Project (3GPP), ITU, etc. Though India has built a strong software and services industry, it is still not a significant player in the telecom technology development and has marginal intellectual property rights (IPR) and contributions to global telecom standards. Many of us from the academia and industry had long felt the need for India's own Telecom Standards Development organization. In a standard- and IPR-driven industry, it is necessary that we should collaborate in the global efforts for developing standards to promote Indian requirements and intellectual property.

One of the significant events in industry-academia partnerships in Indian telecom scene was setting up of the Telecom Centers of Excellence (TCOE) in 2007-8 in IIT Delhi, Bombay, Kanpur, Kharagpur, Madras, IISc, and IIM Ahmedabad. It brought telecom service providers and academia together on a common platform. I led the TCOE in IIT Bombay that was set up in partnership with Tata Teleservices and the Department of Telecom (DoT). Though TCOEs are defunct now, it did help in catalyzing industry-academia partnerships. The idea of forming Indian Telecom Standards Development organization was first formally mooted in the Governing Council meeting of TCOEs in September 2009 held in IIT Bombay. Following this, we held several discussions with DoT officials and a formal proposal was submitted to the ministry in September 2010.

Meanwhile, the April 2011 Telecom Regulatory Authority of India (TRA) recommendations on telecom equipment manufacturing policy also emphasized the need to influence global standards. With strong support from academia, operators, technology vendors and industry associations like the Cellular Operators Association of India (COAI), DoT articulated the importance of telecom standards organization in its National Telecom Policy (NTP) 2012. The policy resolved to promote setting up of Telecommunications Standard Development Organization (TSDO) as an autonomous body with the effective participation of the government, industry, R&D centers, service providers and academia to drive consensus regarding standards to meet national requirements including security needs.

Following several discussions with industry, TCOEs and industry associations such as COAI and AUSPI, we submitted the draft bye-laws and operational plans for setting up TSDO in public-private partnership in May 2012. The organization was named as DOSTI – Development Organization of Standards for Telecom in India. However, even after DoT's intent to set it up, formal approval was not given and protracted discussions continued for the whole of 2012. But, we persisted in our efforts.

Towards the beginning of the year 2013, DOSTI held several meetings. A turning point was reached in May 2013 when the Indian delegation was invited to attend Global Standards Collaboration's 17th meeting (GSC-17) at Jeju Island in the Republic of Korea. The delegation was led by the then Additional Secretary Rita Teotia. I was also part of the delegation. She made a historic statement before the international telecom standards bodies: "I am pleased to announce that, with the support of all stakeholders – industry (manufacturers, service provider and R&D units), academia and government, we have now been able to complete all the groundwork required for establishing the Telecom Standards Development Society, India (TSDSI). We expect the body to be registered and to begin functioning shortly and also that it will include all stakeholders including indigenous manufacturers, service providers, research and academic bodies and government societies and organizations".

> Our contribution on LMLC configuration was included as a mandatory test configuration under the Rural eMBB test environment in IMT-2020 in 2017.

Subsequently, TSDSI's bye-laws were approved by DoT. TSDSI was formally launched on 8 November 2013 in C-DoT Delhi where cooperation agreements were signed with global standards bodies.

TSDSI formally came into being on 7 January 2014 after being registered with the Registrar of Societies, Delhi. Dr. Kumar Sivarajan of Tejas Networks was elected as the Chairman and I was elected as the Vice-Chairman in the first governing council elections held in October 2014. I later became the Chairman in October 2016. From a modest 11-member body, TSDSI has now grown into a healthy forum with 70 member organizations.

The next historical milestone was achieved in January 2015 when TSDSI became the 7th organizational partner of 3GPP and joined China Communications Standards Association; European Telecommunications Standards Institute; the club of Association of Radio Industries and Businesses, and Telecommunication Technology Committee of Japan; Telecommunications Technology Association of Korea; and Alliance for Telecommunications Industry Solutions of the USA. This enabled TSDSI members to participate in 3GPP meetings and influence future wireless standards such as 5G. This also allows TSDSI to "transpose" (i.e. adopt) 3GPP specifications for IMT-2000 (3G), IMT Advanced (4G LTE), and future telecom technologies as its own standards. After spending initial years on a membership drive, drafting IPR policy, working procedures for technical work, and setting up secretariat resources, TSDSI members have now started to actively participate and influence the global standards.

While India clearly missed 2G, 3G, and 4G bus, we wanted to make a new beginning in 5G. This was the time when work for the development of 5G standards (IMT-2020 in ITU parlance) was picking up in 3GPP and ITU. Very soon, our contribution on Low Mobility Large Cell (LMLC) configuration was included as a mandatory test configuration under the Rural eMBB test environment in IMT-2020 Technical Performance Requirements with an enhanced inter-site distance of 6 km in 2017. This test case addresses the problem of rural coverage by mandating large cell sizes in a rural terrain and scattered areas in developing as well as developed countries. TSDSI members followed this up with an indigenously developed proposal on a Radio Interface Technology that is compatible with 3GPP for IMT-2020 standards to ITU. This served the LMLC requirement. This technology has qualified for inclusion in IMT-2020 specifications as an independent technology, catapulting India into the club of standards defining entities, a historical milestone. Under the leadership of Prof. Bhaskar Ramamurthi, TSDSI has made rapid strides in the last two years.

In 2G and 3G technologies, most of the IPR has been held by the US and Europe. However, IPR and standards essential patents holding have slowly shifted to Asia-Pacific – mostly China, South Korea, and Japan – in 4G and 5G technologies. Going forward, we have a wonderful opportunity to develop an Indian eco-system of 5G and beyond 5G telecom industry. Unlike in the times of 2G/3G, competencies of Indian companies in the domain of 4G/5G have significantly gone up. In an all-pervasive digital world 5G and beyond technologies are likely to affect not only communications but other sectors like healthcare, transportation, agriculture, automotive, etc. The development of an indigenous eco-system is not only important from the economic point of view but also from the nation's strategic and security reasons. Enhanced focus on IPR creations and influencing global standards with standards essential patents would be paramount for making India self-reliant (aatmanirbhar).

With TSDSI firmly in place, let us make India a global force to reckon with, in the next 25 years.

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ARUN SETH

GETTING READY FOR THE NEXT 25 YEARS

India is at the cusp of a global supply chain disruption. It is time to implement learning from the past and make the telecom sector Aatmanirbhar

It's been 25 years since 31 July 1995 when Jyoti Basu in Kolkata made a call to the Union Telecom Minister Sukh Ram in Delhi. Over the years, mobile communication has moved from being exotic and for the well-to-do to become the lifeline for the not-so-well-off, and a potential path out of poverty. However, as I start thinking of the day, memories start rolling.

- **Chandigarh mid-1950s:** pick up the phone and ask the operator for a 3-digit number and she connects you. It means that less than 1,000 people have that device!
- **Lucknow 1960:** India's first STD call is made; it was amazing to be able to dial without asking an operator to connect.
- **Kanpur 1970:** standing in line at a PCO in at IIT, Kanpur to book a call to parents and using a 'tickler' to make 'free' calls through the coin box phone at the hostel – part of growing up.
- **Bangalore 1980:** working in Whitefield and booking a call to Bangalore City without even dialing.
- **India 1985:** the PCO revolution takes over and creates employment with the proviso that only the disabled can get a PCO license; the only way to allow the DoT to share its revenue.
- **Delhi 1990:** had the privilege of having access to a car phone; one of a few hundred – a Motorola analog one.
- Delhi 1995: the first GSM call is made in India.

The rest is history

Having been in telecoms for ages, friends form DoT working on strowgers and crossbars recall tales of how they used to "fix" inauguration of telephone exchanges: hardwire two instruments so that no matter what number is dialed it will still ring the second phone. It seemed PM Nehru understood this and dialed a different number and the phone rang up. There were lots of red faces, but the key then was to make the phone ring.

The government was slow in getting out of "telecom is a natural monopoly" mindset. When I was running a phone and EPABX company in the mid-1980s, we used to pay Rs 100 per line of EPABX as royalty. When I asked why I was told it was to compensate for the profit that DoT lost! It took a long time to change the mindset that set us back for many years.

The magic figure for a mobile call was Rs 16.80 per minute and one had to pay the same for incoming too. But the licenses were given only to private players and the DoT was kept out of it because mobile phones were believed to be only for the rich. Since the DoT had the welfare mandate it was expected to focus on providing fixed lines services for the poor.

Today the poor use mobiles, while the rich use fiber-optic high-speed fixed lines!

The policy fallacy

This philosophy of a government having a 'sacred cow' has worked against the interests of India at large. In the mid-1980s the PCO revolution was made possible by allowing only the disabled people to get a license. Then, we had to pay more per call if we consumed more. It was economics on its head to suit a political theme that the government is there to serve the poor only. As a result, mobile licenses were given to private companies. This had a negative impact on the state telecom providers' BSNL and MTNL – causing poor health and near death. This is contrary to the global scenario where incumbents, including BT, AT&T, Singtel, and DT, etc. are very strong. However, India wasted taxpayers' money by not nurturing public sector companies to compete with private players.

> DoT was kept out of mobile telephony because it was meant for the rich. Today the poor use mobiles, while the rich use fiber-optic high-speed fixed lines!

What also impacted them was the decision at the initial stages not to allocate mobile licenses to them.

I recall it was Jagmohan as the Telecoms Minister who got them a license in 1999 when the industry had shot itself in the foot with high license fees in 1995/96 and got NTP 1999 with a revenue share and with DoT getting a license in the bargain. Why did we need a crisis to fix this?

The international telecom monopoly of VSNL was broken early and the company was privatized again on the basis that since international calls were for the rich, the company can be sold to the private sector. The 2000s was the period of glory for the telecom sector. During this period, the power of economics at scale played out and proved to be the basis of telecom as an elastic service in the classical sense – each rupee in price reduction increases volumes by a large factor thus growing the pie. Each rupee spent on telecom infrastructure also created a 3x return on GDP. Finally, we were talking fundamentals and not tinkering with basics of scale.

I saw the same thinking hold back manufacturing in electronics. The same wooly thinking of licensing and catering only to India demand literally killed manufacturing. Telephone licenses were the classic example with 51 licenses being given for as low as 5,000 phones per annum and the government "democratically" gave licenses to all states as well. The only people who made money laughing all the way to the bank were the capital equipment suppliers since irrespective of the volume one still need the same equipment. Sadly, all were sub-scale and none of them were able to hold ground. We ceded the ground to Chinese companies in the mobile phones sector as well.

The root cause was the denominator of manufacturing – we wrongly assumed that our players will cater to Indian demand only, but the denominator was wrong. Finally, with Aatmanirbhar Bharat Abhiyaan we are seeing the right balance of economic policies coming to play – build locally for global demand.

Lessons from the past

We have seen the magic in manufacturing happen when the country recently needed the PPE kits. The government and private sector worked in tandem to create a global supply chain and in months including using Air India planes to get the capital goods and raw materials. I see the signs of replicating it in telecom manufacturing, medical equipment, and pharmaceutical sectors.

We are at the cusp of a global supply chain disruption, thanks to the geopolitical situation. It is time we play our cards correctly this time. We need manufacturing jobs as much as the service sector jobs for the well-educated in the country. We should grab it using a few simple rules that are in the heart of economics and that too without tinkering

- Economies of scale are real, don't tinker.
- Enable scale funding of our companies for global scale; tech is necessary, but funding creates sufficiency to succeed – learn from the Chinese.
- Be very selfish about national security as telecom will build the economy of the future. So, no compromise, please.
- Security is not just cybersecurity. It's about defining what strategic security is for the next 20 years even in diverse fields like pharma. So, focus on creating next-gen industries in each of these spaces.
- Focus on software as a strategic priority. No point in worrying about making commodity servers, etc. Software is now 70% of the value in any sector and we are good at it. Just that our IT industry has been focused outwards not inwards.
- Align research in academia with industry. The government should make big bets with Indian companies in these well-defined fields.
- Lastly, the government should trust Indian companies to do the right thing for the country and work with rather than going for L1 and five years' experience in tenders. This tilts the pendulum the wrong way around for local enterprises.

I can see this change coming; we can't get back the past. In the future please make new mistakes, not the old ones.

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BRIJENDRA K. SYNGAL

LET THE TELECOM SECTOR FLOURISH

Quick-fix solutions during the last 25 years have caused a lot of damage. It is now time for a more principled approach by all stakeholders

There are two success stories led by India's liberalization and globalization efforts initiated in 1991 – opening up of the telecom sector and the emergence of the knowledge-based service industry in the country. The result of the decision is there for all to see. Today, we have moved from kataar (queue) to betaar (wireless) explosion. The market cap of these two sectors alone could be in the region of USD 1.0 trillion.

So what propelled the growth of these two sectors? It was the right choice of cellular technology and digital connectivity and bringing in of the internet in August 1995. There are two celebrations, the silver jubilee of birth of twins, cellular and internet. I will not dwell on the internet, but stay focussed on cellular, though I had a role to play in both of them. The first famous call between Jyoti Basu and Pt Sukh Ram was made using our VSNL tower in the then Calcutta on 31 July 1995. These two events are the bedrock of the digital revolution that we see today.

I remember BK Modi walking into my office in Bombay with his entourage. We settled over coconut water and he broached the topic of using our tower in Calcutta that was so strategically placed. Before I could say anything he offered to pay for the service. I asked for Rs five lakh and he agreed. That was the sharing of infrastructure without government interference or nod. I was recovering my cost of the tower in two years or so, a win-win situation. Ironically, the internet also was launched in Calcutta a fortnight later from Halishahar, and was touted as the second independence by the media.

The cellular was bandied as elitist by some in the 1980s. Thank god it was scuttled then. Had it not been, we would have been investing in one of the outdated technologies: Advanced Mobile Phone Service (AMPS) and the then under development D-AMPS (US), CDMA (US), and Analogue (EU). The fourth, an upcoming Global System for Mobile Communications (GSM) Systeme Global Mobilite, was in a developed stage, deployed in 1991. The choice, in the 80s, would be restricted to two AMPS (US) and Analogue (EU/UK). CDMA had not been commercialized by then, mostly used by the defence. In 1991, too, there was pressure to use DAMPS, but it was successfully warded off by Pt Sukh Ram with a rustic worldly approach, something that one needs at times.

The fate was sealed in favour of GSM following a visit, early on, by a senior official of DoT, where I was an appendage. We called on Tony Booth, Board Director of BT, for cellular networks and Vodafone CEO, Ferozpore-born Gerald Arthur "Gerry" Whent in the UK. Without a blink, both informed that they were removing all analogue equipment and replacing them by GSM end of 1992. Why would anyone in their right mind invest in outdated dying technology, they asked? After his return, Pt Sukh Ram conveyed to the PMO that India should invest in a system of the future and not past. That sealed the fate of the choice of technology.

The success story has been mired in controversy right since inception. The award of the first eight licenses was challenged, resulting in Tata moving out of the race. Ironically, of the original eight, only one Airtel has survived. The rest have either fallen by the wayside or assumed a new avatar. The initial licensing had its own flaws: for example, the aim being to fill government coffer, which continues to this date by taxing the success of the industry in perpetuity.

> An industry which continues to be taxed at 30% while generating EBIT of an average 20% annually cannot service its debts, thus making them, in effect, NPAs.

It was a start, but a false one. Naturally, the tariff for the service was high at Rs 16 per minute, because of a hefty license fee in addition to an equally obscenely entry fee. Perhaps, low-cost high volume theory of economy was considered risky. Both government and service providers were in their cost recovery mode, economies scale be damned, alas that was not to be.

The best use was to call a driver by a missed call, a pager modified. In addition, called party too had to pay. The industry was teetering into extinction when NDA 1 came to power to take some bold decisions in the form of NTP 1999, to move away from the high fixed license fee to the revenue share model. It also introduced an additional private player, plus a government player. That was a booster dose, but the additional competition was contested. I had the task of convincing incumbents that before competition kills us we would be long dead anyway.

NTP 1999 left the definition of Adjusted Gross Revenue (AGR) a bit vague, though accepted by industry in the package; it is the root cause of present AGR issue that is bleeding the industry white. In addition, there are cries of high debt, some because of bad business decisions like the wrong choice of technology – CDMA, African Safari, and obnoxiously high cost of surrogacy to mitigate FDI violations. The road to recovery did not begin until another controversial decision of limited to unlimited mobility (again a creation of another loophole in the definition of local loop in NTP 1999) happened. Circa 2001 leashed yet another three-year war, resulting in the historic recommendation in 2003 for delinking of the spectrum, allocation by auction, and restricting the number of players to a total of six players – four in GSM and two in CDMA (through backdoor).

All was well until 2007, when mayhem of 2G scandal, because of flawed recommendations by TRAI, broke out. Unheard arbitrary actions like bringing forward the cut-off dates for accommodating few cronies never applied first come first served principle, for spectrum allocation despite 2003 recommendations. And then, there was a new nomenclature for spectrum allocation under a combination of technology to Reliance and Tata. That was the bloodbath industry continues to suffer from, in addition to the AGR issue, plus the level of levies. Licenses were traded at huge multiples by most recipients, resulting in no money into the industry, but unscrupulous promoters. The cancellation of 122 licenses was indeed a body blow. Those who ventured back to do business, had little or no money to invest, including less faith in regulation and policy. It did not end there but continued.

Bad policies, a silent regulator

Policy paralysis or irrationality in regulation has been the case since 2003. In 2007, the government did not auction the spectrum, resulting in the 2G scam. It gave a dual technology award to two favoured telecom players Tata and Reliance Com and in 2010 changed conditions of the spectrum usage from "data only" to both voice and data, and lower spectrum charges.

Recently, in 2016-17, and fourth time, lax interpretation of pre-commercial testing regulations in the country, which led to the current blood bath, grabbing a market share in the garb of testing a new technology by releasing promotional offers, one after another. All this happened due to the lack of clear regulations for pre-commercial testing procedures in India.

Despite the clear breach of market norms, the regulator sat silently, while telecom companies went into the frenzied mode of M&A to sustain themselves. Thus, from almost 13 operators just a few years back, the telecom industry has come down to just four, including BSNL on life support. The basics of competition law tell us that such consolidation is a recipe for a disaster if handled with kid gloves.

The role of DoT

DoT has its own share of the blame. Besides the lack of clarity in regulations, the decision making at DoT leaves much to be desired. They sit on TRAI recommendations for years on, such as long overdue regulations on mergers and acquisitions, spectrum sharing, rationalizing

> The cancellation of 122 licenses was a body blow. Those who ventured back to do business, had little or no money to invest, including less faith in regulation and policy.

spectrum usage charges across the industry (today it benefits an operator despite the recommendation of TRAI) and trading guidelines, two-decade-long debate on the definition of AGR and discussions on Unified License, no clarification on the definition and limits of promotional offers etc. are a few of the many such policy issues that plague the telecom industry.

The way forward

One of the immediate benefits that the government can give to the sector is to allow them breathing space in taxes. An industry that continues to be taxed at 30% while generating EBIT of an average 20% annually cannot service its debts, thus making them, in effect, Non-Performing Assets (NPA). One might think that the government is probably waiting for it to happen so that it can bail out the big who-is-who of the industry. The government needs to be more prudent in its approach towards the sector and come out with a well thought out plan to resolve the Debt Crisis, instead of kneejerk reactions like moratoriums on loans or writing off debt, etc.

In the longer run, the government should start by introducing the concept of revenue neutrality in their tax regime, i.e. taxing companies relative to their growth. Thus, in the period of lower growth, lower taxation will provide a stimulus for growth. While doing the opposite, which the government is doing now, is making sure that the industry is decimated in the long run. It further needs to make sure that there are well-defined laws and regulations for market functioning. This may require consultations with all the stakeholders to minimize the policy loopholes. It is vital to ensure that one or other players do not exploit these loopholes to benefit themselves while decimating the market. To my mind, it is imprudent to tax the success of the industry in perpetuity at 33%. The industry must be left money to invest in creating an infrastructure for expansion as well as new offerings.

No single culprit

The industry can keep venting by being economical with the facts, because, you know, yeh dil maange more, but it is also imminently necessary for them to take charge of their bad business decisions. They must become less litigious, and stop internecine wars. I can see another one on the horizon on 2G-mukt Bharat.

The regulator, which is supposedly the conscience keeper and DoT, the custodian of the sector, most of the time, did not act when it was necessary to intervene. The light-touch policy principle should not mean turning a blind eye to the flagrant violations of norms.

Further, the government needs to take into account some key recommendations made, time and again, by various stakeholders to reform the policy issues related to the sector in a timely manner. It also needs to rationalize its exorbitant expectations of revenue from the sector by adopting revenue neutrality and shift the burden of maintaining its fiscal limit to other sectors.

It is critical to understand that piecemeal reductions or quick-fix solutions, here and there are not going to help. There is an urgent need for a principled approach by all stakeholders to ensure that this vital infrastructure can flourish without bleeding the industry and consumers are not left high and dry due to flawed policies and their implementation. At times consumer interest is used as emotional blackmail. However, such actions damage the viability of the industry as has happened recently.

Therefore, balanced consumer interest, adequate healthy competition, commercial interest of industry, with sound predictable policies and regulation is the need of the hour. Let me be very clear: telecom is the future and the 25 years that have gone by would soon be a speck in the rear view mirror because I always see telecom as the tip of the iceberg.

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DR. GANESH NATARAJAN

GOING AHEAD ON THE DIGITAL PATH

To achieve a trillion-dollar economy, India needs to ensure stable mobile connectivity and local apps that can help every business go digital

Twenty-five years ago, I was speaking at a conference in Mumbai where Prof. Pankaj Ghemawat from Harvard mentioned, "We spent many years in the sixties and seventies waiting for a telephone and then years with our land phones waiting for a dial tone. One can only hope that India will find some way to leapfrog." Ten years later, I was listening to a keynote by Sam Pitroda in Ahmedabad where he spoke about his stellar achievement getting the Department of Telecom (DoT) to work and started the revolution of STD-ISD-PCO centres everywhere in the country. And in an almost unobtrusive manner, the Atal Bihari Vajpayee-government in 1999 implemented a key policy reform in 1999, separating policy formulation and service provision and giving birth to the BSNL.

From a country which looked at a telephone as a luxury in my childhood, we are today the proud users of over 800 million mobile phones, a substantial chunk of the five billion-plus phones in use all over the world. Thanks to the burgeoning young and tech-savvy population in the country, the rapid rise of e-commerce and mobile-commerce in the country in the last decade and intense competition driving down prices of smartphone handsets, India has far exceeded every target for telecom penetration and teledensity. This is something to be proud of. And while a lot of people may be given the credit, from Rajiv Gandhi to Sam Pitroda to Vajpayee, we should all take credit and be as proud of the Telecom Policy of the nineties as we are of the Software Technology Parks of India scheme of the eighties. One created a global winner in software services while the other enabled us to leapfrog in mobility to world-class levels.

Watching from close quarters as a participant and evangelist for connectivity in the country, it is amazing to see how many industries and service segments have been transformed through the proliferation of the internet and the availability of the mobile phone in most hands in the country. In the education segment, where I did my first CEO role at APTECH, the mobile phone did not really come into significant use because of the weak response to early attempts at e-Learning and MOOCs. But in recent times, with digital learning platforms like Skills Alpha totally transforming the efficacy of learning, using personalization, adaptive learning, artificial intelligence, e-mentoring and peer group learning, the access to learning content through mobile phones any time and any place has led to a sharp uptick in usage.

Post-COVID, with the need for social distancing, one can expect to see every learner, from the age group of five to 75 reach out for their smartphones for at least pre-requite, remedial or reinforcement learning.

The same is naturally true for skills development. Our own public-private partnership for digital literacy, school education, and employable skills development, Pune City Connect has seen all our learners move seamlessly online thanks to the availability of at least one smartphone in every family, even in the Pune slums. After our weak early results as a nation in skills development, with poor employment rates and major drop-outs thereafter, one can hope to see a new revolution in future for preparing youth for employment and entrepreneurship.

In the manufacturing industry, it has been the introduction of automation and the internet of things (IoT) which has driven the use of mobile phones to be "always connected" with happenings in the factory. With data flowing through the IoT pipes from the shop floor and mingling with process and supply chain data from the

> It is amazing to see how industries have been transformed through the proliferation of internet and availability of mobile phones in most hands in the country.

enterprise resource planning systems, the data warehouses, and data marts are able to process large volumes of disparate information, provide business intelligence and serve up dashboards and predictive and prescriptive actionable insights to the mobile phones of the concerned folks. Supply and demand chain participants are constantly updated through their phones and even in agriculture, crop data is retrieved through drones and made available from farm to fork on every consumer's phone.

The services industry players have predictably been the biggest beneficiaries of the mobile revolution. Banking has been transformed beyond recognition with service like SBI's YONO bringing amazing user convenience to the common man. Insurance, financial services, access to government services and other areas have been transformed and of course in healthcare, a revival of interest in telemedicine has happened, thanks to a large number of video conferencing apps on the mobile handset, enabling easy consultation and healthcare services on demand.

All readers of this special issue would know that while the dream of a five trillion dollar GDP for our country may have to be pushed back from the original target set by this government for 2024, the goal of a trillion-dollar digital India can be realized if we build on the amazing success of JAM – Jan Dhan, Aadhar, and mobile phone – trinity. The India stack in financial services has become truly world-class, almost the entire country has been registered under the unique identity system and the mobile phone numbers keep growing. With the new one lakh crore plus investment in the Jio Platform, one can assume that mobile telephony will receive a substantial fillip in the next few years and quantum computing and 5G innovations will enable mobile usage at an unprecedented scale.

However, there is one note of caution that could put the brakes on the Digital India story. The trillion dollars will see a contribution of not more than a third from the IT sector itself and a whole bunch of IT-enabled shared economy and platform-based services will constitute that other two-third. This will need both urban and rural participation and the infrastructure has to be available.

The much-promised BharatNet or the National Optical Fibre Network (NOFN) must indeed be laid and energize each of the two hundred thousand gram panchayats and a majority of our six hundred thousand villages with high speed or at least adequate connectivity. Mobile phones need that connectivity stability to continue to play their stellar role and entrepreneurs must continue to build and deploy the killer Atmanirbhar apps that will ensure that every business goes digital and we march quickly towards the tryst with a trillion-dollar digital destiny.

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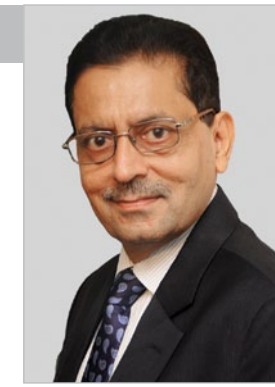
HIMANSHU KAPANIA



FUELLING DIGITAL DISRUPTION

With the wireless infrastructure spread far and wide, India now needs to reinvigorate the telecom sector to realize its new economy dream

When we flashback to the year 1995, India's telephony services were sparsely available and beyond the reach of a common man. The mobile services were classified as a luxury, priced at an exorbitant rate of Rs 16.8 per minute. Quite naturally, teledensity in India was abysmally low. The older generation may recall the endless wait for the clock to tick 9 PM, for us to make half-rate, long-distance and late-night STD calls at the quarter of the peak tariff.

Fast forward to 2020, over 80% of Indian citizens own a mobile. The wireless mobility infrastructure has spread far and wide across 6,00,000 towns and villages across India, and we don't hesitate to make a call as the average voice rates to anywhere in India are at an abysmally low price of 10-15 paisa per minute. This is unbelievable democratization of voice telephony at 1/160th of its tariff 25 years back.

It is a no mean a feat that India is amongst the bright spot where consumers continue to connect and communicate far more than anywhere else in the world, even though mobile voice usage is on a decline elsewhere in the world. The total voice minutes in the country have more than doubled in the last three years, from 1,170 billion minutes in Q1 FY17 to 2,484 billion minutes in Q3 FY20. Gen X and Y – those born after 1965 – population will acknowledge how the telecom sector liberalization and wide-scale presence of wireless communication infrastructure has unified the social fabric of the country and has been instrumental in harnessing India's economic growth.

But we are witnessing yet another revolution that is fast-paced and is creating an exponential impact on everything, everywhere, and anytime; transforming the way we live, work, play, and interact among ourselves. Yes, it is the omnipresent digital revolution. In the last three years, India has risen from being the lowest-ranked country on broadband penetration front to become the Numero Uno nation globally, in terms of data consumption per smartphone at over 12 GB per month. The Rs 10 lakh crore capital investments by the private sector mobile operators during the last four years expanding high-speed broadband infrastructure across India, has been the foundation to attract 660 million broadband users, second only to China. Naturally, India's data consumption has grown a staggering 46 times during this three -year period *(see India's mobility story)*.

The rapid pace of digital adoption has revolutionized the country into an unbelievably large market for a host of digital services in the fields of entertainment, social, e-commerce, mobile payments, food delivery, etc. But this

India's mobility story

	Industry KPI	Q1 FY17	Q3 FY20	Growth
SUBSCRIBERS	Wireless Subscribers (Mn)	1,035	1,151	1.1 X
	Teledensity	81.3%	87.0%	1.1 X
	Wireless Internet Subscribers (Mn)	350	696	2.0 X
	Broadband Subscribers (Mn)	162	662	4.1 X
	Internet Penetration	27.5%	54.3%	2 X
USAGE	Voice Minutes (Bn)	1,170	2,484	2.1 X
	Data Traffic (Bn MB)	477	21,916	45.9 X
FINANCIALS	Gross Revenue (Rs Cr)	73,344	63,764	0.9 X
	ARPU (Rs)	126	79	0.6 X
	Data Rate/GB (Rs)	205	8.45	0.03 X
	Voice OG Rate/Min (Rs)	0.49	0.11	0.2 X

**Source: TRAI*

> India needs Rs 10 lakh crore investments to meet the demand of 3,000-petabyte broadband capacity per day over the next five years.

is just the tip of an iceberg as the country's consumers are gearing themselves for a similar digital revolution in the fields of education, health, energy, advertising, logistics, and transport.

Surprisingly, despite being the foundation of revolutionizing India's communication and digital sector, the telecom industry is at its paradoxical extreme as original operators have either exited or are under severe financial crisis. Out of the three key stakeholders, consumers never had it so good with highly affordable rates and wide-scale 4G mobile services availability. A large surplus is being created for the exchequer since the sector is amongst the highest taxed with nearly 35% of the consumer bill collected on behalf of the government. And all this, while the pioneering telecom operators are in existential crisis.

But I am an eternal optimist and confident, just like the past golden era, the sector with the active support from the government, will reinvent itself. Let us thus forget its 25-year-old legacy and focus on how the future will reinvigorate the Indian telecom sector and how this critical infrastructure will be the catalyst to the Prime Minister's dream of USD 10 trillion-economy.

While the consumer side of the digital story will continue to flourish, the emerging transformation in the enterprise domain will be the key development to watch out, as converging digital technologies like artificial intelligence (AI), cloud and edge computing, robotics, virtual and augmented reality (VR and AR), internet of things (IoT), blockchain, big data, 3D printing, and many more innovations penetrate widely, disrupting all economic sectors. Just like electricity was the fuel behind the 2nd industrial revolution, internet, and wireless broadband connectivity will be the fuel to drive the adoption of these technologies, ushering us into the exciting new world of 4th Industrial Revolution.

In the next decade, we will say goodbye to old era 2G and 3G networks and welcome the arrival of path-breaking 5G services, unlocking amazing new possibilities. 5G is not just another generational upgrade but an exponential technology. The 5G wireless network, as is now widely known, will deliver not only multi-Gbps peak data speeds, but ultra-low latency, higher reliability, and massive network capacity to handle zettabytes of data per day generated by trillions of sensors, and other internet-connected devices. It will enable a new kind of network designed to connect virtually everyone and everything together including machines, humans, objects, and devices. But the key differentiating factor will be the ability to slice 5G Network specifically for varying consumer and enterprise needs. This can be either higher speed, lower latency, or massive machine type communication needs, using specific network characteristics – enhanced Mobile Broadband (eMBB), ultra Reliable Low Latency Communications (uRLLC), and massive Machine Type Communications (mMTC).

The revolutionary 5G services in combination with converging exponential digital technologies will disrupt every existing business and force conglomerates, enterprises, and MSMEs to review their existing practices, processes, technology, skills, etc. Here are some examples of future disruptions.

- **Manufacturing:** A factory may order an uRLLC slice from the operator for industrial automation of production, allowing the robots in the production line to be controlled and monitored. 5G will help transition manufacturing to an intelligent or smart factory.

- **Retail and shopping:** Malls will transform into gigantic high-tech experience centres, replete with hanging sensor gardens and smart changing rooms. The shopping centre will be a hyper-connected micro-city with an incredible amount of personalization. Eye scanners and AI will personalize shopping fast lanes based on prior purchases and magic mirrors will offer virtual reflections of you wearing an entire range of new products.

  5G connectivity will also enable AR and VR capabilities, changing the way brands and consumers interact virtually. Instead of visiting a mall physically, consumers could engage with their favourite brands, through live 360-degree VR experiences, and also make a purchase instantly.

> The rapid pace of digital adoption has revolutionized the country into an unbelievably large market for a host of digital services.

- **Transport:** A modern connected vehicle requires an extremely versatile network that can simultaneously deliver ultra-reliability and low latency (uRLLC) for assisted and autonomous driving, data gathering and analysis from telemetry sensors, device to device communication, high throughput for in-car entertainment, and much more.

- **Healthcare:** On the technological front, every step in the medical treatment chain will be reinvented. On the front end, the convergence of sensors, 4G/5G networks, and AI will upend the medical diagnostics. In the middle, robotics and 3D printing will change the nature of the medical procedures. On the backend, AI, genomics, and quantum computing will transform medicines themselves.

  Remote surgery and patient diagnosis assisted by robots on the ultra-reliable 5G network will be the norm of the future. Telecom broadband networks will also enable millions of healthcare sensors embedded in smart IoT wearables to operate seamlessly and transmit data to centralized medical servers for analysis and raising critical alarms, in real-time.

- **Logistics and disaster management:** Drone-based delivery will disrupt the logistics sector. High speed broadband will enable drones and robotics to remain connected throughout, transmit video footage in real-time, and relay back intelligence such as stocks, automated reorder, etc.

  Disaster management will transform with the faster broadband network enabling remote control of drones and robotics beyond line-of-sight to perform emergency work in difficult to reach or potentially dangerous areas.

- **Education:** Online education is becoming the new normal. Technologies like AI, AR, and VR will transform the way education content is created, delivering more personalized, engaging, and experiential learning. Telecom networks with affordable and massive broadband capacities will deliver content to the remotest parts of the country for the younger iGen population.

- **Live Broadcast:** News, sports or concerts could be broadcast live for users to enjoy through AR or VR on a network slice guaranteeing 1Gbps bandwidth and 10 milliseconds latency. 5G-enabled HD cameras will eliminate the need to use cables, making it far easier to cover all live events.

These cutting-edge technologies will turbo boost the rate of change and the scale of change. Indian entrepreneurs and consumers will experience palpable acceleration as they adopt these bold technologies that are converging and democratizing access. The success of this digital revolution will be the bedrock of the next phase, robust, ubiquitous, and high capacity telecom infrastructure built on 5G and beyond technologies.

With data consumption sustaining its growth at a high double-digit pace, India needs its next round of Rs 10 lakh crore (USD 150 billion) investments in telecom infrastructure to meet the burgeoning demand of 3,000 petabytes broadband capacity per day over the next five years, from existing levels of 300 petabytes.

However, for the digital economy to grow, a forward-looking regulatory intervention will be paramount, one that can address industry challenges including floor price, lower taxes, affordable spectrum, and help resolve the legacy issues. It will also require a policy regime that ensures a thriving competitive sector, attracting large investments that can sustain at least a 3+1 industry structure and provide a boost to the economy.

It is critical that this core sector returns to its role of nation-building. A bold policy intervention by the Government of India can bring the sector back to profitability, attract large capital investments and pave the way to a Golden Digital Economy era that will significantly improve the lives of 1.5 billion Indians.

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(The views expressed are personal)

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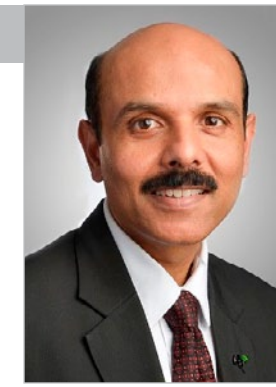

EMBARKING ON A REWARDING JOURNEY

To rekindle the transformative power of the mobile telecom sector, the government needs to facilitate and drive future investments

1991 was a watershed year in India's economic journey. The telecommunication sector reforms started a couple of years thereafter. I joined the Tata Group leadership program in 1990 from IIMA and was fascinated by Chairman Ratan Tata's vision of the transformational power of new-age industries like telecom and information technology, among others. It eventually led me from a group IT start-up, Tata Elxsi that I had joined in 1990, to be one of the four nominees of Tatas and AT&T to operationalize a joint venture in 1993/94.

I saw the immense efforts that large conglomerates, MNCs, young visionary businessmen, and entrepreneurs were putting into this sector. Back then, very few professionals ventured into this space, due to the huge uncertainty. But those of us who dared to stay the course found it richly rewarding. It gave us the opportunity to shape the industry, literally.

The initial years were tough and full of challenges. Telecom was a long term, high capital intensive play, requiring stimulating demand, setting distribution and infrastructure at hitherto undreamt scale. The challenges and need for course correction were soon recognized by industry and the government. With a vision to make telecom the foundation of the new 21st century India, under the guidance of the then Prime Minister Atal Bihari Vajpayee, the transformative NTP 1999 was approved. That decision of allowing migration to a revenue share model, along with reforms on separating the roles of policymaker, regulator, and adjudicator prepared a stable framework for the industry's growth.

Early innovations in technology, manufacturing

Having straddled three facets of the industry – network technology to devices to telecom operators – I participated in tectonic shifts and innovation that shaped the industry in the past 25 years and also led several initiatives. A brief mention of a few key initiatives by the industry follows.

With the turn of the century, India was experimenting with multiple technologies – GSM and CDMA for mobility, fixed wireline, and broadband DSL technologies that leveraged existing copper cables to home.

With an enabling policy and many talented professionals now from multiple industries, the industry drove innovation in technology and business models. This led to wireless connectivity and services to reach rural India at an affordable cost through unparalleled distribution channels. Before that this was accessible only to the urban rich.

The government in the late 1980s and 1990s promoted innovation in design and manufacturing with CDOT and ITI. They played a key role in taking wireline services rural, as did innovation by MNCs like Lucent, Alcatel, Nokia, and Ericsson, amongst others. These global companies made a commitment to stay invested in India for the long haul and set up large factories with high indigenous content. The cost of networks and devices came down sharply. Driven by visionary promoters in the operator space, a nationwide telecoms network was created.

Some innovative models that emerged included managed services, passive infrastructure sharing that allowed multiple operators to share towers, and green solutions to reduce carbon footprint. All this happened in a short duration due to a vibrant telecom ecosystem, along-with trust, and partnership between operators and technology providers across all aspects of network operations and management.

Connecting India with voice and data services

With pan-India 2G connectivity and the world's lowest tariffs, device manufacturers were not far behind. Innovations such as Made for India features including long-lasting batteries, multimedia features, dual-SIM phones, etc. and several relevant, frugal innovations ensured that mobile phones reached the hands of the rural masses.

> The government promoted innovation in design and manufacturing with CDOT and ITI. They played a key role in taking wireline services rural.

The entry of new operators – both Indian and global players like Vodafone which came in with the largest FDI ever – gave choice to consumers to avail world-class voice and data services. Around the year 2010, with over a billion voice connections, India was now ready for the mobile broadband revolution.

The first auction to sell mobile broadband bandwidth was conducted in 2010. Since then operators have spent a whopping Rs 3.68 lakh crore to buy spectrum through auctions. While this put strain on balance sheets, it ushered in the mobile data revolution. Both, private- and public-sector operators played an important role in democratizing 3G and 4G services and provided a robust connectivity platform for the OTT ecosystem to thrive in the country.

Enabling start-ups, OTTs, new-age digital economy

The last six plus years has seen a vibrant start-up and app ecosystem getting created. India is home to over 30 unicorn start-ups and experts suggest that the number will double before next year.

The Prime Minister and the government announced and executed various flagship initiatives like Digital India, Make in India, Start-up India, and Aadhaar platform. Their success is built on the foundation of connectivity provided by the telecom sector. Besides, e-commerce, digital payment platforms, and other services have also flourished, riding on telecom's ubiquitous reach and penetration.

It has brought about transformational changes in the areas of education, healthcare, agriculture, digital payments, content delivery, and governance among others. It also is setting up India to become a USD five trillion-economy in the next few years, with digital alone contributing over USD one trillion.

The ongoing pandemic has further underlined the criticality of this sector which has kept over 1.3 billion Indians connected with their loved ones during the lockdown. With people working from home, accessing news, entertainment on their fingertips, availing healthcare, and other essential supplies at their doorstep, businesses continuing to function near normal – efforts of operators, supported by partners, again proved that telecom remains the backbone of the country.

Learning for the journey ahead

The coming decade will witness the widespread deployment of new technologies like the internet of things, artificial intelligence, machine learning, cloud, robotics, and blockchain to boost economic growth and solve population-scale problems. While looking into this exciting future, it is also important to reflect on the past. Here are some lessons that remain equally relevant as we drive the digital transformation of India.

- Drive scale to keep costs low.
- Foster innovation in technology deployment and business models to ensure inclusive growth.
- Create IPR and drive learning from India to other markets in the technology space.
- Create strong manufacturing base, particularly for devices whether mobile handsets or IoT.
- Stay integrated with the global economy including driving standards.
- Attract a young talent pool to refresh the workforce, while reskilling existing teams.
- Create win-win partnership across the entire value chain.
- Above all, retain the "OPR" which keeps this sector ticking – optimism, passion, and resilience. India is a unique market and to be successful one needs to have oodles of all three attributes.

In conclusion, I would like to mention that while the sector plays a critical role it is under a financial stress. The government has recognized this and hopefully, it will continue to act as a facilitator to drive future investments and rekindle the transformative power of the sector. The remarkable government policy NDCP 2018 and its implementation will provide the right fillip to the industry players and take India forward.

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PRASANTO K ROY

MOBILITY: AFTER 25 YEARS

If 2020 is defined by the pandemic, our response to it has been enabled, driven, and sometimes limited by, telecom and the services that ride it

As I write this, 25 years to the day after India's first mobile call made by then Bengal Chief Minister Jyoti Basu, I realise I've gradually gotten acclimatized to a year that will be remembered and discussed a century later.

Amid the worst pandemic of our lives, the world as we know it has come to a stop – or a long pause. Offices are shut, our mass transit metros, cars, ships, and most trains and planes, are idling, some rusting.

In this extraordinary period, five things stand out for me, all of them connected by a thread that started 25 years ago.

One, the world is working from home. Well, some of it, anyway, a privileged minority. At my home, the typical day sees three two-way video sessions and a HD or 4K streaming TV session on. I've just upgraded my Airtel 100 Mbps fiber link to 200 Mbps, and now I'm getting amazing offers to move to 1 Gbps JioFiber. I've also moved to a mesh network to get stable WiFi everywhere, and noted that the devices reached me with the now-mandated sticker, "Country of Origin: China." I've had to ensure working backup power so there's no downtime. But this is nothing compared to what India's USD 191 billion IT-BPM industry had to do to suddenly move to work from home, enabling most of its million-odd tech workers with stable, secure connectivity, and convincing clients that their data was secure. But first, the industry had to convince to DoT to let it work from home, and a reluctant DoT allowed a relaxation in its OSP license conditions, but demanding that all agents use VPNs, with draconian penalties for violations.

Two, my daughter is studying online. My driver's son is not, like over 1.5 million other school kids in Delhi alone. This exposes a stark digital divide in our society, between kids who have dedicated devices and fast internet access, and those who don't – and schools that can do online classes and those that can't. My school alumni batch struggled to identify a Rs 25k-laptop (we finally managed a pilot AMD-based HP unit at Rs 28k) and are trying to raise funds for laptops for 34 other kids we sponsor at our alma mater in Delhi. Another batch from the same school has donated 100 tablets. Yet most of the kids don't have their own space to study in. Many kids are in one-room homes where parents are struggling with loss of income, and are cutting back on meals. And all this leaves tens of millions of kids in India offline, wasting a year, while kids in richer homes move ahead. India has nearly 300 million kids in 1.4 million schools and 51,000 colleges. Can we get devices to all the kids, along with 4G connectivity, within this lockdown year? Probably not.

Three, not everyone can work from home, and of India's 450 million migrants, some 50 to 100 million lost their jobs and attempted a very difficult journey home, many on foot, when the lockdown was announced abruptly with a few hours' warning. Working with or fundraising for migrant support groups, I realised how difficult it was to even identify those migrants, and send them money. The government says it sent some money by direct benefit transfer into the Jan-Dhan accounts of 330 million poor, and that is amazing, but sadly migrants who walked hundreds of miles home couldn't access that money then. We need a digital revolution to get them to be able to get to their own money anytime, and spend it digitally without needing an ATM. That is work in progress, but

> The mobile phone and 4G networks have transformed connectivity and empowered millions, but in 2020, they've helped aggravate the digital divide for 300 million students.

it's centered around the smart, connected mobile device that half our adult population carries. We need to get that device and connectivity to the other half.

Four, India's commerce has gone digital suddenly, well beyond just payments, something that didn't really happen even after demonetisation in 2016. Entire ecosystems are going contactless in 2020: commerce, delivery, bookings, dining. Imagine the challenges of measuring and ensuring quality of service, something done thus far only for the underlying mobile telecom network. Many tech and logistics innovations are driving all this, with startups and bigger players in the fray enabling MSMEs struggling to survive (and yes, some of those small businesses have died). Even kirana stores, traditionally resistant to tech and at loggerheads with GST, have had to adopt jugaad solutions like WhatApp groups and mobile wallets. And everyone's trying to enable those kiranas – Amazon and Flipkart included. And significantly, Jio Mart. But Jio is another story.

And that is my story number five. Jio. The star of 2020. In the lockdown when companies were shrinking, retrenching or shutting shop, Reliance was raising money to go debt-free. From April to July, it raised USD 21 billion, or nearly Rs 153,000 crore, selling a total of 33% equity stake in Jio Platforms to Facebook (nearly 10%), Google (7.7%), Intel, Qualcomm and a range of private equity and sovereign funds. From its 2016 entry into a crowded market of nine incumbents (which magically shrunk to three by 2019) Jio has had a remarkable ride. With its legacy-free 4G-LTE network, data-ravenous customer base and amazing ability to move obstacles and competition out of the way, including its apparent influence on public policy, Jio has truly transformed internet adoption in India. Can it tech-enable and transform the small business and kirana?

That mobile call 25 years ago was a small step on a journey that has changed our country in once-unimaginable ways, from its economy to its politics. The mobile phone and 4G networks have helped replace dozens of our old tools and brought information, services, banking and payments, education, even healthcare to those who can pay. Telecom-powered services and platforms have brought information closer to citizens, but they've also helped flood them with news that is confusing, misleading and often fake. They've transformed connectivity and empowered millions, but in 2020, they've helped aggravate the digital divide for 300 million students.

As we step into the next 25 years, the first five years will see over a billion Indians becoming 4G smartphone owners. And maybe 5G, a technology set to be transformative in as big a way as the first mobile phone was a quarter-century ago. As we go there, the telecom industry and the powerful platforms that will ride on it, have their work cut out. So do their regulators – not merely DoT but a myriad others including the Competition Commission, sectoral regulators like the RBI, and others yet to be formed: the Data Protection Authority, the Non-Personal Data Authority. The words from the US Congressional hearings where Big Tech was grilled might right a bell in India too: "We can have democracy in this country, or we can have great wealth concentrated in the hands of a few, but we can't have both."

The transformation of the world's largest democracy into a thriving, egalitarian society and global economic powerhouse is work in progress: we haven't reached base camp yet, and the peak is far away. And some the real heavy lifting has to be done by the telecom industry.

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RAVINDER TAKKAR

GET READY FOR THE NEXT BIG WAVE

A light-touch regulatory approach with lower taxation will help India script the telecom success story for the next 25 years

"It always seems impossible until it's done"

Nelson Mandela

When the first mobile phone call was made in India 25 years ago – at a time when getting a fixed-line connection was an achievement – it was unimaginable that it would engineer India's biggest socio-economic revolution since Independence.

We have come a long way since then. Today, India is the second largest-telecom market and the largest data consumer, globally. With 1.2 billion Indians accessing voice and data services at the world's lowest tariffs across five lakh villages, the ubiquitous wireless network in India is unmatched for its reach and impact on people's lives.

The telecom sector including all ecosystem players, contribute nearly 6.5% to India's GDP. Operators alone contribute Rs 58,000 crore per annum to the government exchequer.

Private investment driving economic growth

Telecom in India attracted one of the highest FDI in the last two decades. Vodafone Group did the single largest FDI bringing world-class technology and services to customers. Several other foreign players entered with huge investments but could not sustain for long in the hyper-competitive market.

Over the last 25 years, Vodafone Idea (VIL) alone has made an investment of over Rs three lakh crore, two-thirds of this being in equity. With an investment of over Rs 11.24 lakh crore – the second largest investment in private infrastructure – VIL has set up the world's biggest telecom network infrastructure comprising of over 22 lakh BTS', enabling economic growth at an unprecedented scale during the last two decades.

After making 2G services available to Indians even in areas where basic services such as power and healthcare were unavailable, the Indian telecom industry made huge investments in developing digital highways, bringing the power of the internet in the hands of half a billion Indians.

Meeting needs of data-hungry Indians

Telecom operators have spent over Rs 3.68 lakh crore to buy spectrum through auctions since 2010 to cater to the data-hungry nation. Investments in setting up pan-India broadband networks – 3G and 4G brought about the next wave of the data revolution in the last decade. The telecom operators' effort to rapidly expand 4G services across India, which was further catalyzed by the push from NDCP 2018, has led to 600 million smartphone users consuming data at the rate of 12 GB per subscriber per month.

While offering the world's lowest-priced data at an average of USD 0.26 per GB in India, as compared to USD 6.66 in the UK and USD 12.37 for a GB in the US, investments by operators in broadband networks have also resulted in higher data speeds for users. This led to India registering the highest data growth in the world with mobile data traffic doubling in the last three years, setting the stage for a digital revolution in the country.

Digital communication is now not just driving connectivity, social networking, and entertainment, but has also become the most powerful tool in the hands of every individual and business.

Realizing the Digital India dream

The new Digital India is a vision of a connected India and empowers millions of people with access to real-time information, avenues for commerce, and an enhanced quality of life. It is the enabler for the 'Future Connected India'. Be it smart cities, machine-to-machine (M2M), internet of thing (IoT), artificial intelligence (AI), connected cars, or robotics – telecom has the established ability to deliver a multiplier effect on the growth of the economy and employment in India.

JAM – Jan Dhan, Aadhar and mobile – one of the biggest financial inclusion and governance programs

> With this new normal, telecom will continue to be the lifeline of India enabling other sectors of the economy to grow and thrive.

of the Government of India leverages the deep rural connectivity and mobile penetration. Digital technology deployments in the areas of agriculture, healthcare, rural banking, UPI, government subsidies and distribution, have already demonstrated the impact on rural development.

Powered by mobile technology, Vodafone Idea's transformative CSR projects in the domains of education, financial literacy, preventive healthcare, women empowerment, and livelihood are strong indicators on how technology can be used to close the gap in learning outcomes of students, improving access to education, making available affordable diagnostic tests in areas where proper healthcare facilities are not available.

Our recent initiative in the field of agriculture shows how technology can be used to improve agriculture practices, farm yield, revenues and overall quality of life for farmers.

I believe just as the telecom industry has played an instrumental role in catapulting India to the top five economies of the world, going forward it will be the enabler of India's trillion-dollar digital economy dream by 2025.

I feel honoured to lead the company which has been at the forefront of this revolution right from the beginning. In their various avatars since the mid-1990s, Vodafone and Idea steered the growth of the sector for over two decades, and came together as a merged entity in 2018 to become a leading telecom player in the country. Separately and together, both the companies have set new benchmarks in network experience, rural connectivity, customer service, enterprise mobility solutions, and more recently created history by accomplishing the world's largest network integration in record time.

With spectrum consolidation and deployment of latest 5G ready technologies such as m-MIMO, DSR, Cloud, OpenRAN, and others, VIL has become the fastest 4G network in many markets including the metros. With a robust, future-ready network, the company has moved beyond being a "Connectivity Provider" to being a "Platform for the Digital Society".

VIL solutions help customers not just to connect with their loved ones but also gain a livelihood, infotainment, transact, learn online and avail remote healthcare services. Our secure enterprise solutions enhance business productivity. Electric smart meters, bank ATMs, retail vending machines, connected cars, smartwatches, and many more essential services are running on Vodafone Idea's IoT solutions. Soon we will see a rapid proliferation of drone-based services in the supply chain, agriculture, surveillance, and others.

The pandemic has created a digital thrust as never before. We witnessed the impact of this changing digital behaviour which led to a years' worth of traffic growth in the first week of lockdown in India. In addition to VIL's strong network presence and enhanced capacities, our digital platforms and contact-less services enabled customers to remain connected during this period.

With this new normal, telecom will continue to be the lifeline of India enabling other sectors of the economy to grow and thrive.

Are we 5G ready?

There will be a major impetus for the growth of the digital economy through 5G technology, which, in turn, will give a major push to the adoption of IoT in India. The future will be driven by new technological developments such as AI, machine learning, and blockchain, enabling massive amounts of data to be collected from remote and mobile sensors. AI alone has the potential to add approximately USD one trillion to India's economy by 2035.

In this scenario, data privacy assumes huge significance. I am hopeful that India's own Personal Data Protection Bill 2019, which is currently before the Joint Parliamentary Committee, will address data privacy in a holistic manner and takes a balanced approach in ensuring data protection and security; facilitate innovation; and also offers practical provisions on cross border transfer of data.

As we move into the new era, we need to ensure that the industry is financially robust to invest and accelerate the achievement of the Digital India vision. A light-touch regulatory approach with lower taxation will help script India's success story for the next 25 years. I am sure that as in the past, the policymaker, regulator, and the industry will collaborate and work towards the goal of realizing the new Digital India dream.

The future is exciting and we are ready!

The author Ravinder Takkar is the Managing Director and CEO of Vodafone Idea Limited

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SANDIP DAS

INDIA'S TRYST WITH TELEPHONY

The country's wireless telephony journey has been remarkable in many ways. The sector is now hurtling at a brisk pace to its next transformation

In the mid-1960s, my father a senior government official was assigned a telephone at residence. Despite being officially told that the installation had been rolled into action, it took its own time. Therefore, the day the black Bakelite masterpiece arrived there was some pandemonium. As a grateful family, we feted the proverbial linesman with generous doses of tea and snacks out of sheer disbelief and emotional gratitude.

The list of 'family and friends' to be called had been drawn up much earlier and as soon as the dial tone was detected and the 'messiah of connections' had departed, the tryst began. Most recipients of our calls were of course, affluent and influential people as it was only that section of society that had the means to have those copper wires strung across to their abodes.

What followed was a bit of an annoying series of events, as capricious neighbours suddenly befriended us in hordes and slipped into a steady stream, to make that one emergency call. Dad, the conscientious official, had to take palliative action and swoop down hard to remind us that it was primarily for official purposes and that our generosity needed to be curbed given the prospect of an unsavoury monthly telephone bill, which if not settled on time could lead to an insensitive swift disconnection.

We were also aware that the authorities considered it their largesse to have given us a privilege denied to many who were on the waiting list. In fact, many fathers in middle-class families had the foresight to book a 'telephone connection' for their 15-year old daughters so that when they were ready for matrimony, the years spent on the waiting list would have elapsed brightening their prospects of finding a 'better catch', suitably aided by what could now be a part of the trousseau along with a gas connection.

Years later, when I started working, the perquisite of having a phone at home was conferred on me being part of the firm's prestigious Management Trainee scheme. However, as a part of my modest duties, I had to call up over 21 state headquarters on month ends, to seek information on their model-wise stocks and sales. This meant booking 'trunk calls' some of which would take

> Much blood was shed with the auction of 3G licenses and the paradoxical license fee paid for BWA spectrum. The latter was a classic case of navel-gazing.

a day or two to materialize. Missing a call would mean going back to the end of a laborious queue and missing my dates. I remember spending a considerable time over two days doing my work next to my telephone table and even partaking meals there.

When the calls came through I had to rely on my young auditory abilities to comprehend sounds from the other end. Looking back, they were truly interesting times. How did we fetch children from school, check on ailing parents, hail our drivers, contact a handyman?

Years later one afternoon in 1994

I was invited to a seemingly innocuous corporate lunch at the rooftop restaurant of the Taj Mansingh Hotel in honour of a gentleman called Khoo Chek Nee, Managing Director of Hutchison Telecom from Hong Kong. Ashwani Windlass who was responsible for getting me back to India to work with the group had a mischievous smile. Quite disconcertingly at the sit-down lunch, I was made to juxtapose between the guest and the patriarch Bhai Mohan Singh; both of whom took a rather unusual interest in me.

After lunch, the mystery unraveled as Bhai Analjit Singh drew me aside in Ashwani's presence and told me that there was no need for me to return to my Nehru Place office as I was headed to Thailand the next day. He mentioned that the telecom license wrangling in court had been settled, handing me a copy of a Paging license granted to the joint venture called Hutchison Max Telecom.

I was now the company's 'Mr Paging,' with the task to roll out India's first licenced private telecom operation in months before the dust settled on the year 1994. Next day, I went off to see a paging operation at Shinawatra in Bangkok. Next, I was in Hong Kong at the headquarters of Telecom behemoth Hutchison Telecom. We were put up in the newly renovated Hilton Hotel owned by the group. An hour after checking in there was a knock on the door and I was greeted by two Hutchison Customer Service executives who handed me over a box which housed a Motorola mobile phone that was ready to use.

In excitement, I ran down across the street to the pier and called up my father back in Delhi describing how the ferries were tossing about in the South China Sea and the marvel of talking to him from almost nowhere. My long and eventful telephone journey had unknowingly begun.

They say history is a result of unintended consequences. Little did I realize or foresee the tumultuous change that I held in my hands or those that would be experienced by the millions of Indians. We were under a billion people and were connected with 25 million landline phones.

In mid-1995, a group of anxious journalists at The Oberoi Nariman Point waited with bated breath as BAS from the rooftop made a call to an important man walking into the hotel. Soon with a phone in his hand and still talking, in walked Sunil Gavaskar, our first customer. Next day the city had billboards all over screaming "Hello Mumbai... Max Touch, the world in your pocket."

Those were heady days as our customer roster looked like a veritable who's who list including corporate honchos, celebrities, political leaders, and film stars among others. Within weeks we were overturning every paradigm of the pre privatization world of telephony – no waiting list, quality customer service, services available at several locations through distributors, contemporary technology, choice of internationally branded phones, innovative tariff plans, attentive call centres, slick operations and sophisticated advertising. We were wooing customers now and not the other way around. The word "dial" had, at last, become obsolete.

We called it the Freedom of Movement, but some monstrous roadblocks remained – incoming call charges were prohibitive at Rs 16 a minute, a discouraging Rs 6,000 was levied on every user even before a call was made besides operator license fees and affording a device set you back by Rs 40,000. Moreover, the operators were close to the halfway mark of a 10-year license and were apprehensive of their own lease of life. The pricing regime and burdensome recovery of operational costs had made it an elitist proposition.

> The new circumstances and the "new abnormal" have forced some permanent changes. It has also pressed the reset button.

I remember taking a customary daily walk with Asim Ghosh on Marine Drive sometime in 1998 as we lived out of suitcases in a hotel at one end, waiting for our house leases, mulling over our business. He prophetically said this business would work in an economically challenged India only with an analogous Maruti model of affordability.

As an industry, we got together over sleepless nights and worked in steps with an ambitious government resulting in a watershed moment in India, with a policy called NTP 1999. Incoming calls became free, licenses were extended and the atrocious subscriber levy was replaced by a more sensible revenue share license fee model; though AGR is now a bone of contention after two decades. Mobile or cell phone numbers started appearing on visiting cards and they were now beginning to be called just 'phones'. SMS became a new language. Indian mobile industry was in a hurry. Given the Indian enterprise resourcefulness and their international partnerships, we were quick to adopt globally contemporary marketing practices leaving little elbow room in the market and plummeting customer bill values in our quest to drive subscriber numbers.

The licensing of state licenses (historically called circles) began a race for the hinterland and led to severe land grab as national operators attempted to reduce regional operators into bit players. After the positive aftermath of NTP 1999, this was perhaps the next threshold as it actually opened up India completely forcing a review of the entire gamut of pricing and affordability for semi-urban India. Mobile telephony had by now become proverbially an infectious airborne disease with no cure (not the best time for this analogy). There was a remarkable widening in the demographics of users across economic groups, gender and professions. We were now talking of romantic models of a Kerala fisherman selling his produce while still fishing on his boats to the highest bidder signaling in a power shift in prosperity and equanimity.

Landlines reach landlines, but mobiles reach people. Somewhere in between the introduction of prepaid cards and an FMCG style distribution lowered entry barriers and customized bills to pockets.

There were discussions about how a 10% increase in mobile penetration in a developing nation grew GDP by 1.2%. India was going that way and with close to a dozen operators of varying sizes, stars were aligning as well as conspiring. I use the word conspiring because size, demand and aggressive pricing eventually made it a big boy's game with deep pockets for as long as they lasted. The last decade has seen the demise of the bits and pieces players and thrown open an unholy passage to a duopoly with a wobbly opposition. A free market trembles at this prospect. In many ways, the 'stop-start' presence of the state-owned telcos has not helped to keep this in check.

The miserly allocation of spectrum and the obvious lure of what money the spectrum auctions could fetch forced operators to overstretch their meagre resources in networks much like middle-class India does its toothpaste tubes. The frugal supply of spectrum not only affected service levels but also the 'cost to serve' putting a strain in growing operations cost. The growing adaptability of generational technology to work across the existing allocated spectrum forced a review of the spectrum allocation hitherto allocated in specific bands to become generation agnostic. This unshackled the use of spectrum and some of it was recycled.

Much blood was shed with the auction of 3G licenses and the paradoxical license fee paid for BWA spectrum. The latter was a classic case of "navel-gazing" as incumbent operators sitting on "fat cat" voice revenues failed to see the potential of the LTE spectrum. They, in fact, rubbished it as an exaggerated WiMAX model and hence suffered technology inertia, became complacent in the company of their millions of subscribers and brand invincibility, while overlooking a generation leap and leaving their flanks wide open for revolutionary upheaval in the market place that was not predicated on predatory pricing alone. The incumbents laboriously worked on legacy networks

> Telcos in India are now in their next phase, which is slated for a larger responsibility, new skills, new partners, new alliances, and self-reliance.

and poured billions of dollars of borrowed money into a network that was rapidly getting obsolete. The lending banks, in turn, lent large sums that could wipe out a nation's farmer debts.

This disruption is of a very high order intellectually crafted with a deep understanding of the rising demand in data usage, affordability of smart terminal device to experience high-quality internet access, bridging the digital divide, consumer-friendly pricing and contemporary content. Somebody said, "The future was there for us to see but only a few saw it" and in this case, maybe, only one did. However, I may utter with some alacrity that I was the only other early bidder with Aircel which was clear-headed as a company with its proposition of Pocket Internet. It's another matter that the scale of that thinking was at quite at another level with the Empire that struck back. I still have hope in the pugnacious nature of one other competitor who is a fast learner, tenaciously proud and very agile – one who will not hesitate to adapt and play by the new rules of the game, which it once dominated.

Very early into the game, the Indian telecom market bandied the word convergence. It's only now that we are seeing growing evidence of the emergence of the concept. Contrary to popular thinking it's the device that ultimately drove this change. After all these years the diminutive and shrinking SIM card has magically transformed the form factor and rendered 'mobile phones' a less used word as opposed to a more appropriate 'terminal devices' with the emergence of large screen smart devices, thanks to a certain Mr Jobs. More importantly, they are now being embedded in almost anything that needs to be interactive from doors to the car, air conditioners to vending machines, health-monitoring devices to maybe inserting it in human beings. This has led to networks talking to networks, harmonious coexistence of fixed and wireless worlds, 5G is a strict proponent of the return of the ever-reliable fixed-line. India must inevitably build extensive fibre networks. The concept of the IoT's time has come as have drones, which could possibly clone low-cost satellites. We have struggled with every new thing with two terms 'use cases' and then eventually generation of income (rather than revenue).

Now that's fast disappearing because COVID gave us a rude shock. We have been cruelly socially distanced. This is a time to celebrate those unsung heroes and heroines who have kept networks up and kept us connected. Indian telcos have been second behind perhaps only to the medical fraternity in the manner in which they have kept us connected, sane and social. This is a plucky bunch which has shown up every time whether it be earthquakes, floods, tsunamis, cyclones- with or without money, with or without spectrum and with or without any public applause. The new circumstances and the "new abnormal" have forced some permanent changes. It has also pressed the reset button. Today, in India nobody is questioning why data highways? Why so much emphasis on digital?

The question now is when and how quickly. Everything has got changed overnight: health, education, business, online, supply chain, analytics, information, culture, work, family life, governance, socializing, and communication. Telcos in India are now in their next phase, which is slated for a larger responsibility, new skills, new partners, new alliances, and self-reliance. This needs an understanding of the shortening distance of the hinterland from the mainstream, growing community behaviour, concern for safety and the astonishing pace of contemporary technology.

The joy of the growing wireless bandwidth, exciting terminal devices, internet of things, refiberization, and the world of Indian telecommunications is now hurtling at a brisk pace to its next transformation.

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SANJAY KAPOOR

SHRED LEGACY FOR GROWTH

While India needs to amend telecom-sector policies, it also needs to shift the focus of Aatmanirbhar Bharat to high-value components and activities

Twenty-five years is a long time for any measure and when it comes to technology, a period of two-and-a-half decades denotes an era change. The telecommunication industry in India dates back to 1850 when telegraphy – the long-distance transmission of textual messages using symbolic codes – was started between Calcutta and Diamond Harbour by the British East India Company and it continued to evolve organically till the early 1990s. The government separated the Department of Telecom (DoT) from Indian Post and Telecommunication Department in 1985 and anointed Mahanagar Telephone Nigam Limited (MTNL) and Videsh Sanchar Nigam Limited (VSNL) in 1986 to operate telecom services in Delhi and Mumbai, and international long-distance operations, respectively.

The real telecommunication revolution in India started post-liberalization and privatization of the economy and the subsequent announcement of the National Telecom Policy (NTP), 1994. The country made its first mobile telephone call on 31 July 1995 on a 2G network. Since then the telecom transformation has been awash with structural changes, hyper adoption, technology evolution, value creation, bankruptcies, litigations, and regulatory changes. Despite such tumultuous activities this virtual infrastructure has enriched our personal and professional lives, kept us globally relevant, and been our savior during the cataclysmic times of COVID-19.

Christopher Columbus never set out to prove that the earth was round, but the structural evolution of

> The, inevitable, consolidation post 3G was an outcome of the policy bane which led to bankruptcies, closures, and value destruction in the sunrise sector.

India's mobile telephony sector has proved what the humans have known axiomatically, the earth is round, for thousands of years. It is enigmatic that the market structure of Mobile Service Provider (MSP) has actually come a full 360 degrees in the last 25 years.

The sector started its journey with two players (duopoly) per license area and then morphed into becoming an oligopoly with the fourth cellular license being awarded in 2001. From there on, the sector got distorted to becoming an unsustainable hyper competition, with the advent of National Telecom Policy 2012 which introduced the Unified Licensing Regime and delinking of the spectrum from the license. The inevitable, consolidation post 3G was an outcome of the policy bane which led to bankruptcies, closures, and value destruction in a sunrise sector. We, resultantly, conflated to a sustainable oligopoly once again – a structure that has found economic and regulatory acceptance globally.

With the overhang of AGR dues, monies required to stay competitive and investments for 5G, etc. we may be running the risk of slipping into an undesirable duopoly once again, which can be neither good for the customers nor the industry or the nation.

Unfortunately, the structural consolidation is not confined to the service providers alone but has impacted the infrastructure providers as much from both a geographical dispersion and the perspective of the number of technology providers. During the 25-year journey, the technology revolution has also shifted from North America and Europe to China, especially Huawei. Despite, the current geopolitical situation and polarization, the evolution of technology towards Open RAN, software-driven networks and network functionality virtualization is likely to bring in new network solutions from non-traditional players on an integrated and collaborative canvas. Japan's largest e-commerce site, Rakuten, for example, has become the country's fourth mobile operator with a fully virtualized, cloud-native network. Their success may lead to an industry structure few can comprehend today!

Similarly, on the device's side, we've come out of an era of Nokia, Motorola, Ericsson, and Sony to a device ecosystem that is polarized by two operating systems developed by Apple and Google and devices manufactured and marketed by Apple, Samsung, Huawei, Xiaomi, Vivo, and One Plus, etc. These companies either did not exist or were irrelevant in this space until very late in our journey.

Heuristic changes that the industry witnessed around its eco-system were both incriminating and rewarding during their evolution. The eco-system comprising infrastructure vendors, device manufacturers, and essentially the MSPs, was uncomplicated in the 2G era. However, as we started moving from 2G to 3G, the VAS play got introduced and the power of device manufacturers increased due to their smartphone operating systems. And this happened despite no device subsidies in India. MSPs globally were busy milking the age-old SMS and voice revenues and didn't notice their cheese moving.

The eco-system complexity was brewing, and the first noticeable dent was caused by the likes of WhatsApp when they eroded the profitable SMS revenues and subsequently with the advent of 4G, even voice became an application of data. Like most disruptions, across industries, the MSPs were caught dawdling and OTT players, with innovative offerings, started dominating the non-access revenues of the industry. It was more a "turf issue" at that stage and MSPs lived with a threat of becoming dumb pipes. The rest is history. The top 5-6 global OTT players probably have more cash and innovative capacity than 800 plus MSPs across the world. It's when the eco-system is coming to terms with "winner cannot take it all" and there is need for collaboration between device players, storage and cloud companies, security companies, content, and digital services providers, access providers, etc. to deliver a

> Policy makers need to get the spectrum prices to globally competitive levels and bring down industry's overall taxation while making the framework simple.

"differentiated customer experience" that the turf war seems to be quelling.

Today, operating models are transforming to make the dumb pipes smarter, either organically or inorganically. The spirit of coexistence and coopetition is taking precedence. JIO's current traction to get FB, Google, and Microsoft, etc. in the same tent is the biggest testimony for things to come around the new normal of industry's eco-system. Their all-encompassing, digital services aspiration is a new shibboleth for others to envy or emulate.

India's 25 years of mobile telephony story will remain incomplete without the role of wire in a wireless country. Across the world, the growth of wireless communication has always been accompanied by the growth in wired connectivity. However, for reasons well known to us, India bucked this trend and the wired segment never really grew. Rather, it has been going down and stands at 1.99 crore as compared to 114.952 crore wireless subscribers as on 30 April 2020, according to the TRAI.

India has fiber in its cities, but that essentially provides inter-city connectivity. We have also participated in global under-the-sea cable consortiums to ensure seamless international connectivity for voice and data, but the intra-city connectivity that's required for the real broadband experience to homes and SMEs is still dismal. Today, the number of people on fiber networks with gigabit speed is minuscule and pervasiveness of gigabit homes seems a distant dream. In fact, the country still runs on a massive network of copper including Airtel, Vodafone-Idea, BSNL, and MTNL. According to estimates, less than 25% of towers in India are fiberized as compared to China, Japan and the US where about 80% of telecom infrastructure is fiberized. A Crisil report indicates that for 5G technology to really take off, India needs a fiberization level of 70%. This translates into an investment of over Rs one lakh crore in laying fiber networks in the next 2-3 years. The learning from COVID has only accentuated the demand for fiber access, to facilitate work from anywhere.

Consumer behavior and demand has necessitated technological changes in our network services and products. We have done reasonably well despite being laggards on the adoption of 2G, 3G or 4G while serving our customers with tight spectrum resources and collaborating for resources with our most fearful competitors. However, going forward we have to be cognizant of our economic growth, per-capita income growth, latent data demand of consumers coupled with form factor changes of digital content and rising customer experience expectations while making latent calls on technology adoption.

The world of 5G, here on, is not merely about ultra-high-speed, low latency, and IoT but more about use cases and solutions, a B2B mindset Vs. B2C alone, end-to-end experience as opposed to connectivity, non-linear thinking, intense collaboration, and deep analytics. Both MSPs and the government will have to shred the legacy to enrich individual lives, enable businesses, and render our country competitive.

Policymakers need to get the spectrum prices to globally competitive levels and bring down the industry's overall taxation while making the framework simple. There is a need to shift the focus and incentives under Aatmanirbhar Bharat from mere low value-added assembly and packaging to high value-added components and activities. This will help stimulate the manufacturing nucleus. MSPs on the other end need to raise prices substantially to sustain their business model and customer experience.

As Socrates had said, "The secret of change is to focus all of your energy, not on fighting the old, but on building the new."

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SHIV SHIVAKUMAR

NOKIA, MOBILE TELEPHONY, AND INDIA

The telecom story of the world's largest democracy is laden with good and wrong decisions, blunders and successes, and the initiatives of several visionaries

Nokia celebrated 15 years of the Indian telecom industry in 2010. The company's then Communications Director Poonam Kaul and her team organized an event at the Shangri la, New Delhi. In the hall, mounted on the wall, were copies of the first set of articles the journalists had written about the sector in 1995. TK Arun, then Editor of The Economic Times was there along with many stalwarts from the media industry. It was a magical moment for all of us. Today, ten years later, we are celebrating 25 years of this industry, an industry that has reshaped India and will continue to reshape it in the future.

I have worked in many sectors throughout my career, but telecom remains special. I worked in telecom for close to a decade and was the Managing Director of Nokia in India and head of emerging markets overseeing 90 countries. Nokia has had five CEOs in its original avatar in India. I was the third and had the longest stint. My smart predecessors – Parikshit Bhasin and Sanjeev Sharma laid a good foundation for the company in India. My successors Balaji and Ajay Mehta did their best with a challenging global strategy.

In the early days, the telecom sector institutionalized some industry bodies like the Telecom Regulatory Authority of India (TRAI) led by Justice Sodhi who was the Founder Chair; the Cellular Operators Association of India (COAI) led by TV Ramachandran, and the Indian Cellular Association led by Pankaj Mahendroo, who leads it even today. All three industry bodies played a crucial role in building this sector by convincing the government of the possible best outcomes for the sector.

In this note of a few thousand words, I will attempt to capture the ingenuity, the hard work, and the challenges, as the ecosystem and the government built a world-class telecom sector in India. In the early days, Brijesh Mishra and Vikram Doraiswamy in the PMO, Gopal Pillay, and many others from the government contributed to reframing policy. It was an example of great leadership and collaboration across the ecosystem.

For the first 15 years, till about 2010, Nokia could do no wrong and was the undisputed leader in handsets and the cherished partner to have in the telecom ecosystem. I narrate this story from the Nokia perspective as I saw it.

These 25 years have seen four big shifts in the sector.

1995-2005: The first decade

The telecom sector had a bunch of local operators and global handset manufacturers in the early days. The telecom policy was not conducive to fast growth. Slow consolidation took place in this decade as a few international operators opted out and Airtel, Vodafone, BSNL and Idea took pole position by the end of 2005. Around 2005, there was still a debate on CDMA vs. GSM as the operating standard. There were 90 million subscribers at the end of 2005.

The handset market had all the international players – Nokia, Motorola, Sony Ericsson, Philips, Palm, Blackberry, Samsung, LG, and Panasonic to name a few. Most phones were imported, duties were reduced and factors like 'personality' and 'innovation' of the mobile handsets became important.

Nokia partnered with HCL, ably led by Shiv Nadar, Ajai Chowdhary, JV Ramamurthy and Hari Bhaskaran. Nokia's success in the early day was also a result of this distributor partnership, which took care of its risk appetite

> This industry would have been stillborn and would not have grown as well without the outstanding policy work done by the government and the ecosystem.

in a volatile, uncertain time of the telecom market. This partnership lasted for twenty years.

The network providers were Nokia, Ericsson, Siemens, and a few Chinese players. Right from the beginning, the government was very selective about the origins of network providers. As citizens, we seldom give enough credit to the government. I think the government realized that policies needed to change and did so pretty quickly. This industry would have been stillborn and would not have grown as well if not for some outstanding policy work done by the government and the ecosystem.

2005-2010: The golden years

This was a period of rapid growth where India added millions of subscribers every month. Lifetime plans became a hit, the operators outsourced a lot of their work and EBIDTA ratios were strong. Nokia did an excellent rural program with Airtel that saw 1,000 rural vans building the category in rural India. Nokia and Airtel, along with the microfinance companies bundled phones for women in self-help groups, and that added a new consumer cohort. Innovation in the business model was a daily game.

The operator side of the business was led by some outstanding leaders like Manoj Kohli, Atul Bindal, Sanjay Kapoor, Asim Ghosh, Sandip Das, Sanjeev Aga, Satish Shah, Himanshu Kapania and Kuldeep Goyal of BSNL. Discussions used to be fun, with everyone was energized by the sector, its importance to the economy, and the enthusiasm to make a genuine difference to the country. We estimated that 20% of India's GDP growth was contributed by the growth in telecom in this period.

Nokia was the undisputed leader with close to 70% market share, it went from 40 distributors to 400, and brought in new outlets to the category. This was done with the guiding vision of Vipul Sabharwal, Michelle Moore, and BCG. This concept of large scale distributors is now used by many companies across industries. This upset a few of the old guard distributors who saw it as a birthright to keep distributorship but it gave Nokia better control of the market and helped build a great brand. The consumer electronics dealers were slow and reluctant to see the mobile phone growth and didn't have the appetite for rotation of the phone category vs. consumer durables, a retention strategy they followed with margins in consumer electronics. All the consumer electronics retailers became relatively smaller and poorer on profitability because they missed getting onto this telecom bus.

The operator leadership saw that their outsourced thinking models were working and hence did not get into handsets or did not bundle handsets. This ensured that the handset market grew on its own steam with innovation, branding, and distribution. Vodafone tried marketing its own magic box handsets and I remember a challenging discussion we had with Harit Nagpal, the then CMO. In the end, everyone realized that it is best for each of us to focus on what we were good at. Meetings would happen at the drop of a hat and we would rush to each other's offices to put out a new plan. Nothing seemed impossible in those Camelot days.

In the middle of this period on 15 August 2007, Nokia had its redefining moment. It issued in all honesty and good governance practice, a product advisory on a few faulty BL 5 C batteries. What happened over the next 15 days was just pure shock to everyone who worked in Nokia, a company that prided itself on being the best at governance and values and product quality. For the first time, we saw unscrupulous consumers, unscrupulous trade, etc. trying to take advantage. We were honest and transparent with the consumer and the ecosystem. Shankar Subramaniam and the Nokia operator team worked with the ecosystem. Sanjay Kapoor, the then CEO of Airtel was phenomenal in his support and the whole set of distributors and retailers rallied around Nokia.

We came out even better than before and the handling of this led Nokia to become India's most trusted brand, the first time a non-FMCG brand was doing that. It never

> Handset distribution and OTT have now shifted online. This has made handset brands and the telecom ecosystem rethink their physical distribution strategy.

looked back after that. This was a victory not just for Nokia but for the telecom sector.

As it happens in India, when a sector does well and is profitable, then everyone from unrelated industries thinks they can enter the sector and make money. We never appreciate the capabilities and the execution needed to win in a sector. Consulting firms also made glib presentations to these new entrants and every one of the new entrants failed.

Towards the end of this golden period, we saw fresh licensing of new operators; up to 19 operators at one point in time. The market could never be viable for more than three or four operators. The service providers started cutting price and went to a paisa per second concept and I warned the then CEO of an operator company that he would destroy value in the industry. But, because people got licenses, they were keen to show growth via price discounting.

Around this time, we started measuring value-added services sales and the industry would count SMS as a value-added service. India became the epicenter and pilot market for a multitude of services that were launched globally. Nokia introduced maps in their phones. Devinder Kishore and the Nokia marketing team ran the first set of innovative campaigns for people to use maps in India, way ahead of Google maps!

Nokia Life Tools, an SMS-based subscription service led by Jawahar Kanjilal and BV Natesh offered a wide range of information services covering healthcare, education, entertainment, and agri commodity prices. English learning was launched in India in 2009. This service got 17 million subscribers in less than two years. This service and business model were later exported to South East Asia, Nigeria, and China.

Nokia organized the music industry which was fraught with piracy by launching Nokia Music. It digitized all available music in India developed over the last 100 years. This was a monumental effort led by Karan Grover with the Saaregama team. Nokia then bundled this music in their phones. In 2010, the company launched Nokia Money, a payment service. We test-marketed this in Pune. However, since the ecosystem of payments and the rules didn't allow for faster ramp up, we closed this initiative down after two years.

By the end of 2010, it was clear that GSM was the clear winner and CDMA was struggling.

Nokia made a big move in establishing a huge telecom special economic zone in Sriperumbudur. This plant employed 11,000 people of which 72% were women with an average age of 25. This massive plant had only one landline phone, just in case of an emergency if the mobile system didn't work! Nokia along with seven global partners in the Telecom SEZ Park employed 30,000 people. By 2009, this plant was the world's largest cellular phone plant and exported two million handsets a month to 180 countries with a value of more than USD two billion per annum. Made in India was seen as a quality badge in many countries, including America and European countries thanks to Nokia India.

By 2010, Nokia was India's largest multinational company and its overall activity in the country was between USD 8-10 billion. What was remarkable was the huge confidence that this Finnish company had in India for India.

2010-2015: Fasten your seat belt era

Everyone in the ecosystem was challenged for profitability because of the one paisa per second idea. This pricing led to a unique product in handsets – the dual SIM phone. The Nokia marketing team led by Vineet Taneja did everything to convince everyone of this threat but Nokia didn't move because its global operator partners didn't want a dual SIM phone, and rightly, no operator will subsidize a phone for someone else to benefit from a vacant SIM slot. This was the first misstep of Nokia.

This misstep gave rise to the growth of Indian handset brands, essentially all cellular phone distributors and

> The best days of the telecom ecosystem are ahead of us in the next five years. This will need future-thinking leaders with a willingness to partner.

retailers would slap a brand name and source a dual SIM phone from China. The media hailed these new brands as new geniuses and forgot that they were essentially box pushers and traders with no capabilities in technology, design, or anything significant.

The pressure on pricing led to layoffs in the industry, cost-cutting programs etc. The industry moved from being the poster boy to being the pitied boy. The new license operators ran into legal problems and the sentences of a few senior people in government took the sheen off an industry that contributed so much to India in such a short time. Nokia faltered big time in the choice of the operating system and could never recover from that fatal strategic mistake. Nokia as a handset brand didn't matter after 2014 in the telecom sector. It continued its business on the network side of the ecosystem.

2015-2020: Life as mobile

In this phase, we saw the rapid expansion of 3G, 4G and now the advent of 5G networks. Everything you needed had an app and the mobile phone became the gateway to our life and work. Tariffs dropped and speed increased. We are now down to a few operators – Jio, Airtel, Vodafone Idea, and BSNL. Everyone is driving innovation and ecosystem partnerships to make consumer life that bit easier.

I tell this story of watchmen and liftmen to trace telecom progress. In the early days till 2005, the security man or the liftman would watch your hand to see what phone you were carrying. He then bought his own phone and then we saw them listening to songs on the cell phone radio. Today, they are watching movies and serials.

The Chinese phone makers have taken control of their own brands in India now, bypassing the distributors-turned-brand-owners of the previous era. The Chinese mobile phone ecosystem is a massive one and innovation flows like a river. Tim Cook was right when he said that Apple is in China because of China's manufacturing prowess and the world-class cost and innovation capabilities. Distribution and OTT have now shifted online. This has made the handset brands and everyone in the telecom ecosystem rethink their physical distribution strategy.

Telecom is the center of our universe now. India's physical infrastructure has been challenged and has improved with continuous investments over the years. Its digital infrastructure is one of the best in the world. India has the second cheapest combination of tariffs and phones in the world. This technology has the highest penetration today. It is as ubiquitous as air. We see new business models in every industry with the phone and the app at the core. We will need to evolve new policies for the future and not rely on old policies of a physical era. This industry has reinvented itself many times over and will reinvent itself again. This is a perpetual innovation industry.

Fifteen years ago, we called a building to talk to a person, now we call the person directly. Five years ago, we visited a physical outlet, today the outlet comes to us and our requirements are home-delivered, be it clothes, vegetables, milk, etc. Almost every education, financial, and health need is run via the telecom ecosystem now. Our cell number is a key that opens so many opportunity doors.

India has close to a billion subscribers in 2020. There are 500 million people on the internet, most connected via a mobile phone. The best days of the telecom ecosystem are ahead of us in the next five years. This will need future-thinking leaders with a willingness to partner. I am not in the telecom sector for the last seven years but my time in telecom was the best ever. I worked in many sectors – food, personal products, consumer electronics, etc. A measure of a son's worth is what your mother thinks of your job. My mom was really proud and thought I was making a difference for India when I was with Nokia.

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TARUN KATIAL

REIMAGINING COMMUNICATION FOR BILLIONS IN INDIA

The mobile revolution is one of the biggest success stories in post-liberalization India. The next 25 years will help realize the lower- and middle-class dreams

I remember 1995 not just as the year in which the first mobile phone call was made in India, but also for the release of what would turn out to be the longest-running movie in the history of Bollywood – Dilwale Dulhaniya Le Jayenge. Before the COVID-19 pandemic struck, the movie was still running for over 24 years in a matinee show at the Maratha Mandir theatre in Mumbai. And that jogs another memory. It was also the year when Bombay was renamed as Mumbai. Much has changed since then with digital and technological innovations driving a communication revolution.

Innovation in communication has brought the world closer and opened avenues that were unimaginable before. The first decade saw a slow but steady growth and by the end of April 2005, the total number of telephone subscribers in the country crossed 100 million with mobiles at around 54 million overtaking fixed lines at 46 million; a teledensity of 9.26%. By March 2019, the number of subscribers had increased ten-fold to reach 1,183 million with 1,162 million mobile subscribers and just 22 million fixed-line subscribers to achieve a teledensity of over 90%.

Today, India is home to around 400 million feature phone users and over 468 million smartphone users. India is the second-largest smartphone market in the world and is growing rapidly bolstered by the easy availability of affordable and fast data. The smartphone now occupies a central place in our lives. An ASSOCHAM-PwC study projected that the number of smartphones in the country is likely to touch 859 million by 2022. India also ranks second in the average time spent on the mobile web by smartphone users in the Asia Pacific market. So, while we may have played catch up in adopting 2G, 3G, and 4G as compared to other developed markets, we have been quick to adapt to the technology once it arrived.

Mobile telephony is the foundation of our digital infrastructure, which has not just connected people but has also had a positive impact on economic growth and trends. Mobile connectivity has empowered the people of India, particularly the economically deprived sections of society. Today, no matter where you are, an increasingly democratized access to the internet and smartphones has connected people in every part of the country and given them access to knowledge and opportunities.

As a nation, the influence of smart devices is evident in our daily lives, especially post the lockdown. We are reliant on our devices today to stay connected with work, entertainment, and even socialize. The inroad made by the smartphone in our everyday lives has been accentuated by developments in digital technology. Today, we have a surfeit of apps on our smartphones that impact and affect various aspects of our lives. Messaging apps have transformed the way information is shared. Other apps have become socializing hubs with their interface and features, all in a smartphone that fits in the palm of our hand.

Going beyond calls and messages, the smartphones are a repository of finance (banking, investing), entertainment (music, videos, films, content creation and more), education (online education), business, socializing, and more. Mobile computing technology has evolved to the point where a smartphone today is smarter than the computer on NASA's Orion spaceship.

> The influence of smart devices is evident in our daily lives. We are reliant on our devices today to stay connected with work, entertainment, and even socialize.

The increasing adoption of smartphones have driven the demand for data services and better user experience which in turn impacted the market's transition from 2G to 2.5 EDGE networks and then to 3G and 4G. Today, we are aggressively pursuing the 5G network that has the potential to bring about a paradigm shift through the ability to connect billions of devices such as smart homes and driverless cars, offering speeds of over 1 gigabit per second.

It is easy to see how this technology today has become an integral aspect of the entertainment industry, changing the way people consume content. Digital video consumption numbers are growing at a robust pace backed by the rise in internet consumption and an increase in data speeds. The ASSOCHAM-PwC study predicts the Indian OTT market to outperform global OTT markets by growing at a CAGR of 22.6% as against 10.1% during the period of 2017–2022, to find a place amongst the top 10 markets globally with the market size of USD 823 million. With HD video and high-fidelity audio available on smartphones, an OTT player cannot afford to miss the growing number of mobile phone users among the middle-class and young urban population.

As a conglomerate that has entertained India for over 28 years, we have been a core part of this technological transformation, adapting to this new digital world. The launch of ZEE5 has led us on an exciting journey, the seed of which was laid with the first mobile call 25 years ago. Our vision is to create an unforgettable streaming experience that rides on high-speed data to the range of screens and devices used by our consumers to deliver entertainment on demand. Our focus on the implementation of the best technology enabled us to successfully meet the challenge of smoothly and uninterruptedly delivering entertainment to our consumers during the lockdown, a period that saw a 3X growth in terms of viewers on connected devices within the first month itself with subscriptions growing over 70%.

As a digital content platform, it becomes necessary to upgrade and adapt to stay relevant. Consumer behavior has changed the entertainment landscape and influenced the evolving shift from DTH to OTT. This rise in digital video consumption has been a key driver in building a strong content library, interface, navigation, and streaming experience for OTT players. Convenience in streaming is one of the key factors when developing and upgrading the app and its content. And the convenience that smartphone streaming brings is something that cannot be looked over and building the streaming experience on connected devices will continue to be a key factor.

The mobile revolution is one of the biggest success stories in post-liberalization India that has helped the country's visibility in global markets. With a sharpened focus on 5G and evolving technology, the mobile industry is slated to grow phenomenally with India now charting the course. Smartphones have brought in a convenience that was unheard of 25 years back. There is no looking back. With rising income levels, increasing access to smartphones, and affordable data, the spotlight is on the next 25 years.

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UMANG DAS

THE BELL THAT HAS BEEN ECHOING SINCE 1995

How a Kolkata hotel room became the turning point that unfolded India's telephone revolution

I was leaving the West Bengal Chief Minister's office. All through the ride, until getting out of my car, my mind kept humming on how to get to that golden date. It was not an easy project – ambitious, historic and heavy with all its complexities.

This was a mundane day many decades back. Only then it was not. It was the precursor of history about to be made.

Back then, I was the CEO of Modi Telstra (later branded as Spice) and part of the BK Modi group. In the mid-1994, I along with Dr. BK Modi, who was the chairman of the erstwhile Modi Telstra, went to meet the West Bengal Chief Minister Jyoti Basu. This turned out to be more than a courtesy meeting. In fact, at the end of the conversation, Basu asserted that Calcutta should be the first city in India to have a mobile telephony network. The ever-optimistic and firm Modi also etched an exact date as a commitment: 31 July 1995.

It was a question of meeting professional commitment, especially as we did not exactly have any equipment partner at that time. We flew all the way to Australia to explore possibilities with our joint-venture partner Telstra to help us to find a suitable technology partner.

We needed strong expertise to roll out such a network – this need brought us to Nokia Australia. The company was equipped with cutting-edge technology but was, initially, reluctant, thanks to the looming-short timeline. However, with some convincing and detailed-planning, we got them rolling. By the time we hopped on the same flight back to India, we were more hopeful and confident than before. The bids were finalized in February 1995. And in a span of nine months, the network was in place - Kudos to Nokia.

This network was compliant with all the apt license requirements. We commenced with 11 BTS sites in the prime locations of the central business district of Kolkata, with the blueprint of catering to one million subscribers. Can you imagine the network cost back then? It was USD 500 per subscriber. Today, it would cost 10% of that! As to the mobile call charges, peak rates easily hit Rs 16.80 per minute.

The deadline? Well, we met it, despite all the teething troubles. The state government showed remarkable support at the top level but down the line, bureaucracy and technical snags were still prevalent. But it was the spirit that established India's first mobile network. That very spirit became the foundation of the telecom industry.

It is hard to forget the sound of that first ring on the day when CM Basu made the first mobile call in India to the Union Communications Minister Sukh Ram. In many ways, 31 July 1995 marked a big page in the history of India. Made in a plush room, at the Grand Hotel in Kolkata, the call can be heard loud and clear even after so many years. Those first two 'hellos' at both ends went down in history as a milestone.

Look how far we have come. Today, the role of the mobile ecosystem is even more pivotal when we navigate the pandemic outbreak. Digital India and Aatmanirbhar Bharat are now shining with splendid ambition and progress. There is more history to be made, so let's keep on marching.

The author Umang Das is former CEO of Modi Telstra (later Spice) and former Vice Chairman of TAIPA

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DR. ANAND AGARWAL

TIME TO LEAPFROG WITH DIGITAL INFRASTRUCTURE IS NOW

The government has an important role in building digital infrastructure. It needs to collaborate with private players to ensure the time-bound roll out

India completes 25 years journey of driving mobility to possibly every nook and corner within the country; a journey that goes beyond the country by enabling connectivity with the world at large. We are now home to the world's second-largest internet user base. Twenty-five years ago less than 5% of the population had wired telephony, while now over 600 million people have access to mobile and internet connectivity. We have come a long way. Yet, this is just the start and an exciting journey awaits us, one that will be powered by the right digital infrastructure.

Circa 1995: 25 years of connecting people

We started our journey of mobility in 1995. Back then, buying a SIM card would cost over Rs 4,900, with call charges of Rs 16 for incoming and outgoing. It must have been a tough decision to make a call in those days, right? The telephony services were reserved for the rich and elite. For others, telephony services meant booking a trunk call and waiting long hours for the call to connect with their dear ones.

The telecom revolution advanced at a breakneck speed. Today, we boast about having the lowest tariff plans in the world. As the world's second-largest internet user base, India accounts for over 12% of global users. Over the past many years, devices and technologies have transformed the scale and scope of networks. From Kashmir to Kanyakumari – our mobile networks are robust and offer good connectivity.

The government, telecom operators, and service providers have played an integral part in ensuring this journey became a success story. I take pride in saying that STL has been a key player in India's mobility journey. This year, we also complete a milestone – 25 years of designing, developing, and delivering optical fiber to our customers, connecting India and the world.

The digital divide has to be overcome

The difference in the quality of digital access between the rich and poor has emerged as a major concern limiting growth. Of the majority of the rural population, i.e. around two-third of Indians, only about 25% have access to reliable internet connectivity. Fortunately, urban Indians have much better access though the quality of the Internet still lags as current broadband and FTTX connectivity is behind developed economies.

Recently, COVID-19 has awakened the nation to the need for internet connectivity. It has become an essential service like education, utility, and power. A massive range of services has gone digital – education, governance, banking, and entertainment. The current situation has shown the importance of robust and high-speed digital infrastructure across wired and wireline applications.

This overwhelming shift has highlighted the impact of the digital divide in the country. There is an immediate need to invest in digital infrastructure – fiber-based tower backhaul, localized data centers, and fiber-to-the-home (FTTH) and enterprise along with rural broadband connectivity.

Time to invest in digital infrastructure

Realizing the need for strong digital infrastructure, digital service providers globally have accelerated their digital infrastructure investments. Governments, telecom

> India needs to invest in fiber-based tower backhaul, localized data centers and fiber-to-the-home and enterprise along with rural broadband connectivity.

companies, cloud companies, enterprises, and private players are investing billions of dollars to leverage the opportunities that come with it. Increasingly, they are investing in FTTH network build-outs and rural broadband connectivity.

China, Japan, Germany, and the US are the largest economies in the world, each with a GDP of more than USD four trillion. India is the fifth-largest economy with a GDP of USD 2.94 trillion. While the top four economies are investing 1-2% of GDP each year on digital infrastructure, India is investing at a much lower rate. As the ongoing pandemic has exposed the importance of high-quality digital infrastructure, it is obvious that the investments for it are necessary now. Subsequently, our economy will grow exponentially with the right digital infrastructure – one that spans across urban and rural India.

Digital infrastructure will enable schools, healthcare infrastructure to be more efficient and save critical investments for the government. It will generate 60-65 million jobs over the next five years, and help India become Aatmanirbhar in the true sense. Digital infrastructure can be a springboard for India to leverage Make in India, increase economic activity, and realize the USD 5-trillion-economy vision at an accelerated pace.

Our government can lead an ecosystem to make India leapfrog

Digital infrastructure development requires a scale of investment that private players simply cannot achieve alone. The government has an important role in building India's digital infrastructure. It needs to collaborate with private players to ensure the time-bound creation of digital infrastructure.

In the immediate term, the government can take the following steps towards digital infrastructure investments:

- Unlocking WiFi-6 spectrum for free can help telecom operators, private networks, cloud companies and new players drive the creation of new WiFi and LTE/5G networks. This will drive job creation across the digital infrastructure ecosystem. The overall growth impact of GDP will be much larger than the amount realizable by monetizing spectrum licensing in the next 2-3 years.
- Digital infrastructure can give 2-3x faster returns compared to physical infrastructure so some funds from infrastructure projects such as road, transport, power, railways and petroleum can be reallocated to strengthen our digital infrastructure.
- A central government-led "Broadband Infra Fund" can be set to finance digital infrastructure investment and financing options for the fund could be explored with multilateral agencies and international banks.

I believe that a good implementation approach can be found by looking at global best practices. For instance, in Australia, NBN took the region-first approach, while in Nordic countries the business-first approach was deployed. For India, I recommend a hybrid of the two models. We can plan an initial rollout for 1-2 states, depending on its population density, topography, ease-of-deployment, and economic potential of broadband. This can be followed by districts with a higher per capita income and greater potential to benefit economically from broadband. Starting with these higher potential regions will result in early revenue generation that can be re-invested for network rollout expansion within the country.

Now is the opportunity of a lifetime for us – to leapfrog and lead the way as the shift to digital is permanent. We are blessed with the world's largest democracy and with access to the Internet - we are poised to become a global technology powerhouse.

The author Dr. Anand Agarwal is Group CEO of STL

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DAVID LI

DRIVING DIGITAL INDIA'S GROWTH

The country requires an open and future-oriented environment that can adequately address issues of security and privacy for a healthy economic growth

In 2020, as India completes 25 years of mobile telephony, it is time to mark the revolutionary journey of ensuring a mobile density of over 85%, equipping the people with not just basic communication, but also empowering them with mobile broadband, and digital ecosystem. This achievement is also significant in the scope and scale of networks covered, spanning from urban centers to remote rural areas.

It all started with the economic liberalization in 1991 that was followed by the opening of the Indian telecom sector for private players. Since then, this revolutionary journey has been a collective effort of the government, telecom service providers, equipment manufacturers and other eco-system players whose joint efforts have enabled multiple kinds of mobility – social, economic and informational for Indian consumers and industries.

The last decade in this journey has seen the proliferation of 4G, which has been a game-changer driving India from voice to the data era. Huawei, in India since the last 20-years, has been one of the major contributors to the country's ICT infrastructure introducing several 3G, 4G as well as recent pre-5G innovations like massive MIMO and Dynamic Spectrum Sharing (CloudAIR) among others.

Some of the key factors driving this digital revolution are the enablement of a globally interconnected economy based on the open market, free competition and inter-sectoral collaborations and global supply chain. It is also complemented by the growth of a robust local ICT eco-system, characterized by strong local players having definitive areas of specialization who in turn have contributed to the global eco-system. This whole inter-connected process has resulted in the emergence of several disruptive technological developments such as innovative mobile apps, connected devices, IoT, and ICT infrastructure.

Implementation of unified global standards and protocols developed by organizations like 3GPP, ETSI, and IETF has further boosted these new technological advancements across countries. Standards are a crucial component for the continual development, commercialization, and trade of technological innovations. Developed by technical experts, standards foster unified eco-systems and economies of scale, making it possible for companies to develop products and solutions that are compatible and interoperable across markets.

We are currently at the beginning of the 5G journey. Several 5G use cases are being developed that enhance experiences, empower businesses, and transform verticals. Looking forward, as 5G deployment intensifies the future of emerging technologies will be about intelligent computing and AI. We will see large-scale adoption of AI, which will give rise to new use cases in telemedicine, robotics, manufacturing, and other areas enabling Industry 4.0. This in turn calls for policy updates in line with these industry evolutions.

There is also a need for "adaptive regulation" that keeps pace with changing technology and the sectoral landscape. For 5G and other new-age technologies to realize their potential, the need of the hour is the continued development of neutral, universally accepted standards for security and technology, backed by uniform and progressive policies that can provide a level-playing field for all players. There has to be a consensus on cybersecurity, technical standards, verification systems, and legislative support. Countries that succeed in doing this will reap numerous benefits, including the ability to offer innovative new services and integrate more firmly into the global value chain.

> The last decade in this journey has seen the proliferation of 4G, which has been a game-changer driving India from voice to the data era.

As a leading ICT player, Huawei is an active participant and contributor in a wide range of important global standards-setting organizations. The company has placed security and user privacy protection on the very top of its agenda. It is committed to working closely with all stakeholders, including regulators, carriers, and standards organizations, to build a system of trust based on facts and verification.

5G and other new technologies will prove to be a catalyst in India's digital revolution, one that will generate new growth avenues, boost industrial productivity, and potentially transform the socio-economic fabric of the country.

A prosperous Digital India, therefore, requires an open and future-oriented environment that can adequately address issues of security and privacy for the healthy growth of the country's ICT industry.

The author David Li is the CEO of Huawei India

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AJAI CHOWDHRY

A SLICE FROM HCL'S HISTORY

Though the company could not get into telecom services business, it played a major role in creating a direct distribution model for mobile handsets

Just before mobile telephony happened in 1995, HCL was involved in manufacturing of Nokia FM pagers. In 1994-95 the company bid for the license to provide mobile services in Tamil Nadu and pretty much won the license. But, just before it could be finalized, our partner SingTel moved out due to pressing reasons and HCL could not get into this business.

However, as a System Integrator, HCL provided the first billing and customer care solution to Modi Telstra in Kolkata from where the very first mobile call was made on 31 July 1995. The rest, as they say is a history and India never looked backed after that, with the country now has a mobile penetration of over 90%.

Going back to the HCL story, since we could not get the mobile license, we went on to bring Nokia to India and became the master distributor in 1996. This was a time when prices of phones were very high and our Nokia phone was around Rs 50,000. Of course, the cost of calls was Rs 16 per minute for the callers and Rs 8 for the called!

We founded ICA with some other members. In the beginning phones were bundled and sold by mobile service companies. We also influenced and changed the model in India to direct distribution of phones. In 10 years we took the Nokia brand to 76% market share in India, the highest in the world.

The author Ajai Chowdhry is the founder of HCL

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DIGVIJAY SHARMA

WHITHER INDIAN NETWORKS?

Increasing mobile phone penetration has led to higher expectations. The solution: intelligent, automated, agile and programmable networks

Mobile telephony in India has come a long way since the first mobile phone call made here on 31 July 1995. When mobile phones first launched here, both the handsets and calls were so costly that only a privileged few had access. Twenty-five years later, mobile telephony in India has evolved to a point where we have the least expensive mobile data plans in the world and a plethora of smartphone ranges to choose from. It is not uncommon for me to meet people who own two or three smartphones. Smartphone usage has therefore transformed our daily lives.

Unlike many other countries, smartphones were not only the first internet-connected device for most Indians but first "screen" beside a television. Noticing the growing demand here, both Indian and international entertainment brands are creating new TV shows and movies for the Indian audience, intended for us to stream across mobile broadband here. Some even offer mobile-only subscription plans in recognition that mobile is the most broadly accessible form of internet access here.

Working from home at the scale India has done recently could not have been possible without the stride the telecommunications sector has made in the past 25 years. Telcos in India are providing not just the necessary connectivity to power the economic engine, but also supporting public health and education needs.

Behind the transformation of how Indians connect with the world is the evolution of our telecom sector. While all early mobile networks relied on microwaves, today fiber has been laid across thousands of kilometers in the country. Alongside this fiber build-out, it's no secret that the industry went through a phase of an increasing number of service providers jumping at the chance to offer their services to India's population, using high upfront network investment and low prices to the end-user to do so. In the past few years, the industry has consolidated down to a handful of service providers again, who are all battling for their place in the future of mobility in India.

Digital India's opportunity

With all the progress India has made in the past 25 years, it is clear that even more opportunity lies ahead. You'll notice almost 100% mobile penetration in the cities of India while rural areas still have less than half of that despite housing the bulk of India's population. Digital India is the starting point for a nationwide conversation on the possibilities for bridging the digital divide in previously unimaginable ways, in a way that is digitally inclusive for more of India.

We've already seen the benefits of this in the banking sector. Traditionally, most of the rural population was out of reach of banking. However, with the Digital India initiative and mobile phones, the coverage and hence, the benefits have increased drastically. Transferring money to remote areas can be done within a few seconds, from wherever the banking customer is based.

We have seen similar changes in the farming sector. A lot of Indian farmers are on YouTube, sharing tips with each other. Also enabled by increased connectivity in India, we have a "Soil Health Card" that guides which crop a farmer should optimally aim for in which season and if their farmland is ready for their choices of crops. Once India implements 5G, we will have the opportunity to further address social inequality in farming. Farmers

> Mobile telephony in India has evolved to a point where we have the least expensive data plans, and plethora of smartphone ranges to choose from.

will be able to boost yields and crop quality by precisely monitoring soil and weather conditions using sensors to tailor the use of pesticides and fertilizers.

For the healthcare sector, with the use of tactile internet made possible by 5G, a physician could command a telerobot at the patient's location, allowing remote physical examination with full audio-visual and haptic feedback. With 5G, surgeons could even carry out remote procedures using specialized robots.

Already popular with some gamers, virtual reality and augmented reality (AR/VR) headsets could also be used for education and training. For example, trainee engineers, mechanics, and even medics could learn how to perform specific tasks by following instructions relayed via AR or by using VR simulations. Similarly, these kinds of technologies could be used to teach biology and geography students about specific habitats and environments, either by superimposing digital information on images of the real world or by simulating the real world in virtual reality.

These are just some of the innovations that will be made possible by stronger networks. However, achieving this truly digital economy depends on improving the speed and reliability of the underlying networks that connect India.

Telecom's inflection point

With this growth and the related digital economy, service providers are attempting to scale or adjust to these demands. However, many of their networks are full of legacy systems and protocols, meaning manual processes are often still required to set up, revise, and tear down even the simplest services. Many of India's legacy networks are not designed to adapt to these growing and unpredictable enterprise and end-user demands.

Also to meet customer demands, service providers are building new products and services on top of their existing systems, mixing the old with the new infrastructure, software, and services. Networks are growing quickly and are becoming increasingly complicated. Managing this can easily overwhelm service providers and put them on the back foot, where they manage their network reactively to issues and have limited time to proactively improve their networks for future needs. India's service providers need network architectures that are intelligent, flexible, automated, agile optimized, and programmable.

The adaptive network

By working with service providers, we understand the complexities facing them today. We believe in building each network to grow smarter, more agile, and responsive every day to match user expectations. We believe service providers can and must achieve a more adaptive network to prepare their networks for the torrent of data being unleashed across India from increasing numbers of consumer and IoT devices as well as enterprise cloud adoption.

It is with this need that Ciena brings the adaptive network vision to our customers. This adaptive network approach enables network operators and service providers to keep pace with growth in capacity, devices, and mobility with the right mixture of automation, intelligence, and scale.

The adaptive network includes three important layers of architectural principles: programmable infrastructure, analytics and intelligence, and finally, software control and automation.

The adaptive network is a target end-state and a set of architectural principles. Providers can start at different points depending on the current state of their network and their most pressing needs. As we enter the next 25 years of mobility in India, and all the lifestyle and economic innovations that come with it, we look forward to helping India leverage the adaptive network to unleash even more possibilities of digitization.

The author Digvijay Sharma is Senior Director, Regional Sales with Ciena India

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PUNEET CHAWLA

MAINSTREAMING DIGITAL REVOLUTION

With the telecom sector enabling the adoption of ICT-enabled solutions across the sector, India is moving towards becoming a data-rich country

India has completed 25 years of mobile telephony and is world's second-largest telecommunication market. What we've seen in the last 25 years is no less than a revolution. We went from being a landline-oriented country that had less than 7% telephone penetration to becoming a country where telecom penetration is more than 98.25%, and today every citizen owns a mobile phone and has access to basic telephony service.

India is also the second-largest country in terms of internet subscribers. As of 2019, India had the world's highest data usage, averaging 9.8 GB per month per smartphone and it is expected to double to 18 GB by 2024. App downloads in the country increased from 12.07 billion in 2017 to 19 billion in 2019 and is expected to reach 37.21 billion by 2022. Total wireless data usage in India grew 10.58% year-on-year to touch 19,838,886 TB. The contribution of 3G and 4G data usage in the total volume of wireless data usage was about 5.72% and 93.65%, respectively. Strong policy support from the government has been crucial to the sector's development. Foreign Direct Investment (FDI) cap in the telecom sector has been increased to 100% from 74%. FDI inflow into the telecom sector during April 2000-December 2019 totalled USD 37.11 billion.

Long Term Evolution (LTE) is a broadband telecommunications standard developed as the evolution of Universal Mobile Telecommunications System. The new LTE architecture reduces the number of network entities, making easy the design, enhancing the spectral efficiency, and providing higher data rates. RailTel has adopted 4G LTE as the communication backbone for Modern Train Control System in four sections of Indian Railways. This is one of the few such implementations across the world. In addition, there are a lot of new LTE works that are programmed to be implemented over IR. These will be implemented by RailTel. These works will greatly enhance the critical communication requirement of the Railways for safety, operational efficiency, and the internet of things- (IoT) based asset monitoring and maintenance.

The adoption of IT- and ICT-enabled solutions has been fast-tracked due to the COVID crisis. The changes that we were likely to see in ICT space in the next 5 to 10 years have now become imminent. The Ministry of Railway has, through a recent order, completely banned the movement of persons carrying files and dak from one place to another and have insisted on meetings and exchanges taking place virtually over video conferencing.

Moving forward, rise in mobile-phone penetration and decline in data costs will add 500 million new internet users in India, creating opportunities for new businesses. We will see tremendous growth in this field and because of digitalization, more businesses and economic activities will be conducted over our networks and as we move to 5G, increasingly larger sections of industry will be brought online. All aspects of the Industry will be benefitted by the emerging new technologies and the spread of network of telecom players across the country. India is on track to become a data-rich country, from a data-poor country.

The author Puneet Chawla is Chairman and Managing Director of RailTel

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SANJAY KAUL

ACCELERATING DIGITAL-LED RECOVERY TO THE NEXT NORMAL

Emerging network technologies like 5G and Wi-Fi 6 can help service providers evolve into digital value players and emerge as winners in the new economy

The 1990s was perhaps the greatest decade for technological advancement, witnessing the evolution of mobile networks as well as the advent of high-speed internet. Until a few years ago, these technologies were viewed primarily as communication and information tools. But as we've seen in the last few months, telecommunication and networking can serve as powerful enablers of human welfare and safety, which I believe will continue to be of the highest priority in the new world post-COVID.

This new world will also give rise to a low-touch/no-touch economy where technology will be essential to everything we do. India was already the fastest digitizing country in the world before the pandemic, but COVID-19 has accelerated this journey by at least a few years. At the same time, the country's economy has taken a hit in the last few months, prompting many organizations to reimagine their business models and scale their digitization efforts to recover quickly.

Additionally, even though the country is slowly opening up, the preference for digital alternatives that emerged during the crisis will continue to grow. In India, 966 million people or 68% of the population are expected to be mobile users, and 907 million or 64% are expected to be connected to the internet by 2023, according to a Cisco report.

In this low-touch economy, service providers will become crucial to helping more people across the nation gain access to mobile banking, m-commerce, m-health, m-education, m-governance services, etc. and in assisting businesses to further their digital transformation. Now, the challenge and the focus will be on streamlining the hurdles of virtual experiences. So, while the digital world holds enormous opportunity for technology and service providers, service providers that can not only bring differentiated technologies, innovation and new business models but also embrace digitization to transform their own operations will emerge as the winners.

> Service providers are looking at ways to achieve their long-term digital transformation vision while delivering on short-term business value.

This is where emerging network technologies like 5G and Wi-Fi 6 can help them evolve into digital value players through new revenue streams, reduced costs, and improved operational efficiencies. Most significantly, this will enhance the overall value and experience for end-customers. And though plans for 5G rollout in India seem delayed due to high spectrum costs, and leveraged balance sheets of leading service providers, the pandemic has certainly created the motivation for fast-forwarding deployment. Globally, the fundamental shift has already begun - several service providers around the world are already testing out and launching 5G and preparing for a mass rollout, with APJC in the lead.

Banking on emerging technologies

5G is about more than 5G radio – it is about virtualization, cloudification, digitization, automation/zero-touch, and zero trust. In essence, the 5G and the Wi-Fi 6 have been built from the same foundation. Therefore, 4.5G, along with Wi-Fi 6, can set a solid foundation for testing the use cases and monetization aspects of 5G in India. Wi-Fi 6 offers advancements in broadcast capacity with access points broadcasting to multiple devices at the same time. It will help businesses drive more value from their present IT infrastructure, allowing them to attain 5G-level performance more affordably. The combined force of 5G and Wi-Fi 6 can support new applications and increased network capacity while connecting more users and devices. This will allow more mission-critical internet of things (IoT) devices to be connected reliably through wireless while also providing enhanced mobile broadband for immersive experiences, thus creating new business models and revenue streams.

While the pandemic has led to unprecedented disruptions, the catalyzed pace of digital transformation has only stimulated innovation and opened up new areas for growth. From IT services companies to technology vendors and start-ups, everyone is focused on capitalizing on the possibilities of digital transformation. In such a digital-first economy, service providers need to act fast in identifying and building on the value they can deliver.

Additionally, not all service providers are well-positioned to leverage this opportunity. Many, especially in the Asia Pacific, are confronted with the challenges of competitive pricing and churning out new services. They also need to modernize their network and embrace the latest technologies to improve service guarantees and provide efficient service delivery. Only those service providers that are equipped to offer credible digital value plays will thrive.

With these dynamics in play, service providers are looking at ways to achieve their long-term digital transformation vision while delivering on short-term business value. They realize the benefits of optimal cost and efficiency in deploying automation and orchestration technologies. In addition to these technologies, they are also investing in highly skilled talent, and most importantly, partners to transform their digital vision into a reality. Here, Cisco's mission to solve our customers' most pressing challenges converges with the objectives of service providers, to truly bring in a partner-value framework, built on a holistic partnership to enable digital value play and network architecture that is intuitive, service-agile, and secure.

Standing together for connected future

At Cisco, we are building the future of the internet through technological innovations in silicon capacities, bandwidth scale, density, energy efficiency, software modularity, open architectures, zero-touch, and zero trust networks. This means new possibilities, markets, and revenue streams, but also means numerous complexities and challenges. To navigate the complex world that COVID-19 is shaping, we need to work together.

We are excited to empower our service providers to identify and capitalize on the opportunities that the new normal brings with it – an opportunity that we can't let go.

The author Sanjay Kaul is the President, Asia Pacific and Japan, Service Provider Business with Cisco Systems, based in Singapore

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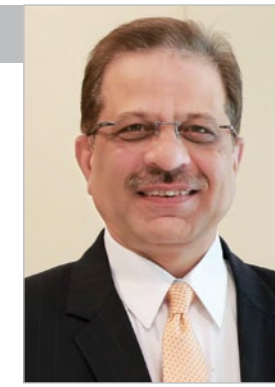
SANJAY MALIK



CONNECTING 100 BILLION DEVICES

Mobile phone has played an important role in connecting billion Indians. It now needs to enable machines to increase industrial efficiency

As the world grapples with the pandemic, we are all adapting to the new ways of working and conducting our daily lives amidst social distancing and public lockdowns. I can proudly say that that the India mobile telecommunication industry has come a long way as it enables the society and business to continue through these tough times.

Famous philosopher Lao Tzu said, "A journey of a thousand miles begins with a single step". This sounds so apt when we look back at the journey of our industry that started 25 years back with the first mobile call in July 1995.

Today, we are at the cusp of a profound shift in the Indian telecom industry. In the last 25 years, the telecom sector has been pivotal in leading India towards economic success and has completely transformed the social landscape of the country. From mobile the phone being an accessory of the rich to becoming an essential tool for development – a lot has changed for the people of this country.

- From the first 11 base stations established in Kolkata to over 1.5 million base stations today spread across the country.
- Telecom-centric technology is more accessible and affordable with the cost of deploying base-stations vastly reduced as we deploy 3-4 base stations at the cost of one base station.
- Telecom industry is generating employment for over four million people despite the humble beginning.
- From Rs 24 per minute for a call in the beginning to free access to unlimited voice calls every month for 1.2 billion subscribers.
- With the advent of 3G and 4G, India is already

> As we enter a new era of technological advancement, we'll see the pace of transformation increasing multifold with the advent of 5G technology.

amongst the leading data-consuming nations today with more than 7,000 petabytes of data consumption per month.

Even though India was a few years behind the world when the first GSM call was made, today we are poised to launch 5G as it is rolled out in the rest of the world.

At Nokia, we take pride in being an integral part of this digital transformation journey of India.

- Starting with the first GSM call in India on a Nokia 2110 handset over a Nokia network, today every single call in the country touches the Nokia element somewhere in a complete call flow.
- From deploying about five sites a month to over 5,000 a month, consistently.
- With the new-age technologies, Nokia is supporting India's largest VoLTE subscriber base, the biggest cloud-based packet network, and largest deployment of massive-MIMO.
- First telecom equipment vendor to manufacture in India transcending from importing 100% of our equipment to exporting 50% of our India-manufactured equipment to over 100 countries.
- Being one of the hubs for managing 5G deployments in addition to managing 120 networks globally.
- Moving from being mere consumers of globally developed software to undertaking research in various advanced global telecommunication technologies at our R&D Centers in India.
- What more! Our strategic partnerships with the operators have catered to the burgeoning demand for connectivity, especially during the unprecedented times of COVID-19 pandemic.

So, what will be the next big wave in the telecom industry? Having connected over 1 billion people in the last two decades, the industry is now headed towards connecting over a 100 billion devices. This vision is also at the heart of Digital India campaign for a technology-enabled and a digitally-empowered society to drive an inclusive socio-economic growth for our nation by improving access to services for the most remote communities and increasing industrial efficiency.

As we enter a new era of technological advancement, we'll see the pace of transformation increasing multifold with the advent of 5G technology. In the coming years, 5G will power a fully connected world with enhanced mobile broadband in real-time that will spawn a number of real-life use cases specifically curated for India.

The benefits of 5G will extend to agriculture – enabling soil sensors and airborne cameras to identify soil, water, and pesticide usage requirements remotely, improving yields by 20% to 40%.

As the foundation of a modern healthcare service, 5G will help save lives by powering high-resolution video consultations, assistance robots and smart wearables to increase the efficiency and effectiveness of treatments. 5G will make telesurgery possible, allowing specialists in one hospital to control equipment in another facility hundreds of miles away.

These are just some of the transformations that the future holds for us. Nokia is guided by the vision to connect people and things over the years, directing all our efforts towards creating a connected world. With this intent, we are striving to connect the unconnected population of India by offering technology and solutions that will power the networks of tomorrow. We are excited and thrilled to witness India's digital journey unfold as we create a digital backbone by transforming legacy networks into future-ready, agile networks.

Let's create the future of digital India together!

The author Sanjay Malik is Senior Vice President and head of India Market with Nokia

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SHIVNATH THUKRAL

BUILDING BLOCKS OF A PROSPEROUS FUTURE

Telecom has a massive opportunity to accelerate digital payments and financial inclusion for the underserved communities across India

The mobile phone has emerged as a critical device that enables Indians to overcome geographical barriers, socio-economic status and to embrace new economic realities. Indians, across all demographics, have leapfrogged to the digital world by embracing mobile technologies, much more than others. The country is in the midst of one of the most dynamic social and economic transformations the world has ever seen, driven by the rapid adoption of digital technologies. The COVID-19 pandemic has accelerated the need to go digital.

Technology is playing a crucial role in scaling solutions and in just the past five years, more than 500 million people in India have gained access to the internet. While this is promising, it also highlights the wide scope of digital opportunities that remain untapped. According to the Telecom Ministry, the country saw its internet dependency increase by 13% during the lockdown. While this was well within the DoT capacity, the government and COAI, made significant efforts to ensure people remained connected at the critical time.

India is at an inflection point, and where we go from here is heavily dependent on the internet accessibility. In this vast and diverse country, only an ecosystem consisting of powerful networks, along with affordability can transform the future of the nation. Today, helmed by Reliance Jio, India is home to the world's second-largest internet user base, accounting for 12% of all users globally. With the help of affordable data prices, Reliance Jio helped spur the digital economy in India as it propelled internet usage in the country.

> In this vast and diverse country, only an ecosystem consisting of powerful networks, along with affordability can transform the future of the nation.

Looking at the future, WhatsApp's collaboration with Jio has the potential to positively impact over 60-million micro, small and medium businesses and other small businesses that may currently be operating in the unorganized sector. Through this arrangement, we envision enabling people to browse the availability of shops, get answers from a business and ultimately purchase a product right within the chat with the business.

Small and Medium Businesses (SMBs) are the backbone of the Indian economy and are critical to the future of the country. Contributing to 6.11% of the manufacturing GDP, 24.63% of the GDP from service activities and 33.4% of India's manufacturing output – SMBs are the second-largest employment generator in the country, providing jobs to close 120 million people.

Digital India has become the centerpiece of the government's plans for the country and is slated to be a key driver of growth and digital inclusion. And as the country continues to transform into a digitally-empowered society, it is no surprise that business tendencies have evolved in that direction too. According to a survey by Nielsen, among people who message businesses, 63% say they have started messaging businesses more often over the past two years, and 67% plan to message businesses even more over the next two years.

Taking a page from Prime Minister Narendra Modi's vision of an Aatmanirbhar Bharat, access to the right digital tools can help lay the groundwork for businesses to be self-reliant and flourish in India. By providing access to a reliable platform, WhatsApp is playing an instrumental role in helping small businesses interact with their customers and optimize sales especially now when digital tools can serve as a lifeline for businesses and customers to stay connected. For example, Books by Kilo (an online portal that sells books by weight) has seen a 50% increase in customer interactions since using the WhatsApp Business app during the lockdown. Similarly, Kriger Campus', an education network and marketplace, business interactions on WhatsApp have increased by 55% since the lockdown. With 15 million monthly users of the business app in India, businesses are finding tremendous value in the very nature of WhatsApp.

In addition to having access to digital tools, we need to make available, efficient, and scalable financial services for people in the unorganized sector and rural India. Despite India's boosting economic growth rates higher than most developed countries in recent years, a majority of the country's population still remains unbanked. In order to achieve inclusive development and growth, the expansion of financial services to all sections of society is critical.

Across sectors, WhatsApp is a platform that enables an ecosystem to start scaling and we truly feel that it can play a key role in driving digital and financial inclusion in the country and connecting the unconnected. If we come up with a technology to solve such issues in India, there is no better platform than WhatsApp to enable this.

We can now take the lead to "engineer in India" and then make it global. Our goal is to create the template for digital public infrastructure, which will further help in solving problems in areas of poverty, digital learning, and economical problems. Over the next two years, we hope to open up in entrepreneurial ways we haven't before. With the help of our partners, we will launch many experiments – scaling digital banking, increasing access to basic financial service for every Indian, helping digitize the MSME operations to enable lending – and these are just starting points that are in motion.

Payments on WhatsApp is a massive opportunity for us to accelerate digital payments and financial inclusion for people across the country. We are optimistic that with the power of a mobile phone coupled with WhatsApp, people in underserved communities will be able to stay connected, recover in the post-COVID world, and prosper.

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RAJAN S. MATHEWS

BEYOND THE REVOLUTIONARY JOURNEY

Telecom has transformed India, but lost its sheen. Is there a political will to afford regulatory and policy relief to help the sector regain its strength?

Much has been written about the stupendous achievements made by the mobile telephony sector over the past 25 years. The growth of the sector during this period and the transformational changes it has brought about in the lives of all segments of Indian society is legendary. From being an aspirational service for the rich and well-heeled, where one waited for over seven years to obtain a telephone connection, to be available on demand to even the poorest citizen, is truly remarkable.

The impact on the economic development of the country has been no less transformational. From being an instrument of simple connectivity, it has become a digital platform where everything from manufacturing, robotics, drones, artificial intelligence, remote medicine, distance learning, connected vehicles, electronic payments, among other things are all facilitated over the mobile network. The vaunted IT industry of India could scarce have achieved its global position and reputation if the underlying connectivity network had not been in place.

The investments in the sector of well over Rs 10 lakh crore, jobs for over two million direct employees at its peak and a network that makes mobile telephony services available to over 90% of the population of the country is certainly staggering. From a time when the average customer consumed less than 250 minutes of voice service a month to a point where the average consumer now consumes well over 750 voice minutes per month, and when no data service and internet services were available to now consuming on average over 12 Gigabits of data a month; from an all 2G network to a 4G LTE network pushing onto 5G, the change has been stunning.

In short, the last 25 years has indeed been revolutionary.

This revolutionary journey was not without its twists, turns, and high drama. The decision by the then government to open up the telephony sector to private participation was a bold step in the long journey of liberalization. It stemmed from the recognition that the nation simply did not have the resources to make the investments required to get the country at par with the leading countries of the world. In 1994, telephone penetration, which was all copper land-line services, stood at a paltry 7%. The USA, UK and leading countries of Europe boasted land line penetration of over 90% of households, with mobile services being introduced rapidly in most countries. The decision to focus on mobile telephony and adopt 2G technology for mobile networks to be implemented in India was bold.

Around 1990, the US had just moved from analog mobile services to digital with TDMA and CDMA fighting for dominance under unique US defined standards (DAMPS). Europe, on the other hand, had adopted the GSMA-based 2G technology. The US continued to innovate under its own proprietary technology, introducing PCS – Personal Communications Services – in 1800 MHz band. However, 2G GSMA technology rapidly expanded to the point where operators in the US themselves largely adopted 2G GSMA technology at the turn of the century. This was due in no small measure from the loss of original equipment manufacturers (OEMs) in the US, pursuant to the break-up of AT&T and the disinvestment of Bell Labs (R&D and IPR), Bell Core

> The adoption of 2G GSMA-based technology by the government proved to be a significant factor for the rapid progress of mobile networks in India.

(Standards), Lucent (manufacturing network equipment), Avaya (manufacturing IVRs, unified communications, etc.), among other companies that were previously part of the monolithic AT&T. OEMs like Motorola also wilted under the onslaught of Japanese products.

The adoption of 2G GSMA-based technology by the government proved to be a significant factor for the rapid progress of mobile networks in India. It provided scope and scale for equipment manufacturers (OEMs) to offer network equipment and handsets at prices that were competitive, globally inter-operative, and at par with the best global standards of customer experience. For operators, it provided freedom from being locked into any single OEM. The 2G GSMA technology allowed integration of OEM network equipment from different vendors using APIs creating a 'mix-and-match' scenario that allowed operators the freedom to choose the best in class components of the network.

Technologies that offered no such benefits found it hard to compete and networks based on alternative technologies such as CDMA soon withered and died. Global OEMs fiercely competed for business in India. Just about all the global OEMs were present in India – Ericsson, Nokia, Lucent, Alcatel, Siemens, and Nortel, among others. On the handset side, Nokia and Ericsson dominated in the early years. Chinese vendors came in later and the handset market saw fierce competition drive prices to levels not seen elsewhere in the world. This again provided the impetus for rapid subscriber growth.

Having chosen GSMA technology for networks in India, the government initially granted two licenses in 1994, for mobile services in each of the four Metros – Delhi, Mumbai, Kolkata, and Chennai. The awards were contested in the courts and finally settled. The government then called for sealed bids from interested parties to provide both mobile and landline services in India in the 22 or so Licensed Service Areas (LSAs) of India. The bids required majority Indian partners to hold at least 51% ownership and technology partners with substantial global operational experience to hold not more than 49%. The bids drew attention from just about all the major US and European mobile operators partnering with major business houses in India. The winners – two in each LSA – were whos-who of Indian business houses and global operators. Brands such as AT&T, Birla, BPL, Southwest Bell, Tata, Canada Bell, Escotel, Modi, Telstra, Swiss Telecom, Hughes, Essar, RPG group, and Usha Martin, to name a few, were all splashed across the media. While mobile licenses drew much attention, the same could not be said for the landline bids. Only a few companies bid for these licenses and most exited in a short while given the difficulty of execution. There was general euphoria in 1996, as companies rushed to roll out networks, sign on customers, and meet the network roll-out obligations included in the licenses.

By 1997, it was becoming increasingly clear to operators that they had grossly overestimated the market and had overbid for licenses. Several operators defaulted on their bid payments. COAI, the industry advocacy group that was set-up in 1995, advocated for a "revenue share" regime to replace the fixed bid payment regime. The government under the then Prime Minister Atal Bihari Vajpayee, in 1999, made a courageous decision to adopt the revenue share model and introduced the historic National Telecom Policy 1999 (NTP), suffering brickbats from the media and political parties in the process.

However, history has shown the wisdom of that single decision. The government earned far more from industry through revenue sharing than it would have made if it enforced the fixed bid payment regime. The revenue share regime introduced the concepts of Adjusted Gross Revenue (AGR), License Fees (LF) and Spectrum Usage Charges (SUC). The industry and government settled litigation and claims against one another and among other things the industry also gave up its rights to function under a duopoly in each LSA. License conditions were changed, two additional operators were given licenses in each LSA, which brought in government PSUs MTNL and BSNL.

The decision of the Vajpayee government had far reaching positive consequences for the industry, freeing

> A significant initiative was the introduction of 'prepaid' technology, which opened the way for faster customer acquisitions and growth.

it from crushing financial obligations and allowing it to invest in network expansion and customer growth. It ushered in a period of industry consolidation and long-term growth.

NTP 1999 was followed by enabling policy measures so as to strengthen the telecom sector. The original TRAI Act and subsequent amendment of the TRAI Act on 25 January 2000 resulted in strengthening the regulator and greater clarity on its role and powers. The amendment also put in place a separate dispute settlement mechanism in the form of the Telecom Dispute Settlement and Appellate Tribunal (TDSAT) to expeditiously deal with and resolve issues relating to the telecom sector. These institutions have served the growth of the industry well, although not always in a linear progressive fashion.

A significant matter that occupied much time and energy of the government, industry and the courts between 2000 and 2002 was the attempt by Reliance to convert its land-line licenses into full-fledged mobile services using its last-mile CDMA spectrum. This too was ultimately decided by the courts and the industry settled on a relatively peaceful period of rapid growth.

Another major impetus to the growth of the industry was the introduction of the Calling Party Pays regime (CPP) in 2003. Previously, both the calling party and the called party paid for the call. The industry rose up in arms against this halving of their call revenues, but again, in the long run, this proved to be a major boost to the adoption of mobile telephony in India. Under the CPP regime, interconnect charges (charges paid by one operator to another to complete a call) became an important aspect of revenue generation. It also led to much altercation and litigation between operators and the regulator.

Among the many significant initiatives brought in early by the industry, was the introduction of 'prepaid' technology, which opened the way for faster customer acquisitions and growth. It must be seen that western operational practices functioned under a 'postpaid regime'. Hence, all global networks supported only this regime. In India, operators soon realized that in the absence of any unique individual identification tool, collection of postpaid dues would remain a major issue. As a result, operators had to write off a huge amount in postpaid dues as 'uncollectible' in the early years. OEMs soon introduced prepaid technology and the industry fast-tracked its growth. It also helped countries similarly situated like India, and soon prepaid technology became an integral aspect of all networks. Today, over 90% of all customers are on prepaid accounts, allowing operators to minimize their financial exposure, reducing collection and bad debt costs, quicken customer acquisition and providing for price-sensitive customers to carefully monitor and meter their usage.

Infrastructure sharing was another innovation introduced by Indian operators to enhance operational efficiency and improve profitability. Soon, separate tower and infrastructure companies emerged, taking over the ownership of the passive elements of the tower infrastructure and saving costs by allowing multiple operators to share the same passive infrastructure. So successful was this innovation that it began to be adopted even by advanced countries such as the US. Soon infrastructure companies formed their own industry association in 2011, called TAIPA. In 2019, TRAI recommended that infrastructure companies should be allowed to share certain portions of the active infrastructure as well.

Mobile Number Portability (MNP) was recommended by TRAI and adopted by the DoT as a license condition in 2009. Two years after its mandate, the complexity of the exercise had left the matter incomplete. In 2010, under the aegis of COAI, the industry came together with the DoT to finally complete its implementation. Nowhere else in the world was MNP introduced with such complexity – over 12 operators, 22 LSAs, four metros, over 365 mobile switching centers, over 250,000 BTSs, several ILD (International Long Distance) and NLD (National Long

> Under the CPP regime, interconnect charges – charges paid by one operator to another to complete a call – became an important aspect of revenue generation.

Distance) licensees, and two MNP providers to ensure redundancy and competition. Recognition must be given to the acumen of our network engineers, the tenacity of the industry project managers, the technical arm of the DoT, and the secretariat of the COAI in helping to manage and implement this complex undertaking. MNP has ensured greater customer choice and focus on service quality by operators.

Spectrum has been the bane of the industry since its inception. Because the spectrum in India had been allocated to various government agencies, the availability of 2G Spectrum was a major challenge at inception. To address this issue, the government allocated only 4.4 MHz in the 900 MHz band for use by operators in 1995, with a promise that it would be brought to international standards (6.6 MHz) as the spectrum was vacated by other government agencies.

As subscribers increased, operators requested more spectrum to cope with the demand. The government brought on line 1800 MHz spectrum for allocation to operators. The allocation was done through a subscriber-linked method with commensurate adjustments to the LF and SUC. In 2010, the government introduced auction for 3G and 4G Licenses and Spectrum. These were bid for and bought at large premiums to the reserve prices set by the government. Thus, began the financial debt burdens on the industry. It would have been thought to be appropriate that once operators paid for the spectrum upfront, the legacy revenue share method would cease. However, the government continued with the extraction of both – upfront spectrum payments and revenue share from the industry. The deep slide into financial distress had begun.

In the context of spectrum allocation, a big blow to the sector came in the form of what is known in common parlance as the "2G Scam". In a landmark decision in February 2012, the SC struck down the allocation of some five to seven new licenses granted by the government along with any grant of spectrum tied to it. All such spectrum and licenses were to be rebid through a public auction.

The regulator, based on orders from the Supreme Court, initiated open consultation on spectrum auction. Based on the recommendations, auctions were held in 2012 and in 2013. However, both these auctions failed due to the high spectrum prices. The operators whose licenses were canceled, as well as other licensees, could not bid successfully due to exorbitantly high spectrum prices. As a result, this auction saw the departure of at least three of the operators and by the time the dust had settled, the number of operators in India had shrunk to seven from a peak of thirteen, with two of the seven being regional operators only.

In 2014, the government advanced the novel ideas of "spectrum re-farming and liberalized vs. administratively allocated spectrum", to claw back previously allocated 900 MHz spectrum from incumbent operators. This was in the context of the expiry of the 20 years of the initial license grant. While the government could have granted a further 10 years extension to the licenses as per the stipulations of the license, it chose to not do so but to go forward with the auction of the 900 MHz spectrum held by incumbent operators. The ensuing hefty premiums bid by incumbent operators to "win back their own business", further roiled an already tempestuous financial sea.

In September 2016, Reliance Jio finally rolled out its 4G LTE network and services with much fanfare. At its inception, it announced that all voice calls would always be "free" and data charges would be free for a period. In addition, various other content were to be free for a period. This caught the incumbent operators off guard, for it was not thought that VOLTE (Voice Over Long Term Evolution) could ever compete in voice quality with either 2G or 3G services or that it would be offered for "free". The dramatic drop in voice and data charges by Jio forced competing operators to match prices. As a result of the hyper-competition and race to the bottom, three operators shortly exited the business, and two filed for bankruptcy protection.

> Over 25 years, the industry has shown its ability to take India to heights, match and exceed growth rates, innovation and set best in class practices.

The competitive pressure also brought about the merger of Idea and Vodafone under a combined entity called Vodafone Idea Ltd. (VIL). Airtel was able to quickly maintain its competitive position as it had already acquired 4G spectrum in the previous auction. It soon put up a spirited fight, but in the process, both Airtel and VIL suffered massive financial losses. The financial position of the incumbents stood heavily damaged with debt alone spiraling close to Rs 7 lakh crore for the industry. The vaunted "poster boy" of India's economic liberalization policy appeared to be in tatters.

When it appeared that things could not get worse, in October 2019, the SC brought to conclusion the long-simmering battle around AGR, with devastating financial implications for operators – over Rs 1.6 lakh crore imposed on operators. The additional financial burden has heightened the financial distress of the industry. The long-term impact of the ruling is still working itself out and full clarity is still awaited from the SC.

It must be said to Jio's credit that their prowess in perfecting VOLTE, marketing acumen, network rollout with fiber connecting a significant number of their BTSs, as well as speedy subscriber acquisition, firmly established Jio in the lead and ensured that 4G LTE would be the dominant network technology.

An indirect outcome was consolidation in the industry to three private players and two PSUs. Incumbent operators would soon seek to shut down 3G networks and migrate customers from their 2G and 3G networks to 4G. Airtel continues to go toe to toe with Jio with a spirited fight to grow their customers and expand their 4G network along with fiber, with considerable success. VIL, while staying in the fray, is handicapped by its stressed financial condition. The recent rounds of tariff increases have helped the industry stabilize their revenue streams through increased ARPUs. However, ARPUs must increase from the present levels of approximately Rs 145 to Rs 300 per subscriber per month before incumbent operators can see the light of day financially. Enterprise revenue will increasingly play an important role in enhancing the revenue streams of operators.

The onslaught of the COVID-19 pandemic has again emphasized the critical nature of mobile networks and the critical role it plays in the overall economic and social health of the nation. The cooperation evidenced between the industry, DoT, regulator, state and local governments to address and resolve issues during the pandemic and the recent cyclones on the east and west coasts could be a harbinger of a realization that cooperation is the only way to progress.

Over 25 years, the industry has shown its ability to take India to heights where it can match and exceed growth rates, innovation and set best in class practices of even advanced countries. It still remains one of the premier attractions for foreign investment. It remains to be seen if there is enough political will to afford the industry the necessary regulatory and policy relief, stability, and predictability required to regain its sheen.

The promises of 5G technology and its imminence could perhaps prompt us to hope that this would be an opportunity to recalibrate our aspirations, address the vexing problem of the affordable and plentiful spectrum, eliminate or redefine AGR once and for all, reduce or eliminate LF and SUC so that operators can retain financial resources to upgrade networks and usher in new technologies to please customers, promote innovation and self-reliance through the development of Intellectual Property Rights and place the industry in a position to make India a USD 5-trillion economy.

The vision of India, transformed as a leading global knowledge economy taking its rightful place in the pantheon of the three top economies of the world, need be no pipe dream. It would be worth striving for in the next 25 years.

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LT. GEN. DR. SP KOCHHAR

A GLOBAL LEADER IN 25 YEARS

The telecom industry has gone through much turbulence in the pre-COVID era. The pandemic has brought to forth the sector's ability to steer the economy

Telecom has today become an all-pervasive technology cutting across the spectrum, thus having a far greater impact on the economy and life of the consumer. COVID-19 has highlighted, what has reverberated during every crisis in the past that telecom is the lifeline of the nation.

Telecom as a Gladiator

During the current pandemic, a significant factor contributing to the uptime of the networks was the field staff on the ground effectively working in tandem with the management. Braving the virus as well as law and order enforcements during the lockdown, the unsung heroes of the telecom sector continued to address problems and maintain the networks, towers, and fiber besides securing Right of Way (RoW) from local authorities.

Telcos, with the help of the Department of Telecommunications (DoT) and local municipalities, were able to bring online, BTSs shut down due to various reasons by local municipalities, from about 900 to approximately 70, ensuring additional coverage and capacity for the users.

Keeping India connected

Ever since the first mobile call, made on 31 July 1995, telecom service providers have always come through in difficult situations, keeping the citizens connected, the nation's economy buzzing, government functioning, and networks running. Surely, we hope to make further strides towards excellence and meet our goals.

There are many sectors doing good work in their respective fields, but without telecom linkages, they would be isolated specks. Telecom interconnects and helps societies to be connected and communicable. It is like the nervous system of the human body.

Let's look at the work done by the telecom sector in the last 25 years. Approximately 1.2 billion subscribers in India have made billions of calls and a staggering amount of data has been used. The sector has seen operators invest over Rs 11.25 lakh crore to deploy over six lakh mobile towers and more than 22.20 lakh BTSs. The service providers continue to make sizeable investments every year, to enhance the customer experience.

Since its inception in 1994, the Cellular Operators Association of India (COAI) has been at the forefront, working with the government and other agencies championing the cause of the telecom sector. It has been focusing on the financial, regulatory, legal, spectrum, licensing, and other such related matters.

A memorable journey with peaks and troughs

The first 10 years (1995-2005) were turbulent for the telecom sector. However, the industry improved the standard and competitiveness besides deploying world-class infrastructure to deliver the benefits of affordable mobile telephony services to the people in India. Today it offers one with the lowest tariffs in the world.

As an industry body, COAI played a significant role in shaping the NTP 1999. The industry's consistent efforts moved the government to give the telecom operators a migration package. It helped them to clear license fee dues up to 1999 and move to a revenue-sharing model with the government for the remaining period of the license.

As a part of the migration package, the GSM service providers surrendered their duopoly rights, and the

> The fierce competition brought in both affordability and choice. However, as cell tariffs started to drop, it created pressure on the industry's profit.

same was replaced by additional operators being allowed to offer licensed telephony services, thus increasing the competitive landscape. The third and fourth GSM operators in every state and telecom circle were introduced in 2001-02. The government-owned service providers, BSNL and MTNL, were deemed to be the third cellular mobile operator in every service area.

Further, with the coming in of Calling Party Pays (CPP) regime in 2003, incoming calls became free and encouraged increased subscription amongst the low-end and marginal consumers. In 2004 policy on broadband was formulated. The government also started identifying the spectrum beyond 2G to achieve the broadband target set for the country.

Among the various challenges that the industry faced, probably the most significant was convincing the government for a Universal License and putting an end to the access deficit charges (ADC), which was a major outgo for mobile operators.

Move to the year 2008. While on the one hand, the RBI was tackling inflation by containing liquidity in the system, telcos started facing problems in generating financing due to the residual effects of the 2008 global financial crisis. Further, the fierce competition brought in both affordability and choice for Indian consumers. However, the drop in cell tariff resulted in pressure on the industry's profits.

The 3G and Broadband Wireless (BWA) auction happened in 2010. But with global markets in bad shape, operators' access to financing narrowed. So the industry had difficulty in finding investments for expansion, which in turn put additional pressure on the telcos financial position.

The crisis in the sector deepened in February 2012 after the Supreme Court of India ruled on public interest litigation (PIL) related to the 2G spectrum case. The court declared the allotment of the spectrum "unconstitutional and arbitrary" and canceled 122 licenses issued in 2008.

Meanwhile, the industry required more spectrum, and the spectrum auction of 2014 was eagerly awaited. But, by the time it was completed, the debt of the sector had bloated. The reason being, funds drying up, and investors, especially foreign investors being unsure of investing more.

New thrust to the digital segment in 2014-15 by the government highlighted efforts of telecom service providers in the country. The COAI deliberated at length with the government towards the formulation of NDCP 2018 and is currently helping in achieving the targets.

The entry of Reliance Jio in the telecom market re-energized the existing operators like Bharti Airtel, Vodafone-Idea and the two telecom CPSEs BSNL and MTNL. The tariff and service quality were redefined by the entry of a new player, with new ideas and infusing a new pace.

The next decade: 2020-2030

Currently, the telecom companies are offering 4G/LTE with high upload/download speeds. 5G is the next generation of mobile networks. So, the task is cut out, as we expect a supportive policy framework and ecosystem to bring in the new technology.

The telecom sector's contribution of the GDP will remain a critical factor (as the industry aims to contribute from current 6.5% to 8%) as usage increases and more subscribers are added.

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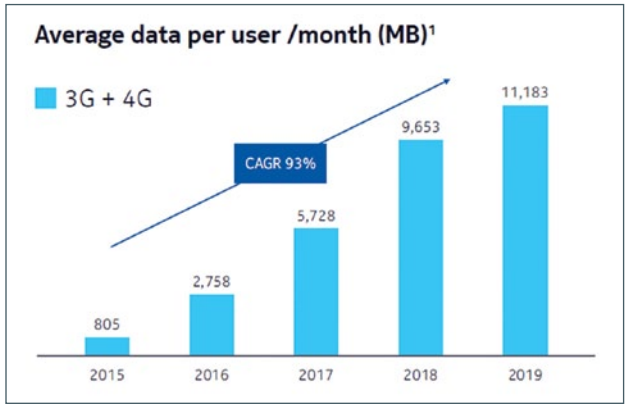
TR DUA

SHARING INFRASTRUCTURE FOR GROWTH

India's tower sharing model has become the benchmark concept globally. Tower companies now need to evolve to provide digital telecom infrastructure

Robust Telecom Infrastructure is an essential enabler for telecom growth which is important for economic development and improvement of the quality of human life. In the last decade, mobile service providers, device makers, and internet companies built a virtual second world for us to live, work, and play in; a digital one. The sector has emerged as a key enabler of digital India, with various new services and applications like digital payments, Aadhar, financial inclusion, e-governance, e-commerce, etc. dependent upon the creation of robust telecom infrastructure. During the last few years, growth became data-centric as the proportion of 3G and 4G customers has risen dramatically.

Not only the broadband subscriber numbers have grown, the data consumption per subscriber has also grown at an astronomical pace, the current consumption being 11 GB per wireless subscriber. Overall, the average consumption per user has increased 14 times over the last four years, at a CAGR of 93%. The increase is driven by an increase in data subscribers and mobile video consumption.



Source: Nokia Mobile broadband index

The catalyst

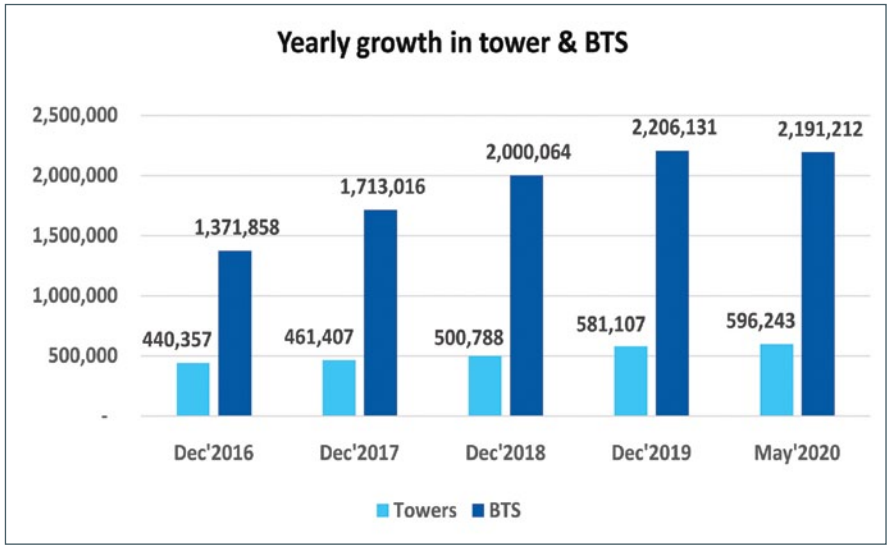
The pandemic COVID-19 has acted as a big catalyst for the rapid acceleration of the digitalization process globally. In order to observe social distancing, the telecom sector has played a stellar role by enabling work from home through virtual meetings, remote work, etc. In fact, telecom connectivity enabled through a robust and resilient infrastructure ensured business as usual during the "new normal" situation due to the pandemic. As a result, the data consumption rose exceptionally, with a change in traffic patterns from business districts to suburban areas.

The much-needed support that telecom extended to distance-learning, telemedicine, e-commerce, entertainment, social media, etc., established the criticality and essential nature of telecom services beyond doubt. According to per media reports, the average per-user data consumption in India jumped by at least 20% during the early days of the lockdown, and it now hovers at 12.4 GB per subscriber per month.

The journey had effectively started in 1994 when in line with New Economic Policy 1991, the government opened the telecom sector for private investments. The regulatory functions of the Department of Telecommunications (DoT) were hived off to an independent regulator, Telecom Regulatory Authority of India (TRAI) in 1997. BSNL was carved out of DoT for the separation of its policy functions and telecom operations. Subsequently, an Appellate body, TDSAT, was formed for dispute settlement with the amendment of the TRAI Act in 2000.

In the beginning, the government issued two cellular licenses per telecom circle followed by the allocation of the third cellular license to BSNL and MTNL in 2000. In 2001, the fourth cellular license was awarded through

> The tower sharing model has led to faster geographic rollout, improved quality of service and lower prices for consumers.



auction. Between 2003 and 2008, the Unified Access Service License was awarded based on the price arrived for the fourth cellular license. Pursuant to Supreme Court order in 2012, the spectrum was auctioned and the process has become the norm today.

The telecom tower industry also played a critical pivotal role in the unhindered growth of the country's telecom sector. It is quite evident that the growth of telecom services could not have been possible without a robust and ubiquitous telecom infrastructure.

Evolution of telecom infrastructure

In 2000, the telecom infrastructure industry came into existence with DoT inviting applications for registrations. Prior to that, telecom service providers were installing towers and other passive infrastructures on their own and there was no sharing. Even up to 2005, the telecom towers were being operated under an integrated model and no sharing was taking place. Only a few operators shared towers on the barter system.

Post-2005, the tower industry evolved under independent tower companies which maintain and install assets like the tower and related infrastructure for renting and leasing to telecom service providers for providing cellular telecom services. The concept of sharing became popular as the towers were shared in a non-discriminatory, transparent and cost-effective manner by a neutral and independent infrastructure service provider.

The telecom sector requires continual investments for ever-increasing capacity and coverage requirements as well as due to technological evolution. The tower companies/IPs reduced the capex burden on telecom operators and brought in much-needed investments through a novel concept of "sharing".

The sharing model resulted in huge savings for the sector in terms of capex and opex, and brought in energy efficiencies as well as a significant reduction in carbon footprint including duplication of resources. The model has led to faster geographic rollout, improved quality of service, and lower prices for consumers. Over a period of time, the infrastructure providers gained expertise in their core operations leading to skilled manpower, efficiency in operation and maintenance, and reduced energy expenses. The tower sharing has been the benchmark concept globally and has become a Harvard Business study.

Digital India, smarter cities

The Government of India has embarked upon the Digital India mission; to transform the country into digitally-empowered society and knowledge economy. The mission is to drive economic growth and improve the quality of life of people by enabling local development and harnessing technology that leads to smart outcomes.

Hundred smart cities are being set up with the objective to promote cities that provide core infrastructure and give a decent quality of life to the citizens, a clean and sustainable environment and application of smart solutions. Telecom infrastructure providers have also

> The carrier-neutral tower company model, which hinged on tenant addition, has to be rebuilt, reloaded and rebooted as well.

participated in the smart city programme in Vadodara, New Delhi, Bhopal, and Dehradun.

Rebuilding, reloading and rebooting

The telecom market in India has shrunk from a 10-12 player market to a mature four-player construct. The carrier-neutral tower company model, which hinged on tenant addition, has to be rebuilt, reloaded, and rebooted as well. The market is now data-centric, aided by reduced prices of smartphones, data tariffs, and availability of various kinds of applications and services over the smartphones.

The Indian telecom market today is characterized by high data demand and the market is expected to witness a 5x increase in mobile data traffic during 2019-2024. The bourgeoning data need has given rise to the demand for new infrastructure and services. New generation technology such as 4G, 5G and internet of things (IoT) require formidable network performance, which has triggered the need for diverse infrastructure mix

The growth of macro sites are expected to be modest in the coming years, majorly driven by capacity expansion for data services for 4G services in the immediate term, and later for the 5G launch. Going further, the enhancement of scope for active infrastructure within the IP I registration would prepare the tower companies to embrace emerging opportunities in small cells, Wi-Fi, IoT, fiber-to-the-tower, etc.

The telecommunication sector is preparing for the next generation of an ecosystem where data is the mainstream and enabler for the upcoming technologies such as IoT, blockchain, virtual and augmented reality (VR/AR), and artificial intelligence. Keeping in pace with the growing data consumption, the tower companies are reshaping their business models and exploring newer business avenues such as small cells, in building solution, fibre leasing, data centres, and Wi-Fi deployments by leveraging the sharing concept.

The transition of the tower companies from mere infrastructure providers to providers of digital telecom infrastructure will enhance their visibility and demand in the telecom ecosystem value chain as the country ushers into the digital era.

The advent of infrastructure providers' industry has helped in shaping the growth of the entire ICT ecosystem. Telecom infrastructure is the backbone of Digital India program. Telecom infrastructure providers are going to play a key role in the realisation of transformative and revolutionary initiatives of the government and will foster partnerships under its various programs like Bharatnet and smart city mission to enhance connectivity by creating robust telecom infrastructure. A robust telecom infrastructure will play a key role in seamless connectivity, which is the essence of true digitization.

The ubiquitous rollout of 5G would require mushrooming of small cells and huge backhaul bandwidth which could only be enabled by tower fiberization. Several challenges are being faced by IP1/ TSPs in the states, like the multiplicity of documents, no common uniform policy, coercive threats by local bodies, etc. It remains to be seen how India meets these challenges.

The number of telecom towers required to roll out 5G may be double than the current numbers. 5G would require rollout of small cells as it would be operational on a higher frequency spectrum and therefore, lesser coverage. Small cell rollout may require special provisions for street furniture, government land, and buildings, metros, bridges, etc. In order to be future-ready and for continually developing a robust infrastructure suitable for new generation technology, TAIPA has been engaged with the government and the regulator and has provided its recommendation.

To summarise, the infrastructure providers are in the transformational mode to support the data centric growth in telecom services, which would continue to grow as the technology evolves to 5G aided by reduced data prices, smartphones, and mobile applications.

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TV RAMACHANDRAN

TIME TO ACHIEVE BROADBAND FOR ALL

Having achieved its telecom dream, India now needs to start working towards providing unlimited bandwidth for its billion people

The year 2020 is a milestone in the history of telecom in India since it marks the silver jubilee anniversary of the first mobile call made in India by the then Chief Minister of West Bengal Jyoti Basu to India's Telecom Minister Sukh Ram. In these 25 years, since 31 July 1995 when the first mobile call was made, the telecommunications sector has gone through a most exciting rollercoaster ride to bring about incredible transformation on several fronts – the national economy, socio-economic development and people's way of living.

Shashi Tharoor aptly called it the "Mobile Miracle" and wrote in his inimitable style: "It is in communications that the transformation of India in recent years has been most dramatic; has accomplished what our socialist policies couldn't – empower the less fortunate." From the eight-year waiting list for landline telephones to versatile mobile telephones on demand, from basic voice calls on landline phones to broadband and multi-party video conferencing and rich interactive applications on 4G mobile phones; from monochrome displays to high definition video streaming; and from steeply charged incoming calls to unlimited data packs, the transformation of the sector has been most outstanding.

Having entered the Indian telecom sector even before the first mobile license was issued I had the great privilege of being involved throughout the incredible journey of this sector, from basic telecom to the evolved digital communications services. As the first CEO of one of the two first mobile licensees of Delhi – Sterling Cellular (a predecessor of Vodafone India) and having co-founded and served thereafter as the first Director-General of COAI for 12 years, I witnessed and participated in this epic tale of surmounting challenges and growth, to achieve the enviable slot of the second-largest number of mobile connections in the world.

It was the country's first National Telecom Policy (NTP) in 1994, which flagged off the privatization and liberalization initiatives that kick started growth in the sector. However, in the initial years, while mobile telephony did commence in a small way as an elitist facility limited to the very affluent, there were also many growth pangs due to policy ambiguities that significantly stilted growth.

While NTP 1994 had ushered in privatization in telecom, it was NTP 1999 which completely transformed the telecom sector story in India, so much so, that explosive growth resulted from crashed tariffs which were possible because of the improved business viability. The tariff in the country has continued to decline since then, becoming one of the cheapest in the world. This was owing to the fact that there was more than adequate competition available, and hence the application of regulatory forbearance led the market to extract the optimum potential of the sector.

The formation of the Telecom Regulatory Authority of India (TRAI) in 1997 was another great milestone for the country. A very vivid memory of Reed Hundt, the then Chairman of USA's Federal Communications Commission (FCC), comes to mind, as he had visited India a few months after TRAI was constituted under the chairmanship of Justice MS Sodhi. It was a proud moment for us when Hundt openly praised the new TRAI Act in a conference and wished that the USA could have similar legislation.

The regulatory framework was further strengthened by setting up a separate legal body called Telecom Disputes Settlement and Appellate Tribunal (TDSAT), which is unique in the world. This gives immense confidence to investors.

The entry of BSNL, the state-owned pan-India telecom operator, in 2000 was another significant development as the policy formulation arm (DoT) was now separated from the service provider arm. BSNL was corporatized with the objective to compete with private operators and was able to garner substantial market share in the first few years.

> The introduction of 4G and uptake of affordable data services has transformed the telephony habits of the nation, making it internet-centric.

The WLL dynamics during 2000 to 2003 threatened to impact the progress of the sector once more, but the industry worked together with the government to resolve the issue amicably, and the sector continued to flourish till 2008 when the unjustified introduction of too many operators (the total at one time as many as 14!) bitterly fragmented the market and caused huge inefficiencies. Legal intervention then led to the cancellation of many licenses and thereafter, NTP 2012 introduced the process of an open and transparent method of allocating access spectrum through auctions, another momentous measure.

Adoption of innovative business models and a strategic long-term approach to the business; operational strategies including outsourcing of networks and other non-core components; focus on the prepaid segment, sharing of infrastructure; intensive and efficient use of spectrum; encouraging financial inclusion through m-banking; low distribution costs; etc. proved highly effective in proliferating mobile telephony services across all socio-economic strata of the country.

The last 3-4 years though have witnessed another era – that of the growth of broadband and the great data revolution. The introduction of 4G in the Indian market and the tremendous response and uptake of affordable data services further transformed the telephony habits of the nation, which has now become essentially internet-centric.

Amongst the several milestones and historic policy actions and reforms, the release of the National Digital Communications Policy in 2018 (NDCP 2018) is an extremely notable one. It is all-encompassing and chalks out a clear milestone-based roadmap for the sector ahead and represents a tectonic shift from all the previous editions of the telecom policies of the past. DoT had meticulously sculpted the policy through 12 specialist committees and consultations with all chambers of commerce, industry associations, and think tanks. It is a forward-looking policy which when implemented properly, will take India to where it rightfully belongs, being a truly digitally empowered nation.

The NDCP addresses the need to take the internet to every Indian and provide an enabling environment and policy ecosystem for all these cutting-edge technologies and entrepreneurship to grow and thrive. In fact, in the present grave scenario of the world having been affected by the COVID-19 pandemic, telecom/digital services have emerged as probably one of the most powerful tools to mitigate its adverse socio-economic effects. The NDCP 2018 presents us with a powerful arsenal to address the prevailing as well as current issues. The entire sector is eagerly awaiting the implementation of the policy to spur the nation to the next wave of digital transformation.

Multiple policy and relief measures introduced in the wake of the recent Covid19 outbreak, have led to adding strong impetus and focus on the areas of creating a robust domestic manufacturing eco-system; expediting strengthening of the country's digital communications network competences; and creating an ambient environment for adoption and progressive work on new and advanced technologies such as artificial intelligence, internet of things, machine learning, big data, etc.

Having had a grandstand view of the fruitful interplay of policymaking, regulation, and entrepreneurship in Indian telecom for over two and a half decades, and the creditable position achieved, India in the next decade can become a global powerhouse for technology and innovation. Digital communications can drive the country's future like no other sector. But that destiny is neither automatic nor preordained. It will need a few bold and decisive steps by the government to build and layout the enabling framework and policies for it to make Digital India and broadband for all as real goals, while implementing the truly forward-looking NDCP in both letter and spirit.

In conclusion, it would be fitting to recall what the former President, late Dr. APJ Abdul Kalam had said in 2006: "Connectivity is the key to the transformation of a billion people into members of knowledge society... The major effort would be towards making unlimited bandwidth available on demand for a billion people."

Today, while we are celebrating the twenty-fifth anniversary of mobile voice connectivity in India, we should also dedicate ourselves to, achievement at the earliest, of Dr. Kalam's vision of "unlimited bandwidth on demand for a billion people".

The author TV Ramachandran is President of Broadband India Forum

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SD-WAN: Transforming Enterprise Network during the pandemic and beyond

The Covid-19 pandemic has emerged as one of the biggest health crises of the decade, with governments worldwide taking strict measures to control the spread of the virus. From impacting millions of lives, the pandemic has caused financial distress across both big industries and smaller enterprises. The wide-scale impact of the coronavirus outbreak has brought unprecedented changes to the world and the people around us. A quarter has passed since India witnessed the first outbreak, but the fraught of Covid-19 is very much visible. From operational challenges, supply chain issues, slowing demand, and the overall economic slowdown, businesses are struggling to adapt to the new normal. Besides, the continued lockdown and a sudden shift to remote working with limited safeguards have made the enterprise segment more vulnerable to the growing risk of cyberthreats.

Rakesh Goyal , CEO Infinty Labs

Remote working: Safeguarding assets, employees and customers

Amid the pandemic, thousands of employees have been forced to work from home, physical meetings and discussions have become a rare sight, and there's an increased reliance on virtual tools and resources. The sudden move towards remote working meant businesses had little scope to plan for the transition or put the infrastructure and tools in place to support its employees. With many employees requiring access to the same enterprise applications, IT teams across organizations had a tough time understanding the challenges and fixing network-related issues - with limited or no access to real-time information and usage patterns that could help them take control over the network. The challenges of the network-related problems not only impacted the workflow but also resulted in productivity losses.

Besides, with the growing push for remote working and people utilizing their home networks for official work, concerns are also growing around the enterprise network's security. A recent report by PwC claimed that companies are seeing a significant rise in their expenditure due to a massive wave of cyberattacks as most of their employees work from home amid the coronavirus pandemic. Hackers frequently look at crises as an opportunity, and COVID-19 is no different. Cybercriminals are taking advantage of the latest trend with attacker groups impersonating reputed health organizations and using COVID-19 themes as a lure for phishing and malware attempts—misleading employees and customers, trying to get their targets to click malicious links and download files.

Among other learnings, Covid-19 has brought in an important lesson for both corporates and individuals - never let your guard down. Businesses today need to step up their approach to cybersecurity even as hackers trying hard to breach the security protocol successfully. Threat vectors are evolving every day with changes in the technology landscape, and cybersecurity is becoming increasingly complicated. The significant reasons why the detection and response of malicious activities are becoming complicated include the impairment of security teams, rapid digitization, and unprocessed technology onboarding.

Overall, Covid-19 has changed the dynamics of the workplace. The perimeter of every organization has reached the residence of the employees. The dependency on WAN, maintenance of un-compromised application performance, and extending enterprise-grade security to individuals working from home, has reached its peak. In-short the extent of digital transformation adoption that was expected a few years ahead of us has been brought nearer.

Preparing the network capabilities for the future enterprise

We are in an era where digital transformation is not an option but a necessity for business sustenance and excellence. SD-WAN is one of the inevitable technologies that form the framework for this market shift. Business needs to equip itself in meeting the evolving demands of their customers. It will have to penetrate through multiple barriers and constraints in the form of location, device

type, and platform, etc., to reach their customers in the most cost-efficient manner.

SD-WAN is an industry agnostic solution that can be used in any business concern that is looking out for cost optimization of WAN and overall efficiency improvement. As per Gartner and other third-party market analysts, the SD-WAN market is still vibrant with a forecast of over 67% CAGR, and the overall market evaluation is forecasted to be about 6Billion+ in 2023. Hence, Infinxt can be the right investment for many organizations across industries, particularly BFSI, NBFC, Retail, IT/ITES, Manufacturing, Service consultants.

As users move off the campus network to remote connections, SD-WAN adoption is taking off because it provides a virtual WAN architecture that lets businesses use any combination of transport services, including MPLS, LTE and broadband internet services securely connect users to applications. These capabilities make SD-WAN the most appropriate solution to address the company's business objective in alignment with its customer aspirations. Secure SD-WAN helps organizations to consolidate multiple routers, firewalls, load balancers into a single software-defined solution.

With more companies evaluating the scope of adopting work flexibility and encouraging remote working, the revaluation of cyber-defenses will become necessary. With distributed networks and remote access to applications, companies need to create models that reveal network redundancies, detect advanced threats, and discover systemic incident response gaps. Even traditional institutions like education and healthcare institutions will have to explore the use of co-sourcing with external consultants after identifying key risk areas.

Traditional SD-WAN requires organizations to make additional spend towards ensuring branch location network security. Further, integrating all these appliances is another challenge and requires multiple dedicated resources to manage the same. For the IT departments powering these industries, SD-WAN will be vital in increasing visibility to remote operations, ensuring company data is heavily guarded and managed with utmost precision.

Building a next-gen Secure SD-WAN

Corporates and Enterprises are aware of the benefits of cost and efficiency that could be brought by making the right choice in SD-WAN investment. As per Gartner's report, more than 90% router refreshes will be replaced by vCPE or SD-WAN by 2022. Routers were architected for legacy WAN networks and did not provide any application-level visibility. The market is spoiled for choices as every OEM is trying to woo the customer with one or the other SD-WAN like offering that does not necessarily abide by the rules of SDN. But, most solutions available today are built on Router platforms or Firewall platforms, which certainly do not deliver the true benefit of SD-WAN. Besides, the pandemic has pushed several companies previously circumspect of adopting BYOD or WFH to embrace it without any other choice. So, this has become a blessing in disguise for many industrial sectors where they got the opportunity to test the waters and realize the benefits.

Infinxt, one of the flagship products of Infinity Labs, addresses the current requirement of WAN and security consolidation through AI lead automation and orchestration. Infinxt is based on pure SDN architecture as per RFC 7426. Infinxt SD-WAN offers a series of benefits to customers. These include business agility by rapid and easy deployment, inherent economics by providing the same level of QoS of MPLS at a fraction of cost and optimized cloud architecture with inbuilt NGFW.

The solution has been developed indigenously and has gone through a continuous evolution process to meet the market's dynamic requirement. Streaming Telemetry, a unique offering in the current solution, brings the advantages of Real-time monitoring over the traditional SNMP based management platforms. Infinxt Next-Generation Secure SD-WAN reduces the total cost of ownership and ease of managing multiple edge devices. The inbuilt NGFW from Palo Networks adjudged as the eight times consecutive leader in Gartner Magic Quadrant provides Layer 7 application Security. The solution comes pre-loaded with DNS Security, Threat Prevention, PANDB URL filtering, and Wildfire.

Moreover, it also provides essential benefits to multi-site customers. It allows branch offices to easily connect to each other, without building VPN connections, managing routing tables, and different complex networking configurations. The solution has been designed to interoperate and co-exist with existing gateway security investment and provides enterprises with the flexibility to make their network and security choices.

The author Rakesh Goyal is CEO, Infinity Labs Ltd
www.infinitylabs.in, www.infinxt.co.in

The new battleground for telcos

It's high time for the operators to focus on the customer experience metrics that matter rather than those that are just easy to measure

BY SOMA TAH

The telecom market in India is brutally competitive. We have seen high spectrum acquisition costs, and tariff rates causing bitter rivalry among the operators in the past. Well, the rivalry has never gone away, and rather became an intense one as the market continued to evolve further with the introduction of new telecom services, making customer experience the new battleground for the operators in the telecom sector.

The most important factor in driving brand perception and delivering a good customer experience for a telecom operator is its network experience, which is commonly referred as network speed.

Today, it is very important for the network operators to decide what use cases (e.g. video, gaming, TV, IoT, and so on) do they want their network to perform the best and assess if they are providing the right experience for that use case. Given that today more than 60% of a mobile operator's traffic is video, this decision becomes more important than ever.

A detailed analysis on the state of video experience in India done by MOZARK shows that network speed beyond a point does not make any difference to the actual experience. The analysis is done on the basis of the performance of 6 OTTs -Youtube, Netflix, Hotstar, SonyLIV, Voot, Zee5on three mobile operators Jio, Airtel, and Vodafone Idea.

Here is summary of the report State of Video Streaming Experience in India.

Focusing on network speed alone to improve video streaming experience is not sufficient anymore: How quickly a video loads once the user clicks on a thumbnail and whether it plays seamlessly without buffering are the most important aspects of video streaming experience. Research shows that Play Start Time (PST) below 4 seconds is what users prefer and MOZARK's analysis shows that about 14 Mbps is what networks need to deliver this level of PST. *(See Figure 1)*

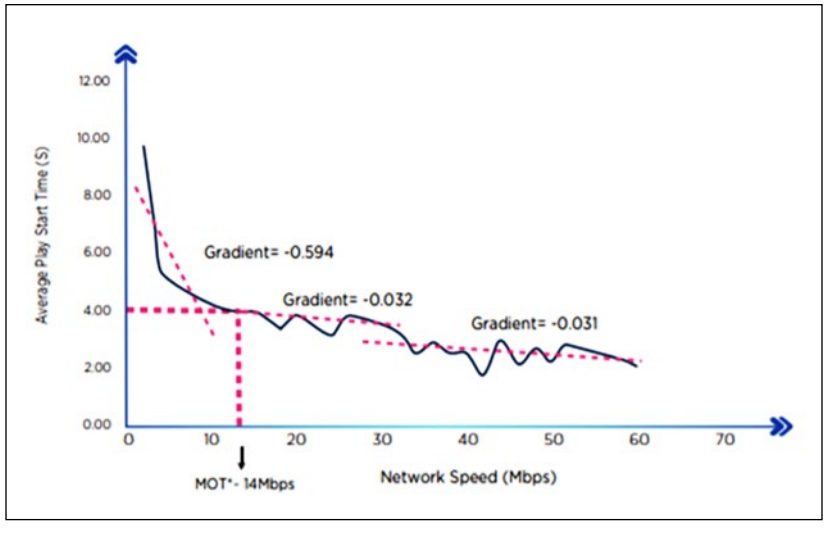

Figure 1: Variation of Play Start Time (s) with Network Speed (Mbps)

The rate of deterioration in PST KPI as network speeds fall below 5 Mbps was quite steep. However, once the network speeds go beyond 5 Mbps the incremental improvement in PST was quite flat. Between 5 and 30 Mbps, the PST times increase only by around ~2s which while does have a material impact on user experience is not as steep as increases of 4s seen when network speeds dropped below 5Mbps.

Maintaining a video rebuffering rate of below 4% is critical for the operators: Research on the customer perception of rebuffering shows that when rebuffering rate increases beyond 4%, it starts to have a material

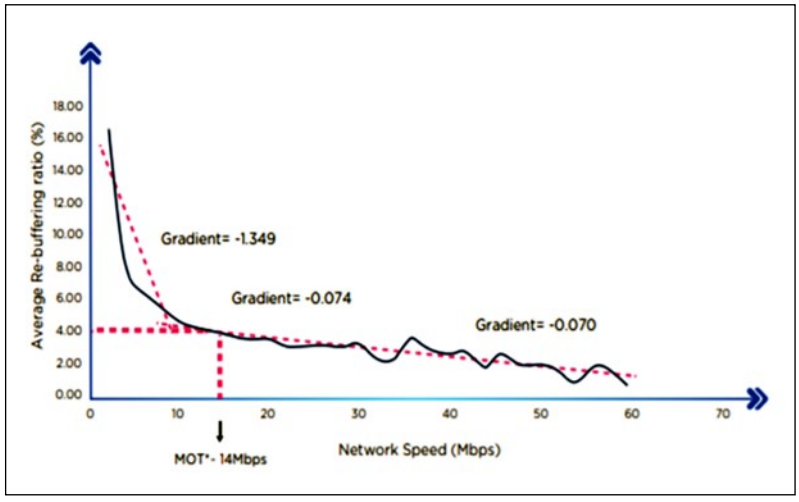

Figure 2: Variation of Re-buffering ratio (%) with Network Speed (Mbps)

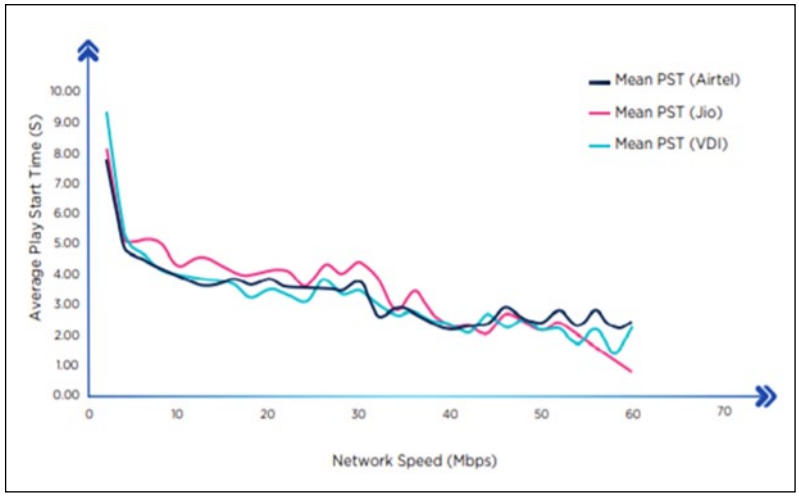

Figure 3: Variation of Play Start Time (s) with Network Speed (Mbps) (Across Operators)

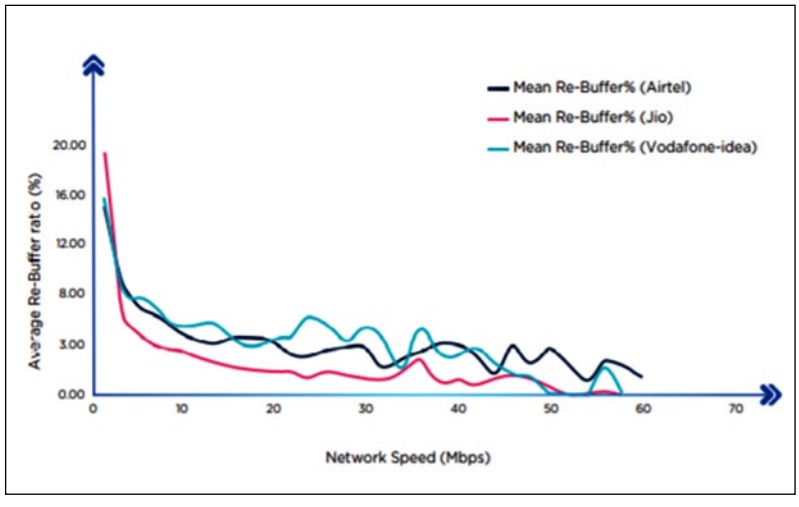

Figure 4: Variation of Re-buffering ratio (%) with Network Speed (Mbps) (Across Operators)

impact on the user's perception. When network speeds go beyond 14 Mbps the rebuffering rate too drops below 4%. Thus, delivering a video rebuffering rate of below 4% is critical. *(See Figure 2)*

Operators must focus on the Minimum Operating Threshold (MOT) for delivering the right user experience: MOT is a function of video optimization performed at the Core and transport architecture. The study has found variations across operators in terms of the MOT i.e. the minimum speed necessary to deliver PST/Re-buffering rate necessary for quality video experience for end user. Jio, for example was able to deliver a better PST and Video Rebuffering rate at the same network speeds as compared to the other operators, especially when the speeds were low. Airtel was only marginally better than Vodafone Idea. This goes to show that investments must be made beyond the radio network, on building a strong backhaul, content delivery core and better peering partnerships with OTTs. *(See Figure 3 & 4)*

Collaboration between operators and apps is critical for the end user experience: The study found significant variances between apps in terms of the PST delivered for a given network speed. Youtube and Hotstar for example, perform extremely well even under poor network conditions. Netflix deteriorates in PST performance under poor network conditions but as soon as speeds get to 10Mbps it dramatically improved in performance to match that of Youtube. Similar trends were observed for rebuffering rates too. (See *Figure 5 & 6)*

The data thus clearly shows the need for investments in a robust content delivery network, streamlined application architecture, and putting in place thorough testing and debugging mechanism within their organization around application experience.

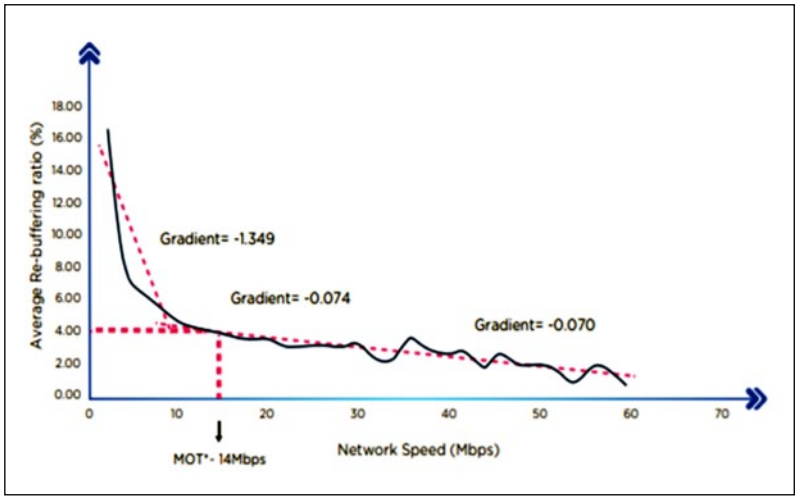

Figure 5: Variation of Play Start Time (s) with Network Speed (Mbps) (Across Video Apps)

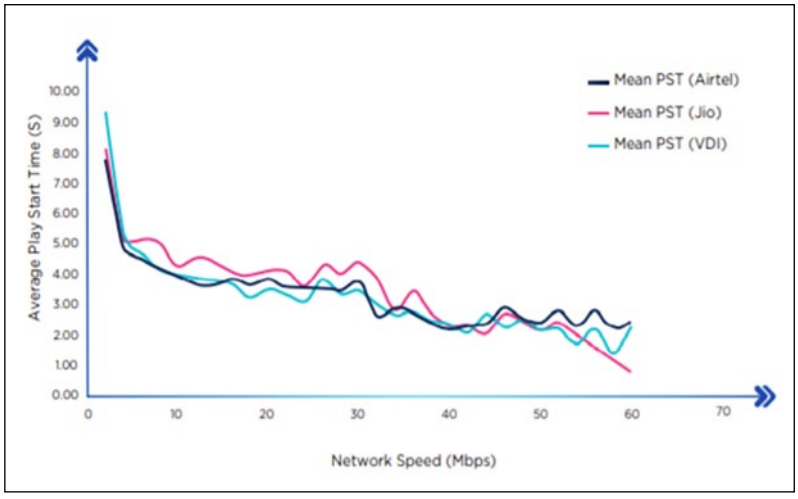

Figure 6: Variation of Re-buffering ratio (%) with Network Speed (Mbps) (Across Video Apps)

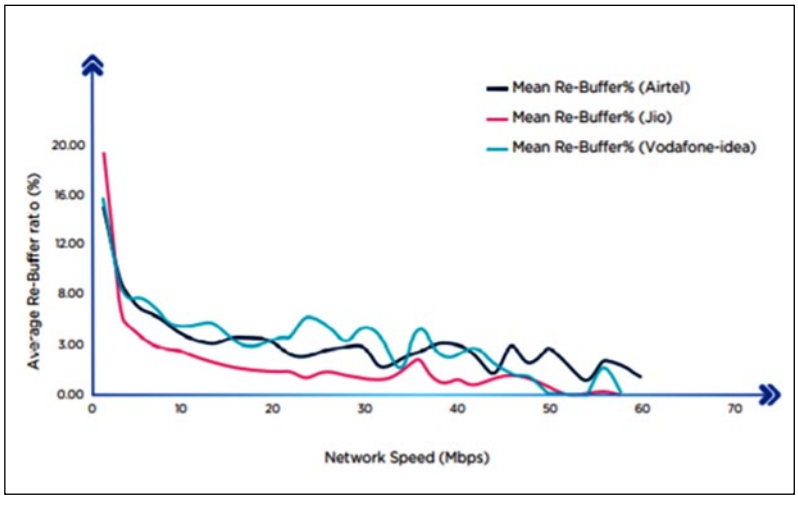

Figure 7: Monthly trend of Speed tests above MOT*

A long way to go before India can deliver the MOT network speeds for ideal video experience: Despite the improvements, we still lack the ideal network performance necessary to deliver seamless video experience across the country. The number of samples that were above 14Mbps hardly touched 20% across the country. Operators need to continue investing in expanding their site footprint, spectrum, fiber to deliver a consistent 14Mbps network speed so that Indian users can enjoy an ideal video streaming experience. *(See Figure 7)*

The analysis of more than 6-months network performance data of the country's top three operators shows that the network performance clearly saw a dip during the lockdown period due to increased traffic and operational hindrances on the field. However, the performance showed an improvement trend and is very close to being back to pre-COVID-19 levels.

Preparing for the future

The MOT may vary for each use case. Network planners need to think about what use cases they want their networks to support and start designing their networks to deliver the MOT required for that use case. This in fact will become a key design factor with 5G as every use case will have a designated SLA.

The study done by MOZARK also highlights the fact that The time has come for network operators and regulators to focus on the metrics that matter rather than those that are just easy to measure. Thequality of service measurements also need to become more sophisticated to not just be focused on quantity of data points of metrics that are easy to measure (e.g. network speed) but focus on measuring the end user experience.

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25 years of mobile telephony

The sector has evolved from 2G to 4G and is fast moving towards 5G. It is time regulators provide the necessary framework for its success

Pradeep Chakraborty

India has completed 25 years of mobile telephony on June 31, 2020!

I remember, in 1995, borrowing a mobile phone from Nani Naryanan, then, of Motorola, to make a call to my wife, using a mobile phone. Back then, each call cost about Rs. 16 per minute! The incoming calls were also charged.

I moved overseas, and was witness to a literal revolution of telecom. First, came high-speed circuit switched data (HS-CSD) in 1997, followed by general packet radio services (GPRS). It was the first time I saw a demo of how the car could respond to mobile phone and traffic signals.

I bought my first ever mobile phone in Hong Kong — the Nokia 5110. It had replaceable face plates, a thing unheard of, back then. It also had a game, called Snake, which got very popular.

The Nokia 5110 had replaceable face plates, a thing unheard of, back then. It also had a game, called Snake, which got very popular

Then came the visit to Ericsson, to Stockholm and Kista, in 1999. I was presented an Ericsson phone by Ake Persson, former President of CDMA Systems Business Unit, Ericsson Wireless Communications Inc. Ericsson bought Qualcomm's CDMA business. Back then, Ericsson bought Qualcomm's terrestrial CDMA wireless infrastructure business.

In 2000, there were talks about a revolutionary technology, called TD-SCDMA or time division-synchronous CDMA. That was the first experience I had with 3G technology. Later, I visited Siemens in Germany, in August 2001, where Klaus Maler actually showed the phone for public use. I even have a T-shirt with TD-SCDMA printed at the back.

In December 2002, in Hong Kong, some friends from India were unable to call back home as they weren't on roaming. I had to lend them my phone to call. On the contrary, I was myself once stuck in Munich, around 2004, as I wasn't on roaming and couldn't call. I had to seek help from a 'friend' at the airport. In places across the Asia Pacific, such as

Hong Kong, China, Taiwan and Singapore, people bought local SIM cards to save on roaming costs. I've done the same on several occasions.

China Mobile selected ST-Ericsson's (yes, STMicroelectronics and Ericsson combination) company in China, T3G, as a major technology partner for the development of its high-end and low-cost handsets, based on TD-SCDMA.

Then, came LTE or 4G! I remember attending the Asia Pacific conference, while based in Hong Kong, when it was introduced by NTT DoCoMo. The difference was immediately obvious! Suddenly, I could access emails and do hotel bookings via the cell phone.

In 2008, while in Limoges, France, I got into a car, only for it to talk back to me, saying, please fasten your seatbelt! We were (are still are) not used to such things! :) In 2015, while in Singapore, I bought a new phone running on 4G LTE. Wow! It was superfast! I could do many more things using my cell phone.

Now, we are in the realm of 5G! Just last year, in Austin, Texas, a friend showed me a pre-5G phone. The features were quite good. Early in February, at the 5G Huddle, Adrian Scrase, CTO, ETSI said we are all looking at connectivity for everything.

According to him, Rel 15 NR was delivered to meet the market needs. Rel 16 involves huge work from the 5G community. Rel 17 is IoT driven. There will be more 5G support for verticals. There are new enhancements for radio and system in Rel 17. The overall RAN timeline for Rel 17 has a 15-month gap. So far, only 5G NR (new radio) has been launched.

In 2000, there were talks about a revolutionary technology, called TD-SCDMA or time division-synchronous CDMA. That was the first experience I had with 3G technology

There is a major push to add more use cases and accelerate releases, which are driven by the demand side. A corresponding response is needed from the supply side. Scale will be essential to close the gap.

In India, it is important to see how fast are the regulators willing to ensure that the necessary framework exists for success of 5G.

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RNI No. 59233/94. Published on 1st of every month. DL(S)17/3114/2018-20. Licensed to Post WPP. U(SE)62/2020.
Posting Date: 4&5 of every month. Posted at Lodi Road HPO.