12. Where India Stands with Advancing Technology

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Abstract

The year 2019 has witnessed an exceptional increase in the adoption of the internet at a global level. The count of network nodes has increased up to 21.7 billion which was four when the first data packets were transmitted back in the year 1969 [1][7]. We have noticed the change in the pattern of how technology is being used. Today, an average of 74,500 GB of data is sent over the internet every single second. It has been noted that the overall growth has slowed down despite the fact that with each passing year millions of new users come online. The problem of last-mile connectivity still persists. A huge population all over the world is not yet connected.

With the 5G rollouts and trial, the expectation is to reduce the gap in connectivity and communication as much as possible. 5G aims to provide rural connectivity by establishing a digital infrastructure along with ultra high speed and energy-efficient services. As the world will migrate towards the fifth generation of telecommunication 5G, the bar of expectations is way higher than the successive generations. 5G holds the potential to affect life in all possible aspects; from health to education to businesses to economic growth etc. Expectation is that 5G will be the key to IoT and Industry 4.0. Smart cities, Industrial IoT, augmented reality, autonomous transport and digital health are just some of the exciting prospects that can be made real with the support of the 5G.

Keywords—*5G, Broadband Internet, Rural Connectivity, Indian Villages.*

INTRODUCTION

The internet always been at the intersection of challenges, risks and enormous oppurtuniities in various sectors. The new business approaches and initiatives are extracting the best from the internet adoption. Providing seemless connectivity will not only transform individual's life but it will add a huge percentage into the Nation's economy, digital ecosystem, education, health, etc. and will form the foundation for a sustainable solution. According to ITU, 2019 marks the first full year when more than half of the world has begun to participate online in the global digital economy [7]. 5G internet will cover up to 65% of the world's population by the end of 2025 [4].

A. What is 5G?

5G is amalgamation of technologies specified by 3GPP's varios releases[2]. It is expected that Release 16 will completely define 5G system. It will include variety of topics: Multimedia Priority Service, Vehicle-to-everything (V2X) application layer services, 5G satellite access, Local Area Network support in 5G, wireless and wireline convergence for 5G, terminal positioning and location, communications in vertical domains and network automation and novel radio techniques. Further items being studied include security, codecs and streaming services, Local Area Network interworking, network slicing and the IoT.

The mobile communication services will continue to cater to a wider business sector, public security and civil defense services. The fifth-generation cellular network technology has three main usages:

- Enhanced Mobile Broadband (eMBB) - standard consumer usage.
- Ultra-Reliable Low Latency Communications (URLLC) - used for mission-critical applications that require uninterrupted and robust data exchange.
- Massive Machine Type Communications (mMTC) - connects a large number of low-power devices in a wide area.

Under the flagship of IMT-2020, it will continue to develop 5G standards[3]. To evaluate the technologies and frequency bands for the next generation of mobile communication, 5G trials and pre-commercial activities are underway. It will be difficult to have a global standard for 5G as each participating country has its own definition, concepts for 5G speed and regulations for spectrum and transmissions.

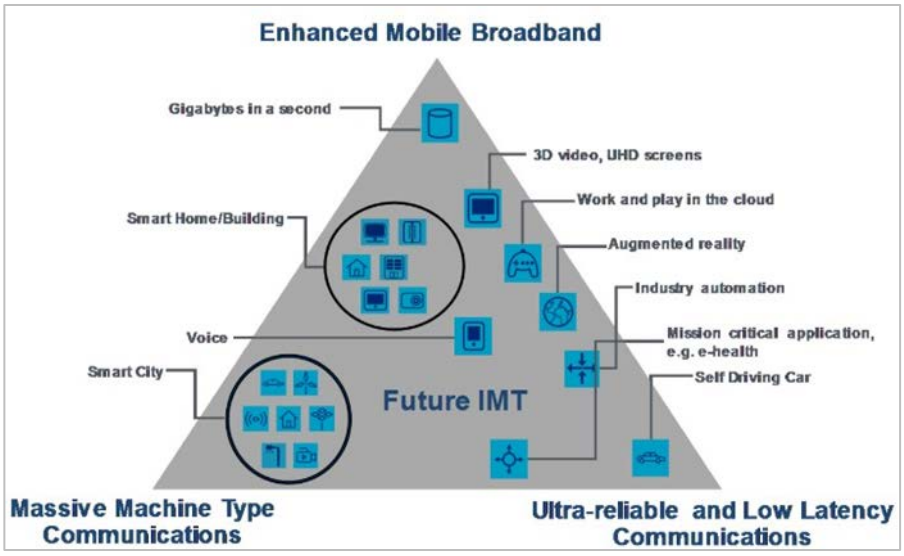

Figure 12-1 5G Usage Scenario [3]

B. Use Cases

To justify the hike in costs for 5G infrastructure and device, 5G mobile networks have stood on the capabilities which are beyond 4G networks. Some of the most promising use cases of 5G networks can be summarized as follows;

Smart automobiles- The autonomous vehicle (AV) will be critical as it connects people with near-zero latency and any lack can cause lives. This will be massive machine type communication with necessary high coverage and low power consumption.

Ubiquitous Broadband and media- Achievable user experience for high-quality broadband service both upload and download with seamless connectivity regardless of densification or extremely remote locations.

Critical services and infrastructure control- 5G brings high reliability and low latency required to control critical services and infrastructure. This unlocks new opportunities for public safety, government, city management, and utility companies.

Massive human-bond interaction- IoT will be accessible by everyone to include context-awareness in daily lives. It will fill the gap between human and IoT nodes and services.

Sensors network- Businesses will grow with the opportunities through monitoring, tracking and automation on a large scale - from connected farms and agriculture to smart cities and buildings.

Healthcare. The availability of low-latency connectivity in rural areas would revolutionize critical care treatment for individuals nationwide.

C. Why 5G will be critical?

5G networks will amalgamate high speeds with reliable infrastructure for mobile devices, which will form the cornerstone. Based on promises made 5G will provide an average download speed of minimum 1GBps, which is average of 12-30Mbps with the 4G networks. 5G is comprised of several technology projects in both communications and data center architecture, all of which must collectively yield benefits for telcos as well as customers, for any of them to be individually considered successful. The research and innovations are broadly catergorised into following categories:

Spectral efficiency– Since the spectrum and frequencies are limited, 5G tends to come up with solutions to optimize use of multiple frequencies and enhancing the coverage to extended distances.

Energy efficiency– 5G should propose economical and efficients ways in which it will not add an overhead costs and effort to reduce cooling costs and keeping the environment green.

Utilization– To afford the tremendous communications infrastructure overhaul that 5G may require, telcos may need to create additional revenue generating services such as edge computing and mobile apps hosting, placing them in direct competition with public cloud providers.

With the full-fledged 5G deployment, it is said that the wires will vanish from the communication mainstream be it fixed devices or autonomous vehicles. The problem of rural connectivity will be solved with the delivery of complete digital connectivity from the tip of the carrier network to the customer.

D. Key Features

The key features of 5G networks will include following and more;

- *Converged service for unified carriers*
- *Small cell infrastructure*
- The global technology economy

Once complete, the 5G transition plan would constitute an overhaul of communications infrastructure unlike any other in history. The paradigm shift from 4G to 5G is not so much to get faster as to make the wireless industry sustainable over the long term, as the 4G transmission scheme is approaching unsustainability faster than the industry experts predicted.

In 2020, a typical 5G smartphone will be similar to any smart device supporting both/either 5G non-standalone (NSA) and/or 5G standalone (SA) mode and have support for;

- 5G carrier aggregation
- Spectrum sharing
- Low-band FDD and mmWave frequencies (as well as mid-band)

STATE-OF-THE-ART

5G currently making an impact as it strengthens its grip over the global market and built its network across the world[4]. With its roll-out in South Korea, 5G subscription touched the figure in millions in just a few months and the expectations are that it will reach up to tens of millions globally with the start of 2020. 3GPP gained acceleration with 5G specifications for early delivery, forming a strong platform for other industries to flourish.

Presently, 2G, 3G, and 4G networks are dominant throughout in respect of the investments, traffic, and subscriptions. Thus the 5G networks are expected to improve and enhance existing networks for greater userexperience and performance for day-to-day business.

A recent survey [4] suggested that by 2025, some 65 percent of the world's population will be covered by 5G cellular networks which will generate 45 percent of the world’s total mobile data traffic. With the ongoing 5G network testing, development, trials, and deployments across the world, some 1.5 billion mobile users will have subscriptions with 5G services in that same time period, with average expected monthly data usage of 21GB per

user as the faster networks allow more productivity and data consumption. That's about four times the amount of data expected to be consumed by the average user per month in 2018. It is expected the 5G adoption will be much faster than 4G. The stats estimates some 2.6 billion 5G subscriptions are expected by 2025 which in the case of 4G networks was about 1 billion subscriptions after six years. A total of 52 percent of all mobile subscriptions are now for LTE. 8.9 billion mobile subscriptions by the end of 2025, out of which around 90 percent will be for mobile broadband.

VoLTE is the foundation for enabling globally interoperable voice and communication services on 4G and 5G devices, providing high-quality services to consumers and business users. VoLTE subscriptions, estimated at 2.1 billion at the end of 2019, are projected to reach 6.4 billion by the end of 2025 and to account for more than 85 percent of combined LTE and 5G subscriptions.

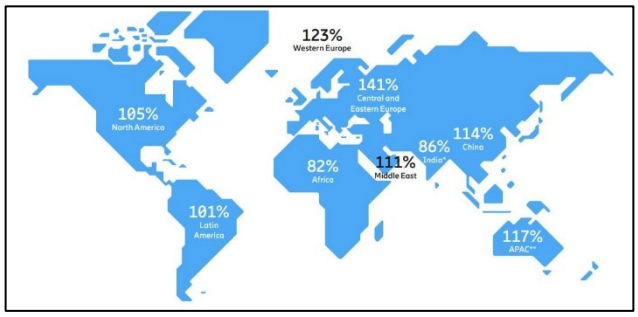

Figure 12-2 Subscription Penetration in 2019 [4]

A. 5G Worldwide

Many operators and giants in telcos are involved in 5G trials since early 2018. Auction for spectrum in 28GHz bands followed by 24 started in November 2018. The FCC approved a plan to make more spectrum in the 37 GHz, 39 GHz, and 47 GHz bands available for the highest-speed communications tier for 5G wireless, called millimeterwave (mmWave). Following are some of the trials going around [6];

- 5GRIT a UK Government project is demonstrating technologies for rural connectivity and targeting to benefit farmers.
- *Verizon's* 5G Home, a broadband Wi-Fi service that bundles wireless phone with nolonger-cable TV service at a very pocketfriendly cost using wireless spectrum marked for 5G.
- *AT&T's "5G Evolution"* targets mobile devices under 4G LTE transmitter service upgraded to 5G specifications. The transmitters used frequencies over and above 4G LTE reserved frequencies to provide, in addition to those already being used, for greater multiplexing and presumably greater bandwidth, although phones
- *AT&T's "5G+"* a mobile hotspot service that uses a prototype of the very-high-speed mmWave technology that is being earmarked for 5G, in addition to existing 4G LTE.
- Many operators have live demonstrations in sports events such as:
    - Korea Telecom in the Winter Olympics in Pyeongchang (in February 2018),
    - Verizon in the super bowl game in the New York City (in February 2018)
    - Telstra at the Commonwealth Games in Gold Coast, Queensland in Australia (April 2018).

About 61 countries agreed on introducing reservd spectrum bands to support 5G trials and innovations for terrestrial services. These countries are in allocating spectrum for use through auctions. Finland, Germany, Italy, Ireland, Latvia, Spain and the UK have already completed auctions of 5G spectrum and thirteen other will complete auction by early 2020 [6][7].

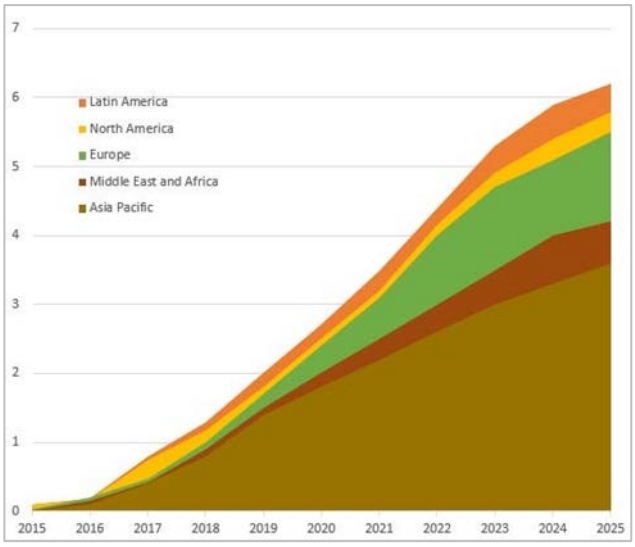

Figure 12-3 VoLTE subscriptions by region in billion

The rural communities long for a reliable connections that urban areas have enjoyed for the past decade. Ericsson partnered with Nex-Tech Wireless to enhance Kansasbased carrier's network to support 5G capabilities in addition to the launch VoLTE and Wi-Fi Calling services. Ericsson will exploit its cloud-based IMS solution and New Radio (NR) hardware and software.

Ericsson also alliance with the Rural Independent Network Alliance (RINA) Wireless to make 5G reach to American outskirts with existing Ericsson 4G Core and Radio Access Network (RAN) [4].

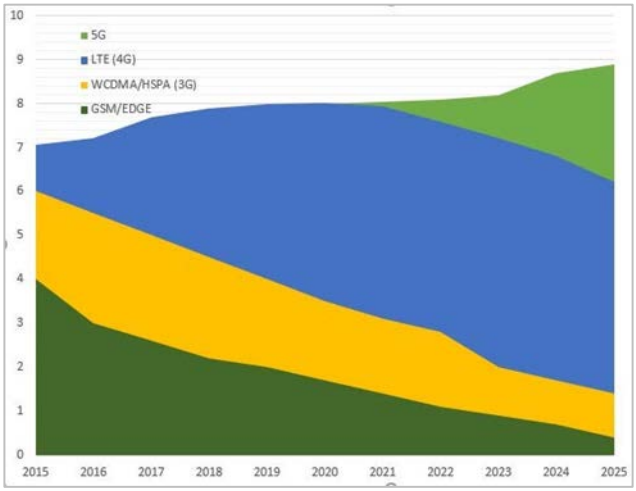

Figure 12-4 Mobile Subscriptions by Technology

B. 5G Initiatives India

India is taking huge steps to have broadband connectivity throughout. Various government initiatives and policies have been supporting different companies to develop digital economies, fostering digital transformation in government services and digital transitions across all sectors [8]. To have digital ecosystem, high speed and ubiquitous internet is elementary.

The National Digital Communications Policy [11], 2018 was envoked to unravel the transformative power of digital communications networks - to achieve the goal of digital empowerment and improved well-being of the people of India. The policy aims to provide broadband to all, Digital Sovereignty and to established

connected last mile. Digital India programme launched by Government aims to provide last mile connectivity to India's smallest towns and villages. The policy has envisaged attracting investments worth US$ 100 billion in the sector by 2022.

LWE BTS, a solution currently implemented in rural regions which provide Wi-Fi services. The Left wing Extremism (LWE) are the aeas in India categorized by poor socio-economic indicators [11]. The Wi-Fi infrastructure was installed at existing BSNL towers where Backhaul was provided by BSNL, through unlicensed radio channel.

The National Broadband Mission (NBM) launched December 2019, has the vision to fast track growth of digital communication infrastructure, bridge the digital divide, facilitate digital empowerment and inclusion and provide affordable and universal access of broadband for all by 2022. The mission also involves Development of Broadband Readiness Index to measure the availability of digital communications infrastructure, and foster conducive policy ecosystem within a State/UT [12].

TELECOMMUNICATION IN INDIA

In India, promotion of a competitive market for digital services, particularly for low-income consumers, saw the overall number of broadband subscribers reach 553.54 million as of April 30 2019 [9]. Airtel in India has also published a database showing all its 2G and 4G tower and network coverage data [10].

India is currently the world's second-largest telecommunications market with a subscriber base of 1.20 billion and has registered strong growth in the past decade and half [6]. As of January 2019, India has witnessed a 165 per cent growth in app downloads in the past two years. 4.8 billion downloads of mobile applications were registered in India in first three months of 2019. India ranks as the world's second largest market in terms of total internet users. The number of internet subscribers in the country increased at a CAGR of 45.74 per cent during FY06-FY19 to reach 636.73 million in 2018-19. Total wireless data usage in India grew 119.00 per cent year-on-year to 17,940,576 terabytes between April-June 2019. The internet subscribers reached 665.31 million till June 2019.

Further, India is also the world's second largest telecommunications market, total telephone subscriber base and tele-density reached 1,195.24 million and 90.52 per cent, respectively, at the end of September 2019.

In the India region, LTE subscriptions are forecast to increase by 150 million during 2019 and pass GSM/EDGE as the dominant technology. Mobile broadband technologies will account for 57 percent of mobile subscriptions at the end of the year, and the share of smartphone subscriptions is expected to have increased from 48 percent to 54 percent. As the transformation toward more advanced technologies continues in India, LTE is forecast to represent 80 percent of mobile subscriptions by the end of 2025. 5G subscriptions are expected to become available in 2022 and will represent 11 percent of mobile subscriptions at the end of 2025.

In the India region, the average monthly mobile data usage per smartphone has seen an extraordinary increase in recent years, becoming the highest in the world. A key factor has been the rapid adoption of 4G, boosted by a disruptive entrant in the market in 2016. Low prices for mobile broadband services, affordable smartphones and people's changing video viewing habits have continued to drive monthly usage growth in the region. Only 4 percent of households have fixed broadband, making smartphones the only way to access the internet in many cases.

As per a recent government data, Reliance Jio, on an average, has installed a telecom tower in every second village as against one in ten villages by BSNL. All other operators including Bharti Airtel, Vodafone India and Idea Cellular have put up a telecom tower in every fifth village.

At the end of November 2018, Reliance Jio had 2,63,775 telecom towers installed in 4,85,297 villages where it has offered services whereas Airtel had just 96,032 towers in rural areas covering 5,10,362 villages. Similarly, Vodafone Idea cover 471693 villages with 101704 towers. BSNL, the state-run operator, covers 430934 villages with just 43239 telecom towers.

In last three years, Airtel has extended its mobile services to 2686 villages, Vodafone Idea has extended to 83354 villages, BSNL has extended to 14052 villages, whereas Jio has extended the same to 305248 villages.

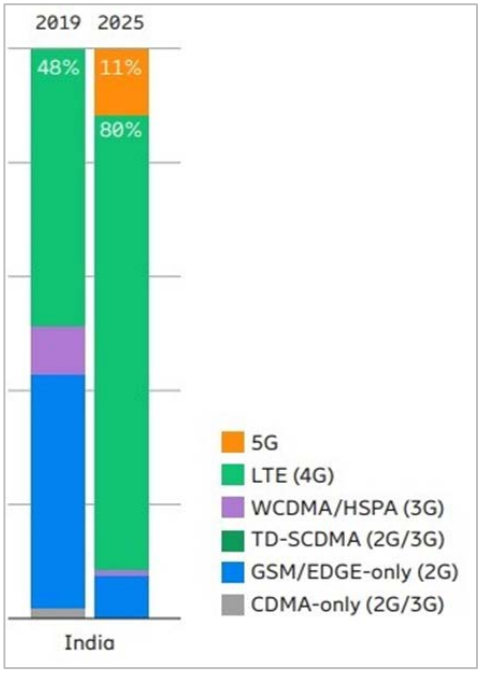

Figure 12-5 Technologies in Telecommunications

CHALLENGES AND POSSIBILITIES WITH INDIA

In defiance of considerable developments on the 5G facade, still India lacks network connectivity in most part of the parts. There are areas, which are technically termed as “Outage Zone” and we are no where closer for the 5G to be rolled out soon.

A. Why India facing Challenges for 5G

Over 43,000 inhabited villages in India do not have mobile phone services. The number of inhabited villages without mobile services stood at 43,088 as on July 27, 2018 (based on 2018 Survey) out of 5,97,618 inhabited villages in the country as per census 2011.

Villages can be classified as small, mid-sized or large based on area and population, and can be located in hilly or plain areas. And wireless network topology depends on factors like size of village, distribution of residential houses and terrain map of village.

Broadband technology allows high-speed transmission of voice, video and data over networks and ICT applications. This, along with community antennae, optical fibres, satellites and fixed mobile wireless technologies, can also be used in rural areas effectively. The ability to access the Internet can bring a positive impact on the rural society. However, there is a wide digital divide between urban and rural areas in India, because of uneven distribution of basic telecom infrastructure.

Further, poverty and lack of education are also factors responsible for the lack of advancements in wireless technology in rural areas. Social interaction can be obtained between urban and rural masses through social media channels such as Facebook, Twitter, WhatsApp and the like. Wireless connectivity in rural areas can also reduce poverty, create jobs, and increase skills and income of the population.

To overcome the lack of Internet connectivity for undeserved communities, Digital Employment Foundation and Internet Society jointly launched Wireless for Communities (W4C) initiative in October 2010. This project includes training rural communities on different wireless technologies, among others.

B. Telecommunication Reality in India

India has no dearth of technological and business innovations for rural areas. However, telecom policies and scams have created a negative impact on the growth of this sector in rural India. Certain policies have forced Internet service providers to rethink their investments there.

Spectrum plays a crucial role in delivery of 5G services. The Department of Telecommunications (DoT) has identified 35 MHz of spectrum in the 700MHz frequency band, and 300 MHz of spectrum in the midrange band of 3.3GHz to 3.6GHz. However, of the 35 MHz of spectrum in the low-frequency (sub-1GHz) band, Indian Railways has demanded 10 MHz, leaving only 25 MHZ for telecom operators. Even the 300 MHz of spectrum from the midrange band is not fully available for telcos. In this band, the space and defence departments have staked claim to 25 MHZ and 100 MHz units, respectively, leaving only 175 MHz of spectrum for telecom operators.

The Indian telecommunications sector has grown rapidly in the last few years. India now has the second largest network in the world, next only to China. In rural areas, tele-density was 56.87 per cent, at the end of August 2017, whereas in urban areas, it was 173.72 per cent.

To enable India’s transition into a digital economy and knowledge society, large investments in infrastructure, both in optical-fibre cables and towers, for wireless transmission are required. The government is committed to extending the reach of mobile networks to around 50,000 remote, rural villages, with support from Universal Services Obligation Fund (USOF). In addition, investments are being made to lay optical-fibre cables for high-speed broadband connectivity in rural areas.

Nine states seem to be holding back India's race to achieve full rural connectivity by 2019 with Assam, Jammu & Kashmir and Jharkhand topping the list, according to a central government assessment.

5G and Global Warming

In May 2017, AT&T President of Technology Operations Bill Hogg declared the existing wireless business model for cell tower rental, operation, and maintenance "unsustainable." Some months earlier, a J. P. Morgan analyst characterized the then-business model for wireless providers in Southeast Asia as unsustainable, warning that the then-current system has rendered it impossible for carriers to keep up with customer demand. And as research firm McKinsey & Company asserted in a January 2018 report, the growth path for Japan's existing wireless infrastructure is becoming "unsustainable," rendering 5G for that country "a necessity."

The world's telcos need a different, far less constrained, business model than what 4G has left them with. The only way they can accomplish this is with an infrastructure that generates radically lower costs than the current scenario, particularly for maintaining, and mainly cooling, their base station equipment.

Cooling and the costs associated with facilitating and managing cooling equipment, according to studies from analysts and telcos worldwide, account for more than half of telcos' total expenses for operating their wireless networks. Global warming (which, from the perspective of meteorological instrumentation, is indisputable) is a direct contributor to compound annual increases in wireless network costs. Ironically, as this 2017 study by China's National Science Foundation asserts, the act of cooling 4G LTE equipment alone may contribute as much as 2% to the entire global warming problem.

According to ITU, 2019 marks the first full year when more than half of the world has begun to participate online in the global digital economy. This year also marks the 30th birthday of the World Wide Web, and 25 years since the first e-commerce transaction.

CONCLUSIONS

It is a capital improvement project the size of the entire planet, replacing one wireless architecture created this century with another one that aims to lower energy consumption and maintenance costs. It's also a huge gamble on the future of transmission technology, doubling down on consumers' willingness to upgrade.

Once complete, the 5G transition plan would constitute an overhaul of communications infrastructure unlike any other in history. The paradigm shift from 4G to 5G is not so much to get faster as to make the wireless industry sustainable over the long term, as the 4G transmission scheme is approaching unsustainability faster than the industry experts predicted.

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