



Connectivity Of The Future:

5G The Gamechanger

December 2021

home.kpmg/in



Table of contents

Foreword	1
Executive summary	3
Telecom service providers (TSPs)	11
Original equipment manufacturers (OEMs)	19
System integrators	25
Device manufacturers	31
Infrastructure players	37
About KPMG in India's 5G Advisory	45





Foreword

COVID-19 has fuelled an entire digital ecosystem where operating from anywhere has gained significant traction. The year 2021 and beyond marks a new era with accelerated transformation in almost every industry. Organisations have quickly adapted to the new ways of operating remotely and in a hybrid model. Mainstream use of AI, IoT, AR and VR technologies in sectors such as education, healthcare, consulting and retail has brought about a need for high-speed and high-bandwidth internet, which 5G has the potential to fulfil, creating a robust demand for it.

While 4G has been instrumental in driving the data revolution, 5G has the potential to transform every facet of digitalisation. Flexibility, speed and capacity are some of the strengths of the 5G cellular communication network. Additionally, 5G has created new business opportunities previously not imagined in areas such as smart factories and their automation, immersive experiences through AR/VR, cloud gaming, wireless broadband, healthcare and telemedicine. To drive this, the industry is witnessing significant collaborations between telecom service providers

(TSPs), original equipment manufacturers, system integrators, device manufacturers and infrastructure providers to create a holistic 5G ecosystem in India.

Apart from bolstering B2C applications, 5G can enable businesses and individuals to operate machines and devices in real-time from anywhere in the world. This can potentially save millions of lives and optimise resources. 5G coupled with AI and automation can help enterprises tap into numerous opportunities and use-cases, those already existing, as well as those yet to emerge.

In recent times, the Government of India rolled out the Product-Linked Incentives (PLI) scheme, which has created an environment that fosters innovation, collaboration and the rigor needed to manufacture devices in India. Support is necessary now more than ever, as supply chains are being localised, 5G is emerging globally, and India is ripe with potential armed with a digitally driven population. Further, the recent reforms introduced by the government to ease the financial and operational hurdles cement the



government's intention to create a robust telecom ecosystem that is geared to adopt 5G in the country.

Although there have been delays caused in the implementation of 5G in India due to regulatory uncertainties and issues related to affordability of spectrum, it is expected to be the gamechanger in the Indian telecom industry with support from the government and robust partnerships being formed locally and internationally. The innovation and progress made in 5G is expected to act as a

catalyst in the overall growth of the TMT sector and expedite India's digital transformation.

In association with IMC and COAI, KPMG in India is proud to present the report, '*Connectivity of the future: 5G The Gamechanger*'. The report provides insights into how the 5G environment is developing along with the readiness levels of different ecosystem players. It also delves into how a smooth transition to 5G can be made by addressing the issues that initially plagued the implementation of the latest cellular communication standard.



Arun Kumar

Chairman and CEO,
KPMG in India



Yezdi Nagporewalla

CEO Designate,
KPMG in India



Satya Easwaran

Partner, Head of TMT and Business
Consulting, KPMG in India



K G Purushothaman

Partner, Advisory and Head of Telecom,
KPMG in India



Executive summary

After achieving digital dominance by becoming the second largest telecom market¹ and having the second-largest internet user base, India is all set to accelerate the digital penetration in the country as it is getting ready to adopt 5G. With 5G opening the window of promising opportunities for ICT industry to move beyond just connectivity, in this report, we have presented our point of view on what 5G means to TSPs, device manufacturers, infrastructure providers, system integrators and technology players, and OEMs. The report also outlines major challenges and expectations from the ecosystem as it relates to each segment. By the end of 2030² there are expected to be 611.97 million 5G connections in India. With immediate promise of applications of fixed wireless access, 5G is expected to bring a significant transformation in the society by taking gigabit speed connectivity to small towns and villages. The industry is betting on enhanced mobile broadband (eMBB) applications to gain momentum in the initial phase of 5G launch

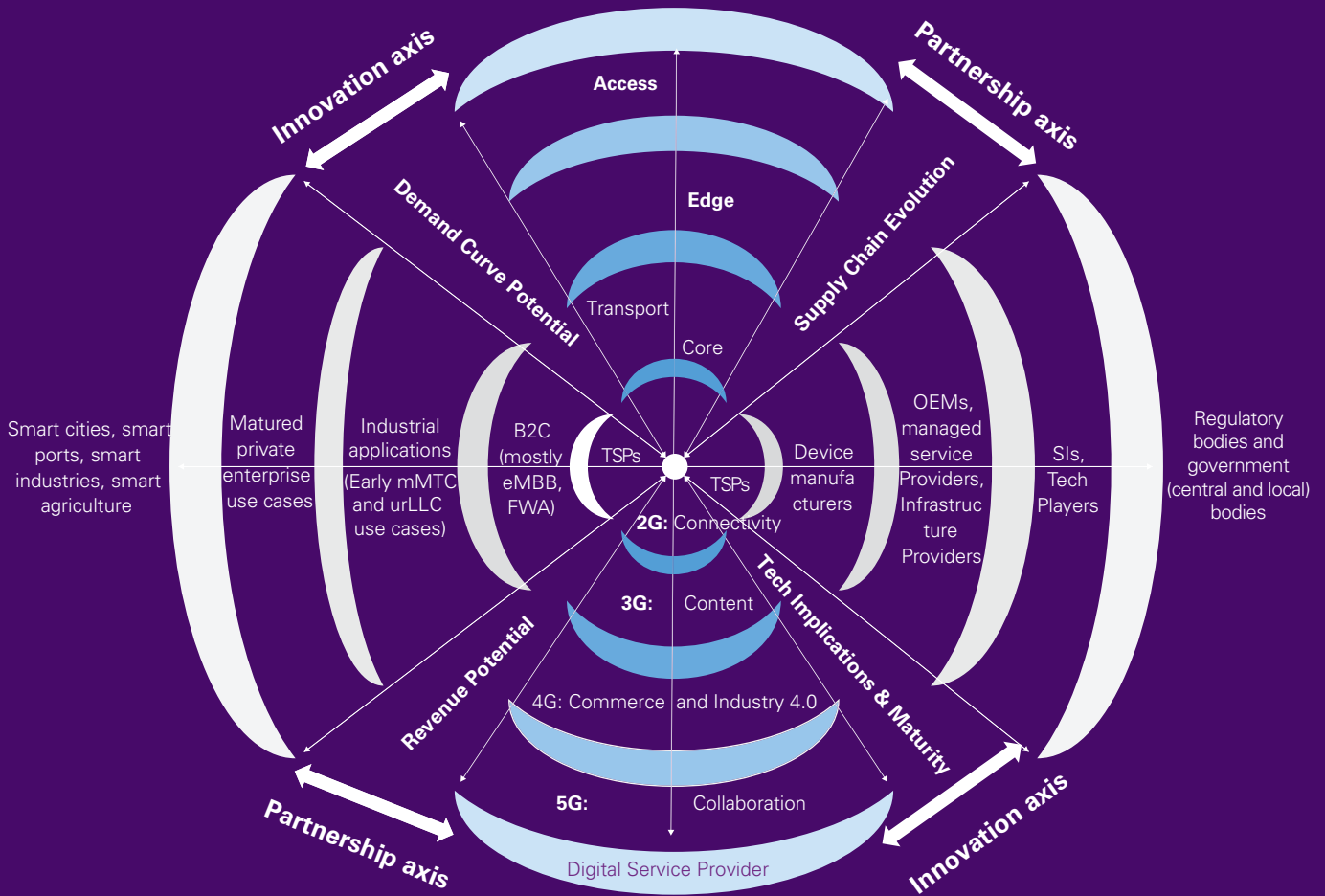
with the real RoI to start justifying once massive machine type communication (mMTC) and ultra-reliable low latency communications (URLLC) use cases become main stream. Given the readiness of the industry, digital infrastructure and the existing challenges of adoption of some of the emerging technologies such as Industry 4.0, IOT, AI etc., KPMG in India estimates the URLLC use cases to gain maturity in four to five years' time from the launch of 5G in India. However, considering the immense automation demand from the industrial sectors which can be supported by the existing technologies such as 4G LTE, NB-IOT, the sector has started targeting the enterprise segment and has pivoted to cloud based virtualised network architectures with capabilities such as network slicing and multi access edge computing (MEC) that allow TSPs to provide solutions beyond just voice and data. However, to realise the true potential of 5G beyond the eMBB use cases, the ICT industry must come together as an ecosystem and create unified digital solutions.



1. Fitch India Telecommunications Report, 2021
2. Fitch India Telecommunications Report, 2021



The evolution of the Indian ICT industry as it readies itself for 5G:



Source: KPMG in India analysis, 2021

As the above chart demonstrates, as the Industry has been transitioning from different generations of communication technology it has been pivoting from voice, to content to commerce and industrial applications. However, 5G is going to be characterised by a TSP becoming a digital

services provider by collaborating with the entire ICT ecosystem to create mature private enterprise use cases where all components of networking including core, transport, edge and access will have to be strengthened on parameters like efficiency, performance, latency and customer experience.



Some of the key imperatives of achieving the above ideal state scenario include:

Telcos to become connected enterprises where front back and mid office are connected through cloud native architecture where the traditional OSS, BSS are transformed and made more nimble through newer technologies like containers, microservices, Kubernetes etc.



Build new 5G revenue streams: Leveraging the core (5GC or LTE) and edge capabilities to create use cases that solve industry, societal and governance problem statements through partnerships across the ICT ecosystem including OEMs, technology providers, device manufacturers etc, to speeden the time to innovate and go to market.



Telcos to adopt agile and DevOps methodologies to provide speed, agility, and scalability to its operations and make them more customer oriented.



Protect margins by reducing total cost of ownership (TCO): As the evolved use cases are being rolled out, the TSPs should leverage cloud native technologies to virtualise NFs that will allow reduction in network integration, maintenance and service cost thereby reducing the TCO and enhance customer experience.



Leverage digital to serve the customers better: To provide digital services to their customers, TSPs have to first become digital organisations with their core oriented towards customer centricity. By creating a unified one truth of the customer (leveraging data lakes, advanced analytics and AI), TSPs can predict customer behaviours and have an omni channel engagement and service model.



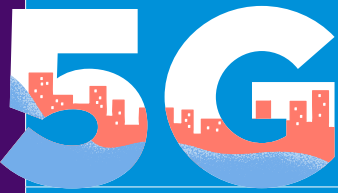




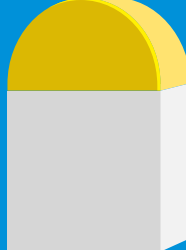

Key findings/segmental view

This report provides a segmental approach to understand the lay of the land and presents an overall picture of the 5G ecosystem. And is a culmination of various reports from KPMG in India insights, primary interviews with industry stakeholders and desk research. We have tried to summarise the segment's views on the opportunity in the 5G ecosystem; their key focus areas and challenges; readiness measures taken by the segment to augment its technological and business capabilities; and critical support that the segment needs from the ecosystem.

Segments → Point of views ↓	TSPs	OEMs	Technology companies/System integrators	Device manufacturers	Infrastructure providers
Opportunities emanating from 5G	The ultralow latency and speed promised by 5G along with evolution of network capabilities such as network slicing, MEC, and convergence of connectivity and technology to allow TSPs to provide advanced technological solutions and open new revenue opportunities	33 per cent of the capex spend is estimated to be on transmission networks so the overall pie is huge to capture. Enterprises and Industrial emerging as an independent customer segment as they embark on their digital initiatives	Technology players including System Integrators have a critical role in TSP transformation as they are pivoting towards 5G functionalities and as their OSS/BSS is undergoing an overhaul	Catapulting the 5G handset manufacturing capability to meet the massive 5G handset market that opens with the 5G launch in the country.	Opportunity to make the country's digital infrastructure 5G ready - vast and fast tower, fiber, and macro cell deployment with edge computing capabilities
	Technologies such as FWA to help broaden the rural reach of TSPs	Favorable for managed services models for OEMs (tailwinds from geopolitics)	Playing the role of an orchestrator as TSPs forge different partnerships for 5G solutions bringing to the fore their design, integration, implementation, and certification expertise (Bringing outside-in perspective)	Enhanced demand of connectivity devices as B2B 5G deployment increases, paving way for new models and new devices	Opportunity to monetise infrastructure investments through 5G use cases
Focus Areas	Increased bandwidth with more frequency channels for higher data needs; and greater data transport efficiency to channelize cost savings			Entry in new markets such as tech wearables, IOT devices; VR/XR/AR provides a niche opportunity	Creation of edge clusters for intensifying demand from data centres
	5G + Edge represents USD500 billion+ global opportunity and connectivity is just 11 per cent of that pie. So, forging partnerships to provide holistic technology solutions is key for TSP to move up the value chain	Shifting of supplier base from global to local	Creating solutions to assist TSPs in: <ul style="list-style-type: none"> Digitise and run 5G operations OSS and BSS modernisation Enable platform led solutions for TSPs to take to market 	Scaling up manufacturing facilities in India to provide cost efficient 5G devices in the country	Development of commercially viable 5G infrastructure including the backhaul and access
	Building a reliable, agile, programmable, scalable, and cost-efficient network through automation	Enhancing products for better ROI. Creating solutions and organisational capabilities to cater to new customer segments beyond the TSPs		Developing capabilities to function in both 5G NSA and SA environment	New business models with small cells and DAS ownership to be explored
	Creating ROI for B2C/B2B use-cases		Move towards outcome-based pricing environment	Addressing interoperability of the existing technology with the Indian standards (5Gi*)	
Lowering capex cost per bit of transmission	Creating innovative use cases around eMBB, URLLC, and mMTC through strategic partnerships		Addressing component shortages		





Segments Point of views	TSPs	OEMs	Technology companies/System integrators	Device manufacturers	Infrastructure providers
Readiness 	Initial focus is on network efficiency by tapping into partnerships with vendors across Open RAN; cloud and networking players; SI etc. Embracing an open horizontal hybrid cloud approach that allows Telcos to host telco and application workloads allowing multitenancy that will facilitate new solution hosting capabilities	Collaborating for inter-operable, inter-connected, and inter-dependent systems that no longer carry the risk of vendor lock-ins for TSPs (nascent stages)	Innovating open source led solutions that help TSPs through partnerships for creating future ready, scalable, and efficient networks	Boost manufacturing capacities under the PLI schemes for the three year period and then move towards R&D based asset/IP creation	<ul style="list-style-type: none"> • Access, data centre, transport, wholesale capacities to be enhanced multi-fold • Innovation in small cells, software defined components • Partnerships in open source 5G • Developing agile networking models • Engaged in skill enhancement • Public-private-partnerships still a WIP
	Working on enhancing B2C use cases focusing on commerce, connectivity, and content vortex	Still evolving verticalised private networking concepts, marketing, and launch strategies in India	Provide test beds in the form of COEs and IP factories to build cloud native, containerised, and virtualised network functions which are pre-integrated and pre-tested	Tap the hyperconnected, content driven, and commerce use cases (but needs an evolution for Indian device manufacturers)	Forging partnerships and access solutions to cater to both the B2B and B2C segment
	Preparing for the rural opportunity focusing on the opportunities presented by technologies such as fixed wireless access.		Technology companies are also playing the critical role of partnering with TSPs in developing indigenous 5G technologies. They have participated in the initial 5G testing and are proposing to be the one stop shop with platform led approach for TSPs in their 5G pursuits		
	URLLC could be the next step as SA architectures gain maturity	Roadmaps related to networking, policy and architecture on Open RAN, cloud RAN, cognitive sensing are still work-in-progress			Working along with various state governments to enhance the digital infrastructure across rural areas
Support needed 	Support in improving the financial health of the sector in the form of: <ul style="list-style-type: none"> • Rationalised spectrum pricing • Reduced levies and taxes • Minimum floor rates; overall liquidity • Better usage of USOF 	Roadmap on PLI schemes to serve end-to-end cost effective 5G scenarios	Support needed from regulatory bodies to formulate and scale key assets and IPs	Harmonisation of standards to ensure global compatibility for devices	Critical support needed for faster implementation of digital infrastructure across the country
	Robust 5G policies including harmonisation of 5G standards and availability of contiguous bands; E band usage for backhauling of traffic	Private networking regulations	Collaboration with NASSCOM under 5G relevant themes required across MSMEs, SMBs, large enterprises, and city clusters across industries.	Clarity needed regarding the licensing of additional wireless bands for security and privacy concerns in the sub 6GHz space	Government's financial support in implementing infrastructure in areas generating insufficient RoIs for private sector (improving liquidity for infrastructure)
		Road mapping on using satellite bands for backhauling of traffic- to ease out access issues	<ul style="list-style-type: none"> • Formation of an industry partnership programme for harmonisation in India • Allowing a few 100 MHz of licensed spectrum to be used for low-power Industry 4.0 applications • Simplifying MVNO related regulations to encourage platformisation 	Policy guidance needed from the government on Wi-Fi 6 and unlicensed bands for private networking to foray into the smart industry segment	<ul style="list-style-type: none"> • RoW and other operational hurdles to be resolved to increase the ease of doing business. • Need status of a REIT or InvIT to reduce the tax burden.

5G is a made in India standard created through a collaboration between multiple academic stakeholders and government entities and encouragement from International Telecommunications Union (ITU). 5G offers more range in the lower frequency bands as opposed to 5G. Based on primary interviews and KPMG in India analysis, 2021



01 Telecom Service Providers (TSP)





TSP: Opportunities emanating from 5G

5G in India is not just expected to augment the much-needed capacity for TSPs in the short term, but also improve reliability and latency for niche as well as broader use cases in the long term. TSPs expect to improve their top lines as well as contain costs by onboarding agile and open ecosystem of partners, suppliers, and vendors.

The ultralow latency for clustered synchronous communication; convergence of connectivity and technology for open networking will open up new revenue opportunities. On the other hand, increased bandwidth with more frequency channels for higher data needs; and greater data transport efficiency will channelise cost savings. Additionally, adoption of IoT, AI/ML, AR/VR, drones, and private networking technologies are expected

to make 5G a go-to technology for any B2C and B2B/B2B2X setup.

The Indian smartphone buyers are already future-proofing their purchases with 5G ready smartphones as 5G gains momentum globally. This futureproofing of handsets will help operators tap the low-hanging B2C 5G use cases initially across AR/VR, OTT video streaming, gaming and others.

The coupling of 5G and edge computing can create significant incremental value for those in the ecosystem including TSPs, software providers, hardware providers and service providers. The value opportunity for a TSP is determinant on how can they maximise their position in the ecosystem by seizing maximum value, or share of revenue, by capturing the market share beyond connectivity.

2023 5G edge computing global opportunity across select sectors (USD billion)

	Connectivity	Software	Hardware	Services
Gaming	33.0	113.3	47.2	42.5
Industrial manufacturing	12.4	72.2	61.9	59.9
Connected Healthcare	6.8	5.0	9.5	24.0
Intelligent Transportation	2.2	6.1	6.8	9.2
Environmental Monitoring	0.8	0.5	2.0	1.9

■ Highest opportunity
 ■ Lowest opportunity

Source: 5G edge computing value opportunity, KPMG International, June 2020

Based on a KPMG study, at a global level only 11 per cent of the 5G edge opportunity lies with the operators in terms of core connectivity. Thus, a move to a platform-oriented, software-driven, and services-led innovation and growth is the need of the hour for TSPs. Even though India is late to

5G auctions and implementations, TSPs have a huge opportunity with enterprise 5G to provide technology solutions to the enterprise's business challenges, thus transitioning into a digital services provider from the current status of being just a communication service provider.



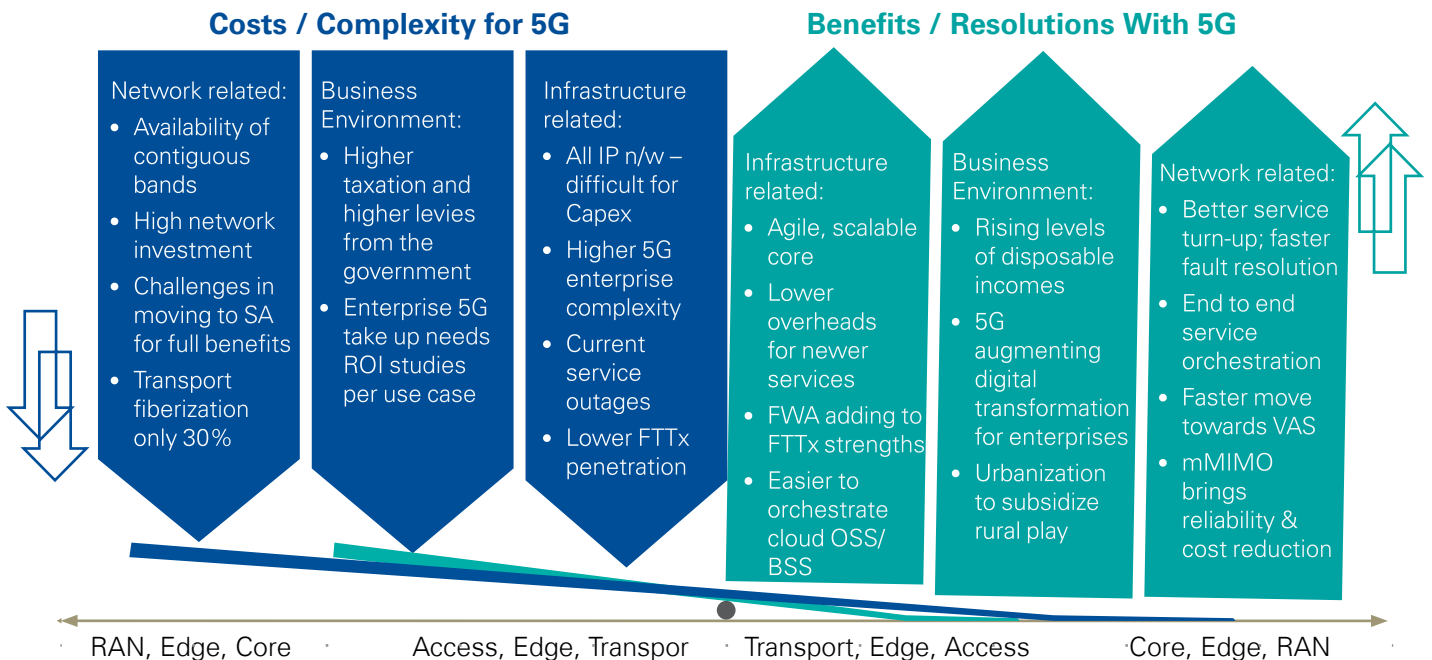
Key focus areas for TSPs:

Operators in India are testing complementary strategies with 5G NSA and SA on the 700-megahertz (MHz), 3.5-gigahertz (GHz), and 26-GHz bands and considering there is a further six-month trial extension until May 2022, these strategies will only mature once the ecosystem around it has matured. Provided the 5Gi requirements are harmonised into the 3GPP standards, KPMG in India believes that such ecosystem maturity will still need a couple of years to prove the ROI. The commercial launch is now expected in late 2022 or early 2023 mostly in urban centres. The initial B2C applications such as cloud gaming, AR/VR, and other bandwidth intensive use cases that centre around FWA and eMBB may only be 20—40 per cent ARPU accretive, as per initial data from TSPs in China, South Korea, and Hong Kong. B2B and B2B2X applications are the real emerging opportunities for TSPs to reap the ROI of their 5G investments. TSPs are collaborating with technology ecosystem providers to create use cases in mission-critical environments such

as utilities and oil & gas; industry 4.0 and industrial environments such as mining, transportation and logistics, and manufacturing, smart cities, drones-based surveillance, remote healthcare, remote education, smart agriculture, smart automotive, gaming, etc. Private 5G will be an innovation engine for enterprises and an enabler and accelerant for IoT, Industry 4.0, and edge computing—all supported by TSPs.

From an implementation perspective, the TSPs must set their eyes on the benefits of 5G in terms of opening new avenues of revenue, lowering the capex cost per bit while dealing with the initial costs and complexity associated with the lack of adequate infrastructure, capital intensive network augmentation, high spectrum reserve price etc. The government on its part, will have to take swift actions in augmenting the infrastructure, availability of contiguous spectrum and finding a solution to make 5G affordable, so that it emerges as a feasible option for the country, in a true sense.

Cost/benefit analysis for 5G levers in India



Source: KPMG in India analysis



Readiness:

To prepare itself for the imminent 5G launch, operators have taken nuanced approaches to partnering as 5G needs an ecosystem view than siloed ways of working.



Focus on network efficiency and upgrades:

TSPs are tapping into B2B and partnering with vendors across Open RAN, semi-conductor chip designers, system integrators, cloud and networking players, and wireless OEMs, to capture edge and cloud opportunities with open approaches to networking. Key investments are flowing into adoption of 5G NR over cloud and edge infrastructure with virtualised network functions that are automated through use of advanced technologies like AI and ML.



Focus on B2C and stabilising market shares:

TSPs have partnered with semi-conductor chip companies, operating systems and search engine giants to cement their position for the long haul in the B2C 5G ecosystem. The strategic investments from large tech players have also helped streamline the '**commerce, connectivity, and content**' vortex. Also, the device leasing strategy in the B2C segment will need to evolve for providing greater affordability. Finally, creation of a metaverse solving diverse set of customer needs could be an evolution path.



Focus on B2B use cases for practical real-world environment:

Some of the test beds are proponents of enterprise-TSP partnerships in creating opportunities for improving operational and business efficiencies across retail, sports, automotive, and other industries as well as horizontal themes such as smart cities, connected workforce and connected machines.



Focus on rural 5G:

Realising the rural potential, TSPs are building rural use cases along with OEMs in the areas of education, agriculture and healthcare. The partnership with platform technology companies helps build a network automation layer in a hybrid-cloud model — further enhancing network carriage under a software defined, network virtualised, end-to-end orchestrated and service automated, and containerised environment.



In each case, there is a niche being created with early signs from POCs and test beds. The overall approach seems to focus first on 5G NSA to handle the increasing traffic and maintain the cost per bit curve, then move to eMBB use cases with FWA for B2C with simultaneous focus on creation of niche use cases with B2B in mMTC category even if these are an extension of private 4G/LTE, and finally transition to 5G SA to handle superior use cases for B2B under the URLLC category.

The readiness of 5G equipment, devices, network quality, and testing and standards, will depend ultimately on the cost of devices, implementation, and maintaining and supporting those networks. Open standards communities such as Open RAN, O-RAN alliance, and others help democratise the 5G rollouts and remain crucial for the next phase of deployment for operators. New business models with OEMs and cloud players will also help define the momentum for 5G. Thus, it depends on how and where TSPs partner across devices, standards, OEMs and infrastructure providers. Further, it will depend on how they progress on maintaining open networks that lower the opex and capex.

Indian TSPs were strategising IoT network expansion in 2019/2020 so 5G mMTC would have become a natural extension of choice if 5G auctions had taken place in time. However, presently the operators are focused on building slice-based coverage and multi-access edge computing (MEC) use cases for B2B in their trials. The cloudification of core and access coupled with data centre transformation is still underway, which will lay the ground for 5G ready infrastructure. Given the readiness of the industry, digital infrastructure and

the existing challenges of adoption of some of the emerging technologies such as Industry 4.0, IOT, AI etc., we estimate the URLLC use cases to gain maturity in four to five years' time from the launch of 5G in India. Although the platform-driven approach seems more open and automated, it will take some time to mature for specific use cases. As per KPMG in India, multi-cloud and edge is an intersection where TSPs will need to pivot their own IT stack into open, sellable, and configurable wares further beefing up competition in the communications market.



Edge with cloud has been instrumental in reducing latency in applications such as cloud gaming, AR/VR viewing, connected experiences, and others.

As a next step, we have multi-tenancy of vendors on a horizontal cloud where telco and IT workloads scale up and down in a containerised and virtual environment providing us necessary automation for design of network and processes, operations and management for onboarding of partners, service assurance, observability, and finally delivery of superior customer experience.

Sandeep Gupta,
Executive Vice President, Chief
Architect, Networks, Bharti Airtel.







Support needed:

While the potential of 5G to transform India into a digital economy remains undisputed, high spectrum reserve prices and payment terms, gaps in digital infrastructure deployment, and regulatory policy concerns are expected to impede the success of commercial launch of 5G. Accordingly, the government will need to take swift actions on some of the critical support areas highlighted:

Rationalise spectrum reserve price and payment terms balancing the short term objectives and the long term benefits enabled through affordable 5G services.



Allowing 100MHz of contiguous spectrum will enable efficient and faster rollouts that also harmonise network ownership across the country



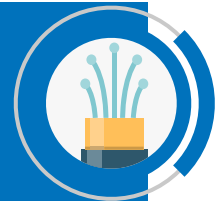
Swift implementation of National Digital Communications Policy (NDCP), 2018 plan that outlined broadband for all and availability of adequate digital infrastructure.



Financial strengthening of the sector through reduction in taxation and government levies (accompanied with rise in floor rate charges).



Policy reforms aiming at 5G harmonisation, further liberalisation of active sharing of components, availability of high capacity backhaul, better usage of USOF for broadband rollout under the BharatNet programme, and mandates on openness of equipment usage.



Roadmap on edge data centres will also be crucial for how TSPs forge relationships with cloud hyper-scalers, infrastructure players and other stakeholders.





Private 5G white box solutions will also need incentivisation to help TSPs avoid vendor lock-ins and faster democratisation. Any further innovation or specialised solutions for an enterprise could be a value add for TSPs for monetising opportunities.



Further, even though the Prime Minister Wi-Fi Access Network Interface (PM WANI) project aims to connect 2 million Wi-Fi hotspots by 2021 end, it does so by creating a license-free model for all stakeholders involved in the project. The opportunity for Wi-Fi offload and even 'connecting the unconnected' is huge.

However, the lack of private sector involvement (big three TSPs) has seen a tepid demand from other stakeholders (Public Data Offices, Public Data Office Aggregators, and app aggregators and creators) who do not necessarily understand the Wi-Fi connected landscape or storage policies of user data. As such, there needs to be a proper incentive structure for TSPs to engage in Wi-Fi led models (this creates a test bed for Wi-Fi6/Wi-Fi 6E to thrive with 5G standard).



“

We are fast moving towards a connected, digital world. As India takes strong strides to achieve trillion-dollar digital economy target over the next few years, telecom operators will play an even larger role in connecting people and machines. The networks of tomorrow will be more advanced and 5G will only deepen the role of TSPs for the diverse connectivity needs of users. I am confident that 5G will bring a better tomorrow delivering significant benefits to consumers, businesses and society, driving digital economy growth in India.

P Balaji

Chief Regulatory and Corporate Affairs Officer at Vodafone Idea Limited.

”



02 Original equipment manufacturers (OEMs)





OEMs

Nearly 75 percent of the global telecom capex is spent on the wireless and transmission equipment while commissioning a mobile network.¹ The OEMs form the hardware intensive infrastructure, which has now been mostly virtualised. This section is focused on wireless OEMs and network equipment OEMs.

Opportunities emanating from 5G for OEMs:

As new markets open in the enterprise and industrial space, OEMs expect more growth in 5G core, analytics & AI, private wireless, and secured operations use cases globally. There is particularly double-digit growth reported for private wireless networks globally among enterprises keen on rapid digital transformation. Further, Asia Pacific overall remains the highest growing region for most OEMs.

According to Gartner, the wireless network infrastructure market is poised to grow on the back of 5G spending as shown in the table below. Unlike 4G, the rollout for 5G will be longer because of its complex technological nature and higher implementation costs. Globally most of the wireless OEMs witnessed a change in revenue from -1.6 per cent to +14.6 per cent CAGR from

2018 to 2020.² However, as part of the TSP capex is now being subject to open-source computing, open networking, and open storage models, there is a shift in how OEMs increasingly pursue opportunities in the managed services space. OEMs on their part are also developing and contributing to the evolving landscape by investing in open RAN and cloud RAN. TSPs need highly interoperable, inter-connected and inter-dependent systems that no longer carry the risk of vendor lock-ins — hence OEMs will need to decouple their proprietary products and leverage the power of connected ecosystem, which also lowers the cost of operations in the long term. However, this ROI needs to be proven right at the test bed/trialling phase.

Wireless Network Infrastructure Revenue Forecast, Worldwide (in USD million)

Segment	2020 Revenue	2021 Revenue	2022 Revenue	CAGR (as %)
5G	13,768.0	19,128.9	23,254.6	29.6
LTE and 4G	17,127.8	14,569.1	12,114.0	-16.3
3G and 2G	3,159.6	1,948.2	1,095.2	-41.1

Source: Forecast: Communications Service Provider Operational Technology, Worldwide, 2019-2025, Gartner Press Release, August 2021

1. UBS report

2. KPMG in India Analysis based on CAGR of revenues and R&D spend extracted from Annual Reports of major OEM companies



Key focus areas for OEMs:

Some of the early 5G use cases that also resonate with the TSPs include enhanced mobile broadband and fixed wireless access. These use cases address the concern of limited fixed broadband penetration levels in India and enhance the data experience. With the help of higher data throughput and lower latency, OEMs are promoting 5G services such as 4K and 8K ultra-HD video, AR/VR devices and applications for gaming, TV, 3D video, and other digital services. As Ethernet is replaced with fixed wireless solutions in connected factories and stadiums, and as neutral host edge services providers churn real-time analytics, there is a greater opportunity for enabling video

surveillance at multi-tenant sites. OEMs are further expecting bigger 5G opportunity to emerge from mMTC and URLLC type applications on the enterprise side. However, uptake of eMBB and mMTC is expected to be faster than URLLC over the next three to five years.

About 15 per cent³ of global organisations have already invested in private 5G networks, 21 per cent are planning to invest in 5G over the next 12 months and about 36 per cent will invest in 5G for the next four years. 5G-led digitalisation is expected to boost global GDP by USD8 trillion, or 7 per cent increase in global GDP by 2030.

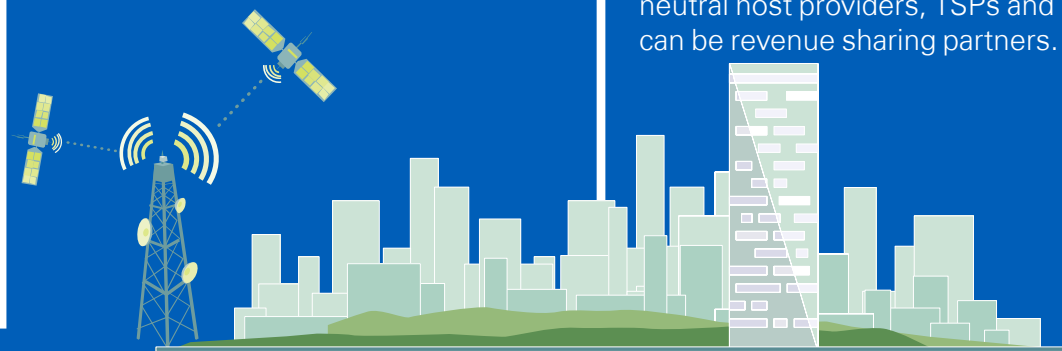
For their evolution, OEMs are betting their plays on:

Strategic partnership models

OEMs are partnering exclusively with TSPs in various geographies and fostering industry-level partnership through open innovation/cooperation. These areas are gaining traction under the test beds with 5G trials *currently*.

Shift in focus towards private networking models

There is a marked shift in how OEMs are building use cases relevant for enterprise from a solutioning perspective. Globally, OEMs have witnessed 15–20 per cent⁴ of the deals from the private enterprise side. While the Indian strategy depends on the regulatory developments, the stage is set for vertical growth strategy through infrastructure ownership where neutral host providers, TSPs and OEMs can be revenue sharing partners.



3. Nokia: 5G set to add \$8trn to global GDP by 2030

4. As per guidance from OEMs in India



Readiness:

With 5G there is an ongoing need for new and evolving business models. Several TSPs feel that 5G opportunity is bigger in delivering services to enterprises. However, a recent survey by an OEM and Omdia Research indicates that the TSPs are facing significant headwinds in solutioning and its go-to-market. It concludes that nearly 50 per cent of TSPs said business models and go-to-market strategy are the biggest challenges they face. This is a perfect opportunity for OEMs to step up their game to fill the missing pieces here — acting more as partners than sole suppliers in the space.

As Indian TSPs look for more cost savings, OEMs have stood up with product innovation with virtualisation, power savings and novel approaches to building an open ecosystem that is more receptive in proving the ROI. With the enterprise story for OEMs still maturing over next three to five years, their reliance on TSPs remains higher. Accordingly, the OEM's current focus is to innovate around TSP solutioning which helps in improving the ROI for TSPs and reduces overall TCO of networks.



Nokia has recently introduced several new and innovative 5G solutions to deliver and further improve the cost of ownership, capacity and network performance for its customers. We are committed to having one of the industry's most energy-efficient product portfolio and by 2023, we plan to reduce the power consumption of its 5G base stations by 50 per cent. We played a pivotal role in defining many of the fundamental technologies enabling 5G and recently reached the milestone of 4,000 5G essential patent families.

On the enterprise side, as a leader in Private wireless, we are working with our enterprise customers in various segments to help them drive efficiency and automation.

Amit Marwah

Head of Marketing and Corporate Affairs, Nokia India



As TSPs are overhauling their networks to be 5G ready, OEMs are supporting them in their network virtualisation and cloudification journey. OEMs are building in-platform automation and orchestration layers and implementing end-to-end project execution and network management through managed services models. They are also enhancing software defined networks by adding features such as 5G automated assurance to simplify 5G network maintenance and reduce deployment

risks. It reduces the risk of managing a multi-vendor 5G network, providing a variety of services ranging from infrastructure management to slice automation, and utilising open and secure software components. However, much needs to be done in terms of Open RAN initiatives and proving ROI and TCO for OEM clients in India in Indian setups and Indian use cases.



Further, OEMs are focusing on a multi-pronged approach to enhance their network strategy in India:



OEMs are combining cloud native technologies, comprising of SA, NSA, and LTE packet core functions, to enable remote video monitoring, telemedicine, digital twin, and other use cases across the Digital India theme, particularly focused on the rural communities. The OEMs are increasingly focusing on enriching their 5G software packet core as the radio side units are increasingly virtualised. For this, they are blending in more cloud partners for scale and **network effects**.



For addressing the unconnected, the satellite microwave E band is also being considered to reach the remote and the unconnected with FWA type use cases. OEMs and operators are targeting **100 km** radial clusters around metros to engage in testing and simulation exercises to blend reliability, throughput and latency at a rural level.



Cognitive sensing networks with beam forming integration, massive MIMO, indoor 5G small cells, and multi-band technology support are some areas where OEMs are focusing their current efforts. In order to achieve cost benefits, OEMs are adopting AI, ML, microservices and automation, and increasing their efforts in R&D in radio systems, custom silicon, next gen wireless systems with **spectrum sharing and carrier aggregation**.





Support needed:

Some areas that require pertinent support from the ecosystem are:



Clarity on network sharing:

OEMs will need to open up interband components to provide higher QoS. This active sharing will also provide cost efficiency.

For OEMs to invest in future roadmaps for 5G products, a clear policy framework could enable them to stay focused on 3GPP or 5Gi standards across each band, use case and geographic circle.



Private networking regulations and policy roadmap:

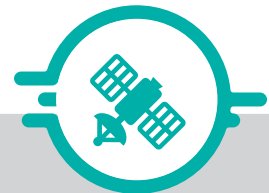
While the initial 5G test beds are proving fertile for B2C and B2B use cases, private networking policy direction could enable newer business models for OEMs with TSPs

Large seaports, airports and other logistical hubs will be some of the earliest adopters of 5G private networks.⁵

However, several security concerns are to be considered for building private networks. One of them is preventing such networks from cyber attacks. This can be achieved with the help of 5G telecommunication hardware combined with software algorithms.



Roadmap on augmenting 5G NSA/SA with E and V bands for backhauling of traffic as well as broadband penetration.



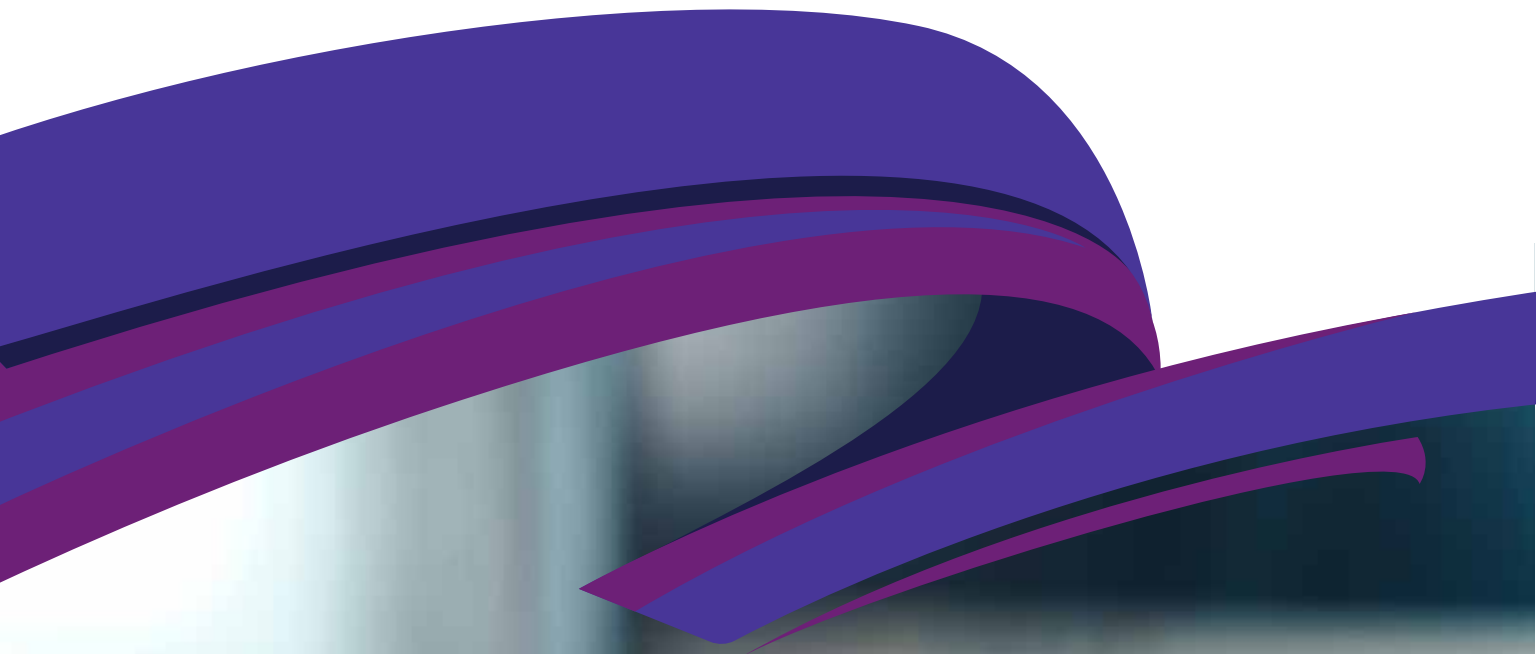
There is a need to have a common ground on improving last mile access with satellite broadband.

OEMs need to be prepared to position their products that can cater to both sides of the equation with multi-band, beam forming and multi-frequency radio antenna systems.

5. Companies are choosing to build private 5G networks- Here's why - Nokia Blog



03 System integrators



5G



Technology companies and System Integrators

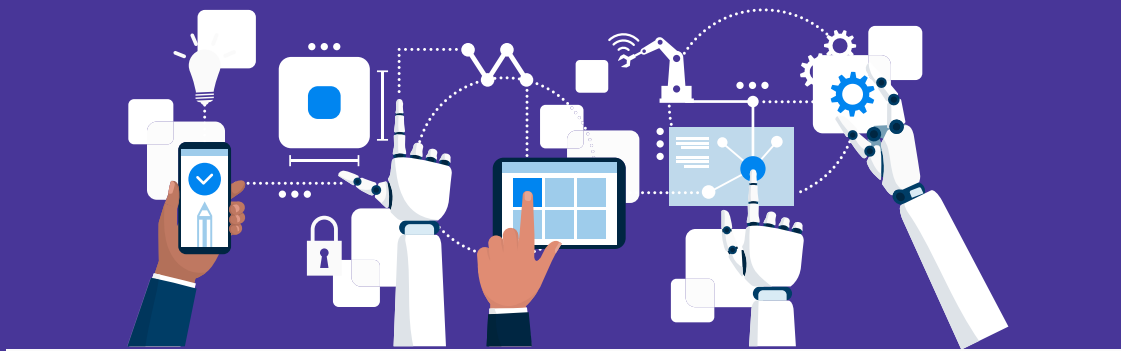
Indian IT firms are laying the groundwork for the upcoming 5G revolution through collaboration with TSPs, academic institutions and technology partners. Edge computing with 5G in a multi-/ hybrid-cloud, multi-platform environment is one such opportunity for TSPs where they need collaboration with system integrators to build cost effective yet scalable networks. As enterprises are adopting various technology use cases, private 5G is an opportunity where technology companies and system integrators can play a critical role in orchestrating the deployment by bringing together multiple partners. Design, operations, and management of private 5G is expected to be overwhelming for most enterprises. Hence, there is a need to turn to services firms that excel in IP creation and sellable wares and have expertise in orchestrating and designing the rollout.

Opportunities emanating from 5G:

As TSPs pivot into 5G functionalities including analytics at the edge, cloud-first operating model, supporting O-RAN based radio with NSA/SA core, integrated IoT ecosystem solutions, they need to rethink their network management and transformation design and IT/OT blueprints. It will require TSPs to overhaul their current OSS and BSS and adopt bespoke and agile architecture that is scalable. It will need to build a microservices architecture that will allow TSPs to shorten the time-to-market for newer services and allow greater flexibility in managing the infrastructure

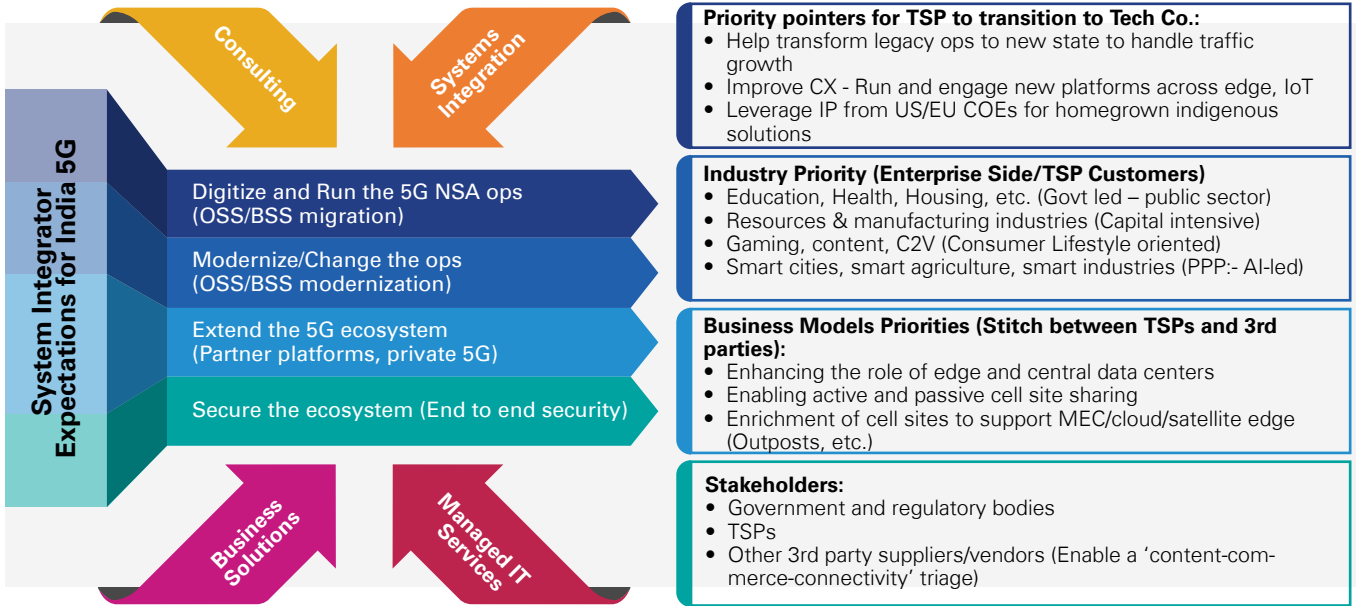
and services. Technology players and system integrators have a critical role in this TSP transformation. Also, as the TSPs look at expanding their partnerships to create joint solutions for enterprises, the role of an SI gets accentuated as it brings in its integration, implementation and certification expertise.

The role of system integrators is expected to be more nuanced and complex with the rise in adoption of newer technologies. The telecom value chain has traditionally not been very successful in monetising its telecom investments beyond voice and data. Given that 5G enterprise deployment will require vertical industry knowledge and a host of capabilities from AI to robotics, the need for technology companies that have worked with vertical industries and in diverse technologies gets heightened. Be it enabling better communications between oil & gas sites, vessels and other offshore platforms, or be it the automation of processes and machinery in the manufacturing sector, enabling surveillance drones for the government, or to increase accessibility and improvement in patient treatment in the healthcare sector — system integrators and technology platform providers will need to take giant leaps to provide an interconnected mesh of opportunities. In the long run, platform adoption will lead to newer players emerging who will also need to be included in operator or vertical industry specific alliances.





Key focus areas:



Source: KPMG in India, 2021

The evolving telco architecture has been focused on disaggregating the network functions into smaller functionalities, wherein microservices can be placed across multi-/hybrid- cloud. This also

creates the possibility of new players emerging in the market. A SI can play a pivotal role in helping TSP transition from best of suite models prevalent in the network domain to one that entails best-of-



The journey from telco to tech co will entail a few re-alignments – de-risking of 5G adoption by selecting best-of-breed rather than best-of-suite models; platformisation with vertical specific solutions; and up-skilling with data-science roles for AI, real-time analytics, IT/OT, robotics, and automation. SIs are creating an ecosystem of partners for edge DC, private RAN and core workload migration; setting up validation labs; and identifying niche opportunities jointly marketed with TSPs.

Murali Madhavan,
Chief Technology Officer – Communication at L&T Smart World & Communication





breed to exploit the flexibility offered by the new technology. SI's should help in forging alliance of such best-of-breed product vendors and avoid vendor lock-ins.

Also, the platformisation process will accentuate the differences between 'tech cos' and TSPs. SI's can play a critical role in creating platform ideas that can be plugged into the network through standards compliant interfaces and bring pre-integrated partner products. A pre-integrated solution is expected to enable modular components of the

network to be built and/or operated through neutral third parties such as system integrators.

However, moving towards an outcome-based pricing and deriving further efficiencies through automation can be both a challenge and opportunity for SIs and technology players. Managing risks for 5G adoption, avoiding vendor lock-ins and being a hub of innovation are also some areas where system integrators are preparing to help TSPs.

Readiness:

Technological: With exorbitant roll-out costs, TSPs may need to consider innovative business/ownership models to cut rising costs. Network sharing in 5G has some added challenges that did not exist with 3G and 4G. TSPs will eventually depend on the system integrators, OEMs and device manufacturers to have open source led systems in place to provide test beds in the form of COEs and IP factories to build cloud native, containerised and virtualised network functions that are pre-integrated and pre-tested. The SIs have also started creating an ecosystem of partners across edge, DC, private RAN and core and are pre-integrating their solutions. These pre-integrated solutions, particularly in the areas of private 5G RAN and edge DCs as well as purpose-built cores, can be operated through neutral third parties such as SIs enabling network sharing across TSPs.

Additionally, Indian telecom companies have been depending on Dynamic Spectrum Sharing (DSS). Enabling a multi-level parking like system for internet traffic in which 5G and 4G customers have their own lanes, with their own bandwidths, system integrators can assist in an SD-WAN enabled, open RAN led, hybrid cloud and a hybrid technology landscape. However, that will again depend on the uptake and adoption of multi-technology layers within the TSPs.

SIs are also taking initiatives on Kubernetes and cloud native network functions, open APIs, DevOps, and artificial intelligence/machine learning help create ROI and TCO roadmaps for predefined functions. This helps achieve non-linearity in savings for some of the areas in development of the 5G ecosystem.

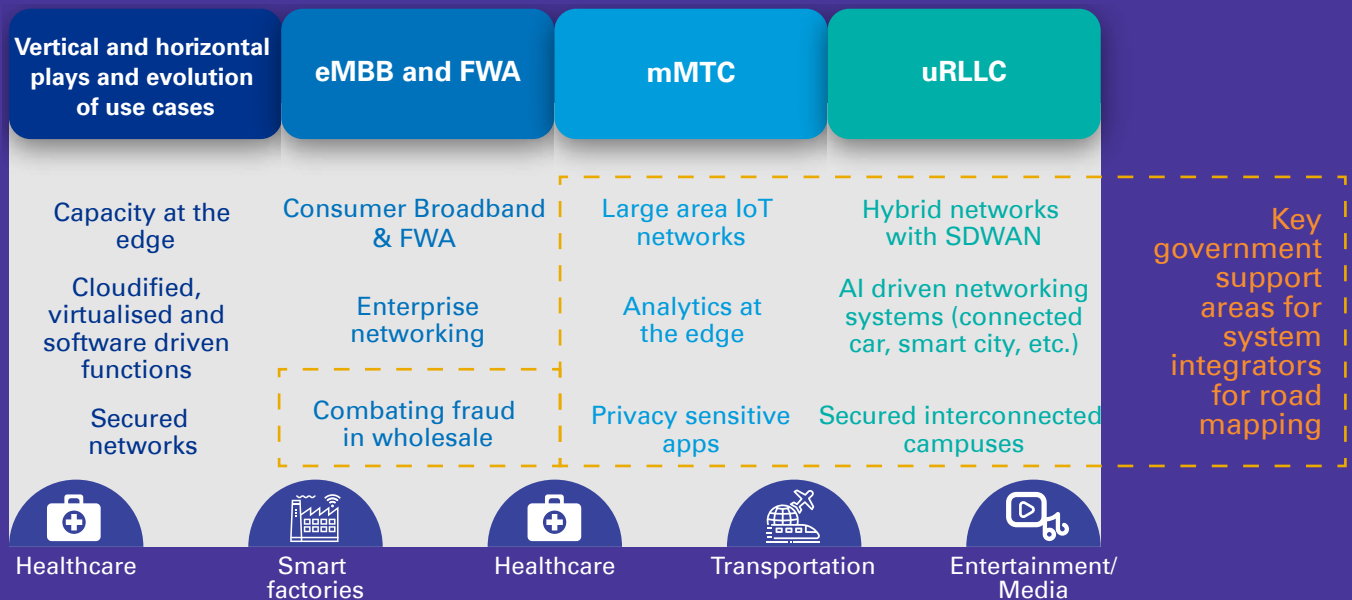
Business/Use case led: Technology companies are also playing the critical role of partnering with TSPs for developing indigenous 5G technologies. They have participated in the initial 5G testing and are proposing to be the one-stop shop with a platform led approach for CSPs in their 5G pursuits. System integrators are

also reaching out to enterprises for their digital transformation initiatives across IoT, cloud, and others with automated operations. They are playing the role of a conduit and bringing in the TSP, though more as a connectivity provider. SIs with established track record in various vertical industries besides telecom would be in great demand to penetrate vertical use cases.



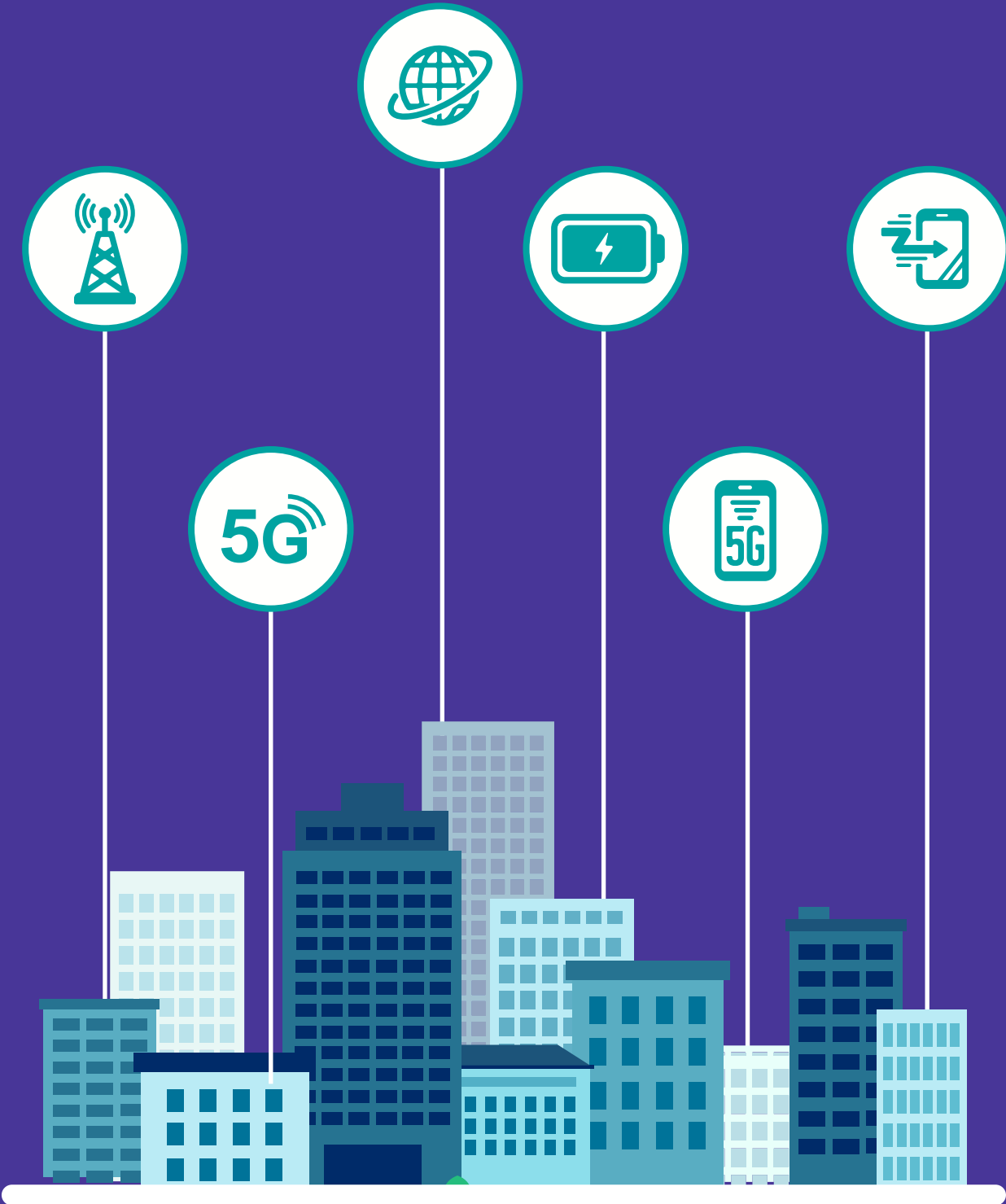
Support needed:

- As Asia Pacific becomes the new epicentre of growth in the following decade, system integrators need a clear policy path in terms of technology, investments and business operations. Their role in innovating, deploying, maintaining and scaling for growth will be crucial for TSPs in India too.
- System integrators also expect free flowing platform development initiatives across DevOps, automation, AI/ML and test factories. For this, they need active collaboration among all stakeholders.



Source: KPMG in India analysis, 2021

- System integrators expect support from regulatory bodies in terms of formulation of key assets and IPs and need collaboration with NASSCOM under 5G relevant themes pertaining to each ministry. **The role of TRAI will become more critical and it work closely with key objectives for each vertical and ministry.** URLLC type applications across mission critical services; eMBB type applications across public response and disaster response; and mMTC type applications across smart cities, buildings, and agriculture will need nuanced approaches.
- Allowing a few 100 MHz of licensed spectrum to be used for low-power Industry 4.0 applications
- Simplifying MVNO regulations to encourage segmental platformisation will also be a critical factor for enabling faster 5G rollouts.
- System integrators also seek support from the government in creating an R&D ecosystem including faster setup of COEs and labs in SEZs, etc. and promotion of platform related technologies (ML, IoT, Blockchain, etc.) to promote Indian variants with 5Gi for African or under-developed countries.





04 Device manufacturers





5G subscriptions are projected to reach 3.5 billion globally, accounting for about 40 per cent of all mobile subscriptions by 2026, of which India is estimated to have about 330 million 5G subscriptions (about 26 per cent of mobile subscriptions in India at the end of 2026).¹

Mobile phone adoption will accompany the rapid growth in 5G subscriptions. It is projected that from 2018 to 2025, the number of unique mobile

phone subscribers will increase from 5.1 billion to 5.8 billion, out of which 175 million subscribers are expected to be from India. While a commercial 5G network is not present in the country, consumers have begun futureproofing themselves by buying 5G-enabled mobile devices. In the third quarter of 2021, 5G-enabled mobiles accounted for 22 per cent of all smartphone shipments in India.²

Opportunities emanating from 5G: Enabling mobile phone devices to be compatible with 5G networks will have an impact on the functions they can execute. Some of the expected developments in mobile phones owing to 5G technology are as follows:



Machine Learning

5G's features will enable mobile devices to function as high-speed and high-processing computers. This will allow complex use cases such as image processing and cloud-based multi-player gaming to be conducted efficiently over mobile phones, without the setbacks of cloud-computing such as higher latency and lesser privacy.



VR, AR and XR

With the gaming ecosystem building in terms of products such as gaming PCs, VR, AR and XR glasses and headsets, interfaces and new gaming services, the missing key to the picture remains high speed networks that connect all these independent parts. 5G's ability to reduce computational speed, latency and streaming time is especially relevant in gaming.



Hardware Upgrades

While 5G network is being rolled out by telecom operators, it must be supported by devices that can access it. To this end, chip vendors that sell modem chips to mobile device makers are catching up with 5G technology. Innovations in chip technology include carrier aggregation of different 5G bands, adding eSIM capabilities to devices, higher uplink/downlink speeds, etc.



UX

With the promised benefits of higher speeds, lower latency and improved visual quality by 5G, UX of mobile phones and applications are bound to be significantly impacted. Even features of 5G such as improved battery life and memory are expected to improve the overall UX of smartphones.

1. "Ericsson Mobility Report", Ericsson, June 2021, accessed on 25 November 2021
2. CMR: India Mobile Handset Market Review Report, 2021



Key focus areas:

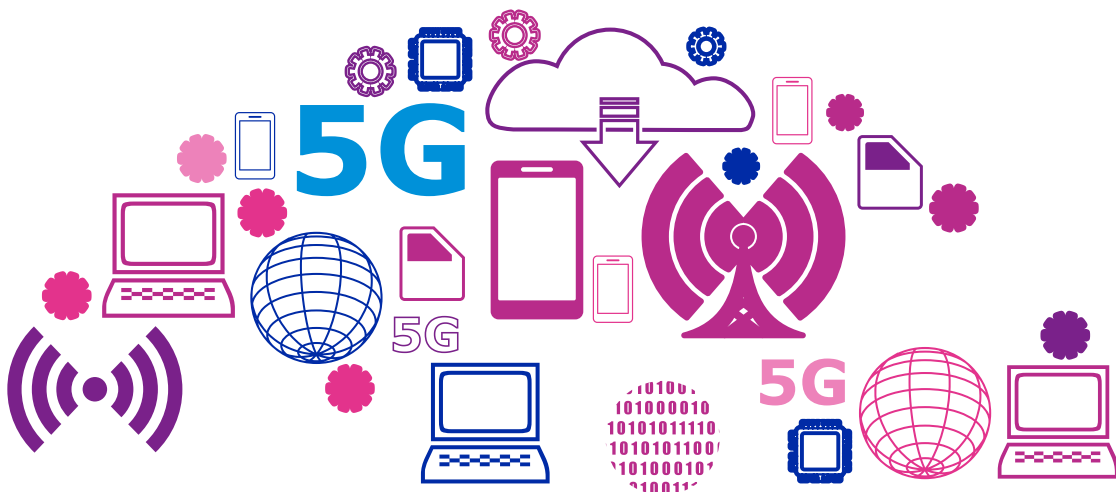
While it is expected that devices such as 5G smartphones will account for 50 per cent of all handset sales by 2025 globally,³ device manufacturers are feeling the impact of component shortages.

Globally, over 2019 and 2020, the capital expenditure of mobile device and testing equipment manufacturing companies fell. However, from 2020 to 2021, the capital expenditure for most companies increased due to rise in demand. And to capture this growth in demand, government laid down a Production Linked Incentive (PLI) scheme to promote telecom and manufacturing in India for the next five years starting 1 April 2021.

The incentive-to-capex ratio for the Production Linked Investment (PLI) scheme is expected to be at nearly fourfold⁴ for mobile phones, telecom equipment, IT hardware and other electronics, which is the highest of all PLI schemes.⁴ The designated amount for the PLI scheme is approximately USD1.64 billion,⁵ which will be distributed over five years for 31 companies (16 MSMEs and 15 Non-MSMEs). Specifically, in

the case of sales of mobile phones and specific electronic equipment, the incentive structure is 4–6 per cent of the incremental sales over the base year. This is the first scheme among PLIs to provide such high incentives to MSMEs and this will allow them to be a bigger part of the global supply chain. KPMG in India believes that although the benefits are comparable to other sectors, additional steps need to be taken to support R&D in telecom across specific device categories so that the incentives and schemes are channelised to attract manufacturing of hi-tech devices that promote Indian IP. The creation of UPI like payments platform for MSMEs in the electronics supply chain could boost productivity.

The local device manufacturers are taking various initiatives such as boosting their capex plans under the PLI scheme, partnering with international players and co-investing for the three-to-five year period to manufacture cheaper products. Some of the device vendors are also trying to move up the value chain by expanding into smart IoT home solutions, wearables and audio products.



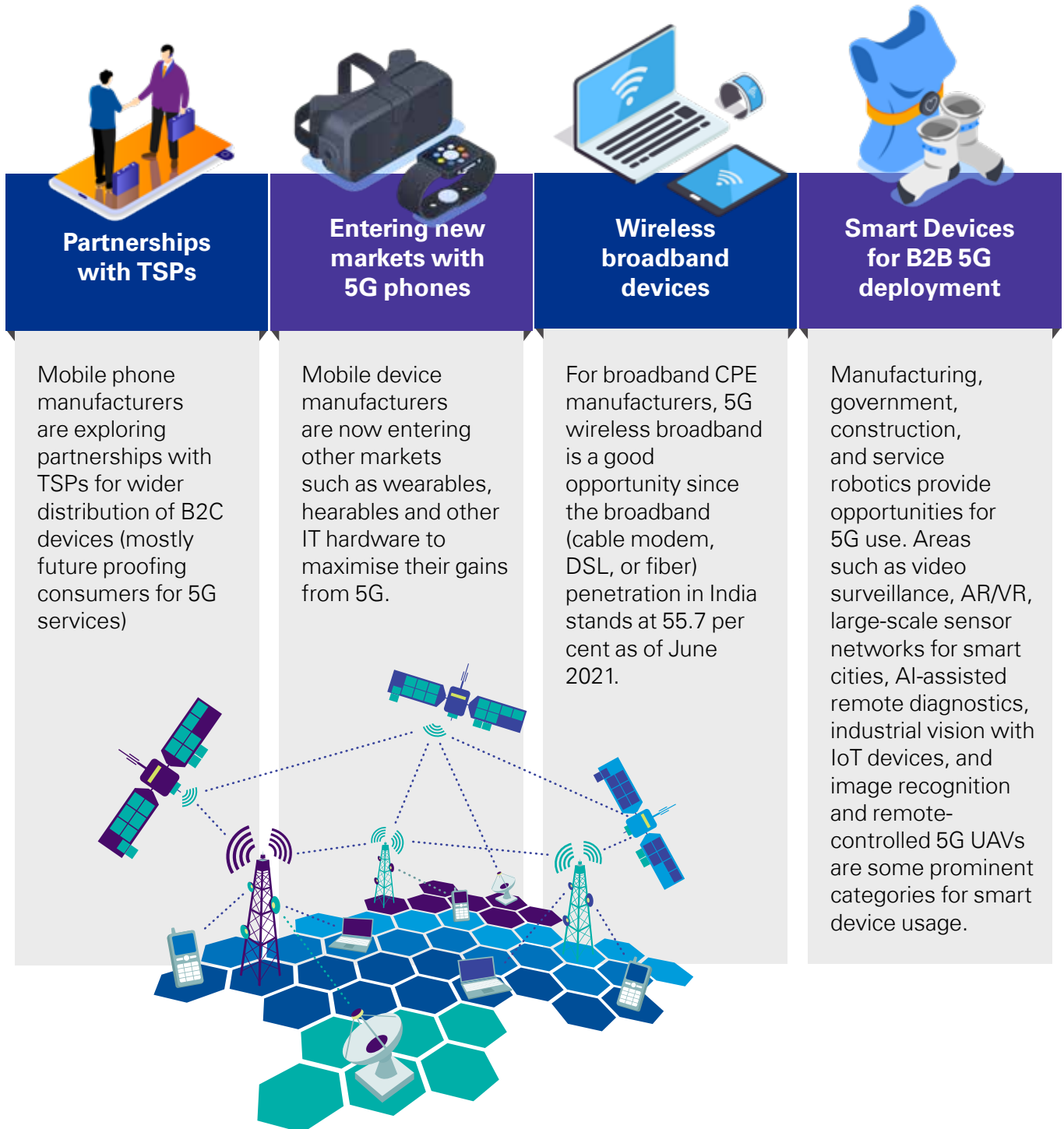
3. Juniper research, August 2021, accessed on 25 November 2021

4. "Ringing in local sourcing", CRISIL, August 2021

5. Invest India, Telecom sector



Various business models and opportunities are emerging for companies to monetize from 5G:⁶



6. Calculated basis total number of broadband users for June 2021 (published by Telecom Regulatory Authority of India) divided by the population of India in June 2021 (MOSPI)



Readiness:

Although significant progress has been made in the Indian smart devices manufacturing, the mobile device manufacturing sector still needs to evolve by rooting deep into global value chains and making affordability of 5G devices a prime criterion for mass penetration of 5G devices in

India. The value chain movement from assembly operations to creating hi-tech products that support hyperconnected ecosystems geared towards business-to-anything (B2X), government-to-anything (G2X), and machine-to-anything (M2X) scenarios will be key.

Currently, device manufacturers are focusing on key initiatives such as:

Mobile device manufacturers are now entering other markets such as wearables, hearables and other IT hardware to maximise their gains from 5G.



Mobile companies in India have begun building testing facilities and conducting 5G tests to support propagation of cost-effective handsets and devices.



Similarly, device manufacturers are partnering with Indian SIs and TSPs that are using their own campuses to build private LTE/5G networks and establishing 5G labs to create private 5G test beds.



Some are leveraging technology partnerships to address component builds through R&D and tap the connected, converged and content consumption play.





Support needed:

With India building its own indigenous standard of 5G called 5Gi, local and international smartphone makers alike have raised concerns regarding this, as it could adversely impact the mobile phone manufacturing initiatives in the country. Mandating 5Gi could create a significant gap in the industry with the current insufficient manufacturing capabilities in India and also hinder global innovation reaching India.

To monetise on 5G, manufacturers may require partners to develop new-age solutions and secure best return on investments. Mobile companies should also leverage AI and other technologies to ensure dynamic pricing of models and reduced vendor dependency with open APIs and SDKs.

Although Wi-Fi 6 is a predominant part of the 5G umbrella, KPMG in India believes it would be used mainly for home and fixed wireless business environments due to its lower cost to deploy, maintain and scale. 5G on the other hand is more suited for applications that involve higher security, scheduled mobility and requires a wider coverage area, such as smartphones, autonomous vehicles, smart cities, and large manufacturing facilities with dynamic requirements. The device manufacturers have a greater opportunity for providing a secured way to access 'ruggedized' devices in the 6GHz spectrum for industrial use cases.





05 Infrastructure players





Infrastructure players

Globally, COVID-19 has boosted infrastructure spending and India is not an exception. However, currently the budgetary allocation on telecom infrastructure is less than 0.5 per cent of India's GDP. This not only creates an unprecedented bottleneck on existing infrastructure as data traffic keeps rising y-o-y, but also slows down the digital penetration in the country.

Expectations:

Even with more than 600,000¹ cell towers, over 2,200,000¹ base transceiver systems, and 28,00,000 optical fibre kilometres, India's need for capex outlay on infrastructure is not enough for a country too vast and diverse to fully leverage the advantages of 5G. With only ~30 per cent towers fiberised and fibre deployment to population ratio standing at ~0.1 per cent, there is a need to fiberise at least 70 per cent towers in the future. With 5G, the expectation is to have four-to-five times the number of installations and at least 10 times the optical fibre deployment. Given the financial stress of the sector and significant investments being geared towards 5G network readiness and

Key focus areas and challenges:

The role of infrastructure providers needs to evolve in accordance with the future needs of 5G – particularly lit fibre capacity and optical transport bandwidth, number of towers, 5G repeaters, edge sites, number of small cells, and Distributed Antenna Systems (DAS) for in-building and outdoor solutions. Further, the role of infrastructure providers (tower companies and IP-1 holders) will need to be nimble to adapt to providing dynamic business models in rural and urban setups. Innovative business models and collaborations and infrastructure sharing could accelerate the last mile access. An illustrative infrastructure sharing model is highlighted in the figure below. Building/venue

spectrum auctions, there is a significant gap in the investments required and funding available for digital infrastructure. Taking cognizance of the funding requirement, the government has undertaken a mission to plug the loopholes by launching National Broadband Mission (NBM). Given the dire need of fast-tracked digital connectivity, it would now be critical to ensure speedy implementation of NBM objectives along with ensuring all required resources, public and private are made available for its implementation.

With 5G on the anvil, telecom infrastructure is reshaping itself to include macro, micro and small cell base stations with edge computing capabilities. Although edge is defined loosely by various ecosystem players, this presents a perfect opportunity for infrastructure providers to transform themselves into digital infrastructure providers and explore newer revenue models by leveraging their existing investments and reach across the country. Some of the adjacencies being explored by infrastructure players include IoT, smart cities and data centres etc.

owners, TSPs, and third-party DAS integrators all need to collaborate for outdoor and indoor DAS coverage. The urban use cases (B2B, B2G, as well as B2C) could try to subsidise the rural use cases pertaining to agriculture, sanitisation, education and healthcare.

Emulating some best practices on infra sharing from China and the US, infrastructure players in India could leverage multiple DAS ownership models that could provide a fresh lens to business models and alleviate pressure on TSPs and OEMs. Infrastructure sharing is the core for widespread 5G adoption in India.

1. Department of Telecommunications Annual Report 2020-21



Business Models to tackle Outdoor and Indoor Distributed Antenna Systems (DAS) Coverage in India:

Infra Providers' Stakeholders



3 Flavors of Distributed Antenna Systems (DAS) Ownership

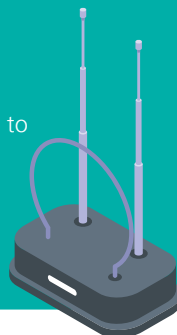
- 1 Building owners** own the DAS infrastructure and try to recoup the costs of the infrastructure from all 4 carriers
- 2 Single TSP** owns the DAS infrastructure with a contractual agreement with all TSPs to integrate their signals eventually
- 3 3rd party DAS integrator** owns the DAS infrastructure, with a guarantee to provide integration for all TSP signals

Ownership

- In-building DAS systems (IDAS), once installed, become the property of a carrier, a building owner or a third-party owner

Regulations

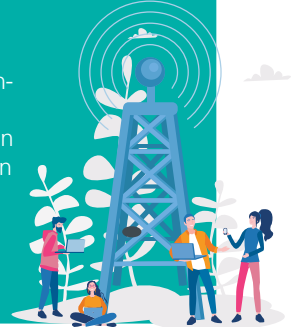
- With IDAS, there is no regulatory hurdle or permitting requirement to overcome as it can be commissioned on unlicensed bands



Outdoor DAS

- The ODAS developer to overcome the regulatory hurdle (zoning, public hearings, central and local permit clearances) and fights for ROW on behalf of TSPs

- ODAS closely resembles the traditional tower model and can be commissioned on unlicensed and licensed spectrum





Readiness:

In August 2020, the Prime Minister laid out his vision to connect every village in the country with optical fiber cables in 1,000 days. To achieve this vision, the cables would have to be laid at an average of 1,251 kilometres a day from the existing 350 kilometres a day. RailTel's and other IP-1 holders' renewed focus on laying fibre could increase the speed of laying fibre, but the overall progress remains slow to date. The technical methods of laying fibre in far reaching corners and hilly/marshy lands also need to advance and complement future wireless 5G networks.

- Currently, the players have started innovating and launching new 5G products such as small cells, multi-band radios, deep fiberization, disaggregated networks and software defined components. Some have also started their R&D units and have built IPs around 5G products and solutions to address bend sensitivity, attenuation, and other important technical key performance indicators across 5G cross-haul.
- Partnerships to drive Open RAN and open source 5G have also taking shape to speed up large-scale 5G deployments.
- Infrastructure players are also keen on presenting 5G ready agile networking models to TSPs
- Some of the infrastructure players are actively engaged in creating 5G specific use cases with network slicing, orchestration, automation and management of specific use cases outside India. With the proper policy support, these use cases can support local cloud gaming, video streaming and AR/VR use cases.
- Skill enhancement and job empowerment are also areas of progress.

A lot more needs to be done to improve access and transport capacities:

- Public private partnership is one area private players are missing on. Work with C-DOT needs to be aligned with other IP-1 holders to gain from common infrastructure ducts, poles and street furniture.
- For broadband companies, 5G presents a viable opportunity to provide a wireless broadband experience and help resolve the challenges faced by rural India. Since the broadband (cable modem, DSL or fibre) penetration in India stands at 55.72 percent as of June 2021, this is a useful opportunity for them as previous attempts at 4G based wireless broadband solutions were not successful. 5G FWA type solutions will be key for consumers, hence pocket/mobile devices that enable work from anywhere scenarios will be the first steps towards 5G adoption. Hence, infrastructure players will be key in providing last mile access — wireless or wireline — with DOCSIS 3.0, GPON-enabled technologies.
- For data centre (DC), edge DC and micro-edge DC players, the opportunity around multi-access edge computing is huge especially in tier-II cities. Further, a lot of equipment will need to be pre-tested, prefabricated and pre-loaded with custom components to capture bolt-on opportunities. With 740 districts, the need for a data centre in each district is paramount for India, because such infrastructure players will need to step up for providing last mile digital access and services in a secured and profitable way.



Support needed:

Lack of fibre infrastructure in India has adversely impacted the last-mile connectivity. Although initiatives such as NOFN (National Optical Fiber Network) and BharatNet were launched, the implementation was slow. The gap will further aggravate with implementation of 5G, which requires a significant overhaul and densification of network. The NBM aims to connect 6 lakh villages across India at an estimated outlay of INR7 lakh crore, including a 10 per cent contribution from the state reserve (USOF) over the next three-to-four years. While 10 per cent of the total funding requirement has been identified, it would be critical to identify and source the balance funding requirement and ensure there is adequate public private collaboration for speedy implementation of the set target.

Further, infrastructure players are facing significant implementation challenges in terms of compliance with Right of Way (RoW) rules. The RoW rules were announced in 2016 to simplify the process of deployment of underground (optical fibre) and overground (mobile towers) infrastructure in India and also to streamline the RoW-related charges across the states/UTs. However, ground level implementation challenges have prevented their uniform application across the country. These include long delays due to the variable and complex procedures across states, delay in permissions, exorbitant charges and varying fees by different bodies, no standard documentation and multiplicity of formats. As the government intends to significantly increase India's fibre footprint, it is critical that the ground level challenges of implementation of RoW policies are eliminated.



Ciena addresses the TSPs' requirements to create connectivity platforms that are scalable, reliable, and drive capital and operating expenditure efficiencies via innovative architectures in the converged 4G/5G xHaul transport space. We also focus on upgrading national fibre-optic backbone networks to multiple terabits-per-second capacities to address exponentially growing data traffic. Challenges around rights of way, active infrastructure sharing, and the cost of laying fibre in metro areas has impeded progress for infrastructure providers. Finally, ongoing semiconductor industry challenges will push the telecom industry to plan large infrastructure projects well in advance.

Gautam Billa,

Vice President, International Sales Engineering, Ciena





The government should also consider the following measures to ease some of the operational hurdles faced by the sector:

- **Common duct policy:** There has to be a fundamental shift in policies and regulatory environment and common duct policy should be implemented to facilitate common infrastructure roll-out and avoid wastage of resources and delays. 'Dig once' policies and use of centralised portals to plan for common ducts should be put into immediate effect.
- **Synergized GIS system** for ongoing maintenance and management of utilities will help city planners optimise cost of maintenance of infrastructure. This can prove beneficial with India's new mapping policy (which was liberalised at the start of 2021), NaViC (Navigation with Indian constellations) and the 5G rollouts (targeting B2G use cases).
- **Security of telecom infrastructure:** The government has maintained communications installations as a lifeline and critical infrastructure. However, incidences of theft, vandalism of batteries, cables, fiber cuts, etc. have increased considerably in the recent times. The policy for 5G implementation must define telecom infrastructure as 'critical infrastructure' with clauses that stipulate any wilful damage, vandalism and theft as a cognizable offence attracting penal actions.
- **Policy for setting up of telecom infrastructure on government land and buildings:** It is essential to allow installation of telecom infrastructure on government lands and buildings to help the industry provide services in the critical business districts wherein availability of land is often a challenge due to exorbitant rental charges. Towers should be allowed and a provision for ducts and in-building solutions should be mandated in central/state government lands and buildings/new establishments.
- The government should also revise standards of procurement, deployment, and maintenance to enhance life of assets deployed across public and private deployment. Benchmarked standards on fibre quality that addresses a 30-plus year network reliability, through tough terrains, natural or wilful disasters, dense and poorly planned Indian cities should be considered. Globally, OFC is moving away from fragile G625B towards G657A2 fibre. India should also align itself with global standards and mandate these quality standards across public and private deployment.
- **No coercive action against telecom infrastructure:** In many states, the local authorities continue to follow their rules/policy and initiate coercive actions such as shutting down/sealing/demolition of operational sites or cutting of fiber etc. There is an urgent need to issue directives by the respective state authorities to the local municipal bodies to not to initiate coercive actions. There is a need to appoint nodal officers by local authorities to resolve such issues.
- Census of available assets per municipality should be created and 60-day approval timeline should be set for small cells to be deployed on street furniture such as electric poles, streetlight etc. to create a conducive regulatory environment.
- Keeping in mind the small size, less space requirement and being a low power BTS, there should not be any requirement for separate approval for installation of small cell from local authorities.
- Necessary guidelines may be promulgated for small cell installation in building codes for large MDUs/office buildings.



Approximately, 31 per cent of the total 600,000 towers are fiberised. The NDCCP's aim is to reach at least 60 per cent fiberised towers. Although fibre and microwave with carrier aggregation can reach up to 10Gbps, mmWave E- and V-bands for fibre backhaul have been demanded by COAI and TRAI with a soft-touch regulation.

Further, since there is a sudden rise in fuel costs for tower operators, most turn to renewables where the underlying infrastructure is not ready yet. Even with a push on renewables and green energy, the energy demand for running/maintaining the tower infrastructure and paraphernalia over the next three-to-five years is expected to increase further. As only big conglomerates with scale will be able to provide battery powered gensets for mobile towers/central office (rearchitected as a datacentre). Hence, more needs to be done on the policy front to enable innovation and speed grass

roots level adoption in greener infrastructure at the gram panchayat level.

On the access level, at the end of March 2021, there were 22.8 million wired broadband connections,¹ implying that only 6.9 per 100 households have access to fixed line broadband compared with 7.6 per 100 in March 2020. The tele density for wireless connections increased from 57.6 per cent in March 2020 to 63.9 per cent as of March 2021.² The wireline subscriptions over the last three-year period have lost ground as mobile broadband took off since 2016-2017. There is a need to support and incentivise wireline access investments for a reliable 5G rollout.

Further, the infrastructure providers would demand a status of a REIT or InvIT to be more tax efficient. The REIT structures also need to evolve in India to cater to various IPs such as fibre, data centres, tower companies, small cell or DAS operators, IP-1 holders, etc.



1. TRAI, June 2021

2. TRAI, July 2020 and June 2021 Subscriber Data Sheets

Conclusion:

5G in India is expected to shape new realities for various ecosystem players, provided there is swift, proactive and progressive policy intervention from the government. The NDCP, 2018 now needs to evolve into a 5G specific agenda for each stakeholder (from TSPs, device manufacturers, infrastructure providers, system integrators and technology players, and OEMs) to drive meaningful progress. Capacity, reliability, latency, bandwidth and efficiency are cornerstones for 5G ecosystem to thrive — and every stakeholder of the ICT ecosystem will have to come together and collaborate especially around common threads such as end-to-end infrastructure and service automation, virtualised networks, SDN enabled centralised and regional data centres, as well as multi-access edge computing, availability of affordable devices, creation of industry relevant use-cases.

For TSPs to launch profitable 5G services, there is a need to relay the inter-segment benefits to drive consensus, collaboration and co-operation.

Some of the critical interdependencies across the ecosystem include:

- There is a need for government's support on rationalised spectrum pricing and reduction of government levies;
- For 5G to deliver its promised capabilities around latency speed and bandwidth, TSPs will have to innovate and collaborate with OEMs and SIs to build those virtualised 5G ready networks;
- For mass proliferation of 5G, the devices ecosystem should be affordable, infrastructure players need to provide cost effective and reliable connectivity and OEMs to provide product innovation that will bring various 5G usecases to life.
- We are confident that with capacity, collaboration, co-innovation and consensus, India's ICT industry can reach new heights and prove itself to be a formidable player in the global ICT landscape.





06 About KPMG in India's 5G Advisory





About KPMG in India's 5G Advisory:

With sharp focus on 5G for each stakeholder, there is a need to drive business and network value in five areas, particularly:

1. Capacity
2. Reliability
3. Latency
4. Bandwidth
5. Efficiency

A 5G private network is a single network in contrast to the diverse challenges of Wi-Fi, carrier cellular, Ethernet fibre, PAN/LAN/WAN, and UBR. 5G private network promises security, reliability and flexibility, along with interoperability and openness. KPMG in India focuses on providing comparative benefits to organisations including emerging areas such as private 5G consulting services, delivery services with design and deployment, and management of networks.

KPMG in India strongly believes in knowing the customer requirements and advocating the ROI differences across public wireless and private wireless use cases. Assessing and mapping IT maturity and telecommunications maturity is a logical step that KPMG in India proposes for early test beds.

Key industries that KPMG in India focuses on are financial services, consumer and retail, government and public sector, industrial manufacturing, healthcare, mining and utilities, among others. Technology enablement, process change, deal advisory and security are key offerings for 5G and the four stages of 5G implementation are as described below.

Strategy:

States the objectives and end goals with business cases and ROI templates; roadmap studies



Design:

Assessment and impact studies, solution architecture design, RF design, pricing, site layouts, commissioning, and decommissioning



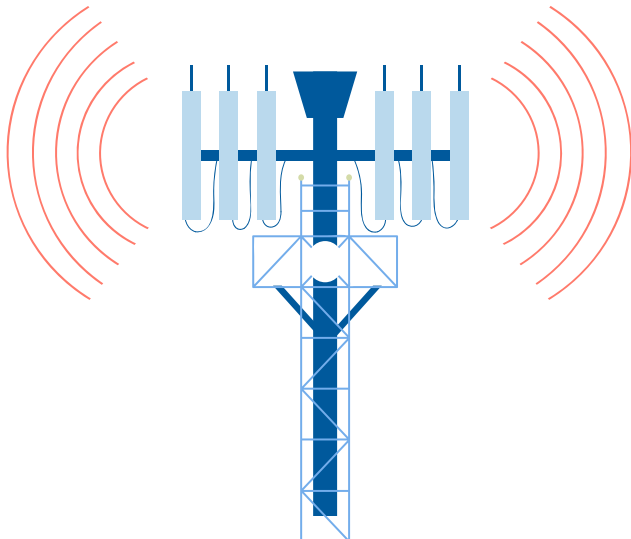
Deployment:

Installation and testing, transport network integration with wireless networks, OSS/BSS, etc.



Operations:

Device management, customer experience, network maintenance, repairs, ongoing tasks, managed services, cybersecurity, etc.





Acknowledgements

We would like to acknowledge the core team from KPMG in India who worked extensively in preparation of this report:

Content Team

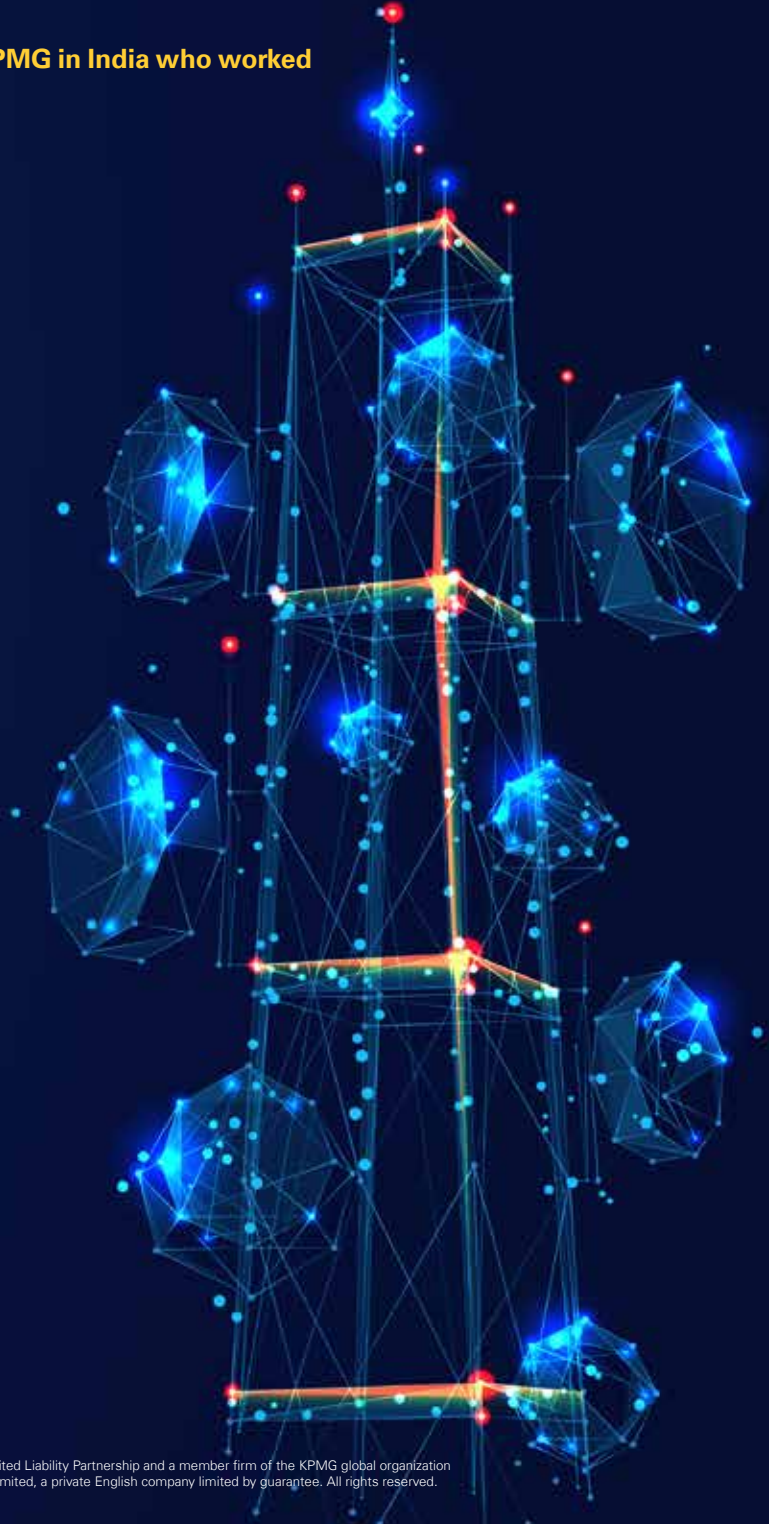
- Sonica Bajaj
- Yash Jethani
- Dipayan Ghosh
- Rahul Hakeem
- Shubham Sharma
- Bhumika Pravin
- Navdeep Saluja
- Cijo Rajan
- Tijel Mahendru
- Manika Saxena
- Lalitha Krishna
- Lovesh Bhatia
- Neha Pevekar
- Devika Deshpande

Insights Centre (Knowledge Management)

- Abhijith A

Brand and Compliance

- Sameer Hattangadi
- Satyam Nagwekar
- Lata Rathod
- Rahil Uppal
- Anupriya Rajput





KPMG *josh* IT SHOWS

IN OUR ABILITY TO TRIUMPH OVER ANYTHING
IN OUR SPIRIT OF UNDYING ENTHUSIASM
OUR DRIVE TO ACHIEVE THE EXTRAORDINARY
UNMOVED BY FEAR OR CONSTRAINT
WE'RE DRIVEN BY JOSH AND IT SHOWS

HIS ADVERTISEMENT FEATURES EMPLOYEES AND ALUMNI OF KPMG IN INDIA

KPMG in India contacts:

Harsha Razdan

Partner and Head

Clients & Markets

E: harsharazdan@kpmg.com

Sonica Bajaj

Partner

TMT Sector

E: sbajaj@kpmg.com

Satya Easwaran

Partner, Head of TMT and

Business Consulting

E: seaswaran@kpmg.com

Dipayan Ghosh

Executive Director

TMT Sector

E: dipayan@kpmg.com

Purushothaman K G

**Partner, Advisory and Head
of Telecom**

E: purushothaman@kpmg.com

Rahul Hakeem

Director

Risk Advisory

E: rahulhakeem@kpmg.com

Aditya Rath

Partner

TMT Business Consulting

E: adityarath@kpmg.com

home.kpmg/in

#KPMG josh

Follow us on:

home.kpmg/in/socialmedia



The information contained herein is of a general nature and is not intended to address the circumstances of any particular individual or entity. Although we endeavour to provide accurate and timely information, there can be no guarantee that such information is accurate as of the date it is received or that it will continue to be accurate in the future. No one should act on such information without appropriate professional advice after a thorough examination of the particular situation.

KPMG Assurance and Consulting Services LLP, Lodha Excelus, Apollo Mills Compound, NM Joshi Marg, Mahalaxmi, Mumbai - 400 011
Phone: +91 22 3989 6000, Fax: +91 22 3983 6000.

© 2021 KPMG Assurance and Consulting Services LLP, an Indian Limited Liability Partnership and a member firm of the KPMG global organization of independent member firms affiliated with KPMG International Limited, a private English company limited by guarantee. All rights reserved.

KPMG (Registered) (a partnership firm with Registration No. BA- 62445) converted into KPMG Assurance and Consulting Services LLP (a Limited Liability partnership firm) with LLP Registration No. AAT-0367 with effect from July 23, 2020.

The KPMG name and logo are trademarks used under license by the independent member firms of the KPMG global organization.

This document is for e-communication only. (039_THL1221_AR_RU)