

The background of the entire page is a photograph of several tall, lattice-structured communication towers. The towers are silhouetted against a bright, low sun, creating a golden glow and long shadows. The sky is filled with soft, white clouds. The towers are covered with various antennas and satellite dishes. A large yellow rectangular area is overlaid on the left side of the image, containing the main text.

Next-gen infraco

Unlocking new business opportunities



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Recommendation and
initiatives to enhance ease of
doing business

Foreword



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The Indian mobile industry and its closely tied mobile tower industry has undergone a period of unprecedented market restructuring. In the span of a decade, India went from an 18-player market in 2008 to a mature four player market in 2019. The price based competition has also led to stretched balance sheets for telcos. Telecom operators are keen to divest non-core assets to pare these high debts and bring in more opex efficiency.

Against this backdrop, the disarmament of India's carriers' passive infrastructure continues. The majority of carriers had already carved out or monetized their passive infrastructure. The remaining operator-captive towers, and majority of operator-owned tower companies, have been sold or are now coming to market.

While the market consolidation will have a short-term impact on tenancies, results should be positive for the Indian market in the long term, leading to healthier competition, wealthier

players and an overall more sustainable environment. Also, India has been experiencing an unprecedented jump in data demand as a function of the sharp decline in data tariffs, driven by the decline in data pricing and availability of affordable smartphones.

To support this burgeoning data growth, MNOs across the country have ramped up their spending on 4G and site densification. The consumption pattern has also shifted from data being an urban phenomenon, to mass market adoption of data services, leading to increase in demand for infrastructure support.

The importance of fiber connectivity to create a high-performing, dense urban network, which is able to sustain the level of data growth has become paramount. Infrastructure ramp ups will be necessary to support the data needs to a bandwidth hungry consumer. The future technologies also demand infrastructure build-outs at massive

scale. 5G has moved from being a buzzword to a strategic advancement expected in the next four to five years.

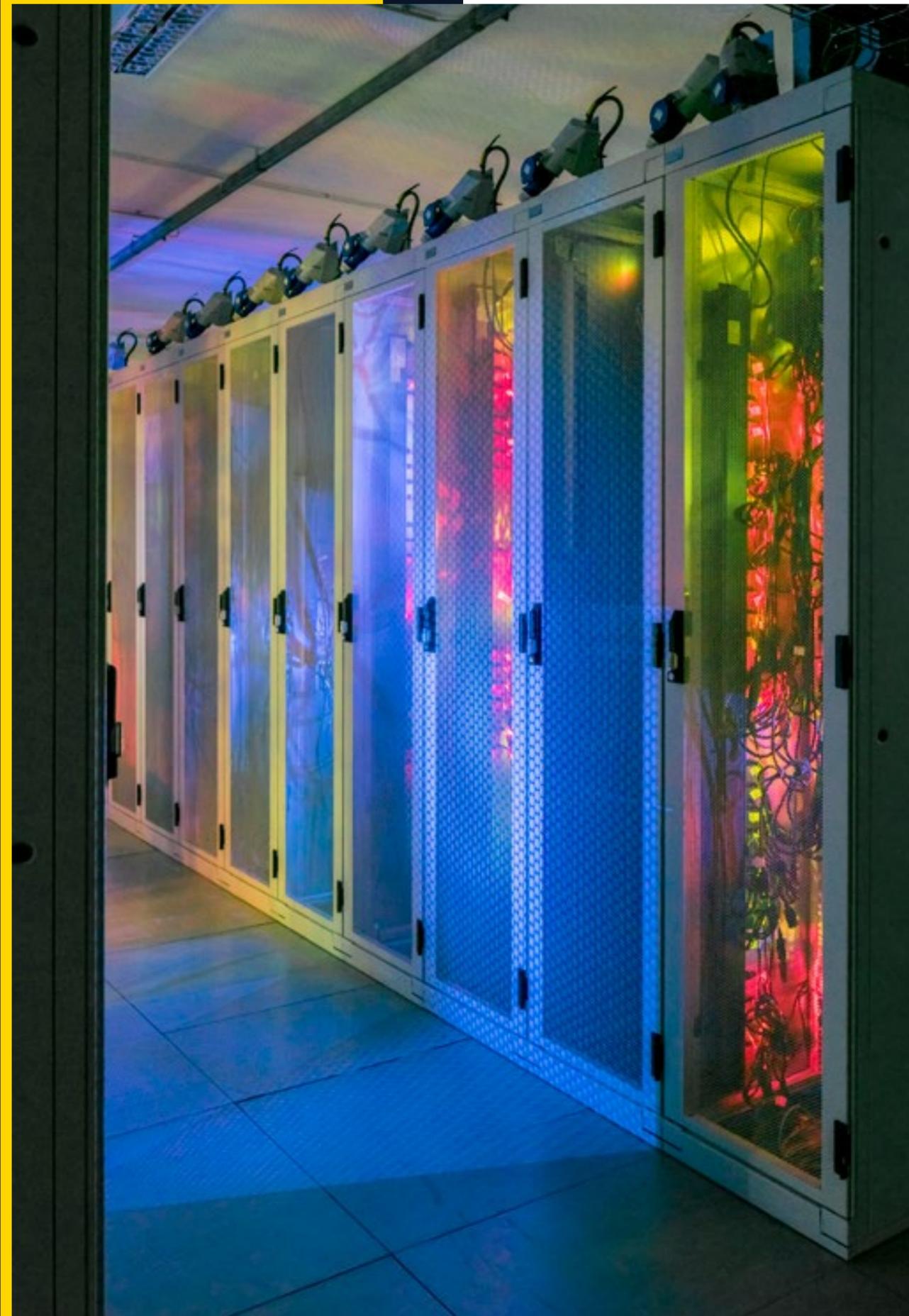
In this seismic shift, plenty of opportunities are arising for tower companies to move their attention from a macro tower focused business, to additional revenue streams such as fiber, small cells, data centers, Wi-Fi and smart cities and beyond. Globally, tower companies are already reaping the results of these new areas of investment and the business case has proved to be successful for multiple global infrastructure companies (infracos).

With this backdrop, EY has drawn out the future business landscape for Indian telecom towers industry, and done an in-depth study on the new opportunities which have already started to gain ground. With the high industry momentum, and government's push on infrastructure growth, the future is promising for the telecom infrastructure sector.

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Executive summary

The telecom towers industry has played a pivotal role in the unhindered growth of India's telecom sector. Indian tower industry has been one of the pioneers in infrastructure sharing globally, which has resulted in significant operational efficiency and capex saving for telcos. The business of building, buying and leasing of macro towers has proven its merit over the years, and has created an investible proposition for tower companies in India. Currently, Indian tower companies (towercos) are amongst the largest telecom infrastructure companies across the globe.

Currently, 71% of tower portfolio in India is held by telecom infrastructure providers that are directly controlled by telecom operators or are independent tower companies¹. Only 28.8% of the sites are telco captives². Portfolios of independent tower companies are further expected to grow as telcos continue to divest their tower assets to pare their debts and focus on core service delivery.

While the tower lease model for infrastructure providers has flourished over the past decade, the transformation witnessed by the telecom industry is opening new business avenues and revenue streams for towercos.

Changing dynamics of the Indian telecom sector

The Indian telecom market has shrunk from a 10-12 player market to a mature four player construct. The carrier neutral towerco business model, which hinged on tenancy addition, has limited prospects in a mature market with lower number of players. The growth of macro sites is expected to be modest in the coming years, majorly driven by capacity expansion for data services for 4G services in the immediate term, and later for 5G launch.

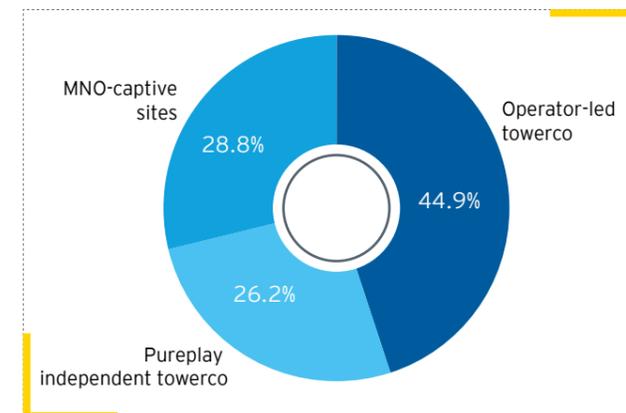
The telecom market has also undergone a significant transition, moving from a voice centric to a data heavy

consumption pattern. Factors such as aggressive data pricing, 4G roll outs by operators, decline in handset costs and availability of relevant content have contributed considerably to this data deluge.

The Indian telecom industry is today characterized by high data demand and the market is expected to witness a 5x increase in mobile data traffic during 2018-24. This burgeoning data need has given rise to the demand for new infrastructure and services. New generation technologies such as 4G, 5G and IoT require formidable network performance, which has triggered the need for a diverse infrastructure mix.

Towercos today are well positioned to expand their infrastructure portfolio, by tapping into adjacencies to cater to the changing needs of the telecom industry. Across the globe, telecom infrastructure players are witnessing a transition from just macro tower sites, to inclusion of small cells, fiber and Wi-Fi solutions. Countries such as the US, Indonesia and China are already seeing infracos diversify into these new assets and services.

Figure: India tower ownership split (as of October 2018)

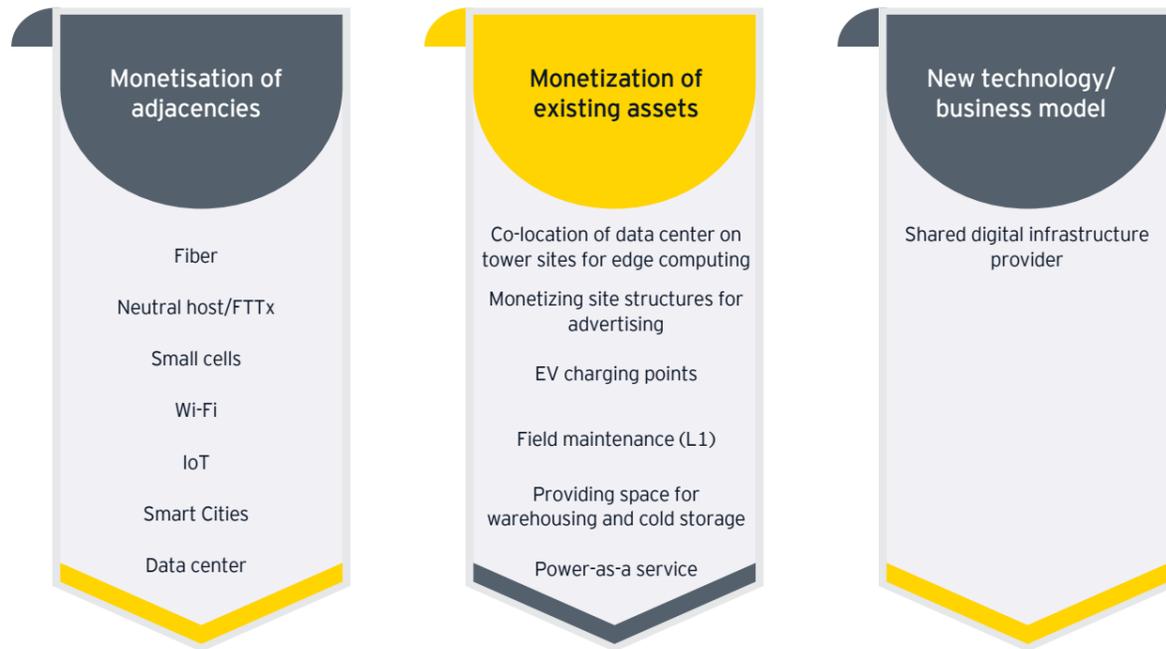


Share of towers held by tower companies = Share of towers held by operator-led towerco + Share of towers held by pure-play independent towerco

Source: TowerXchange Issue 24

1. Tower Xchange Issue 24
2. Tower Xchange Issue 24

Business opportunities for towercos



Source: EY analysis

Monetization of adjacencies

Fiber: Fiber is a fast-growing infrastructure asset class which is gaining attention as fiber demand in India is increasing at a rapid pace. Deployment of large amount of high frequency 4G and 5G spectrum needs a fiber backhaul. Telcos' ambition of increasing fibre to the home/building (FTTH/B) penetration for residences, buildings and enterprise customers would boost the demand for fiber lay outs. Government initiatives such as BharatNet's and Digital India's focus on telecom infrastructure, especially fiber, is also contributing to increased fiber deployment.

Towercos are well positioned to address the fiber opportunity, with their existing experience of managing distributed infrastructure assets. Certain use cases that have towers as the central piece

of network architecture, are already gaining traction. On the forefront is site fiberization, as it enhances backhaul and increases the valuation of the core tower assets, giving towercos increased control.

Small cells: Coverage and capacity have long been called out as the prerequisites for high speed data networks, especially with the advent of 4G and 5G. Network densification has already begun in metros with 4G network roll outs, and will further increase with 5G and IoT use cases. Globally, towercos are already adding small cells to their inventory of site typologies - mostly functioning as site acquirers, with the small cells themselves owned by telcos. A bigger opportunity lies where towercos acquire and own their small cells, and offer fiberized small cell sites to the telcos.

Public Wi-Fi: Owning and maintaining distributed assets gives towercos a synergistic playing field in Wi-Fi. Despite

significant growth in mobile data traffic, Wi-Fi penetration in India has remained dismal. Towercos have an opportunity to penetrate this market. They can choose a host of business models - providing Wi-Fi equipment and operations and maintenance (O&M) to clients, or becoming a neutral host public Wi-Fi provider. The latter will need active infrastructure deployment which is subject to license conditions.

Internet of Things (IoT): The IoT ecosystem is expected to grow at a rapid pace with the advent of 5G. IoT connections in India are expected to grow at a CAGR of 32% over 2017-2023 to ~423 million connections. This presents a unique opportunity for towercos to position themselves as the infrastructure providers for the IoT ecosystem. From deployment and maintenance of sensors, to entering the application and hardware value-chain, towercos can explore multiple business

directions, based on capability and skill set enhancement.

Smart cities: India's smart city initiative has opened a new avenue of growth for infrastructure providers. Digital infrastructure forms the backbone of the smart city initiative and towercos are well positioned to create and maintain this infrastructure. The Indian government's Smart Cities Mission, which was launched in 2015, aims to create 100 smart cities in the country. Towercos in the country have already jumped on the smart city bandwagon and are keen to make most of this opportunity.

In most cities, purchasing right of way (ROW) is expensive and one key revenue opportunity in smart cities comes from gaining rights to the street furniture and an easy RoW. Under the public private partnership (PPP) model, towercos can build the communications infrastructure for the city and in lieu use the RoW and site rights for mounting their own infrastructure for revenue generation. Leading Indian towercos have already entered smart city projects.

Data centers: In line with the capex to opex conversion model supported by towerco's traditional business of tower rentals, data centers is a potential area of business which aligns with this model. Upfront high capex investments by towercos in data centers, to lease out space for colocation or to provision of managed hosting services, is a prospective business model. With the increase in data consumption, data centers are witnessing a steep growth trajectory - data center market in India to grow at 8.4% CAGR from 2018-2023.

Monetization of existing assets

Apart from tapping on the above adjacencies, an immediate proposition

for towercos is to monetize their existing assets. Towercos can expand their service portfolio beyond tower-based real estate and include provisioning other services on their tower sites. With distributed, power-backed and increasingly fiberized sites, towercos can explore revenue streams that exploit this dispersed real estate advantage.

A potential business stream includes setting up of edge computing on tower sites by deploying micro data centers near the network edge. With steady power supply and ready backhaul, tower sites can support edge data centers closer to the user, reducing the need to send backhaul data traffic to a centralized hub.

The location advantage of towercos also renders them fit for serving as storage, warehousing and delivery centers for various businesses. With availability of power and air-conditioning, even perishable goods storage can be explored as a business stream. As e-commerce companies are trying to penetrate deeper into remote and rural areas of Indian market, distributed location of tower sites can be leveraged for storage as well as collection point for goods ordered online.

Tower structures can also be monetized for out of home advertising, with placement of billboards on towers/monopoles. Another service proposition beyond vertical real estate is the provisioning of primary and backup power. This innovation is well established by the "powerco towercos" (towercos offering power management solutions) of Sub-Saharan Africa and Southern Asia region³. As towercos have significant expertise in managing energy assets, they are well-positioned to provide power-as-a-service.

With advent of electric vehicles, towercos can play an important role in this upcoming opportunity and unlock a new revenue stream.

The availability of reliable power and possession of distributed sites makes towercos well-suited to provide EV charging infrastructure.

In the long run, there is an opportunity for tower companies to play a much larger role in the ecosystem by becoming a shared digital infrastructure provider. This role would include management and sharing of active elements along with passive infrastructure. By assuming the overarching role of a shared infrastructure provider, the tower companies can offer wholesale services to digital service providers, who in turn can focus on their core business. This opportunity would be subject to regulatory approvals and a much more evolved ecosystem.

Opportunities aside, ease of doing business remains a prime concern for all infrastructure projects in the country. Delays in getting approvals from municipalities, lack of uniform charges and clearances for RoW and multi-body approvals are key concerns that needs to be addressed for faster infrastructure roll-outs. To expedite the creation of robust telecom infrastructure and to fulfil the agendas of Digital India, it is pertinent that ease of doing business is treated as a priority.

In this scenario, it has become important for towercos to explore new opportunities and diversify their business models. The immediate proposition for towercos is to expand their service offerings beyond tower based real estate, and capitalize their tower sites for hosting other services/infrastructure. With distributed, power backed, and increasingly fiberized sites, towercos can explore revenue streams that exploit this dispersed real estate advantage.

3. TowerXchange

Assessing the opportunity landscape for towercos

Opportunities such as fiber and small cell have already gained traction globally for towercos and have significant potential in India

Opportunity	Assessment	Challenges	Heat-map	
Adjacencies	Fiber deployment and backhaul through fiber and microwave	Tower fiberization Intra-city fiber Fiber to the curb National long distance Fiber O&M Microwave	<ul style="list-style-type: none"> RoW Pricing of intra-city and NLD fiber Regulatory approval for microwave 	
	Small cells deployment with 4G/5G	Small cell sites deployment	<ul style="list-style-type: none"> Site acquisition and RoW 	
	Wi-Fi	Neutral host Wi-Fi provider	<ul style="list-style-type: none"> Monetization 	
	Internet of Things	Build-operate-maintain IoT network Sensor O&M + installation	<ul style="list-style-type: none"> Capability enhancement Workforce management for large scale sensor deployments 	
	Smart cities opportunity	Digital infrastructure deployment Platform and application provider	<ul style="list-style-type: none"> Revenue models 	
	Data center deployment	Build and operate data centers (co-location)	<ul style="list-style-type: none"> Market in nascent stage Capability enhancement 	

Long term opportunity subject to capability enhancement

Source: EY analysis

Opportunities such as IoT and EV charging have significant potential, but depend on ecosystem development and market maturity

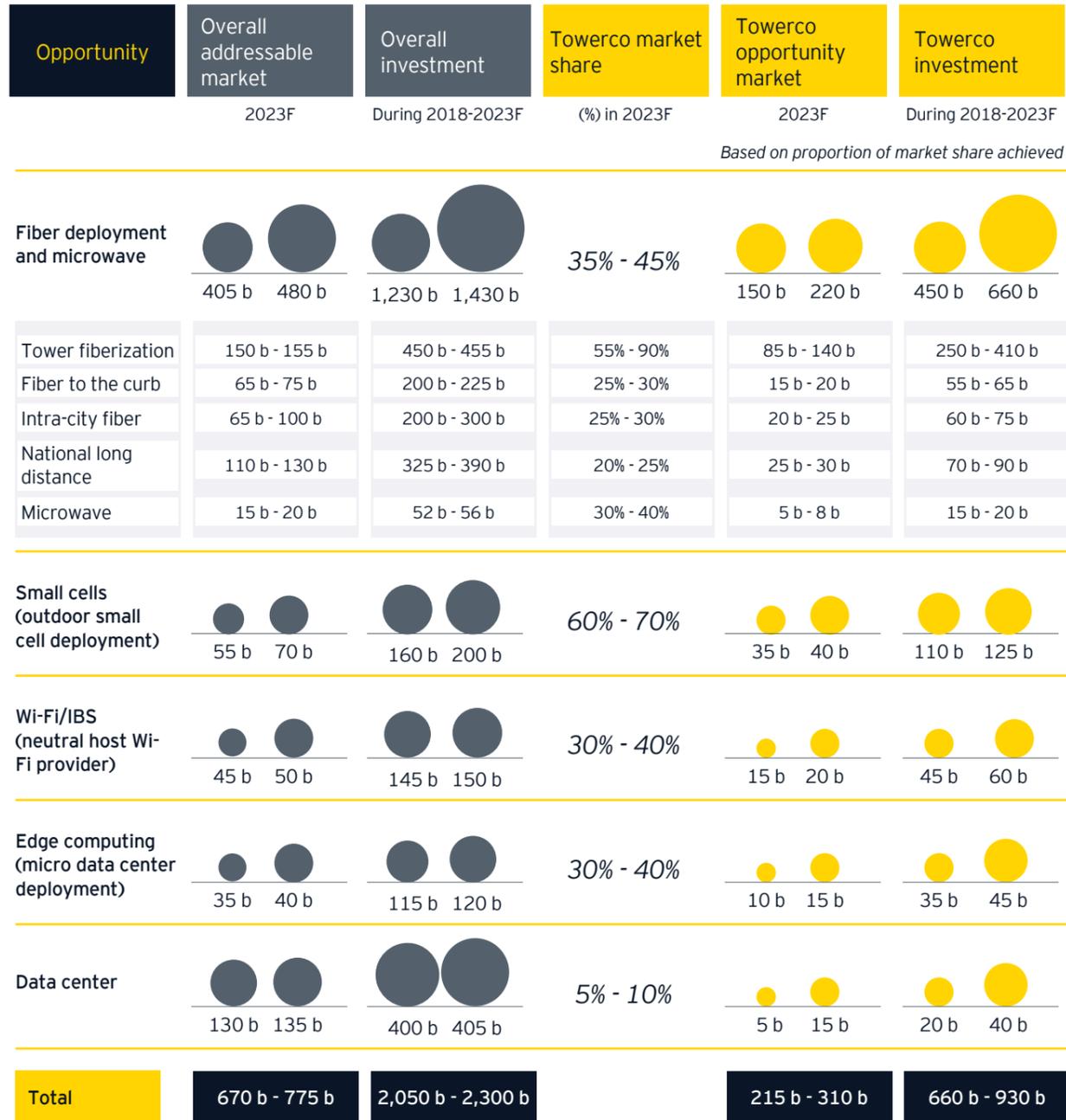
Opportunity	Assessment	Challenges	Heat-map	
Monetize existing assets	Field maintenance (L1)	Level 1 field maintenance	<ul style="list-style-type: none"> Currently under the purview of OEMs 	
	Edge computing (micro data centers)	Co-location and managed services	<ul style="list-style-type: none"> Market in nascent stage 	
	Out-of-home advertising	Static billboards Digital billboards	<ul style="list-style-type: none"> Complex approvals Limited opportunity 	
	Warehousing, collection point for goods	Space for warehousing and cold storage at tower sites	<ul style="list-style-type: none"> Limited opportunity 	
	EV charging	Use power at sites for providing EV charging	<ul style="list-style-type: none"> Underdeveloped infrastructure 	
	Power management as a service	Power management for other industries	<ul style="list-style-type: none"> Capability development 	

Long term opportunity subject to capability enhancement

Source: EY analysis

Addressable market and investment analysis of select opportunities

INR



Source: EY analysis

Detailed assumptions for the market assessment models⁴



Sources: Ministry of statistics and programme implementation, Worldometers, Ministry of marker research India, Arizton Advisory & Intelligence, Industry inputs through primary interviews, EY analysis

4. "Housing - Statistical Year Book India 2017", Ministry of Statistics and Programme implementation, <http://mospi.nic.in/statistical-year-book-india/2017/197>
 4. "India Population Forecast," Worldometers, <https://www.worldometers.info/world-population/india-population/>
 4. "Socio- Economic classification: The new SEC system," Ministry of market research India, <http://mruc.net/uploads/posts/8d373188d2f2f813f7f85759aa0304f4.pdf>
 4. "Data center market in India: Industry Outlook & Forecast (2019-2024)," Arizton Advisory & Intelligence via EMIS

Caveats

- ▶ Assets of new entrant not considered on a shareable level for these projections.
- ▶ Shift in technology can have significant impact on the projections. Revenue assessment does not take technology risks into account.
- ▶ Business forecasts are subject to investment potential by telcos. EY has not independently validated the future business health of the telecom industry.
- ▶ The forecasts have not taken into account any future new towerco hive-offs or any potential deals of the future.
- ▶ Limited availability of reference data for new opportunities due to absence of current business models for the same.
- ▶ Assessment of the business opportunities have been done as per industry trends. The future business directions/ ownership of telco assets such as fiber, microwave, Wi-Fi access points, small cells, IoT infrastructure not validated with telecom players.
- ▶ EY has relied on primary survey for revenue estimates. EY has not independently validated forecasts and adequacy of the same taking into account the sensitivity analysis.
- ▶ Potential impact of any Forex risks has not been accounted for.
- ▶ Any future consolidation or entry of a new player in the telecom market may impact the revenue projections.
- ▶ The revenues are estimated using the principal operational guidance from the current business plans of a long term capex to opex conversion models. There may be variations in operational efficiency of the new opportunities.
- ▶ EY has not considered the regulatory barrier for the current assessment.
- ▶ Future regulatory changes or changes in terms of license conditions may impact the projected revenues.
- ▶ 5G launch, scale of availability and pace of ecosystem development may impact revenue projections.
- ▶ Competitive landscape has not been assessed in detail for any of the revenue projections.



1

India telecom tower industry overview

Sector landscape and industry growth

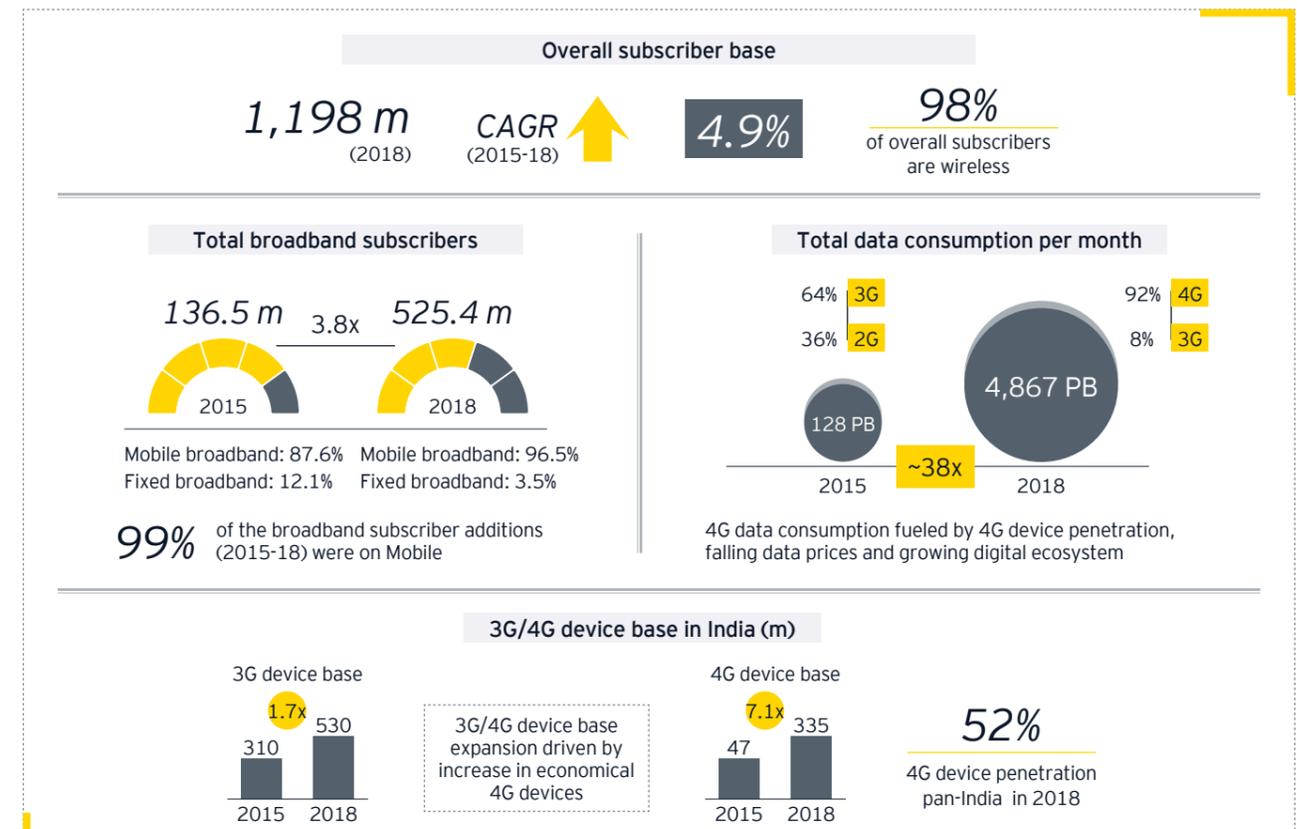
The telecom sector in India has witnessed a remarkable growth over the last two decades and has contributed significantly to the socio-economic development of the country. Currently, India is the second largest telecoms market with over a billion wireless subscribers. The unprecedented success of India's telecom sector is attributable to the wireless growth backed by a robust tower infrastructure industry which has played instrumental role in bridging the digital divide and facilitating ubiquitous mobile connectivity.

India today is at the cusp of digital revolution driven by paradigm shift in usage pattern from voice to data centric services, propelled by roll out of 3G/4G services, increasing penetration of smartphones and affordable data tariffs. Going forward, emerging technologies such as 5G, augmented reality, virtual reality and internet of things (IoT) are set to redefine the communications landscape communication in the country.

The government has also embarked on an ambitious Digital India Programme

to transform the country into a digitally empowered society. It seeks to provide digital interface between the government and citizens to provide a plethora of e-governance services including healthcare, education and banking which would ride on ICT infrastructure. With communication and connectivity at the heart of Digital India vision, telecom infrastructure providers are poised to play a critical role.

Figure: India's telecom growth story



Source: TRAI, Nokia Mbit Index 2019, Nokia Mbit Index 2016, media articles

Telecom towers industry transformation

Over the years, Indian tower industry has laid strong foundation of growth for the telecoms sector and has supported the sector in keeping pace with the technology advancements. India was one of the pioneers in passive infrastructure sharing. Pooling in towers and bringing in the passive infrastructure sharing model - providing integrated neutral host platforms for the telecom players - has found success in the market. It has not only led to capex and opex efficiency through optimal utilization of infrastructure for telecom operators, but has also facilitated faster time to market and affordable services for end users.

The business model of towercos currently depends on the long-term

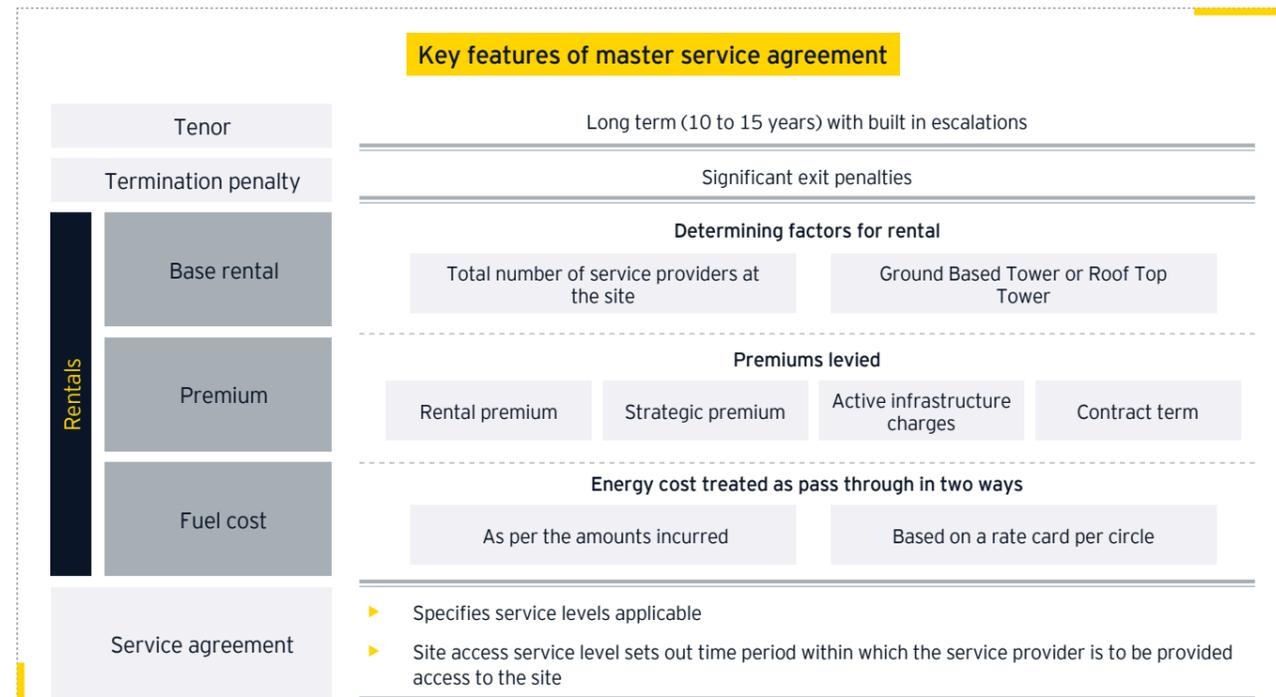
contracts, known as the master service agreement (MSA) with telecom operators. Under the terms of the agreement, the towerco provides access to its sites to all its tenants on non-discriminatory basis for installing active infrastructure. The MSAs contain significant exit penalties which hedge the towerco's cash flows against risk of premature winding up of tenancies. The agreement is economically viable for telecom operators as they are able to leverage economies of scale with declining rentals and share energy cost for the towers.

Currently, 71% of the tower portfolio in India is held by telecom infrastructure providers that are directly controlled by telecom operators or are independent tower companies⁵. Going forward, telecom operators are expected to

further divest their tower portfolios triggered by stressed financials.

The ongoing price wars in the telecom industry has resulted in debt ridden balance sheets and is tapering the top line of telecom operators. The gap between the sector debt and overall revenue continues to widen - telecom industry's overall debt has spiraled to INR 4.7 trillion⁶, while the gross revenue has declined to INR 2.5 trillion⁷ in FY18. In the current scenario, operators are keen to reduce stake in tower subsidiaries, or divest their captive tower assets, to pare their debt and focus on their core business. Going forward, independent towercos are expected to own majority of the towers in the market as tower leasing results in higher operating efficiency for the telcos.

Figure: Typical master service agreement



Source: Company investor presentation

Figure: Regional comparison of share of towers held by tower companies (%) (as of October 2018)

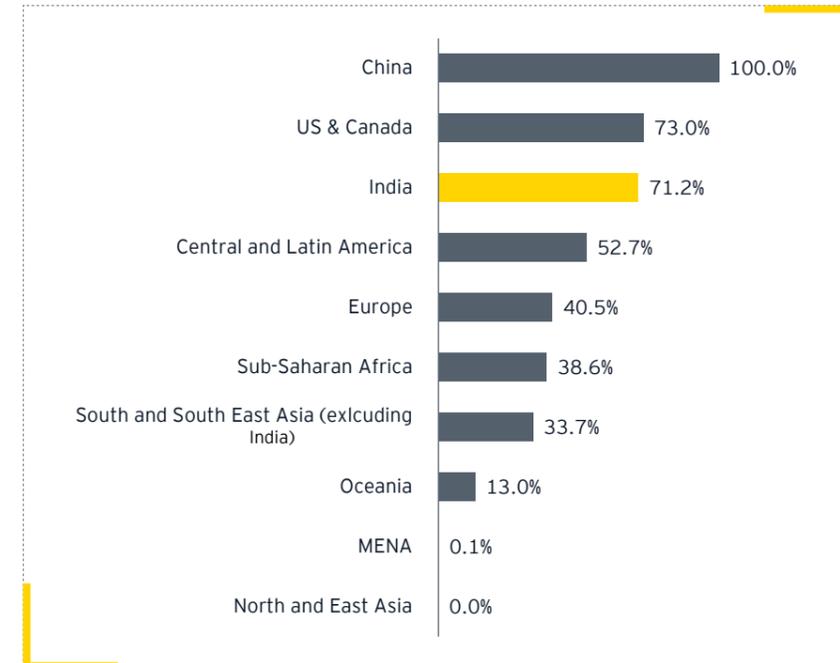
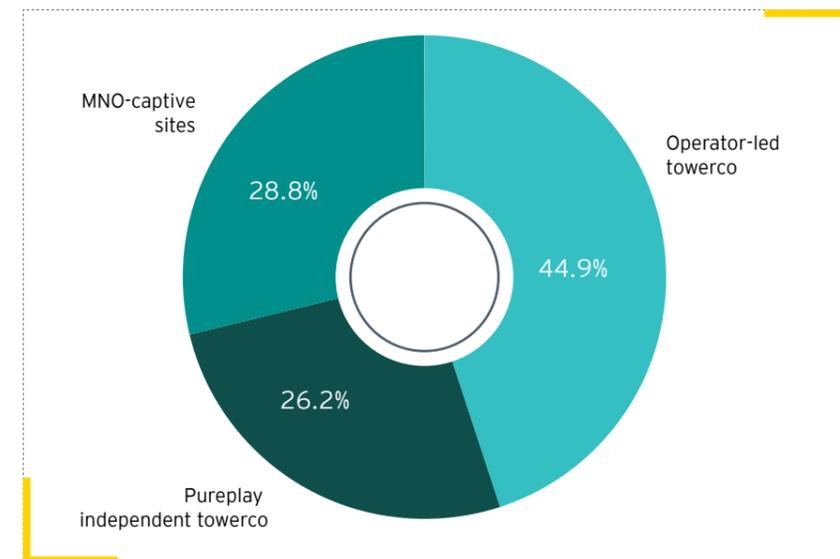


Figure: India tower ownership split (as of October 2018)



Share of towers held by tower companies = Share of towers held by operator-led towerco + Share of towers held by pure-play independent towerco

5. TowerXchange Issue 23

6. "Telecom Outlook For Next Year Bleak: ICRA," Communications Today, 5 December 2018, <https://www.communicationstoday.co.in/telecom-outlook-for-next-year-bleak-icra/>

7. "The Indian Telecom Services Performance Indicators: January-March 2018," TRAI

Over the last decade, the tower industry has been on a consolidation spree. The on-going mergers are expected to create two to three strong independent towercos followed by smaller towercos. The consolidation underway in the tower industry is expected to bring in more stability in the market with scale and synergy benefits and would also enhance the ability of the towercos to invest in new opportunities.

Changing industry dynamics bring in new opportunities and challenges for towercos

With the fast-paced growth in the telecom sector, the model of tower industry to lease the space at tower sites to multiple operators on a long-term contract had flourished. Capital had flowed into towers on the assumption that there was a minimum secured return due to long term lease contracts.

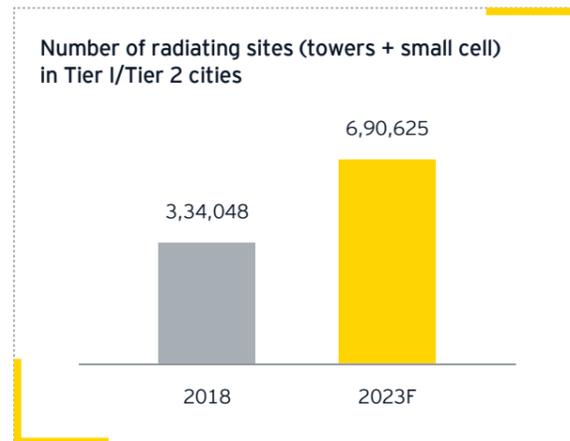
The tower industry had witnessed promising growth with number of towers increasing from around 250,000 in 2008⁸ to 506,746 in 2018⁹. The tenancy ratio had jumped from 0.9 in FY08¹⁰ to 2.13 in FY18¹¹ (ending March 2018). The sector's overall operating margin was in the range of 43%-44% in the past four-five years (ending March 2018) majorly driven by rental and energy margins expansion¹².

However, the dynamics of the telecom sector are changing. The recent restructuring in the telecoms market has led to mergers and exits. The India telecoms market has shrunk from 10-12 player market to a mature "3+1" player market. With lesser number of players, the need for new tower sites in the short run will be limited.

On the flip side, the introduction of 5G will add impetus to tower sites growth in the medium run. It will also bring growth in form of non-traditional small cell sites, which would be needed for network densification to meet 5G standards.

With this transition in the industry outlook, towercos are aligning their business priorities with the changing sector needs. New business models and revenue streams have opened for towercos globally and Indian infrastructure market is ripe to explore these diversified business streams.

Figure: Projected growth in the number of radiating sites



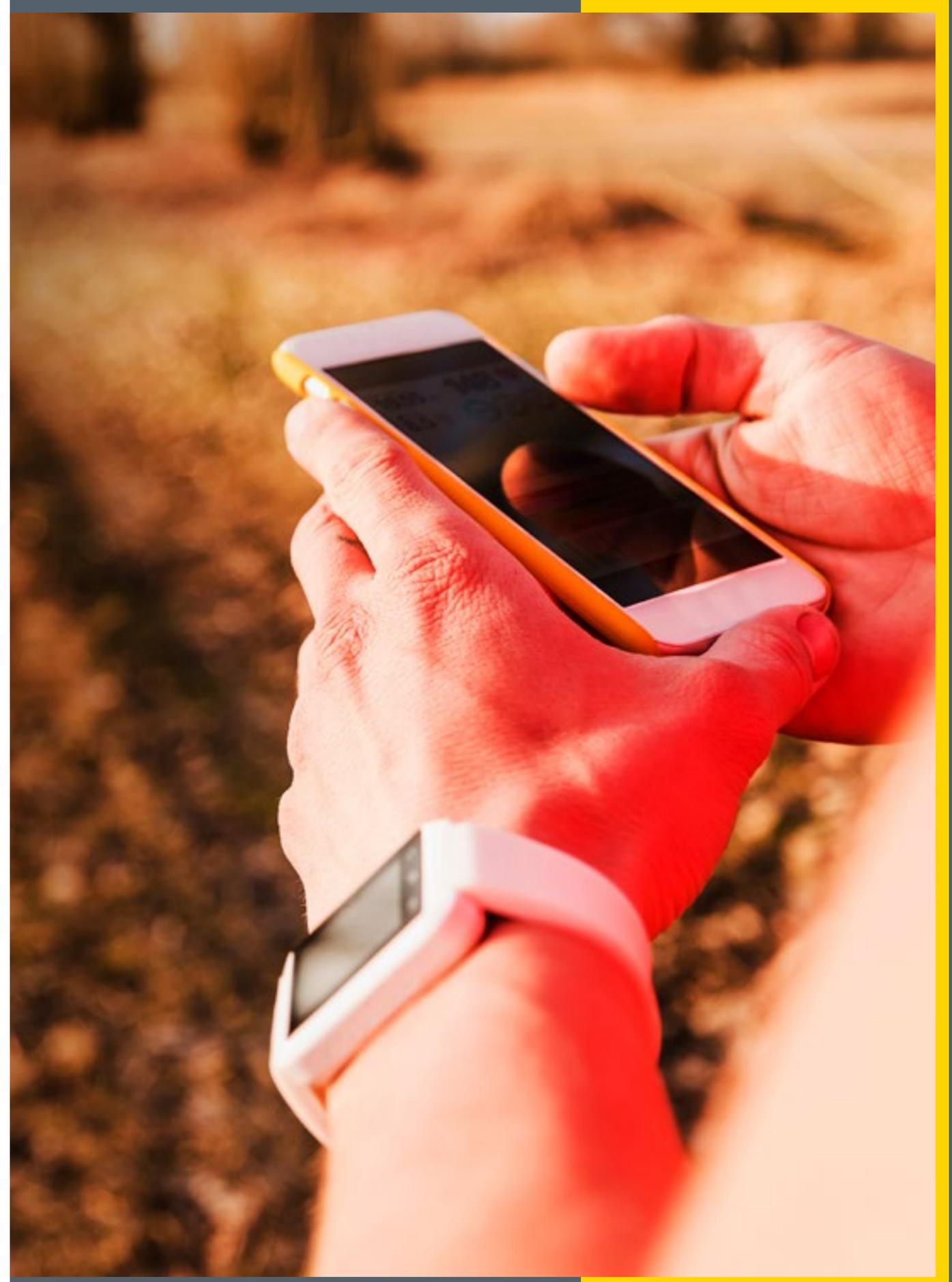
8. "Speeding ahead on the telecom and digital economic highway," EY, 2015

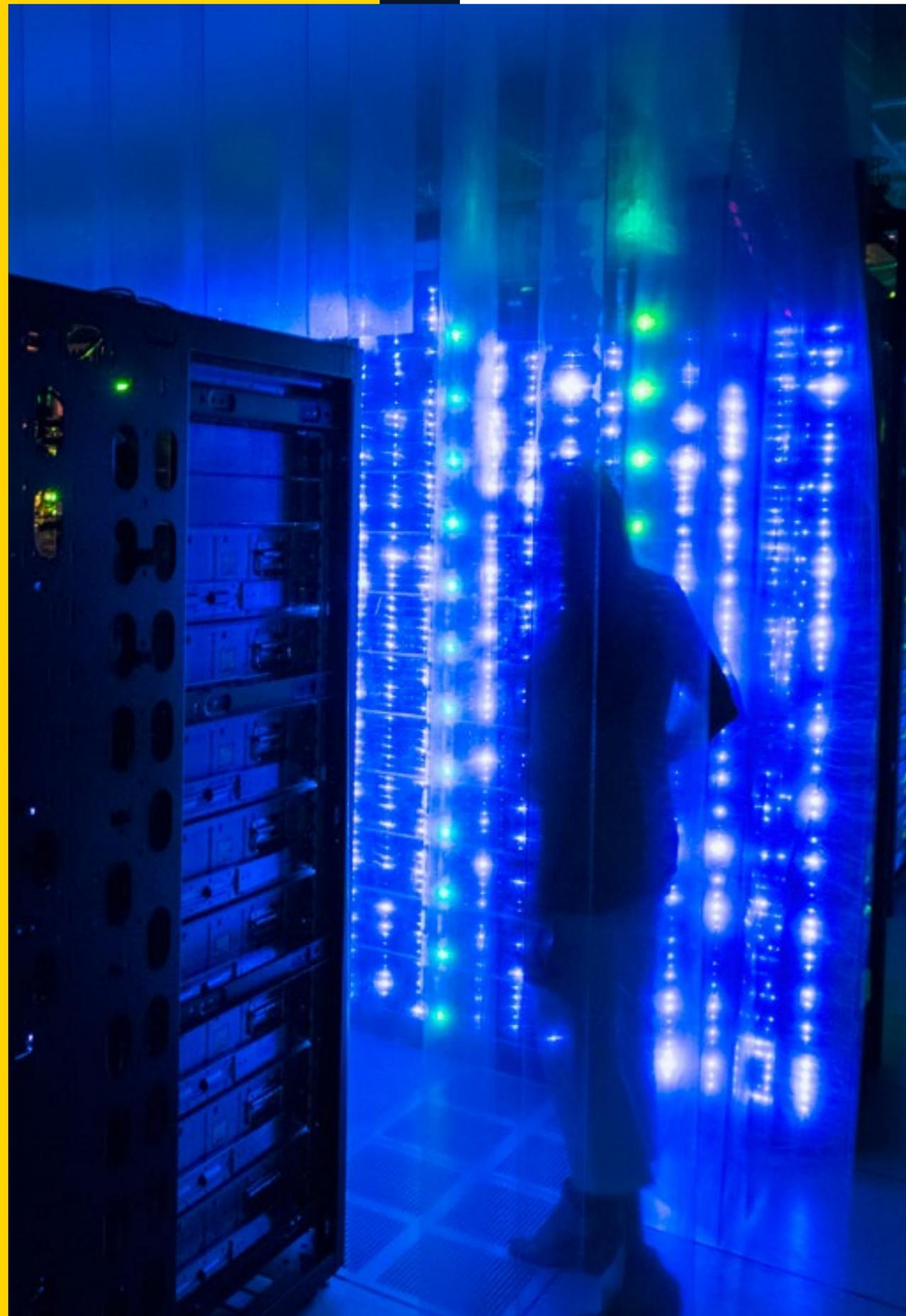
9. DoT

10. "Speeding ahead on the telecom and digital economic highway," EY, 2015

11. "Towerco consolidation no offset to margin dial-down," CRISIL, October 2018

12. "Towerco consolidation no offset to margin dial-down," CRISIL, October 2018





Exploring new opportunities - what lies ahead for towercos

Telecom sector evolution opens new opportunities for towercos

Consumptions patterns have changed radically for the Indian telecom consumers in the past 3-4 years. From a voice dominant market, there has been a clear shift towards data centric usage patterns. The Indian market is expected to witness a 4x increase in mobile data traffic during 2018-24. Multiple factors have contributed to this shift in demand toward data.

One of the key drivers has been the decline in tariffs. In the recent past, data tariffs have come down due to competitive forces, making mobile broadband services affordable especially for residents in rural India. This has led to a much larger scale of adoption of data services.

Figure: Data traffic forecasts

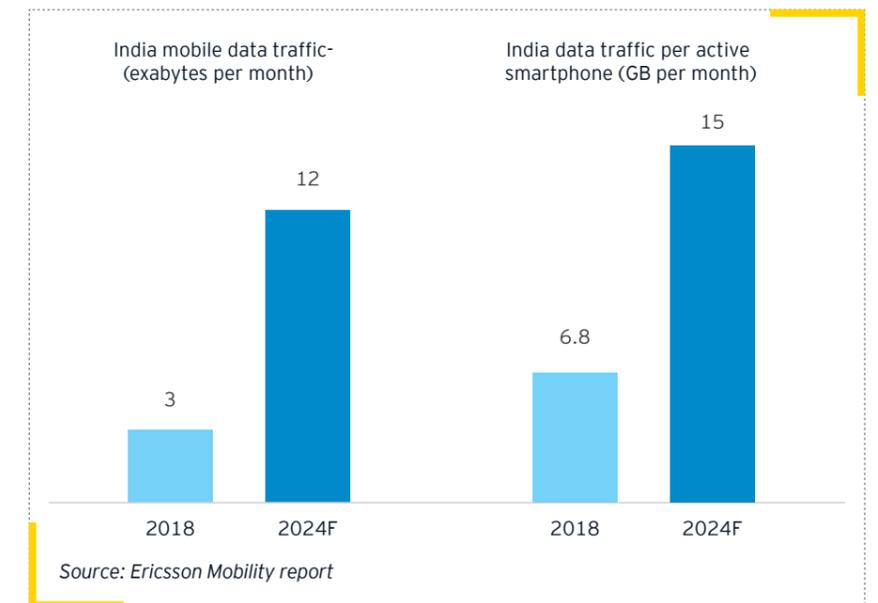


Figure: Decline in data tariffs

India has witnessed steep decline in data tariffs in the past few years

INR269/GB in 2014 to **INR19/GB** in 2018

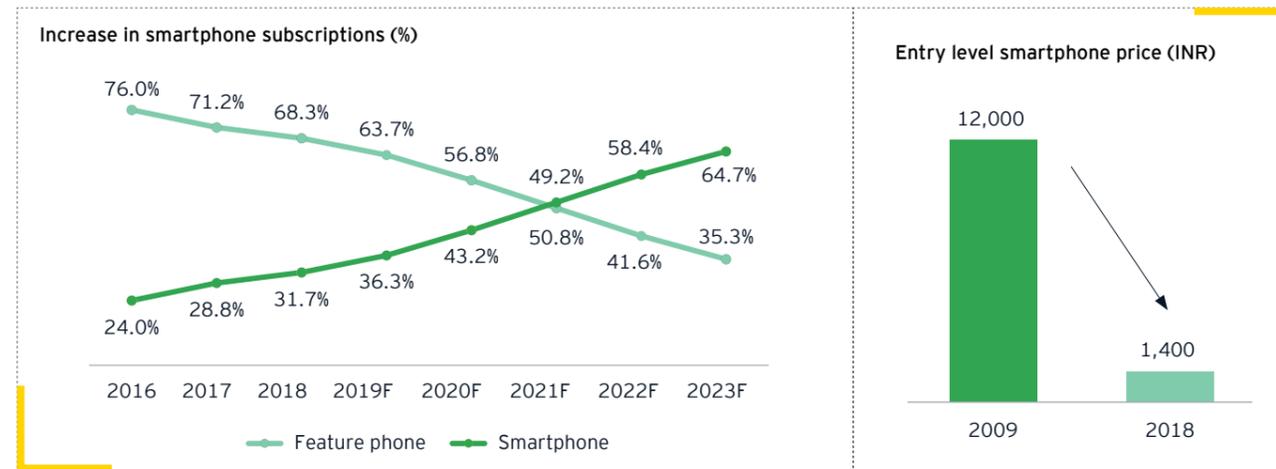
Bundled plans with unlimited voice, large data allowances

Source: IDC, GSMA, Nokia, Media articles

In addition, decline in smartphone prices has played an important role in driving data consumption amongst masses. Smartphone subscriptions is gaining pace and is expected to account for 64.7% of total mobile subscriptions by 2023¹³.

13. Analysys Mason

Figure: Smartphone adoption on a rise



Source: Analysys Mason, media articles

Operator investments in 4G has been another important factor in driving data adoption. Over the past two years, Indian operators have invested heavily in their 4G networks. India has leapfrogged from 2G to 4G and with this fast-paced transition, the infrastructure requirements have also become more sophisticated. Availability of advanced networks delivering high speed data has also played an important role in data uptake.

Availability of digital content has contributed to the data demand. Content consumption is growing amongst Indian users. Video has become a primary contributor accounting for 65% to 75% of total mobile data traffic. Adoption of video has been majorly driven by increase in availability of vernacular content with 93% of the time spent on videos in Hindi and other regional languages¹⁴.

Social media apps have been gaining traction. On an average, an Indian consumer spends 200 minutes per day on apps. Of this, 38% of time is being spent on social media and communication¹⁵.

Figure: Share of 2G, 3G, 4G and 5G connections (million)

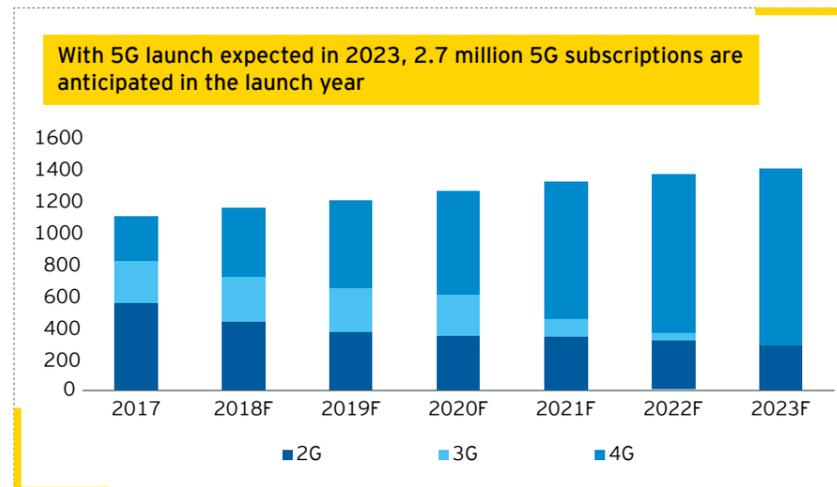


Figure: Increasing content consumption



Source: #Broadband2022 -Unlocking a trillion dollar digital economy, EY; A billion screens of opportunity, EY; Nokia Mbit Index 2019

14. "Re-imagining future of M&E in India, EY-FICCI, 2018"
 15. "#Broadband2022 -Unlocking a trillion dollar digital economy," EY, 2018

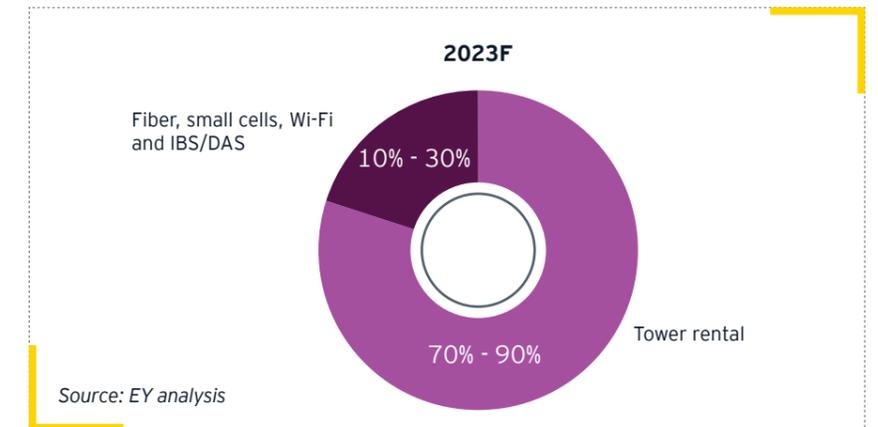
Towerco business model will witness transition

The growth in data demand, along with the roll out of 4G and impending launch of 5G, has changed the infrastructure requirement for telcos. High speed data services are fueling the need for a denser network along with increase in fiber penetration. In the coming years, telecom infrastructure will comprise of not only macro tower sites, but also small cells, fiber, wi-fi and in building solutions (IBS) solutions.

Further, technology evolution expected with the transition to the next generation will pose new requirements for infrastructure. 5G requires gigabit speeds to be delivered to the consumers; hence, each mobile site (both macro and small cell) will need to backhaul multi-gigabit throughputs to the aggregation network. The launch of 5G mobile networks will significantly affect both the wireless side and the wireline side of network infrastructure. The formidable network performance goals of 5G - for latency reduction (from 50ms to 1ms) and speed from 100 Mbps to 10Gbps - would heavily predicate on the availability of fiber, and a majority of it, to the cell sites.

The bandwidth intensive applications such as IoT/M2M and AR/VR will demand network densification which will entail the deployment of small cells and this will make the network more heterogeneous. These small cells will further require fiberization due to operational complexities of using microwave backhaul.

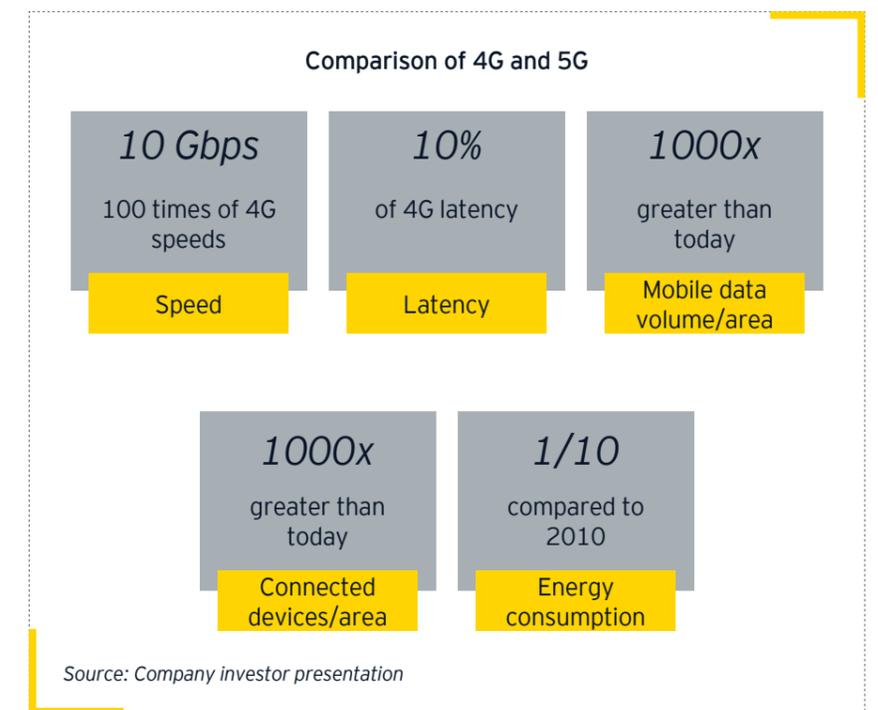
Figure: Towerco revenue split forecast



Source: EY analysis

Note: Assuming telcos will hive-off their fiber assets and will be renting out fiber from third party service providers

Figure: 5G requires deeper and denser network



Source: Company investor presentation

Business model evolution

Over the years, towercos have gained extensive experience in managing distributed assets. Their current business model has helped them build core assets and strengths that can be further leveraged for revenue gains. The physical assets - site location, tower structures, power backed sites, air-conditioning and fiber - can be cross-leveraged for varied use cases. Further, the towercos have well established

relationships with telecom operators, experience in managing long terms MSAs and the know-how of RoW clearances processes. These skills and assets taken together, give towercos a unique value proposition to broaden their portfolio.

As towercos explore higher revenue streams, they can follow a multi-dimensional approach. The infrastructure demands of the sector are evolving and towercos can leverage their expertise to explore adjacent

opportunities that fit in with their core competency. Business streams such as fiber, small cells, Wi-Fi, smart cities, IoT and data centers are some of such opportunities. Additionally, they can explore utilizing their physical assets and skills for generating new revenue streams. This would majorly entail colocation of other infrastructure on their sites and extending their service expertise to other sectors.

Figure: Towerco business evaluation

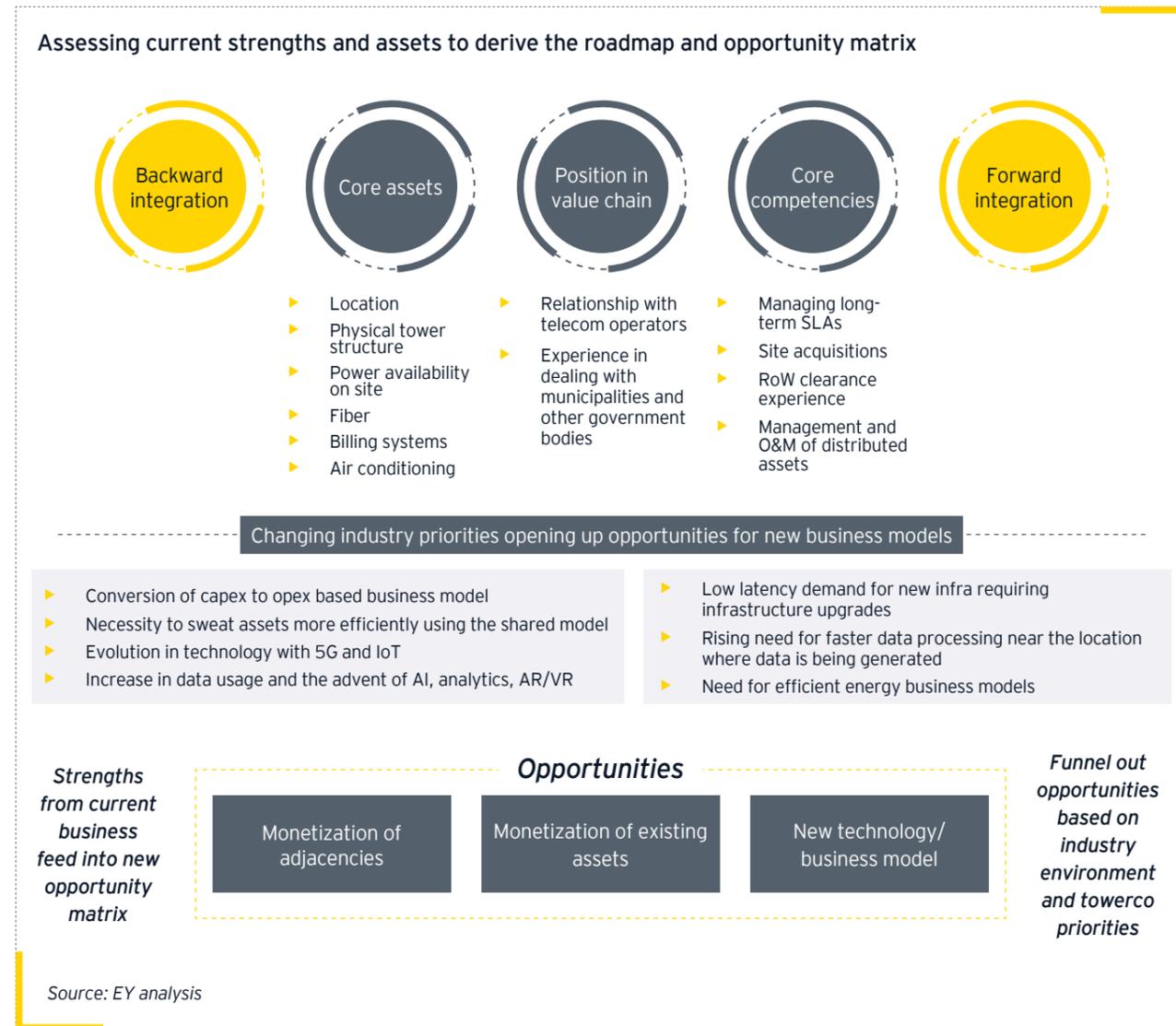
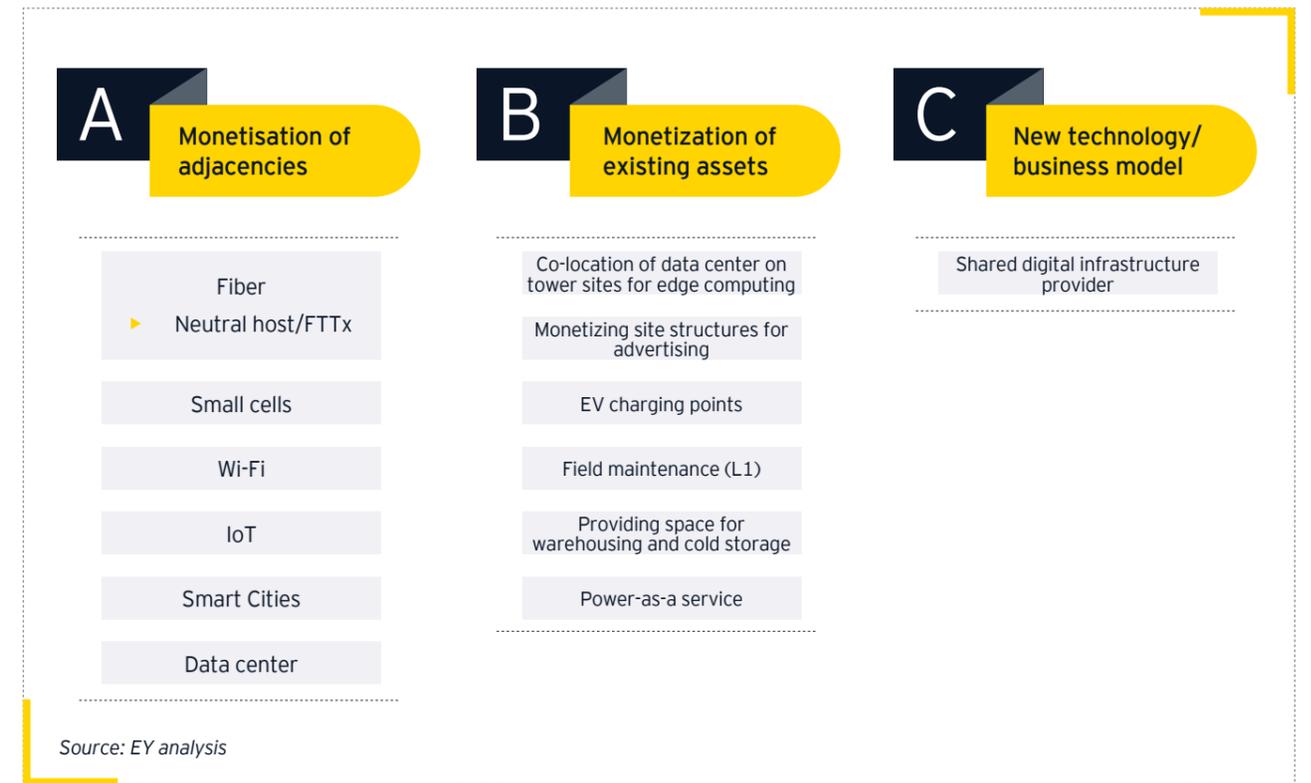


Figure: Business opportunities for towercos

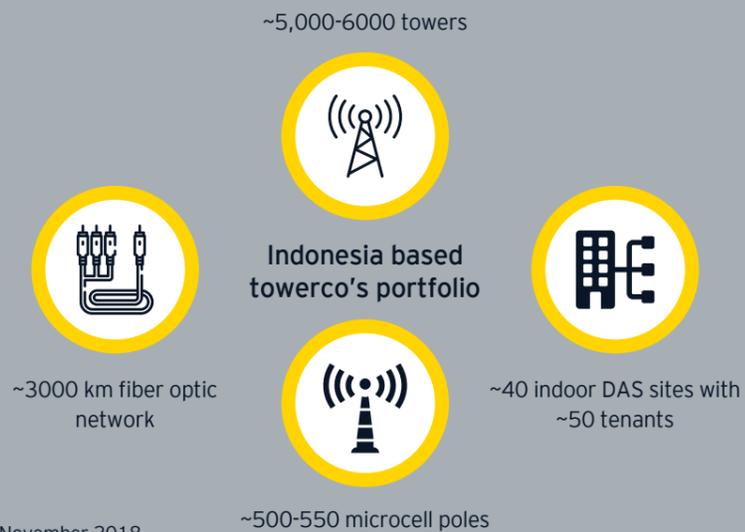


Towercos across the globe are already exploring ways to evolve their businesses by tapping on the adjacencies by diversifying asset class and migrating into new services. The most common asset class diversification has been fiber and small cell rollout.

Case study

An Indonesia based towerco strengthening its value proposition in adjacent business segments

The towerco has diversified beyond traditional tower business to build comprehensive portfolio comprising of fiber, DAS and microcells solutions



As of November 2018

Growth pillars of towerco

Continued co-location on existing portfolio	Prudent build-to-suit roll out	Monetization of fiber assets	Expansion into new segments
---------------------------------------------	--------------------------------	------------------------------	-----------------------------

Key strategic developments

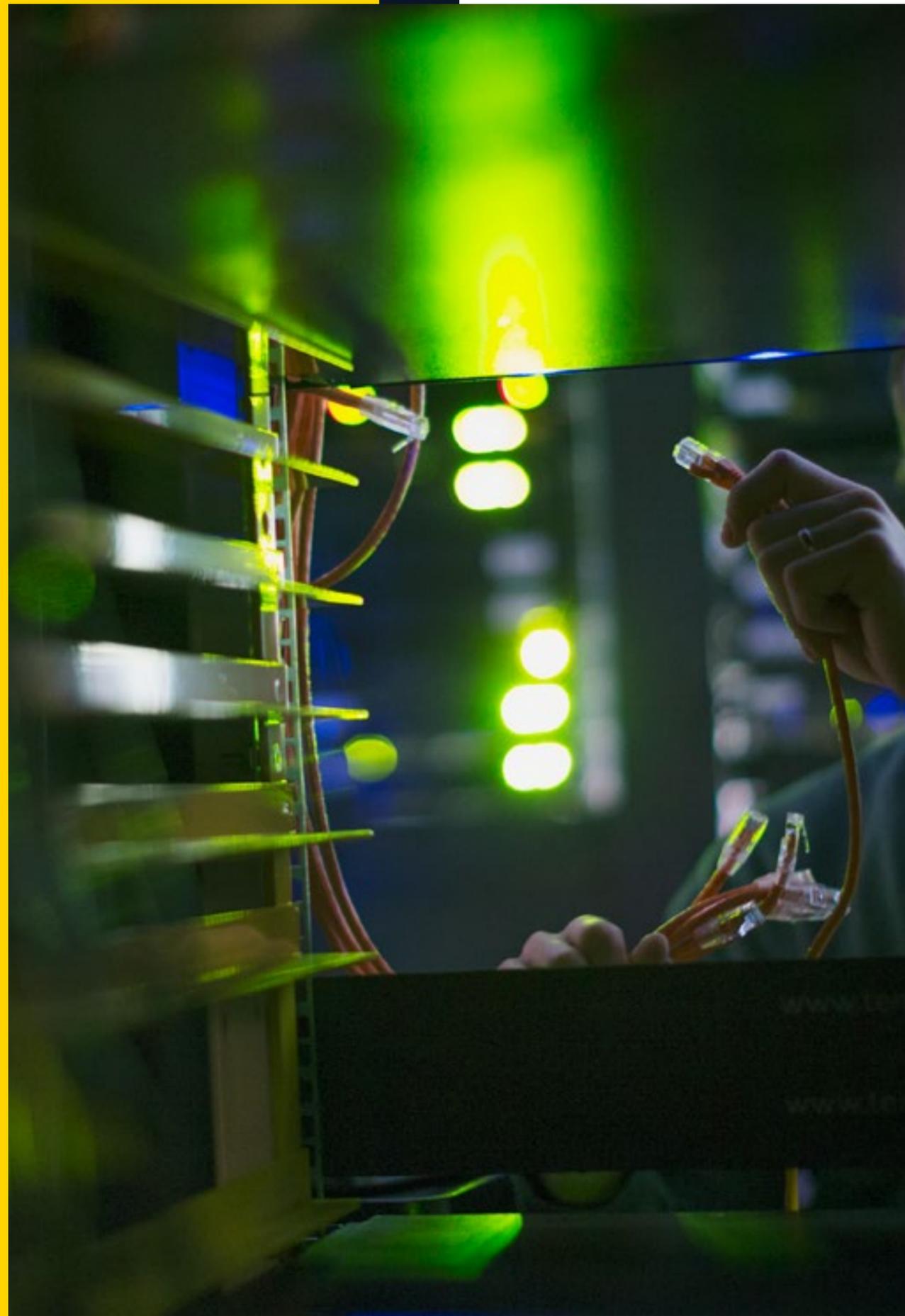
- 1 In 2012, entered into fiber market with acquisition of a Indonesia based fiber optic network provider
- 2 Completed pilot project of fiberization of ~3,300 homes in 2017
- 3 Signed partnership with a leading global technology services company to provide cloud and data center services to enterprises in Indonesia

Increasing revenue contribution from non-conventional tower business (microcell poles+fiber)



Source: Towerxchange, company investor presentation



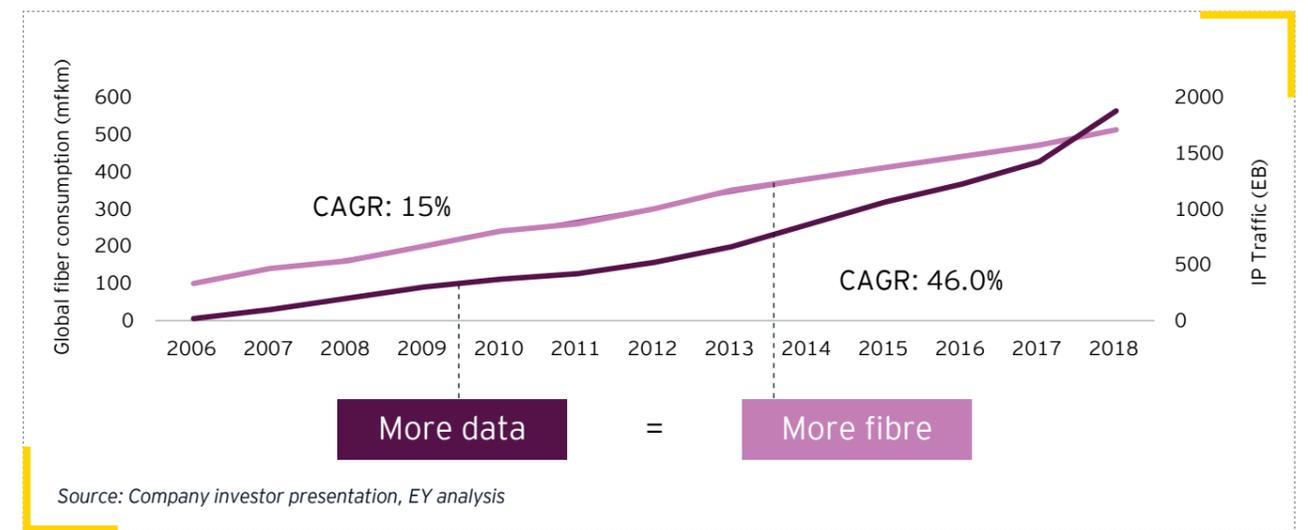


Evaluating the play of tower companies in adjacent business segments

The fiber opportunity for towercos

The demand arising from the impending data growth and telco ambitions around 5G roll-outs have significantly increased the need for telecom infrastructure, especially fiber. The global fiber optics market was valued at around US\$2.75 billion in 2016 and is expected to reach approximately US\$3.72 billion in 2022, growing at a CAGR of slightly above 5.2% between 2017 and 2022¹⁶.

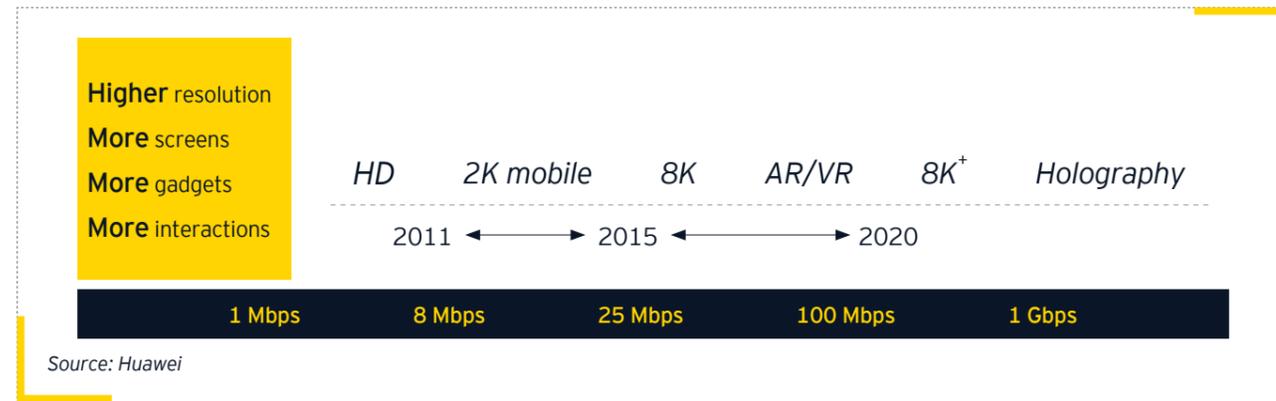
Figure: Global growth in fiber consumption vis-à-vis IP traffic growth



Also, with the bandwidth requirements of the high definition content and data heavy applications, the need for fiber will increase exponentially.

16. "Global Fiber Optics Market will reach USD 3.72 Billion by 2022: Zion Market Research," Zion Market Research, <https://globenewswire.com/news-release/2017/01/23/909814/0/en/Global-Fiber-Optics-Market-will-reach-USD-3-72-Billion-by-2022-Zion-Market-Research.html>, accessed 16 April, 2018

Figure: Increase in bandwidth requirement with the increase in applications



Fiber connectivity is key to create a high-performing, dense urban network able to sustain the level of data growth experienced in India. In comparison to copper cables, fiber delivers much higher bandwidth, which has become extremely vital for supporting burgeoning data traffic.

Globally, it has been witnessed that fiber requirements grow exponentially as we move from one generation to the next. For instance, in moving from 3G to 4G and FTTH, fiber deployment increased by almost 4.5x¹⁷. Another surge in demand is expected with the launch of 5G services¹⁸.

Figure: Fibre expansion with upgrade of wireless technologies

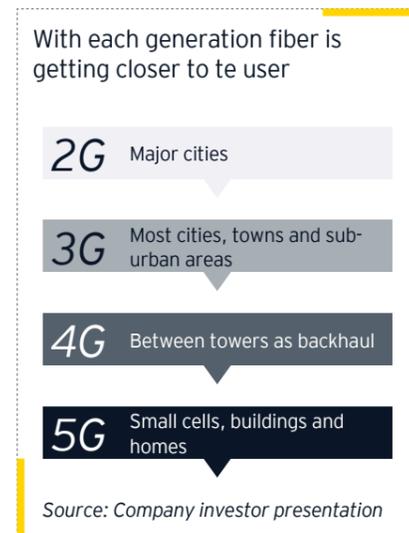
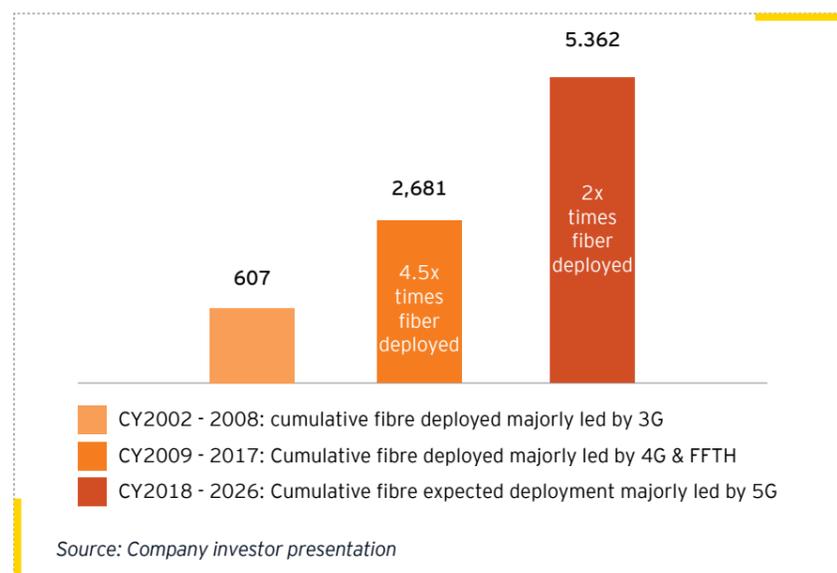


Figure: Global fibre deployment forecasts



Towercos are well positioned for the fiber opportunity

High speed data networks (such as 4G/5G) demand fiberized sites for backhaul. For operators to remain competitive, it is essential that backhaul is efficiently managed. Fiberization of towers had already been initiated during 4G deployment phase and 5G would necessitate 100% tower fiberization. If tower companies want to unlock new revenues from fiber, their ability to acquire or lay fiber will be crucial.

Government programs such as BharatNet and Smart Cities are also adding to the demand for fiber deployment. Robust inter-city and intra-city fiber networks have already been deployed in India and would continue to add to the demand due to replacement cycles and densification of network.

Given that operators have disparate plans, for enterprise, indoor, fiber to the tower and for FTTH/B, a centralized approach from an independent towerco will be more suitable from a deployment standpoint. Further, as telcos continue to function in a highly competitive environment, fiber assets hive-offs are being considered as a potent route to go asset light.

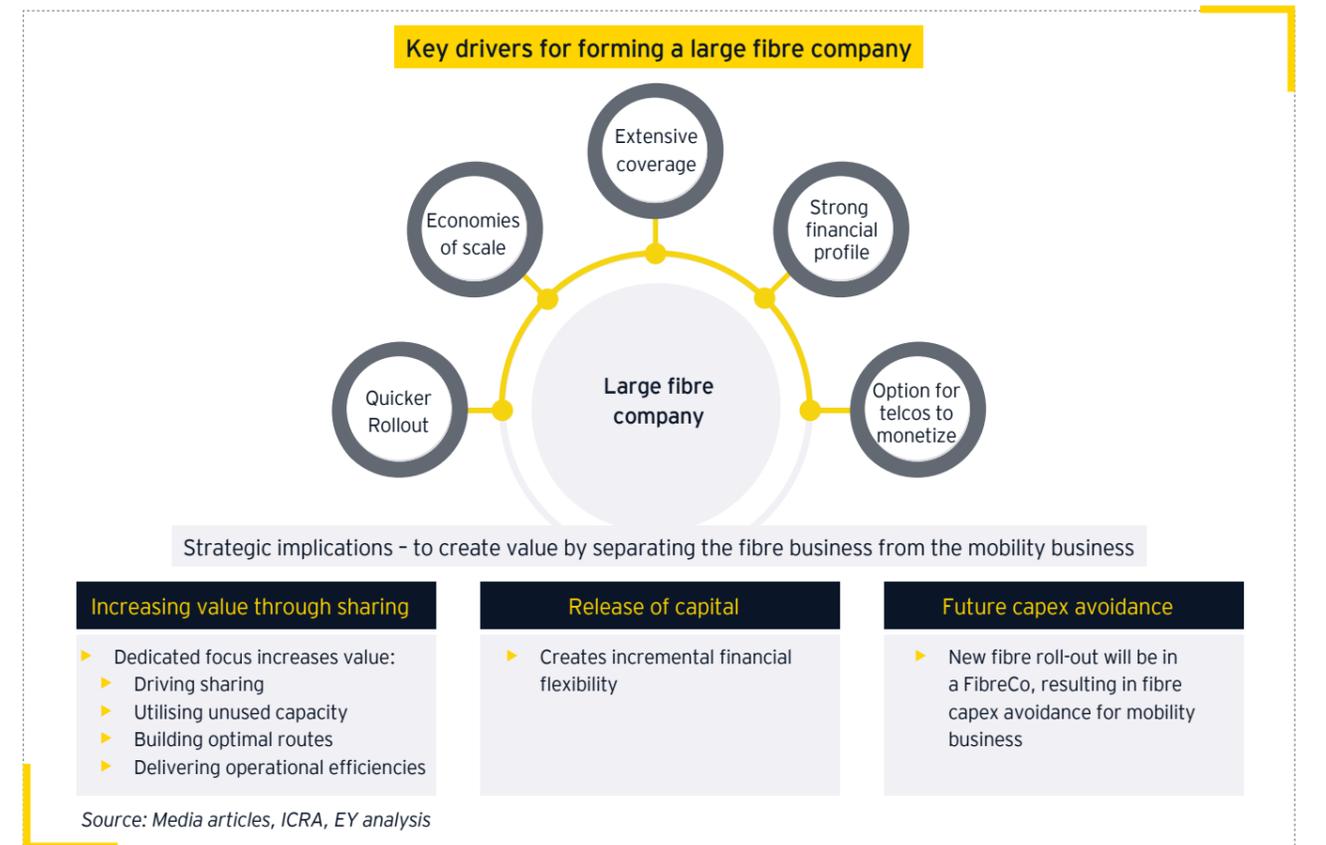
Hiving-off the telco's fiber assets into two separate units - on similar lines as tower hive-offs - will make it easier for the telco to use the assets more efficiently and even monetize them in the future. Such a move would make the operating company asset light, increase its ability to leverage and open the units to monetization.

Currently, the leading Indian telcos have already made announcements of fiber

unit hive-offs, and others may follow suit. This will open an opportunity for towercos to consider acquiring these assets from telcos. As telcos start to consolidate core assets and offerings, towerco owned and managed fiber assets for leasing can emerge as a potent model. Additionally, towercos can explore provision of centralized fiber O&M for the laid networks.

The strong business case for towercos in the fiber space is visible from some of the global moves by tower infrastructure providers. Towercos stand to tap a significant revenue stream from deploying fiber-fed small cells. For instance, tower companies in the US and Indonesia have already started offering both fiber and small cells to telecom service providers.

Figure: Drivers and strategic implications of a large fibre company



17. Investor presentation of a Fibre manufacturer
18. IBID

A US based towerCo is repositioning itself as a fiber company and has made strategic acquisitions to strengthen its fiber assets

Current tower assets of the towerco

The towerco owns, operates and leases more than 40,000 cell towers in every major U.S. market

New focus area - fiber

The towerco is repositioning itself as a fiber provider (focused on the small cell opportunity)

Adopted the acquisition route

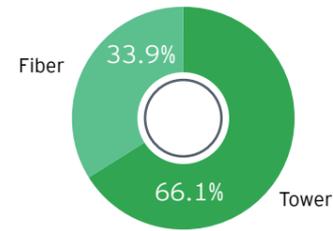
Over the period of last two years, the towerCo has purchased eight fiber operators, have rights to approximately 60,000 route miles of fiber, with a presence in 23 of the top 25 metro markets of the US

Strategy behind the acquisitions

Fiber acquisitions serve two main business lines: small cells and other enterprise and adjacent wholesale opportunities

Breakdown of towerco's site rental revenues

100% = US\$4.7 billion

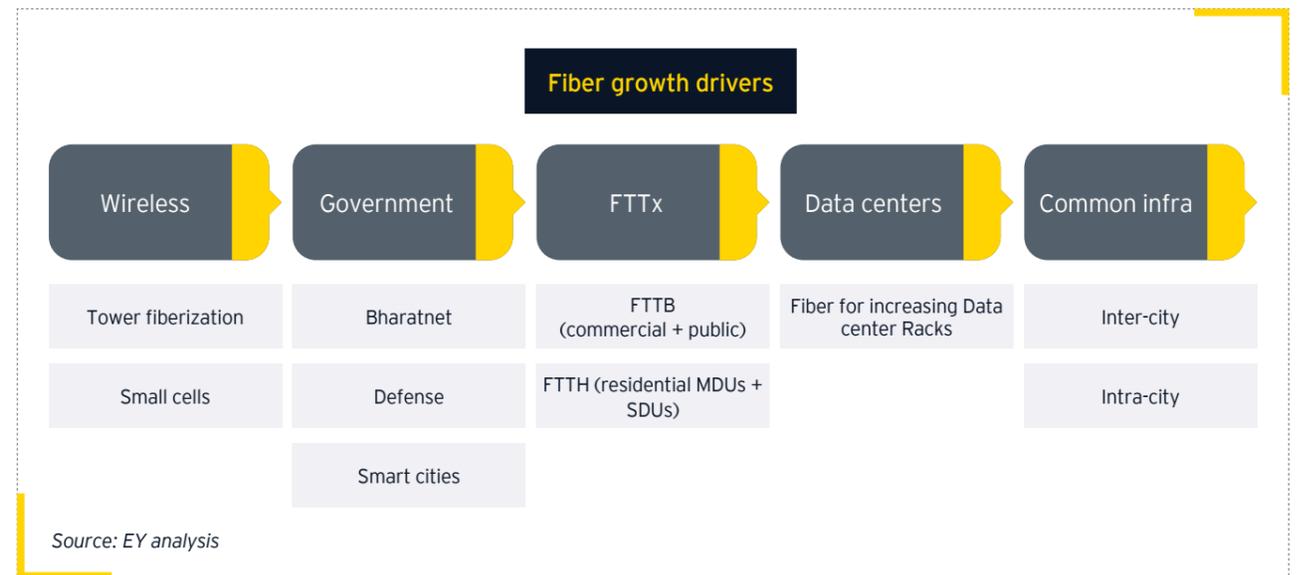


(As of December 2018)

Note: Fiber includes both fiber and small cell solutions

Following its acquisitions, the towerco has emerged as one of the larger fiber U.S. network operators

Figure: Demand drivers for fiber growth in India



A. Wireless infrastructure driven fiber demand

India currently has close to 506,746 towers in 2018 and 20-25% towers are fiberized^{19,20}. In a 4G/5G environment, microwave-based backhaul will become less relevant and there will be a need for more fiber. While the initial investments are huge, rewards from fiber backhaul

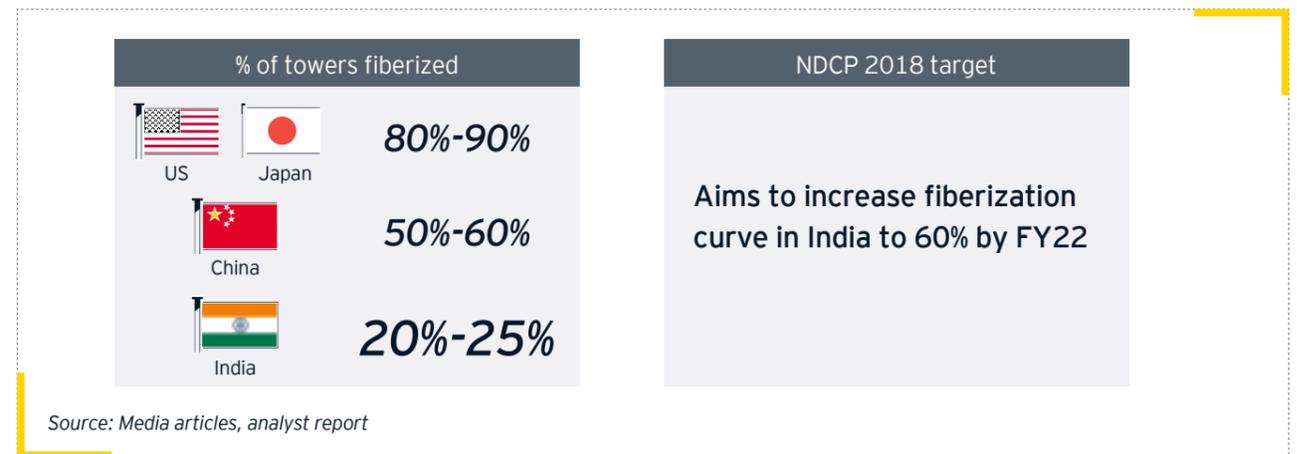
are considerable. For telcos to fully monetize the spectrum they would have to add more fiber backhaul.

Operators that outsource tower backhaul from towercos can benefit from significant cost savings. The main benefit relates to avoiding high capex associated with backhaul deployment and rather converting it into opex. The

backhaul that a towerco can provide offers the opportunity for cost sharing amongst multiple operators, and these cost savings could be passed on to telco tenants.

India currently lags behind global peers in terms of fiberization rates and is expected to witness rapid fiberization going forward.

Figure: India lags behind global peers in terms of tower fiberization

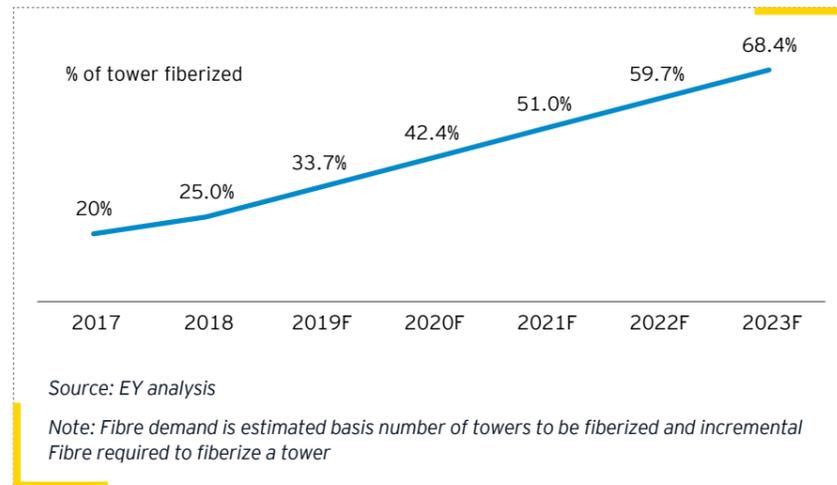


19. Tarang Sanchar

20. "5G will require huge investment in fiberization says TRAI Chairman," Communications Today, <https://www.communicationstoday.co.in/5g-will-require-huge-investment-in-fiberization-says-trai-chairman/>, accessed, 5 Apr, 2018

Tower fiberization is expected to witness a steady growth in the future. Especially with India's 5G launch anticipated in 2023, fiberization rates are expected to surge from 2021 onwards.

Figure: India tower fiberization forecast



Microwave backhaul provision by towercos

Microwave antenna - used for point-to-point connections as an alternative to a fiber backhaul link are currently owned and provided by the tenant operator

- ▶ Microwave transmission involves large antennas, often requiring a specific location in terms of height and direction
 - ▶ With heavy microwave antennas, having one set of microwave dishes rather than four could free significant Exposed Projected Area, to sell to additional tenants or for next generation equipment upgrades
- ▶ Towercos can offer shared transmission to existing tenants as part of the initial deal - acquiring transmission assets as well for leaseback, with a view to upgrade or replace those assets to support multiple tenants
 - ▶ The mode of transmission - fiber or microwave would be decided by towerco
 - ▶ Such a model is subject to regulatory approvals

B. Government led fiber programs

BharatNet for facilitating fiber roll-outs

For deeper digital penetration in rural areas, the government took the BharatNet initiative to link each of the 250,000 Gram Panchayats (GPs) of India through optical fiber network. The project initially was structured around laying incremental underground fiber to link the GPs.

The BharatNet project evolved with the launch of Digital India in 2015. Progressing from laying down of optical fiber, to creating the seamless connectivity backbone, the erstwhile National Optical Fiber Network (NOFN) was renamed as BharatNet in 2016. A modified approach for Bharat Broadband Network Limited (BBNL) was approved by Cabinet in July 2017.

In the modified strategy, the most important aspect is the involvement of states along with Central Public Sector

Undertakings (CPSUs) and private sector in implementation of the project. Further, special emphasis has been laid on provision of services. The Cabinet has also approved last mile connectivity model for the GPs.

Figure: BharatNet - Gov's key initiative for enhancing the ICT infrastructure to improve connectivity

Erstwhile: NOFN

- ▶ Initiative to trigger *broadband revolution* by providing connectivity till GP level
- ▶ 250,000 GPs were intended to be covered in NOFN
- ▶ 220,000 km of duct was to be laid down to provide last mile connectivity
- ▶ At least 100 Mbps of bandwidth was committed to be provided at GP
- ▶ Committed timeline of *two years* to lay down the fiber till GP level
- ▶ INR 200 billion was estimated to be the total project outlay

Now: BharatNet

BharatNet is a project of national importance, with a highly scalable network infrastructure to provide on demand, affordable broadband connectivity of 2 Mbps to 20 Mbps for all households and on demand capacity to all institutions, to realise the vision of Digital India, in partnership with States and the private sector.

- ▶ Initiative to provide *on demand and affordable* connectivity to all households and institutions
- ▶ 250,000 GPs are intended to be covered under BharatNet
- ▶ On demand connectivity of 2 Mbps to 20 Mbps for all households
- ▶ INR 785.1 billion is estimated to be the total project outlay
- ▶ Four implementation models: *state led, center led, private led, PPP led*

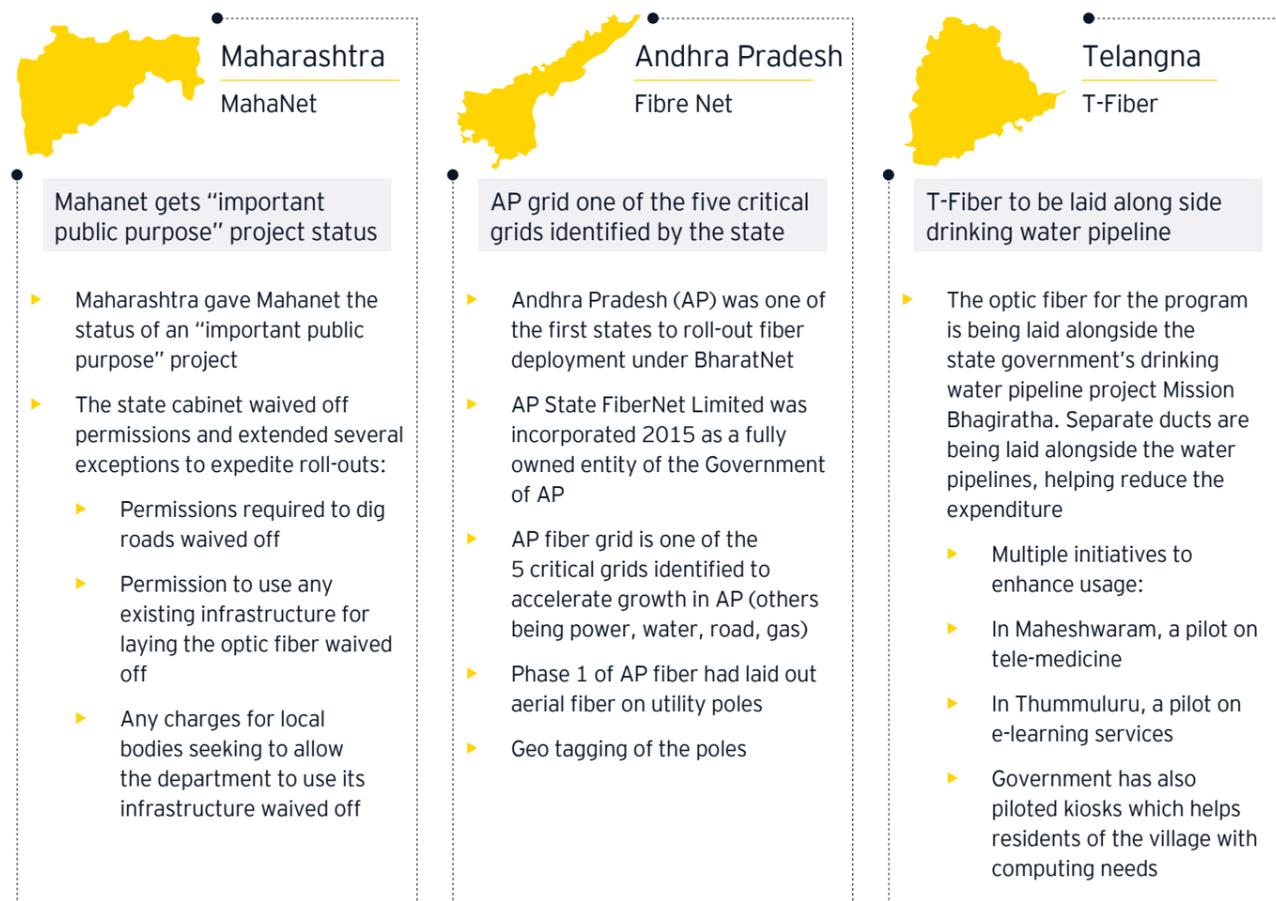
Phase I of BharatNet	Phase II of highlights	Phase III of BharatNet
<ul style="list-style-type: none"> ▶ Connect 100,000 GPs from BHQ via OFC ▶ Service opened in 59,124 GPs ▶ The implementation of the project was only through three CPSUs namely, BSNL, RailTel and PGCIL ▶ Connectivity to GPs was only by laying underground OFC 	<ul style="list-style-type: none"> ▶ Connect 150,000 GPs using optical mix of underground/ aerial OFC, radio and satellite ▶ Cabinet approved last mile connectivity model for GP. ▶ Connectivity through Wi-Fi, and the operation and maintenance (O&M) of the entire 250,000 GPs ▶ Implementation through states, private sector besides CPSUs as in Phase-I 	<ul style="list-style-type: none"> ▶ Building redundancy of network ▶ Futuristic network with ring topology to be used between districts and blocks, and blocks and GPs ▶ Targeted to be completed by 2023

Source: Government websites, Media articles, Report of the Committee on National Optical Fibre Network (NOFN) dated 31st March 2015

State led BharatNet initiatives

As a part of phase II, eight states - Chhattisgarh, Gujarat, Jharkhand, Andhra Pradesh, Maharashtra, Tamil Nadu, Odisha and Telangana - are implementing BharatNet project under state-led model and MoUs have been signed with the states.

Figure: Best practices from state led fibre programs



Source: Media articles

Underutilization of extensive fiber infrastructure laid under BharatNet program emerging as a key concern

BharatNet is facing challenges regarding efficient utilization of the infrastructure. It is imperative for all the state-level bodies to come together and run an on-ground awareness programme at panchayat level to enlighten people regarding usage and maintenance of the infrastructure.

In addition, public-private partnership needs to be encouraged to bolster communications infrastructure across the country. The terms of use needs to be streamlined and cost structure should be made rational so that private players find it favourable to lease bandwidth of BharatNet infrastructure to provide broadband services. This is imperative to ensure effective utilization of the laid fiber.

DoT exploring to sell fiber assets laid under BharatNet

In January 2019, TRAI recommended the DoT to auction the fiber assets on "as is where is" basis to private players due to underutilization of the infrastructure. In February 2019, the Telecom Commission gave an in-principle approval to hand over the fiber assets to private players. DoT is currently working on modalities for the execution of this proposal, where it is exploring to sell or lease the fiber assets to private players after following a bidding process.

Source: Media articles

National digital communications policy (NDCP) 2018 - emphasis on fiber infrastructure²¹

NDCP 2018 has laid significant emphasis on fiber deployment in the country suggesting multiple improvement initiatives to boost fiber connectivity in India. Viewing fiber as the backbone of high speed connectivity, the government has taken important initiatives.

Implementing a "Fiber First Initiative"

- ▶ Accord telecom optic fiber cables the status of public utility
- ▶ Promoting collaboration models involving state, local bodies and

private sector for provision of shared duct infrastructure

- ▶ Facilitating fiber-to-the-tower program to enable fiberization of at least 60% base stations
- ▶ Leveraging existing assets of the broadcasting and power sector to improve connectivity, affordability and sustainability
- ▶ Incentivizing and promoting fiber connectivity for all new developmental construction
- ▶ Making requirement for telecom installations and the associated cabling and in-building solutions mandatory in all commercial, residential and office spaces by amending National Building Code of India (NBC), through Bureau of Indian Standards (BIS)

Establishment of a National Digital Grid

- ▶ Create a National Fiber Authority
- ▶ Establishing Common Service Ducts and utility corridors in all new city and highway road projects and related elements
- ▶ Creating a collaborative institutional mechanism between center, states and local bodies for common RoW, standardization of costs and timelines and removal of barriers to approvals
- ▶ Facilitating development of open access next generation networks

21. National Digital Communications Policy - 2018

C. Fiber demand from FTTH/B segment in India

The fiber optic industry currently in India is characterized by significant capacity on trunk and national long distance (NLD) routes, but there is very little capacity in the access routes. Fiber-to-the-home/ building (FTTH/B), forms a minuscule proportion of an already limited fixed broadband access user base. FTTH/B penetrations rates in India remain exceptionally low.

However, operators are chalking out huge expansion plans for FTTH/B roll out across the country. The cumulative capex investments in the country are expected to grow by a six-year CAGR of 32.5% to reach US\$10.3b in 2023 from US\$1.9b in 2017²².

Figure: FTTH/B penetration for several countries, 2016-17

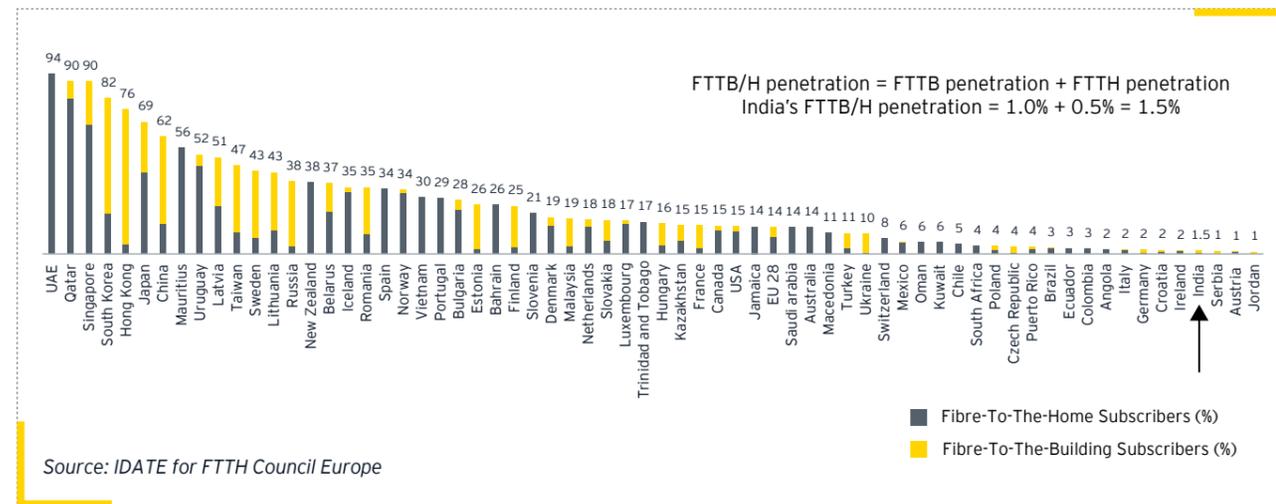


Figure: Comparison of cumulative FTTH capex investments and expected CAGR of FTTH capex during 2017-2023 in BRICS countries

Country	Capex investments in FTTH in 2017	2017-2023 CAGR of FTTH capex
Brazil	US\$5.5b	17.0%
Russia	US\$10.4b	2.8%
India	US\$1.9b	32.5%
China	US\$72.7b	6.6%
South Africa	US\$0.76m	16.3%

Capex investments in India are growing fastest at a CAGR of **32.5%** during 2017-2023

Source: Analysys Mason

D. Data center related fiber growth

Data center build-outs continue to grow, driven by the increase in bandwidth demands and changes in network architectures. As a result, time-to-market needs for the data center production environment continue to compress. Data rates of 10 Gb/s and higher are now common place in the modern data centers, easily exceeding the capability of electrical interconnects on copper cabling.

With their longer reach and reduced electromagnetic interference, fiber optic adoption is increasing for data centers. India's data center market is growing at a rapid rate and is expected to further feed the demand for fiber. Carriers can

now offer multi-gigabit speeds to any location served by fiber. More than 90% of Fortune 1,000 data centers use fiber channel as the de facto standard for storage networking²³.

E. Fiber demand from common infrastructure

Inter-city fiber and intra-city fiber is the most mature fiber network in India. Telcos have laid down this fiber and all major operators are sharing their fiber infrastructure. Operators typically share fiber for redundancy purposes or to offer services in difficult terrain.

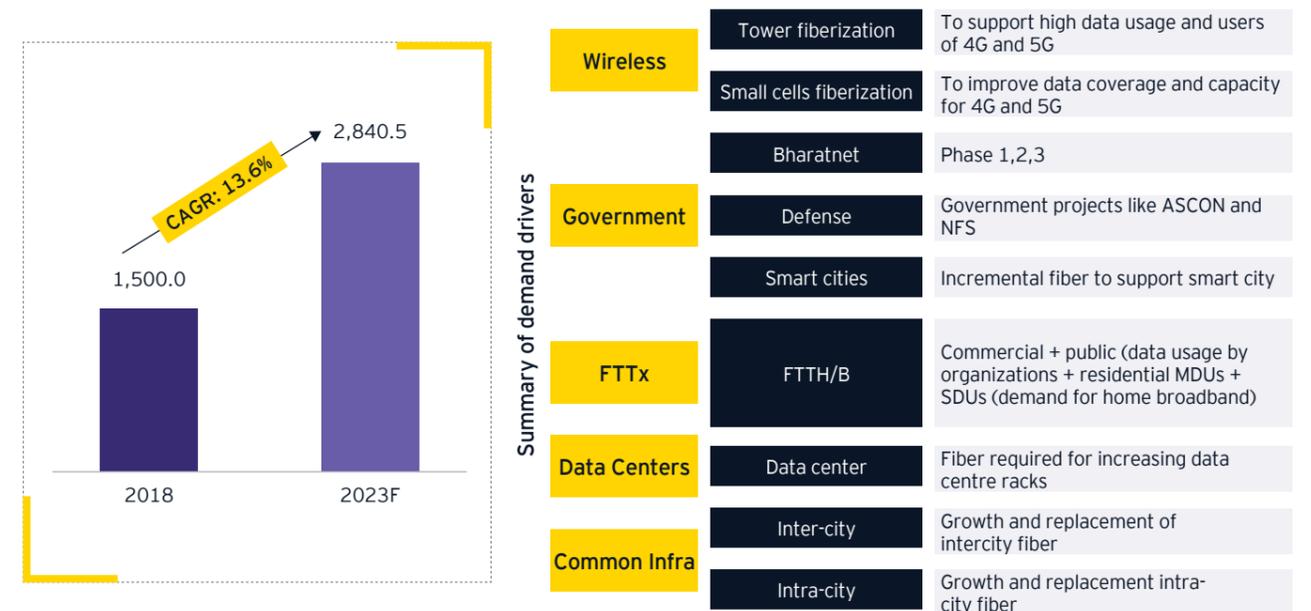
BharatNet also includes beefing up of the common fiber infrastructure, and phase three of the program envisages building in redundancies as well in the fiber network, to make it more robust.

India fiber demand forecast

Backed by the mentioned growth drivers, fiber demand in India is increasing at a rapid pace and represents a strong opportunity for towercos. The overall fiber deployment in the country is expected to increase at a CAGR of 13.6%, from 1.5 million cable kilometers in 2018, to 2.8 million cable kilometers in 2023²⁴.

Wireless, FTTH and common infrastructure would be the major contributors to fiber demand. The fiber growth is expected to go up 2020 onward, with expected launch of 5G in 2023.

Figure: Optical fiber cable deployment ('000 cable km)



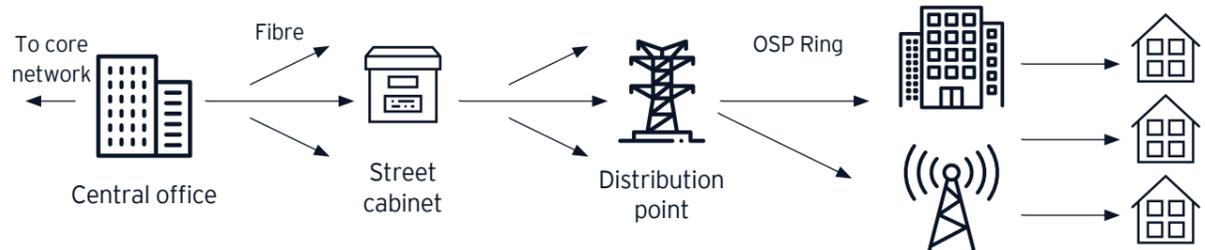
23. "Fibre Channel: The Best Kept Secret in Enterprise Data Centers," Data Center Knowledge, <https://www.datacenterknowledge.com/archives/2013/09/30/fibre-channel-the-best-kept-secret-in-enterprise-data-centers>, accessed 15 January 2019

24. "India readying for 5G launch - slightly behind Asian 5G leaders," Developing Telecoms, 9 August 2018, <https://www.developingtelecoms.com/tech/wireless-networks/7977-india-readying-for-5g-launch-slightly-behind-asian-5g-leaders.html>

Neutral host FTTx: Potential opportunity for towercos

Towercos can consider becoming a neutral host for fiber deployment - enabling them to play a larger role in the value chain. While the current regulatory regime does not allow this provision for towercos, future policy reform may open up this potential opportunity.

Neutral host FTTx model

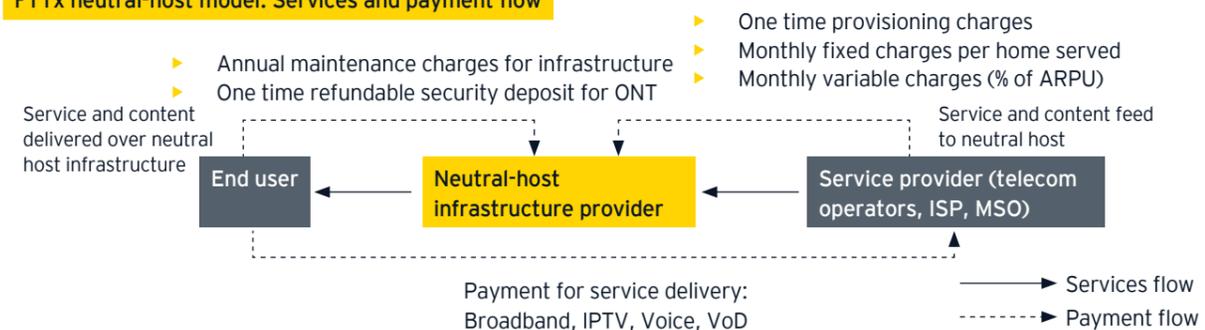


Backbone	Middle mile	Last mile to customer premises / towers
<ul style="list-style-type: none"> Central office equipment is deployed by neutral-host provider Operators/ internet service providers (ISPs)/ multi-system operator (MSO) are responsible for providing connection /feed to central office equipment 	<ul style="list-style-type: none"> Middle mile (OSP Ring, distribution cable splitter) will be deployed by neutral-host infrastructure provider and will be shared amongst partner operators once they sign the contracts 	<ul style="list-style-type: none"> Last mile network (drop cable, optical network terminal) is deployed by the neutral host provider

Advantages of neutral host model

- Increased take up rates**
 - Customer has multiple service provider options, leading to increased uptake
 - Multiple service providers (including neutral host provider) are involved in promotional activities, leading to increased awareness and adoption
- Infrastructure sharing**
 - Reduction in overall CAPEX per service provider
- Specific expertise can be leveraged by Service providers**
 - Specific expertise (understanding of FTTx technology, local market understanding enabling building access) can be leveraged for faster time to market

FTTx neutral-host model: Services and payment flow



Issues and challenges:

Non-uniformity in RoW policy continues to impede telecom infrastructure roll out

Establishment of the telecoms infrastructure in India is accompanied by challenges of RoW, that largely stem from fragmented and non-uniform policies adopted by various states and local bodies.

The Gazette Notification on RoW issued by government in 2016, is an effort to expedite the deployment of underground (fiber cables) and over-ground (telecom towers) infrastructure. In May 2018, DoT brought infrastructure providers in category-1 (IP-1) under the ambit of RoW rules. However, these new rules are yet to bring benefits to the Indian telecoms infrastructure sector due to lack of clarity and implementation delays.

Revised RoW rules

- Simplify the grant of RoW permissions by making it transparent and time bound process
- Developing an electronic application portal within one year of roll out of the rules
- Single window clearance for application
- Designation of nodal officers for appropriate authorities
- Rationalisation of administrative expenses across the country (to a maximum of INR1,000 per km for fiber and a maximum of INR10,000 per application for overhead towers)
- Fast-tracking decision on RoW permits to within 60 days after application

Category	Challenges	Key recommendations
RoW: permissions while laying telecom infrastructure	<ul style="list-style-type: none"> Policies of the state governments are not aligned with the central guidelines, resulting in delays in roll-outs Lack of defined processes, permissions and approvals during the awarding and execution stage of project impacts timelines RoW process requires permissions from varied authorities including electricity, gas, sewerage, Railways, NHAI, forest authority causing delays and cost inefficiencies RoW process requires multiple NOCs and documentation States have imposed varying restrictions on installation of towers near hospitals, airports, defence establishments, etc. Sealing of towers and disconnection of electricity at tower sites Delays in provision of Standing Advisory Committee on Radio Frequency Allocation (SACFA) clearances to tower companies and mobile operators 	<ul style="list-style-type: none"> Need to create collaborative institutional mechanism between centre, state and local bodies for common RoW mechanism as envisaged in NDCP 2018 Single window clearance by leveraging digital to bring transparency Set up a central or state level agencies or a task force to oversee the implementation of RoW rules Seek a status update on the state tower policies from states Consult concerned departments (e.g. urban development/IT), advise state representatives to follow DoT guidelines for formulation of respective tower installation policies Establish common permissions processes for all utility purposes - water, electricity, gas pipes and fiber Incentivize utilities infrastructure like power, water, gas to include ducts and optical fiber networks as part of the new infrastructure Process on priority all pending SACFA applications

Source: Media articles, NDCP 2018, TRAI consultation paper responses, primary research and EY analysis

Category	Challenges	Key recommendations
Execution: Digging and trenching for fiber roll out	<ul style="list-style-type: none"> Inefficient and uncoordinated digging and maintenance impacts roll out time and life span of fiber 	<ul style="list-style-type: none"> Adhere to Geographic Information System (GIS) systems and "call before you dig" and "dig once" policies. In line with NDCP 2018, establish common service ducts and utility corridors in all new city and highway road projects, and related elements Ensure that utility corridors and duct dimensions accommodates high count optic fiber Optimise execution via collaboration with upcoming utility and infrastructure projects Define custodian of the utilities map within the nodal agency for RoW
Payment/Charges Need for consistency	<ul style="list-style-type: none"> RoW charging mechanisms vary across cities/states/municipalities Current RoW process includes multiple levies and high administrative charges 	<ul style="list-style-type: none"> A single window for payment clearance with defined timelines to be provided Ensure standardization of rates for the RoW as envisaged in NDCP 2018 The government to consider adopting issuance of "letter of credit"
Activation and deployment of telecom infrastructure Approvals	<ul style="list-style-type: none"> Multiple government personnel currently tasked to approve the same sections of deployment Significant number of human touch points -leading inefficiencies in time, cost and resource 	<ul style="list-style-type: none"> Reduction of approvals by empowering government officials to represent various departments An efficient utilization of technology for surveillance and documentation Self-certification to optimize time, resource and cost. Push for audit and high penalty Automate workflow for interdepartmental approvals and partner portal using ERP systems Focus on operating from standards and strong SLAs A transparent vendor selection criteria to be followed

Source: Media articles, NDCP 2018, TRAI consultation paper responses, primary research and EY analysis

Status of alignment of state policies with RoW rules 2016 (progress in states)

Policies notified and aligned

S.no.	State	Notified date/ Cabinet Approved
1	Jharkhand	4 December 2015
2	Rajasthan	6 February 2017
3	*Tripura Government Order	6 September 2017
4	Odisha	14 September 2017
5	** Haryana	6 October 2017
6	Assam	16 February 2017
7	Maharashtra	17 February 2018
8	*Tamil Nadu Government Order	18 February 2018
9	Arunachal Pradesh	10 May 2018
10	Uttar Pradesh	15 June 2018
11	Uttarakhand	13 September 2018
12	***Meghalaya	

*GO only (detail policy is under discussion)
 **Aligned with RoW policy 2016 (except the fees and other charges)
 ***Cabinet approved on 10 December 2018, policy will be effective from 15 January 2019

Source: Voice & Data

Existing policies under discussion

S.no.	State
1	New Delhi Municipal Council (NDMC)
2	Himachal Pradesh
3	Punjab
4	Chandigarh
5	Gujarat
6	Goa
7	Madhya Pradesh
8	Chhattisgarh
9	Kerala
10	Karnataka
11	Andhra Pradesh
12	Telangana
13	Pondicherry
14	Bihar

No uniform policies

S.no.	State
1	Mizoram
2	Nagaland
3	Manipur
4	Sikkim
5	Jammu & Kashmir
6	West Bengal
7	Andaman & Nicobar
8	Lakshadweep
9	Dadar & Nagar Haveli
10	Daman & Diu

Best practices on ROW access from across the globe

Single window clearance

In Greece, the EETT (Hellenic Telecommunications and Post Commission) assumes the role of a one-stop licensing body, whereby applications are filed electronically and subsequently forwarded to the various competent authorities and agencies for concurrent issuance of the relative authorizations or approvals.

The final approval is then issued by the EETT. The competent authorities are required to respond back to the EETT through the e-portal within four months.

Concept of shot clock

In the US, under "shot clock" rules employed by the FCC, there is a deadline of 90 days for local government bodies to process applications for co-located facilities, and deadline of 150 days for new tower construction.

If timelines are not met by the local governments, the siting proponents have a prima facie argument that the local authority is in violation of the US Communications Act.

'Call before you dig' policy

In the US, both federal and state laws require excavators to notify the respective utility companies before undertaking any operation involving digging, trenching, demolishing, boring, or any other earth-moving operation. The FCC has designated 811 as the national toll-free number for all local 'Call Before You Dig' phone centers throughout the US. Other country examples include Australia, Singapore, the UK and Canada.

Gujarat Gas Limited, India's gas distribution company, follows this approach to avoid any damages to their natural gas pipelines.

'Dig Once' approach

The objective of Dig Once approach globally is to have all major infrastructure programs install an underground fiber link when building or renovating roads, railways, pipelines, utility infrastructure and energy distribution channels. When fiber installation is coordinated with a road or utility project in urban environments, there are 20% cost savings.

Free RoW access saving deployment time and cost

Austria provides for free RoW access without an authorisation on public property and in relation to private property, free ROW under conditions of inter alia existing line expansion or existing line unable to jointly use.

Germany allows operators of public telecom networks to use thoroughfares free of charge and requires timely update of the infrastructure database.

In the Netherlands, municipality must provide operators free access to their infrastructure and promote sharing and coordinate upcoming civil works to minimize civil disruption.

Small cell deployments

Network transformation with next generation technologies: Hetnets

The telecom networks are advancing towards hetnets - layered and denser networks - to support the data surge. Globally, mobile data traffic is expected to increase five-fold between 2018 and 2024²⁵. With the increase in data traffic, telcos are supplementing their macro networks with small cells.

Small cells are low-powered wireless access points that can be deployed indoors or outdoors to improve coverage and add targeted capacity. The advantages of small cell deployment include closing coverage gaps at low cost, better customer experience, low

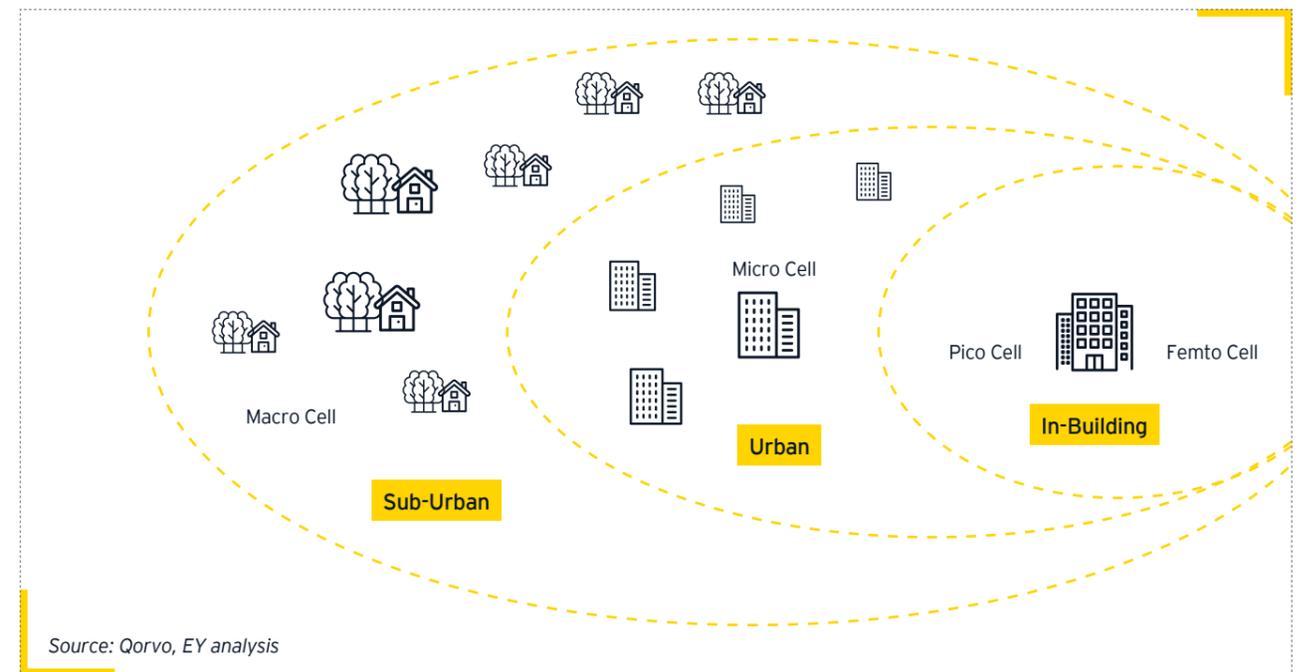
subscriber churn and suitability to urban use as they can be attached to street furniture. Telecom operators have already started deploying small cells with the rollout of 4G services in dense urban areas.

Going forward, small cell deployment will increase exponentially, as they would form a critical component of the 5G network. The transition to 5G unlocks a gamut of new uses cases in critical application areas, such as remote surgery in healthcare, autonomous vehicles in transportation and remote control of heavy machinery in manufacturing. These use cases would require high throughput and an ultra-reliable low-latency network, which stipulates the need for heterogeneous

networks comprising of both macro cells and small cells.

Traditionally, mobile networks have been based on spectrum bands ranging from 700MHz to 2.6GHz with certain regional differences. However, for 5G services higher spectrum bands have been proposed globally comprising of cm-Wave and mm-wave spectrum, which have significant variation in the maximum cell radii. The very low maximum cell radii for proposed 5G spectrum bands underpins the need for densification of network with large number of small cells.

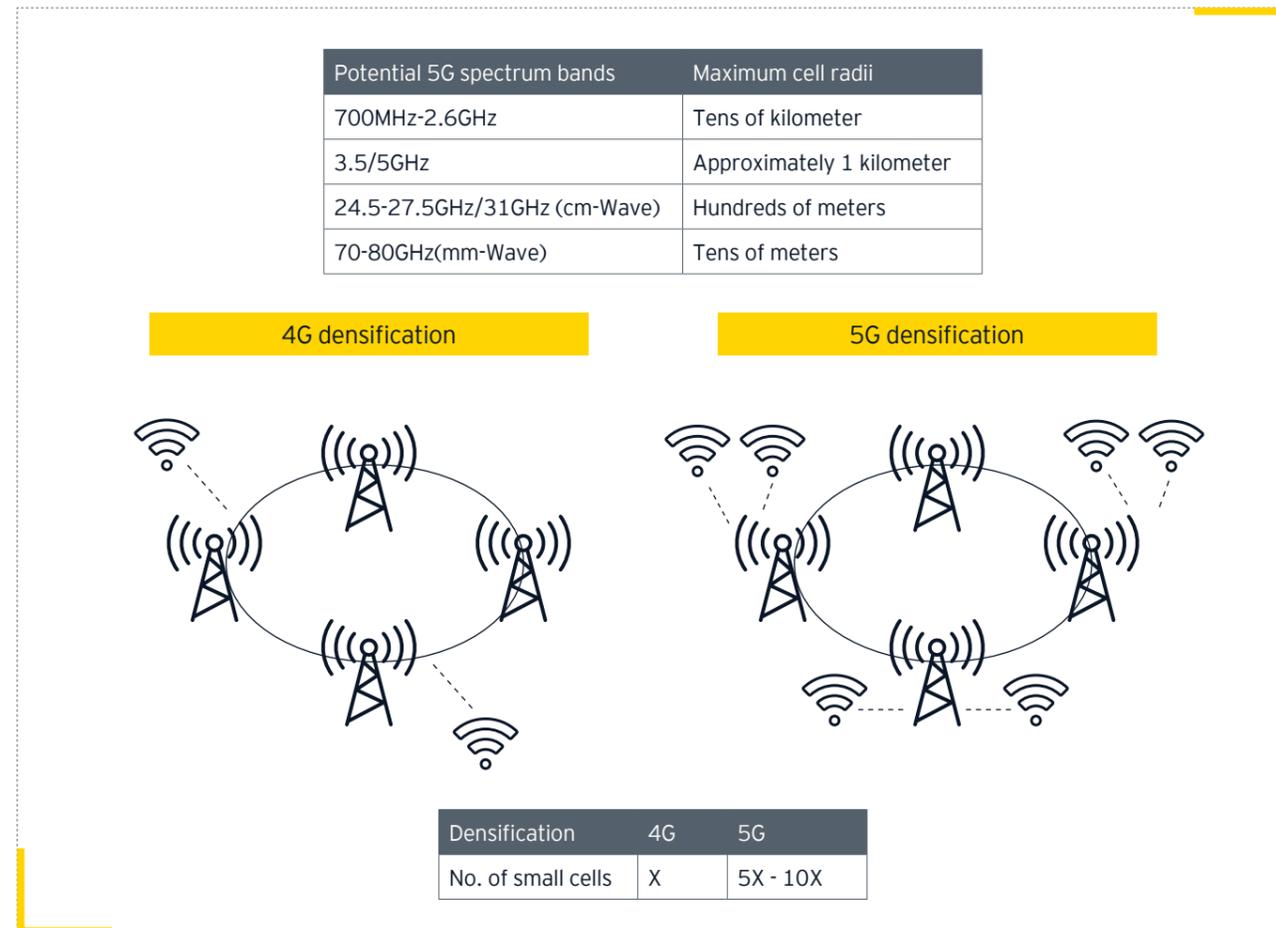
Figure: Small cell varies on the basis of environment and capacity/coverage requirements



Source: Qorvo, EY analysis

25. Ericsson Mobility report, June 2018

Figure: Propagation of different 5G spectrum bands



Opportunity for towercos to play central role in small cell deployment

Globally, telecom operators have been facing challenges in deployment of small cell roll out due to strict permission requirements, high site acquisition and backhaul cost and a lack of internal capacity to coordinate the rollout at several sites. This opens up an opportunity for towercos to develop a value proposition for telcos to deploy small cells that offers faster time to market and cost efficiency.

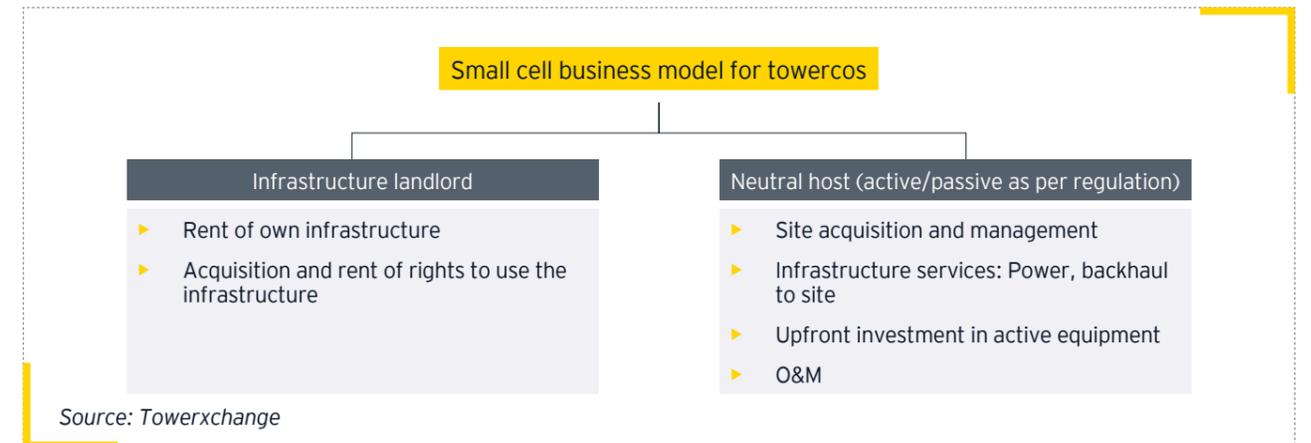
Telecom operators can smoothen the process and ease off the burden by collaborating with towercos for small cells. To capitalize on this opportunity, towercos should focus on developing operational capabilities to provide service level agreements for small cell deployments at competitive costs.

Before entering a small cells segment, towercos need to understand the network economics of the small cells as it is a volume rather than a value business. The business may generate a fraction of the revenue generated by a

leasing a tower. The small cell revenue is expected to be mix of rental, service and management fees.

Towercos' know-how in securing contracts with municipalities for small cell sites will enable them to strengthen their value proposition. They can aggregate sites in the municipalities which can be leased further to telecom players for 5G densification.

Figure: Small cell business models



Small cell fiberization to fortify position of towercos

In most instances, small cells would require fiber, as microwave backhaul would limit the performance. Towercos can explore provision of fiberized small cells as it would position them as an integrated player. In accordance with time to market consideration, towercos can either deploy their own fiber backhaul or partner/acquire independent fiber companies to provide small cell fiberization.

Providing fiber backhaul for small cells will reinforce the investments by towercos in this space as 5G will require high bandwidth for fronthaul as well backhaul links. This would also increase revenue share for towercos in the small cell rental market significantly as they will have considerable pricing power. It is a viable proposition as provision of site and backhaul together enables cost sharing among multiple operators and these cost savings can be further passed on to the telecom operators.

US based towerco aggressively expanding into small cell deployment and provisioning of fibre backhaul solution

The towerco positions itself as an end to end solution provider - involved in supplying sites, small cell equipment and fiber backhaul

40,000+ towers | 65,000+ small cells supported by route kilometer fiber | 65,000+ route kilometer fiber

The towerco is focusing on accelerating its efforts to expand its small cell business



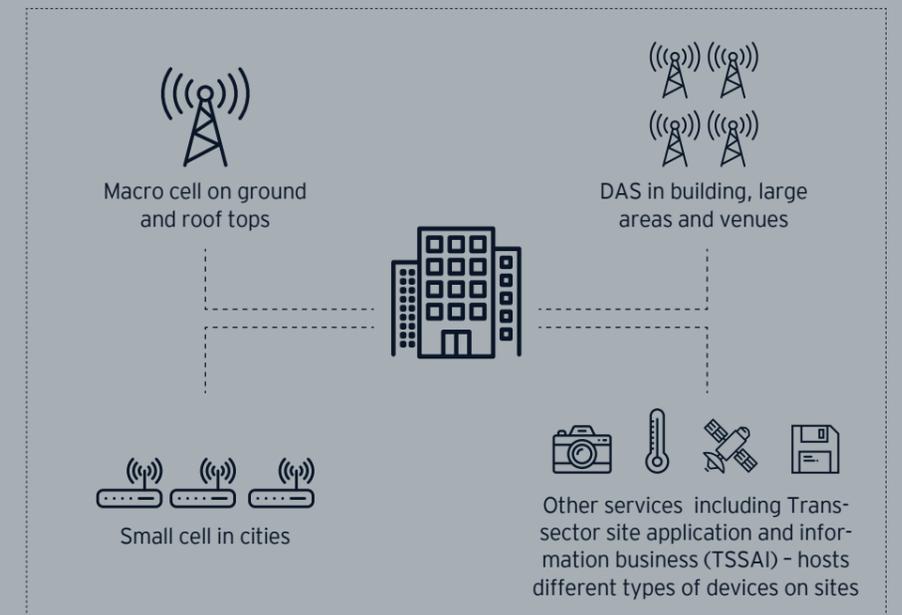
Small cell business significantly contributing to overall revenue

Of the US\$280m organic contribution to site rental revenues expected in FY19, towerco management expects ~5% growth from towers, ~20% growth from small cells and ~5% growth in fiber solutions

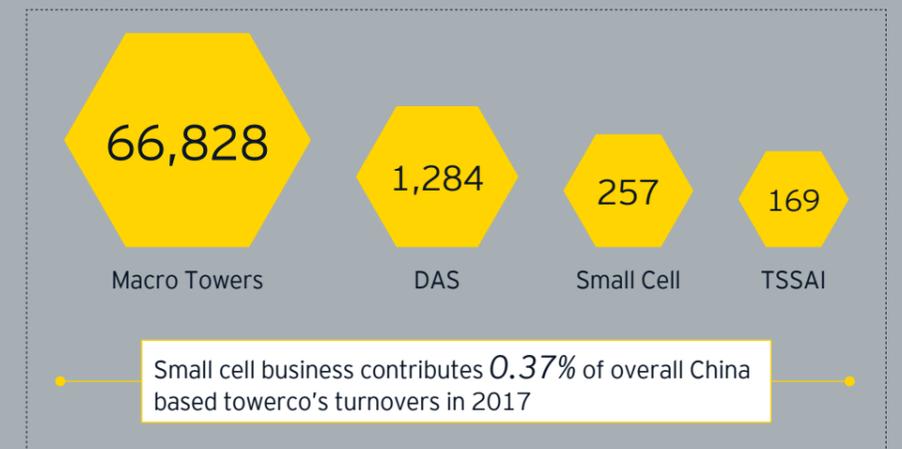
China based towerco is strengthening its position in small cell segment to play a pivotal role in densification of network

In 2017, China based towerco set up its small cell business unit to support telecom operators to densify their networks. It provides site space, including towers, poles and other infrastructure resources to telecom operators and hosts their small-cell equipment.

China based towerco has ventured into different business lines



Comparing 2017 operational revenue of China based towerco from different business lines (RMB millions)



Source: Towerxchange, China Galaxy International

Small cell deployment proliferating in India

Currently, small cell deployments in India are majorly led by 4G densification to cater to increasing demand of data. From 2023 onwards, the rollout 5G services is expected to commence which would contribute to large number of small cell deployments to support increasing bandwidth requirement for new use cases.

Outdoor small cell deployments in India expected to reach
250,000
by 2023

Source: EY analysis

Issues and challenges:

Cost and RoW issues hampering proliferation of small cells

Small cell deployment requires approval for site acquisition, negotiation of fees with municipal corporations or other government bodies and availability of suitable backhaul and power at site. It should be noted that business economics of installing small cells varies from that of a macro tower, since a number of small cells are required to provide the same coverage as by a macro tower. The deployment of a macro tower goes through a planned process to choose a site location that has suitable power and backhaul. The small cells would typically leverage urban infrastructure where it would be challenging to ensure availability of power and backhaul to large number of small cells in a cost-effective manner. The requirement for multiple approvals increases the time to roll out small cell sites.

Additionally, the current regulations do not allow deployment of small cells using existing street furniture due to restrictions imposed by local bodies on the Discoms as they are not allowed to realise commercial revenue using existing public infrastructure.

For faster deployment, the approval process for small cells needs to be streamlined as well as standardized at the city, state and national levels to reduce time and cost to activate a small cell. Simplified rules are required to allow access to the existing street furniture and other sites to install small cell equipment.

Case study: Best practices on small cell deployment

In the US, time and cost have emerged as key concerns for small cell roll-out. As per telecom carriers it takes almost 18 to 24 months to deploy small cells, of which majority of the time (~18 months) goes in obtaining permits for installation of the equipment. Citing these issues faced by the telecom carriers, recently FCC has come up with new regulations to create an enabling environment to speed up small cell deployment.

Key steps:

- ▶ **Shortening time of approvals:** Local government required to process approval for installation of small cells on existing structures within 60 days and for installation on new pole buildouts within 90 days
- ▶ **Capping of fees:** Local governments can charge non-recurring fee of US\$500 for an initial application fee covering up to five small cells with the application of each additional small cell thereafter to cost US\$100; non-recurring fees for new infrastructure is capped at US\$1,000. Recurring fees, including RoW access fees, are capped at US\$270 per small cell per year. The local bodies can levy higher fees, given they demonstrate that the fees are a reasonable approximation of costs incurred

Source: 5G Americas, Media articles

In-building solutions gaining prominence

The burgeoning data traffic has made it imperative to lay necessary infrastructure to increase capacity of the networks. In the light of the fact that 80% of data traffic originates or terminates inside the building, in-building solutions (IBS) are gaining traction²⁶.

IBS provides indoor coverage using a series of hubs/equipment which distribute the signal to several antennas. It facilitates better quality of services, enhanced coverage, efficient usage of spectrum and reduces the load on macro sites. The introduction of 5G services and proliferation of IoT services is further expected to increase the demand for IBS.

Favourable operating environment facilitating IBS

In October 2017, the **Telecom Commission approved sharing of in-building infrastructure among telecom operators**

NDCP 2018 aims to **amend National Building Code of India to mandate telecom installation and IBS in commercial, residential and office spaces**

Source: Media articles, NDCP 2018

Towercos are well suited to play pivotal role in IBS. They can enter into a contract with building owners to get access to the location and build neutral host IBS infrastructure which can cater to multiple operators. Subject to regulations, IP-1 players can deploy neutral host IBS infrastructure.



The Wi-Fi opportunity

Current scenario of Wi-Fi networks in India

The proliferation of public Wi-Fi hotspots continues to be a missing link in India's communication infrastructure. A robust public Wi-Fi network would provide significant boost to the government's flagship programs of Digital India and Smart Cities; as the success of these programs predicated on ubiquitous connectivity, digital inclusion and affordable infrastructure. The government's aim of making internet connectivity available to the masses, will need support from Wi-Fi deployments.

Moreover, at high-traffic venues like airports, stadiums, universities, and transit hubs, etc. the demand for mobile data far exceeds the capacity of cellular networks. Data-hungry consumers and bandwidth-hungry devices can place a burden on wireless networks, causing decreased performance and slow connection speeds due to network congestion. In such scenarios, a public Wi-Fi network is more suitable to meet the demand.

As Wi-Fi network operates on unlicensed spectrum, provision of Wi-Fi services is a relatively faster and cost-effective way to connect the unconnected, in comparison to deploying traditional mobile infrastructure in remote and rural areas.

India is still in an early deployment phase in terms of public Wi-Fi services proliferation and adoption, with just about 50,000-60,000 Wi-Fi hotspots²⁷. Lack of monetization models has been one of the key factors hindering the growth of public Wi-Fi in India.

Government's initiatives in driving proliferation of broadband through Wi-Fi networks^{28 29}

Government initiatives to proliferate broadband through public Wi-Fi networks

A state owned company plans to deploy 100,000 Wi-Fi hotspots across the country; working with a global internet company on the Express Wi-Fi project for proliferation of Wi-Fi services; plans to provide voice over Wi-Fi services through carpet Wi-Fi network

Indian Railway owned telecom company deployed Wi-Fi facility at more than 800 stations and caters to 8 million unique users per month; worked with a US-based Internet giant to equip 400 railway stations in India with high-speed internet facility

IIT Bombay running Gram Marg rural broadband project to provide broadband connectivity services across 25 villages; developed test beds using TV white space technology and spectrum in unlicensed 5.8GHz band

NDCP 2018 facilitating deployment of public Wi-Fi hotspot - Targets to deploy

5 Million

Wi-Fi hotspots by 2020 and

10 million
by 2022

Source: NDCP 2018

Towercos as neutral host Wi-Fi providers

In order to meet the demands for higher quality wireless service in dense traffic venues such as stadiums, shopping malls, and airports, telcos are always looking to improve and expand coverage. For such use cases, a third-party player can provide shared infrastructure that supports multiple operators at the same location, making the business model profitable for venue owners, telco, and the neutral host Wi-Fi provider.

Towercos are well-suited to play the role of a neutral host in Wi-Fi deployments. This would help telcos avoid considerable cost stemming from installation of individual infrastructure. Infrastructure sharing model can be extended for Wi-Fi deployment as well, bringing significant opex and capex efficiency for the telecom operators.

Multiple revenue streams can be explored to monetize public Wi-Fi

The towercos can monetize public Wi-Fi by distributing service set identifier (SSIDs) for Wi-Fi access point to multiple stakeholders to leverage the services for various uses cases. The revenue for Wi-Fi can be realised by the stakeholder from multiple streams such as bundled data packs, voucher sale, advertisements on Wi-Fi networks, and provision of local content.

Potential revenue opportunities	Type of location								
	Hospital	Education	Transit	Corporate parks	Malls	Select retail	Other public (MCG, Khan Market)	Courts and institutions	Clubs, etc.
MDO/Bundled data packs	Y	Y	Y	Y	Y	Y	Y	Y	Y
Ad-funded Wi-Fi	Y	Y	Y	Y	Y	Y	Y	Y	Y
SSID Others	Y	Y	Y	Y	Y	Y	Y	N/A	Y
Intranet (managed services)	Y	Y	Y	N/A	Y	N/A	N/A	N/A	Y
Location funded Wi-Fi	Y	Y	Y	N/A	Y	Y	N/A	N/A	
RoW benefits and building permissions	Y	Y	Y	Y	Y	N/A	Y	Y	N/A
Branding benefits	Y	Y	Y	Y	Y	Y	Y	Y	Y
Voucher sale	Y	Y	Y	Y	Y	Y	Y	Y	Y
Local content Sale	Y	Y	Y	Y	Y	Y	Y	Y	Y
International roaming	Y	Y	Y	Y	Y	Y	Y	N/A	Y
Enterprise clients	As managed services partner to anchor partners for Wi-Fi layer								
Smart City projects	As managed services partner to anchor partners for Wi-Fi layer								

Source: EY analysis

26. "Wireless in Buildings: What Building Professionals Think," Commscope, https://ranplanwireless.com/wp-content/uploads/Commscope_Wireless-in-Buildings-Survey-Report-CO-109989-EN.pdf

27. "Want to set up 10 million Wi-Fi hotspots by 2022: Aruna Sundararajan," DNA, 28 December 2018, <https://www.dnaindia.com/business/interview-want-to-set-up-10-million-wifi-hotspots-by-2022-aruna-sundararajan-2701143>

28. "Mobile users can access WiFi services from BSNL hotspots," DNA, 16 January 2019, <https://www.dnaindia.com/business/report-mobile-users-can-access-wifi-services-from-bsnl-hotspots-2708426>

29. "All railway stations till Mysuru are now Wi-Fi enabled," The New India Express, 4 March 2019, <http://www.newindianexpress.com/states/karnataka/2019/mar/04/all-rly-stations-till-mysuru-are-now-wi-fi-enabled-1946319.html>



IoT technology is currently at a nascent stage in India, but it is steadily becoming an indispensable part of communication infrastructure. IoT connections in India are expected to grow at a CAGR of 32% over 2017-2023 to ~423 million connections led by advancements in semi-conductor technologies and decline in the cost of sensors³⁰. The government's Make in India initiative has the potential to further bring down hardware costs.

A number of factors are expected to fuel IoT growth in India. Among the key drivers, innovation in product offerings, increasing operational efficiencies and focus on greater customer experience will be critical. In addition, thrust on evolving partner ecosystem, maturing IoT solutions, increase in network coverage and data speeds would also provide impetus.

Figure: IoT connections in India (million)

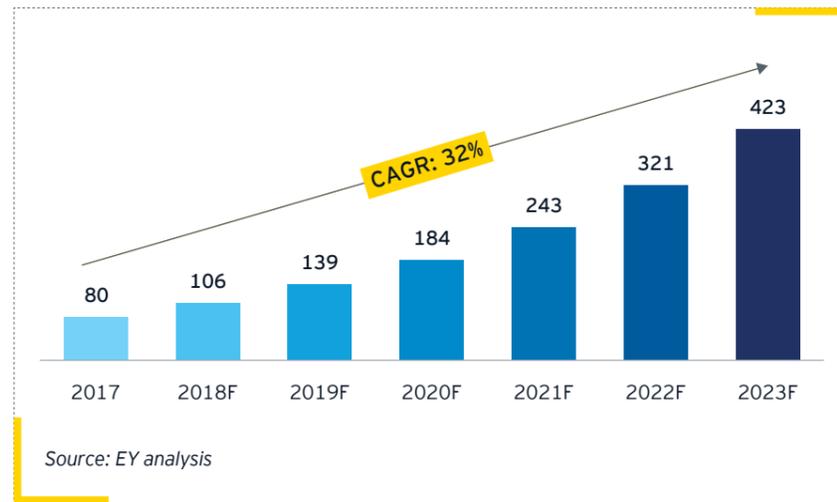
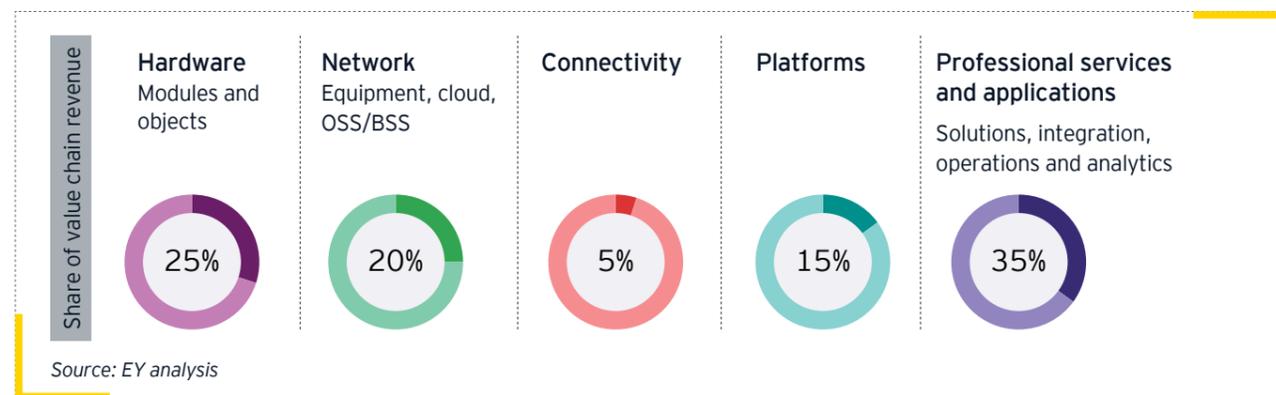


Figure: IoT value chain



Towercos can explore penetrating into growing IoT market to earn additional revenue by adopting different business models.

Sensor maintenance and deployment

As part of IoT network, a number of sensors are being deployed to collect and transmit data. The towercos can

play an important role is provisioning, maintenance and de-installation of sensors. Sensor maintenance is synergistic with towerco's capabilities of leveraging the Tower Operations Center (ToC) for real-time remote monitoring and maintenance of distributed assets.

Build, operate and maintain IoT network

By its very nature, IoT refers to myriad use cases, customer interfaces and technology standards. The network and device performance requirements of IoT use cases such as smart metering and street lighting are quite different from those required for connected car solutions and home automation services. Therefore, a new generation of technologies is emerging that are sensitized to needs of specific IoT services. In this context, low-power wide area networks (LP-WAN) are gaining prominence and have emerged as viable alternative to traditional wireless technologies to cater to IoT applications which require very low bandwidth and low power consumption so that the battery life span of the IoT device can last several years.

While, rolling out LPWA network such as NB-IoT or LTE-M that uses licensed spectrum bands, would require just software/hardware upgradation of existing base stations, deployment of network on other LPWA technologies in unlicensed spectrum bands such as LoRa/Sigfox need building of entire network from scratch. Globally, leading telcos have already started rolling out their LPWA networks in both licensed as well as unlicensed bands at a steady pace.

The towercos can venture into building IoT networks in unlicensed bands by collaborating with IoT technology providers and install LPWA base stations and related hardware on their sites. The telcos can in turn lease coverage from the towercos and use it along with their licensed LPWA technology network to support a wide range of IoT uses cases and scenarios.

Capability enhancement

Developing new capabilities is at the heart of moving up the value chain. Depending on connectivity services alone may limit the revenue pie for the towercos, therefore they can also explore developing capabilities for entering deeper into IoT value chain such as hardware, applications and analytics.

Types of low-power wide area (LPWA) networks



Source: Media articles

30. EY analysis

31. "What's the progress of Smart Cities Mission?," DownToEarth, 23 June 2017, <https://www.downtoearth.org.in/news/urbanisation/what-s-the-progress-of-smart-cities-mission--58147>

Smart cities

India smart city mission - targets and status

India has embarked on an ambitious journey with the Smart City Mission (launched in 2015), that aims to

build 100 smart cities in the country. The initiative is being operated as a centrally sponsored scheme (CSS) with a total outlay of ~INR 480 billion over five years, to be funded by GoI³¹. The implementation of smart city involves

the incorporation of a special purpose vehicle at city level, under the companies Act 2013, with both state/UT and urban local body having 50:50 equity shareholding. The tangible results of smart cities mission are expected to be visible by 2021-23.

Figure: India Smart City Mission - 100 smart cities

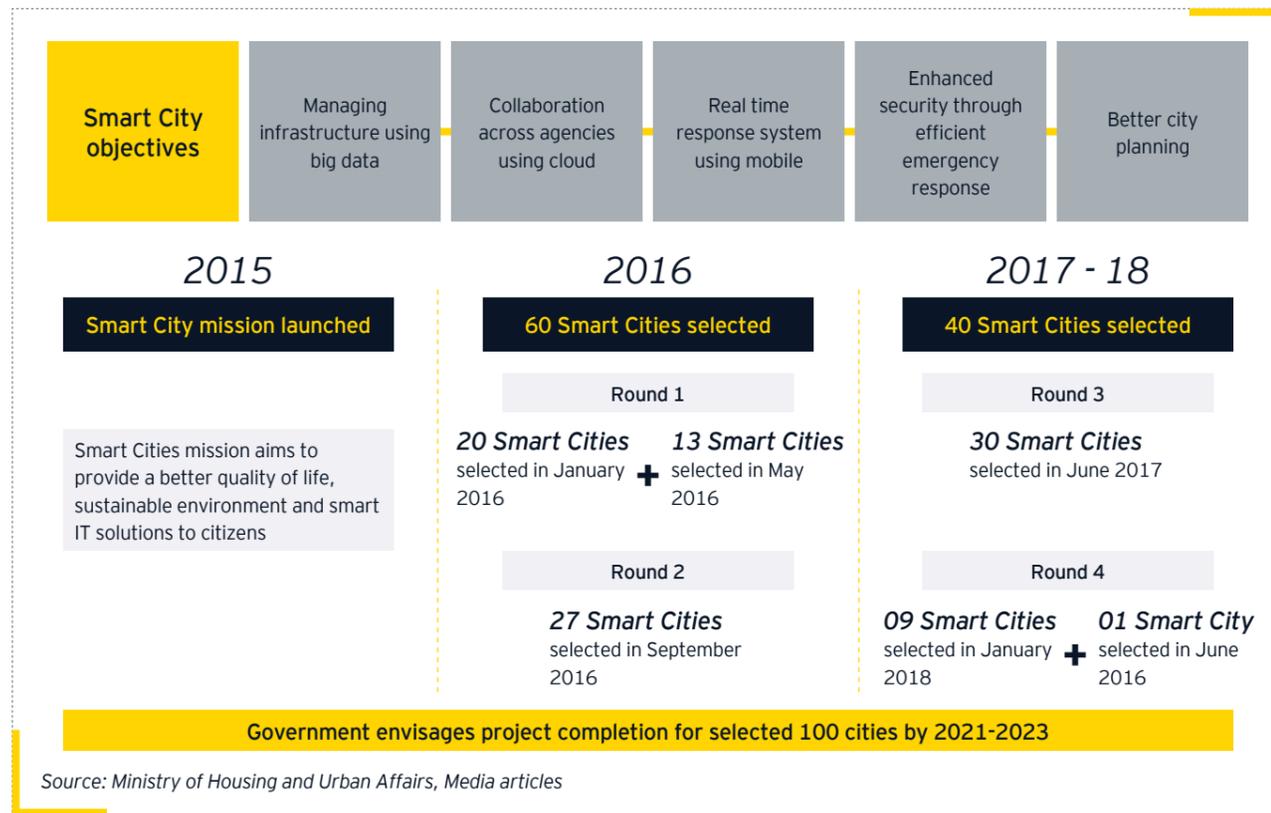
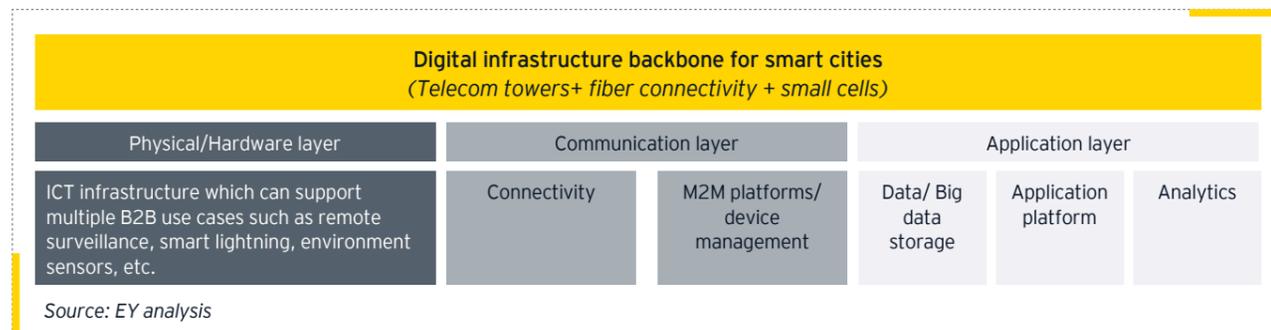


Figure: Smart city opportunities for towercos



The smart city vision will be achieved by marrying ICT infrastructure with existing city infrastructure to drive sustainable development and optimize resource consumption. With digital infrastructure at the core of the smart cities, telecom infrastructure providers can tap on the business opportunity presented by smart cities.

One critical part of smart city projects will be the development of scalable models for smart cities by integrating digital infrastructure with the existing infrastructure including highways, railways and buildings. Towercos already have the experience of managing such infrastructure assets. Venturing into platform development for smart cities would enable the towercos to diversify their revenue streams.

In addition, towercos can enhance their expertise in-house or via partnerships and enter the application layer of smart cities for a larger play.

Building street furniture for smart cities

An important advantage for towercos in smart city projects is getting access to locations for deploying telecom infrastructure. For instance, smart poles form an integral part of smart cities' street furniture and can be used to host telecom equipment. Towercos participating in smart cities can also convert existing street elements such as street poles, light poles and traffic lights into smart poles.

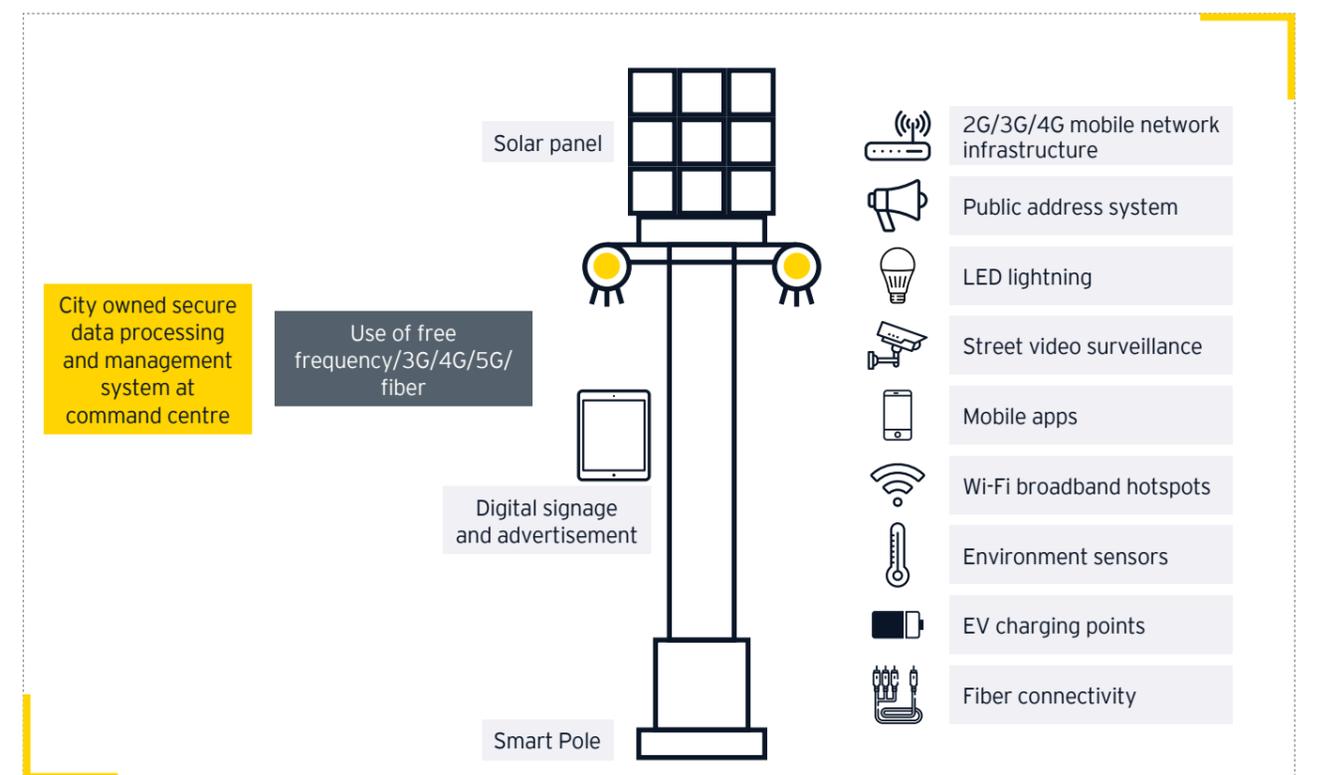
Apart from mounting telecom infrastructure, the smart pole can also be monetized by hosting equipment for

other services such as LED lights, CCTV cameras, Wi-Fi access points, public address system, SoS/emergency call box, billboards, EV charging points and environmental sensors. Based on user adoption, these services can open new revenue streams for towercos.

Another advantage for towercos from smart city participation is priority access to RoW permissions. In most cities, purchasing RoW is expensive and clearance processes are time consuming. Smart city projects would enable towercos to get easy RoW permissions. This would in turn allow them to roll out tower sites and lay fiber with a faster time to market.

The towercos can further extend deployment of smart street furniture across 700+ digital districts³².

Figure: Smart city architecture and role of towercos

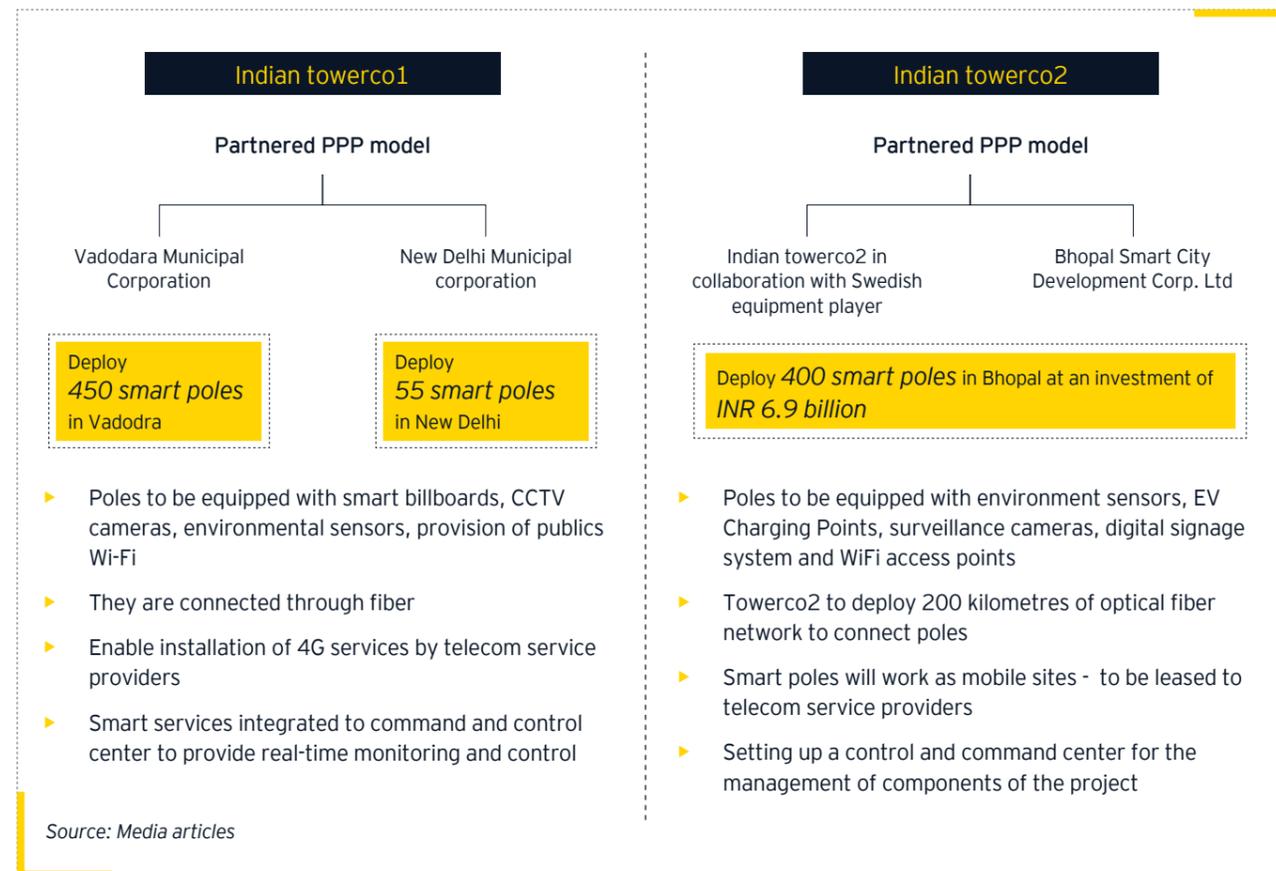


32. "Districts of India," Maps of India.com, <https://www.mapsofindia.com/districts-india/>, accessed 25 April 2019

Sensor deployment and maintenance

Smart devices equipped with sensors will be core to smart city solutions such as smart lightning, smart parking, smart energy management and remote surveillance. The towercos can extend their capability of sensor provisioning and O&M for IoT solution deployed as part of smart cities as well.

Figure: Leading Indian towercos have ventured into smart city market with deployment of smart poles



Case study

Asia based towerco building smart city infrastructure in Sri Lanka

A leading towerco in Asia has initiated deploying "smart lamp poles" in collaboration with road development authority in Sri Lanka.

Features of smart lamp poles

- 1 Energy efficient telecom infrastructure solutions
- 2 Design is sleek, camouflaged, green and blend well with town-planning for modern metropolis cities
- 3 Equipped the poles with CCTV surveillance cameras, smart and solar powered street lighting to ensure efficient energy management, and an integrated advertising space

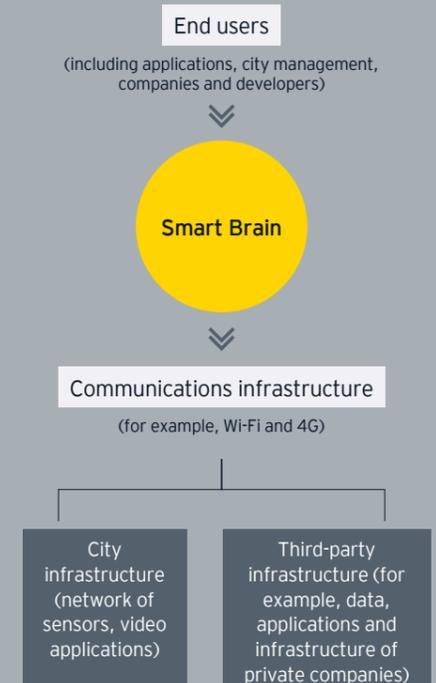
The company has successfully rolled out smart lamp poles in Colombo and is replicating same model in Jaffana

Spain based towerco enhanced its smart city proposition through deployment of data management platform

Spain based towerco unveiled the "Smart Brain platform" to manage smart city deployments through provision of access to urban infrastructure by standardizing the data gathered from various sources.

Key features

- Platform captures the data provided by IoT sensors and other sources and integrates transport of information through its communication infrastructure
- Comprises of a modular design IT infrastructure with open standards and a series of cloud applications that enables data exchange
- Enables the data to be used simultaneously by different users such as citizens, public authorities, social interest groups, distributors and developers
- Access to the Smart Brain platform is available via APIs
- Facilitates real-time decision making by providing holistic view of the city and enabling top to bottom management of information



Source: Analysys Mason, media articles

Smart city implementation challenges and issues

The challenges for developing smart cities can be overwhelming. From augmenting existing city infrastructure to the timely clearance of projects, the challenges include managing projects, scheduling resources and working in a multi-vendor environment.

A number of issues have contributed to the slow progress. Since the majority of the smart cities involve transforming existing cities, retrofitting legacy infrastructure is a challenge. Delays in the clearance and approval of projects, lack of coordination between different stakeholders, poor financial health of urban local bodies and lack of investments in capacity building are some of the other key challenges.

Meanwhile, there remains a gap in financing, which is expected to be addressed through funding from municipal bonds, value capture financing and private participation. Public-private partnerships (PPPs) are expected to make a substantial contribution towards bridging the funding gap.

- ▶ **Financing smart cities:** Each selected city receives INR 5 billion from the center for implementing projects, while an equal amount on matching basis is contributed by urban local bodies of the state. This is only part of the project cost and the balance funds are mobilised from private sector through public-private partnerships (PPPs). The total proposed investment for 100 smart cities is expected to be INR 2,050 billion. A key challenge is ensuring this level of financing as majority of project need would move through complete private investment or through PPPs.
- ▶ **Availability of master plan or city development plan:** Most of the cities don't have master plans or a city development plan, which is the key to smart city planning and implementation. Currently 70-80% of Indian cities don't have one
- ▶ **Retrofitting existing legacy city infrastructure to make it smart:** There are a number of latent issues to consider when designing the smart city plan. The integration of existing legacy systems to achieve citywide efficiencies can be a significant challenge.
- ▶ **Providing clearances in a timely manner:** For timely completion of the project, the clearance process should be streamlined. An online process can facilitate the same and ensure clearance in a time-bound manner.
- ▶ **Dealing with a multivendor environment:** Another major challenge in the Indian smart city space is that the software infrastructure in cities contains components supplied by different vendors. The ability to handle complex combinations of smart city solutions developed by multiple technology vendors would be crucial.

Source: Media articles

Data center

The data center market is poised to witness robust growth at a CAGR of 8.4% over 2018 to 2023³³ led by exponential growth in data traffic driven by rising internet penetration, smartphone adoption, consumption of social media and other digital services. Adding to the momentum is adoption of emerging technologies like big data analytics, AI, IoT and blockchain as well as migration towards cloud-based business models by local and global enterprises. Moreover, increasing complexities within IT infrastructure brought about by virtualization and consolidation, coupled with cost constraints has motivated enterprises to embrace third-party data center services. Sectors such as telecom, IT, BFSI and e-commerce have been significantly contributing to the demand for data center services.

Government led digital initiatives are also playing a critical role in data center deployment in India. At the heart of

these initiatives is Digital India, where the government has been investing on migrating the existing traditional service offerings to digital platforms resulting in surge in data.

Another important initiative was introduction of draft Personal Data Protection Bill in June 2018 requiring personal data to be stored within the country³⁴. This bill once enforced is expected to give a significant boost to data center development in India as the enterprises would be prompted to invest in local data center facilities.

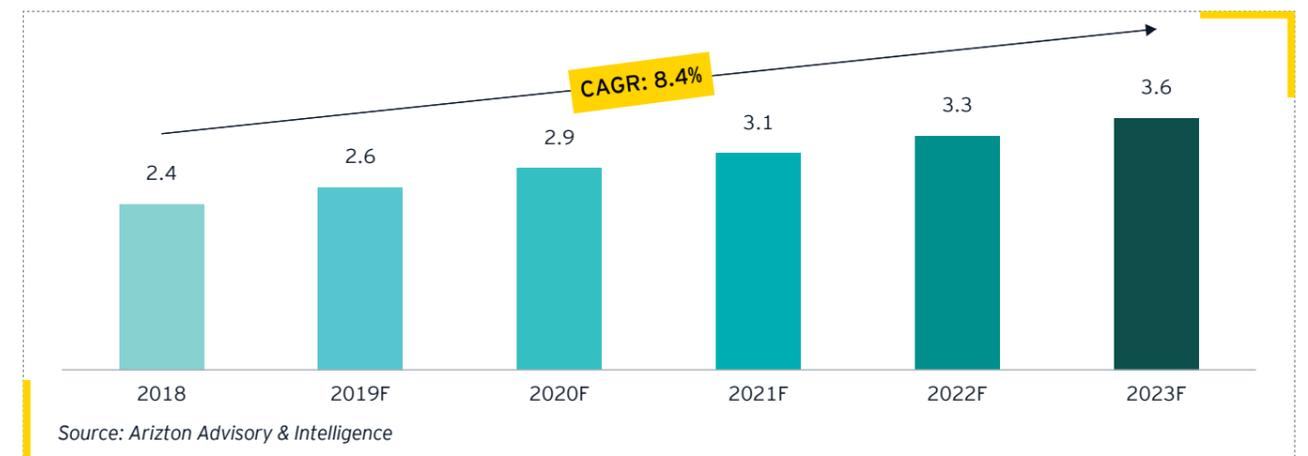
Data center services primarily comprise of colocation and managed hosting services. Colocation refers to leasing space in racks with provision of basic infrastructure such as power, cooling, physical security services, and network connectivity. On the other hand, in managed hosting, the data center operator extends the benefits

of colocation and provides dedicated hardware such as servers, and related IT maintenance and support services on lease to the customers.

The towercos can explore the opportunity of entering into data center space as there are synergies in the business model of a towerco and a data center service provider. Both are capital intensive businesses, and depend on leasing capacity to enterprises. Additionally, expansion of towercos into fiber would provide them an edge in establishing data centers as fiber connectivity has become a critical enabling factor.

The area of towerco play would majorly be in shared infrastructure offering based on colocation services. In the long term, they can explore building the server hosting capabilities to extend their share of the pie. Given that the operation of a data center business is

Figure: India data center market (US\$ billion)



33. "Data center market in India: Industry Outlook & Forecast (2019-2024)," Arizton Advisory & Intelligence via EMIS

34. "Personal Data Protection Bill only after new government takes over," The Economic Times, 4 January 2019, <https://economictimes.indiatimes.com/tech/internet/personal-data-protection-bill-only-after-new-government-takes-over/articleshow/67374919.cms>

a service rather than just provision of infrastructure, a towerco will need to make certain structural changes to act as a data center service provider.

The data center business is in line with capex to opex conversion model followed by towercos in their traditional business of tower rentals. The towercos can venture into a full-fledged data center business by enhancing their capabilities in this space.

Figure: Synergies between towerco and data center service provider





Monetization of existing assets - an immediate opportunity for towercos

Distributed tower sites are valuable assets held by towercos which can be tapped for revenue opportunities without incurring substantial additional capex.

Edge computing and micro data centers at tower sites

With the surge in data usage and high bandwidth applications, it has become essential to bring computers and storage closer to the customers. In such a scenario, deploying micro data centers near the network edge would be essential as it reduces the need to send backhaul data traffic to the centralized hub. Moreover, with emergence of low latency and high throughput applications such as high-speed video, augmented reality/virtual reality (AR/VR), autonomous driving, robotic surgery and other mission critical communications apps, edge computing technology is gaining momentum.

In this context, tower sites with distributed and widespread location network, are well suited to co-locate edge computing infrastructure. It opens avenues for the towercos to add new revenue stream by leasing the space at their sites for data centers. The placement of micro data center at tower sites depends on the network design, geographic location and surrounding population³⁵.

Key attributes of towers

Consumer location proximity

Reliable power supply and security

Ready access to backhaul

Emerging as favourable proposition to co-locate data centers

consumer for micro data centers as legacy wireless network architecture has cloud interface at regional level resulting in long distances travelled by the traffic³⁶. Therefore, micro data centers at tower sites can also be leveraged for enabling localized cloud-RANs³⁷.

Currently, edge computing at tower sites is still at a very nascent stage and the towercos need to evaluate the business/ revenue model to realize maximum potential.

The combination of distributed real estate assets with edge data centers would bring in additional benefits such as the ability to handle local content consumption, enable communication among devices locally and manage processing of computations at relatively faster rates. This unlocks the prospects for real-time applications with richer and immersive experience for end users.

The towercos can also venture into investing in micro data centers and deploying them on their sites for edge computing. This would enable the towercos to sell new services to customers with stringent latency needs such as content delivery network providers and cloud providers which support edge specific applications. Telecom operators are another potential

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US based tower infrastructure companies are venturing into edge computing by leasing space for micro data center deployment on their tower sites

Towerco A	Towerco B
US based towerco invested in an edge compute infrastructure provider to diversify into edge computing	US based communication infrastructure investment firm entered into edge computing through its investee companies - a towerco and a data center services provider
Assets of towerco 40,000 towers 60,000 route kilometer fiber	Assets of towerco More than 266,000 owned and managed sites nationwide, including wireless and broadcast towers, rooftops and other site locations
Lease space and power to edge computing vendor at its towers sites to install micro data centers	Leverage site locations of towerco to deploy micro data centers

Bringing cloud closer to consumer by combining distributed tower site locations with edge data centers

Target customers for edge computing

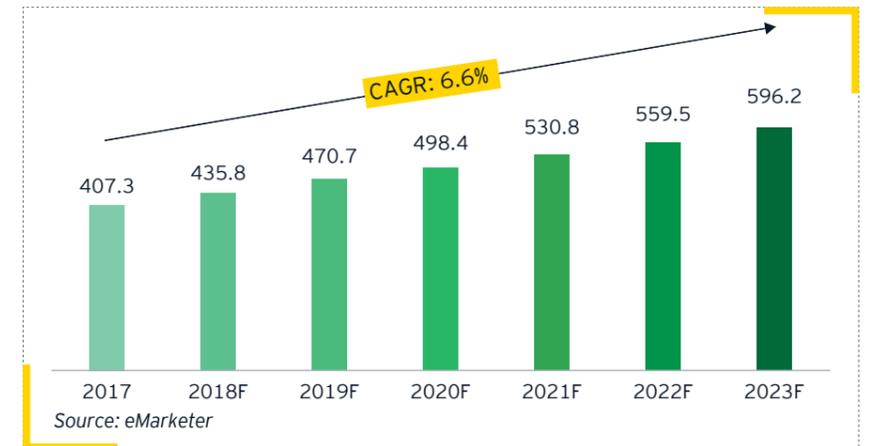
Content provider	Cloud provider	Telecom operator
<ul style="list-style-type: none"> Store tailored content for region it serves Reduce data transportation cost Enhance user experience 	<ul style="list-style-type: none"> Improve performance by bringing computing closer to consumer 	<ul style="list-style-type: none"> Support smart city networks Network virtualisation Deploy cloud RAN Support 5G use cases

Source: Media articles, company website

Monetizing structures for advertising

Out of Home (OOH) advertising is another potential opportunity for towercos to expand their revenue stream. The towerco sites are well suited to leverage their distributed locations at highways or densely populated areas to co-locate billboards for advertising. They can venture into digital advertising space by installing digital billboards at remote locations for displaying government announcements.

Figure: India OOH advertising revenue (US\$ million)

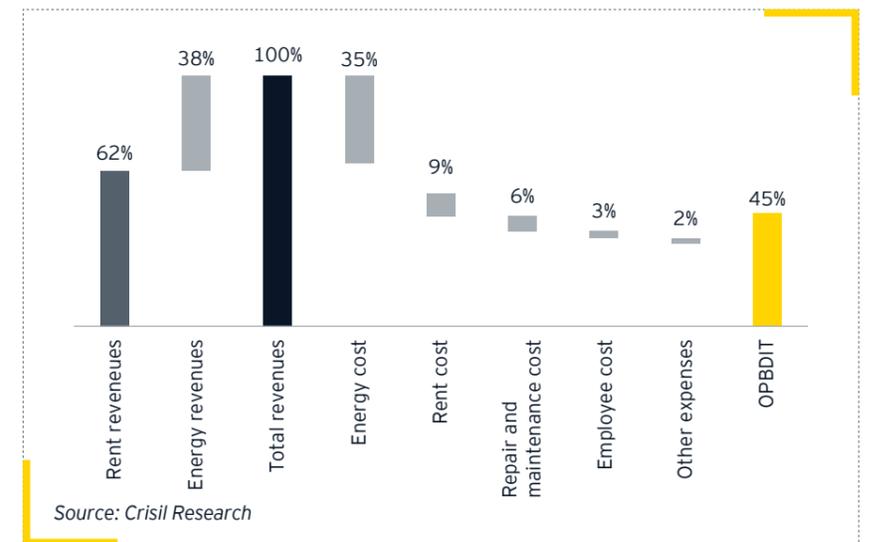


Power-as-a-service

Energy cost is one of the principal cost component for the towerco industry – constituting ~35% of total revenue of tower industry. One of the key reasons for high energy cost is increasing usage of diesel generators (DGs) as back-up due to unreliable electric grid supply at multiple sites – telecom industry is one of the leading buyers of diesel after the Railways and is estimated to spend INR90 billion annually to consume ~2 billion liters of fuel³⁸. The DGs do not make a viable solution due to their high operating cost and significant greenhouse gas (GHG) emissions.

Over the years, towercos have gained considerable expertise in energy management space as they have experience in managing and optimizing energy costs in different topographies, climates and grid power availability scenarios. In this backdrop, towercos are in a compelling position to place themselves as energy/power management solution providers. They can explore the opportunity of providing power-as-a-service.

Figure: Tower industry cost structure



The tower industry has been working towards implementing energy management solutions that are environment friendly. The targets set by TRAI to reduce the carbon emission by the telecom sector as 30% by 2019-20 and 40% by 2022-23, assuming the base year as 2011-12³⁹, has given impetus to adoption of such solutions.

The towercos have been actively taking steps to manage their energy costs by adopting hybrid solutions comprising of renewable energy technologies, energy storage solutions in addition to DGs and electric grid supply to power their sites.

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Renewable energy:

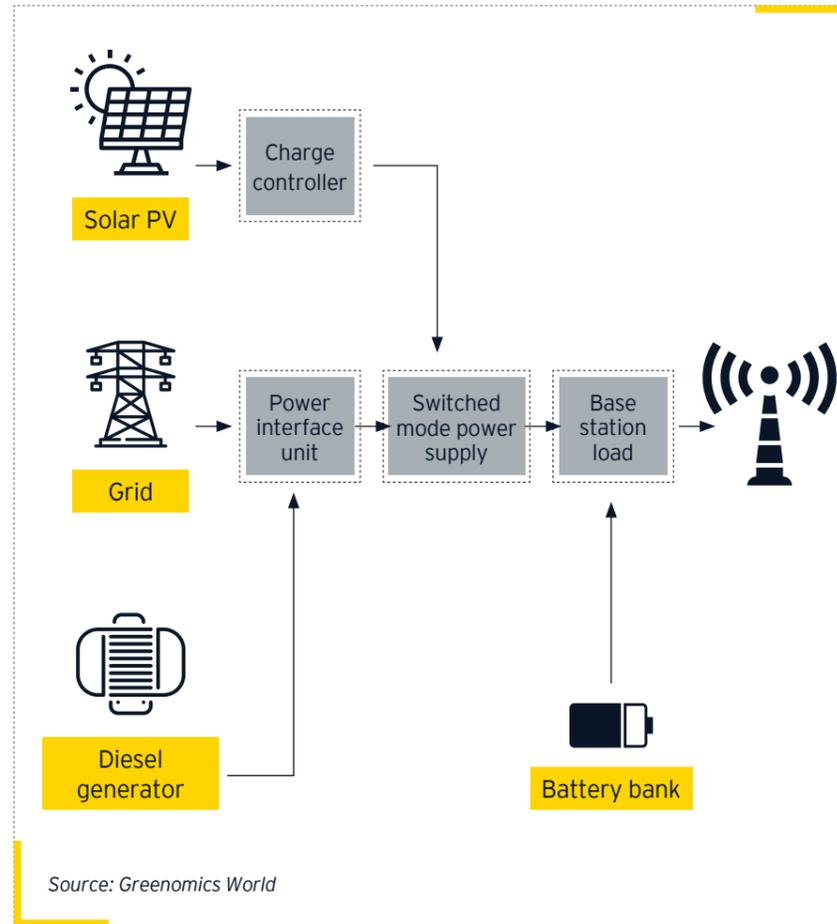
Back in 2012, the industry adopted the renewable energy service companies (RESCO) model to promote usage of renewable energy solution for reducing greenhouse gas (GHG) emissions. RESCO is an off-grid decentralized energy based power generation and distribution model which uses renewable technologies such as solar, biomass, wind to generate energy at hub location and feeds that to the tower sites.

The collaboration between towercos and RESCO have gained traction to reduce usage of diesel and move towards sustainable model of controlling energy costs. Through these alliances, the leading towercos have successfully deployed renewable energy solutions at their sites.

Energy storage:

Efficient energy storage solutions as an alternative to diesel generator have also gained momentum in the industry. The usage of energy storage solutions has evolved over the years. The towercos have been actively deploying various energy storage solutions such as lithium-ion batteries (Li-ion), valve regulated lead acid (VRLA) batteries, lead-acid batteries, flow batteries, thermal energy storage solutions and protection circuit module batteries. Of all the battery solutions, lithium-ion batteries (Li-ion) batteries has gained widespread usage in the industry due to their compact size, quick charging and slow discharge properties.

Figure: Schematic diagram of hybrid solar power telecom tower



Asian towerco diversifies into energy management space

An Asian towerco purchased energy assets of 1,250 telecommunication tower sites from a telecom operator in Myanmar to manage energy on these sites. The towerco aims to evolve from just “tower” service provider to “tower+power” service provider. The deal enables the towerco to maintain and operate the overall power management system which will eventually optimise energy systems across sites.

- | | | | |
|--------------------------|---------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Key features of the deal | 1 | 2 | 3 |
| | Optimize energy management and energy pass through management | Remote monitoring of energy assets facilitating real-time resolution of assets | Enable sharing of energy assets among the tenants - increasing energy efficiency and reducing carbon footprint |

Source: Media articles, TowerXchange

Case study

Space for warehousing, cold storage and collection points for goods

Warehousing and cold storage are crucial links to the supply chain and logistics industry. Overall, the warehousing market in India is highly fragmented with ~90% of the warehousing space controlled by unorganized players. The distribution of warehouse is concentrated in metros and bigger cities - 60% of modern warehousing capacity present majorly in top six cities namely Ahmedabad, Bangalore, Chennai, Mumbai, National Capital Region (NCR) and Pune due to presence of industrial activity.

Given India is an agrarian economy, cold storage warehouses play a critical role in the value chain. However, the uneven distribution of warehouses has resulted in the perishing of ~15% of agricultural produce as the location of cold storages is near consumption rather than near farms⁴⁰.

The towercos are well-suited to provide space for warehouses and cold storage by leveraging their existing land assets at distributed location with reliable power supply, security and air-conditioning. This would unlock opportunity for them to earn additional revenue by capitalizing on their existing assets.

Collection point for goods:

Rural e-commerce market is another area which has significant potential. It is expected to grow to US\$10 billion-US\$12 billion by 2021⁴¹. The towercos can play a pivotal role by facilitating the e-commerce players to reach rural areas by providing them access to their

distributed locations for storage as well as for collection of goods ordered online.

Field maintenance

Downtime on telecom network is a cost concern and creates outages for operators and subscribers. However, the risk of failures and outages at sites due to poor or malfunctioning equipment may be drastically reduced when the condition of the infrastructure is closely monitored and tracked on an ongoing basis.

While some outages involve solving relatively complex issues, which can be supported only by a network engineer, others require limited knowledge and skill to troubleshoot basic issues/problems at the tower site. This category of support referred to as L1 typically includes individuals that have limited technical expertise. L1 level maintenance needs a field personnel that can implement basic, documented break-fix tasks along the lines of following an instruction manual.

L1 level field management can be easily outsourced to towercos. With their field force already managing at the hardware side of tower infrastructure, this can be a synergistic addition to their area of work.

The current arrangement with multiple site visits by a diverse set of personnel for passive and active infrastructure maintenance, comes with its pitfalls. For instance, overlapping site visits results in cost inefficiencies as well as site owner inconvenience.

Outsourcing L1 support to towercos, has several benefits

Benefits for telcos

- ▶ Cost savings due to sharing of field visit costs
- ▶ Improved synergies and turn around time by improving productivity
- ▶ Telcos can leverage on this field force to cost-effectively manage fibre, Small Cells, Wi-Fi and other future network elements
- ▶ Address issues arising from site owner inconvenience caused by multiple interfaces and field visits

EV charging points

Electric vehicles (EV) have witnessed an unprecedented global interest in recent times and are emerging as the one of the most promising alternate powertrain technologies with zero tailpipe emissions and long term economic viability. India, too, is actively considering EVs to reduce India's excessive dependence on oil imports and curb pollution levels.

The Indian EV market is at a nascent stage with EVs forming less than 1% of overall vehicle sales⁴². The market is now seeing a renewed interest and engagement on the back of government's target of EVs to contribute 30% of vehicle sales by 2030⁴³. Currently, the EV industry is majorly dominated by e-rickshaws and two-wheelers. The transition to EVs is necessary for the Indian automotive industry to continue to retain its foothold and gain additional ground as the world shifts its axis towards EVs.

Key initiatives by the government to promote EV adoption in India:

- ▶ Under the National Electric Mobility Mission Plan 2020 (NEMMP) scheme, a total estimated subsidy worth INR140 billion is planned to be invested in creating infrastructure and promoting the use of environment-friendly EVs⁴⁴.
- ▶ In 2015, the Government of India launched Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) scheme for a two-year period at an approved outlay of INR 7.95 billion. It has been further extended with total outlay increased to INR 8.95 billion till March 2019 or till the time an inter-ministerial consensus on funding for the FAME- II scheme is reached⁴⁵.
- ▶ Under FAME-II, the government is planning to extend financial support of INR 55 billion for five years, which will provide subsidy to all types of EVs including two-wheelers, three-wheelers and four-wheelers, besides setting up charging infrastructure. FAME-II is expected to provide incentives such as exemption from paying road tax, registration fee and parking charges for various categories of electric and hybrid vehicles⁴⁶.
- ▶ The government is taking steps to build robust EV charging infrastructure⁴⁷:
 - ▶ It plans to set up EV charging stations at every 25km on highways and roads. Additionally, it plans to set up at least one station on each side of highway every 100km for long-range and heavy-duty vehicles.
 - ▶ It aims to implement deployment of charging stations in two phases. In the first phase, the government plans to set up EV charging stations in mega cities with a population of 4 million over the next one to three years. In the second phase, the government aims to cover cities such as state capitals and union territory headquarters.
 - ▶ The government stated that no license will be required for setting up of public charging station. The stations will need to meet certain charging requirement infrastructure. The charging station can obtain access to electricity from any power company through open access system.
 - ▶ It allowed setting-up of private charging stations in residential areas.

The towercos are well-suited to provide EV charging infrastructure. They can leverage their distributed location of sites and reliable access to power backhaul to tap this opportunity and realize new revenue stream.

40. "Overview of the India Warehousing Industry," CARE Ratings, 16 October 2018

41. "Rural e-commerce market a \$10b-\$12b opportunity in the next four years," Economic Times, 2 November 2018, <https://tech.economictimes.indiatimes.com/news/internet/rural-e-commerce-market-a-10b-12b-opportunity-in-the-next-four-years/66481398>

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47. "Centre issues guidelines on charging stations for electric vehicles, brings much-needed clarity," The new Indian Express, 21 December 2018, <http://www.newindianexpress.com/business/2018/dec/21/guidelines-on-charging-stations-for-evs-bring-much-needed-clarity-1914539.html>

A leading German telecom operator is leveraging its infrastructure for building EV charging stations

A leading German telecom operator plans to use its nationwide infrastructure for phone and internet distribution to provide EV charging services. The company aims to transform 12,000 of its fixed line and cable distribution boxes across country into EV charging stations.

Key features

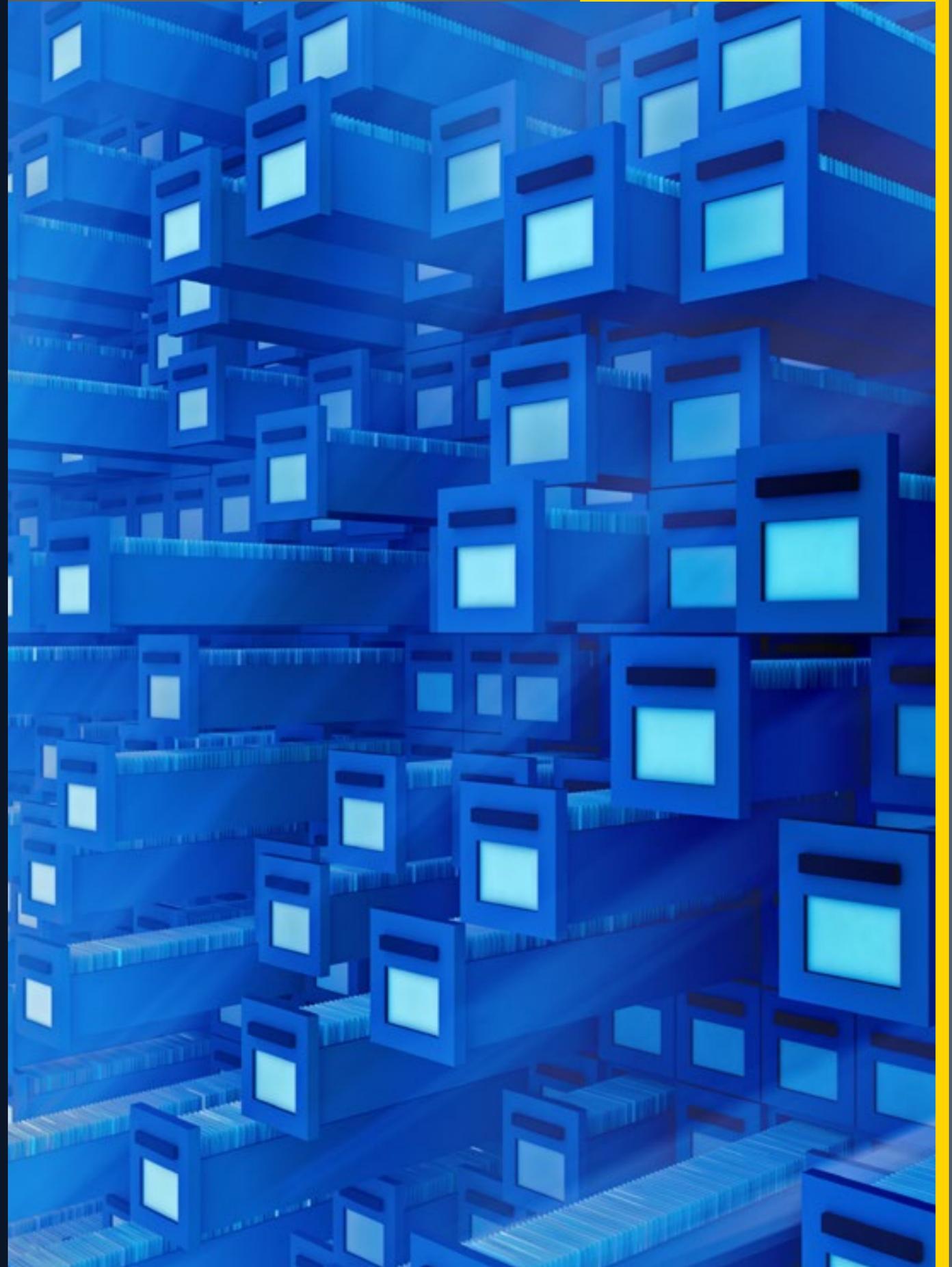
Converting existing telecom infrastructure for EV charging points

Boxes are being fitted with required charging and measurement hardware

Charging station will provide one or two charging points that can charge vehicles upto 11KW

Plans to use renewable energy sources for additional energy requirement for EV charging network

Source: Media articles, TowerXchange



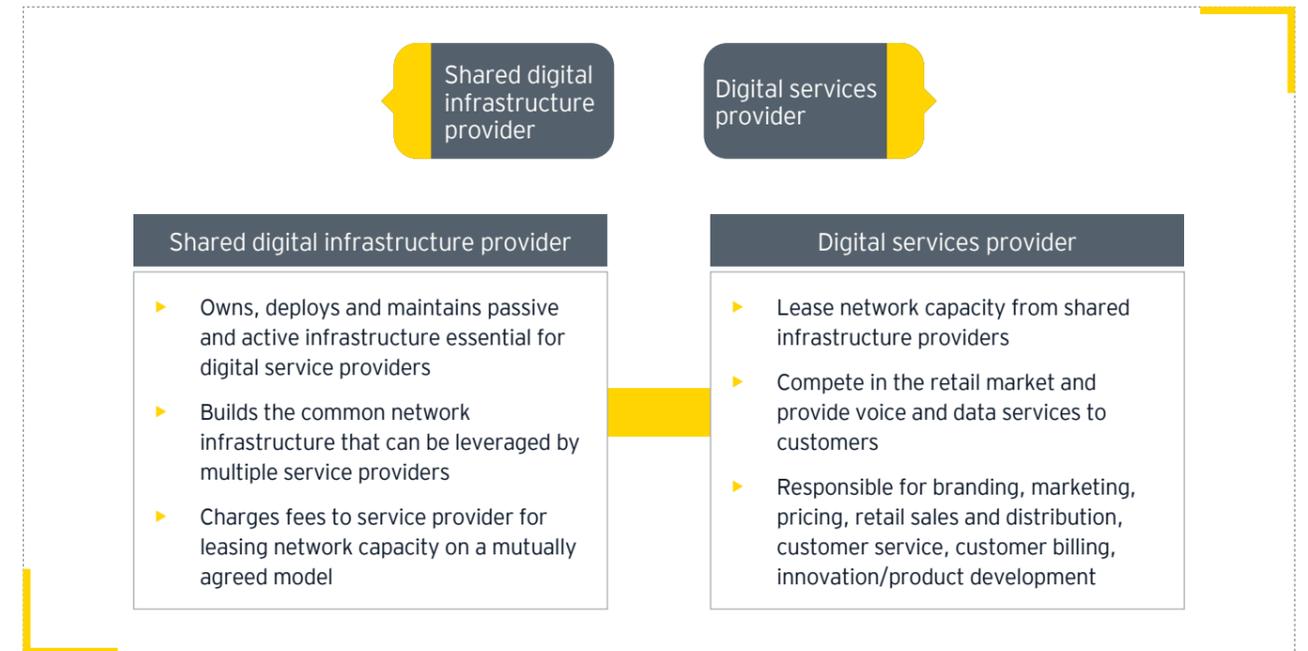


Shared digital infrastructure provider- a potential future opportunity for towercos

Towercos can explore playing a larger role by becoming a shared digital infrastructure provider, which entails active infrastructure sharing also. By assuming the role of a shared infrastructure provider, the towerco will take sole responsibility of network infrastructure and provide wholesale services to digital service providers. In turn, the digital service providers can focus on managing the marketing, providing retail services to the end consumers and handling customer services.

Shared infrastructure provider business model brings in reduction in operating costs by avoiding duplicate infrastructure by multiple service providers. It enables portfolio rationalization by decommissioning redundant sites, consolidating the asset base and optimizing the backhaul infrastructure. The current regulatory environment does not allow towercos to take the shared infrastructure provider business path.

Figure: Shared digital infrastructure model



Case study

French telecom operators plan to deploy shared 4G network to ensure there are no coverage gaps

The telecom operators in France have come together to deploy 4G network to plug network gaps. The roll out plan aims to bring 4G coverage to more than 10,000 towns and villages which are currently being served by either 2G or 3G networks

Investment and targets

- ▶ Each of the telecom operator to install 5,000 masts and antennas
- ▶ Jointly ensure network coverage along 30,000 km (19,000 miles) of rail tracks
- ▶ Telcos plan to invest Euro 3 billion to roll out 4G network in black spots across the country to ensure there are no coverage gaps by 2020

Source: Arthur D Little, Media articles, EY analysis





Recommendation and initiatives to enhance ease of doing business

Ease of doing business remains a prime concern for all infrastructure projects in the country, and especially for broadband infrastructure roll-outs. To be able to expedite creation of robust telecom infrastructure needed to fulfil the agenda of Digital India and bridge the digital divide between disparate economic classes, it is important that ease of doing business is treated as a priority to create an enabling environment.

Category	Key recommendations
Expediting RoW permissions	<ul style="list-style-type: none"> ▶ Setting up of single window clearance and time-bound processing of applications ▶ Ensure standardisation of rates for the RoW as envisaged in NDCP 2018 ▶ The government to consider adopting issuance of "Letter of credit" ▶ Reduction of approvals by empowering government officials to represent various departments ▶ Ensure efficient utilisation of technology for surveillance and documentation ▶ Promote self-certification to optimize time, resource and cost. Push for audit and high penalty ▶ Automate workflow for interdepartmental approvals and partner portal using ERP systems ▶ Establish common permissions processes for all utility purposes - water, electricity, gas pipes and fiber ▶ Process on priority all pending SACFA applications. ▶ Focus on operating from standards and strong SLAs ▶ Timeline of the project should start post permissions like RoW and approvals
Enhance coverage inside buildings and public spaces by installation of in buildings solutions and Wi-Fi hotspots	<ul style="list-style-type: none"> ▶ As envisaged in NDCP 2018, mandated provisioning of spaces and ducts in all commercial, residential and office spaces for installation of telecom infrastructure and the associated cabling and in-building solutions by amending National Building Code of India (NBC), through BIS
Make India future ready with a robust communication infrastructure for provisioning of technologies like 5G, AI, etc.	<ul style="list-style-type: none"> ▶ Reclassify common telecom / digital infrastructure under a single umbrella ▶ Promote sharing of telecom infrastructure among telecom service providers on the infrastructure deployed by IP-Is ▶ Streamline the deployment and site clearance processes for new infrastructure such as small cells, Wi-Fi
Enhancing ease of doing business for the telecom infrastructure providers	<ul style="list-style-type: none"> ▶ Need to create collaborative institutional mechanism between centre, state and local bodies for common RoW mechanism and removal of barriers as envisaged in NDCP 2018 ▶ Consult concerned departments (e.g., urban development/IT), advise state representatives to follow DoT guidelines for formulation of respective tower installation policies ▶ Set up a central or state level agencies or a task force to oversee the implementation of RoW rules ▶ Endorse on-ground implementation of infrastructure status benefits to infrastructure providers ▶ Improve the availability of grid-based power for telecom towers

Category	Key recommendations
Ensure protection of critical telecom infrastructure by imposing stringent penal	<ul style="list-style-type: none"> ▶ In line with NDCP 2018, take measures to reduce the vandalism and address security issues across layers including physical infrastructure, cyber-physical infrastructure, hardware and network elements ▶ Impose stringent penal actions for damage to critical assets ▶ Adopt proactive steps such as “dig once” and “call before you dig” to safeguard the laid fiber ▶ Optimize execution via collaboration with upcoming utility and infrastructure projects ▶ Set up of Common GIS platform for management of utilities ▶ Define custodian of the utilities map with the nodal agency for RoWs being the central pillar ▶ Ensure the utility corridors and duct dimensions accommodates high count optic fiber
Optimal utilization of government laid fiber infrastructure (BharatNet)	<ul style="list-style-type: none"> ▶ Encourage public-private partnership to bolster communications infrastructure ▶ Streamline terms of use and make cost structure reasonable ▶ Run on-ground awareness programmes at panchayat level to enlighten people regarding usage and maintenance of the infrastructure
Smooth implementation of Smart city projects	<ul style="list-style-type: none"> ▶ Ensure timely provision of financing for smart city projects ▶ Streamline clearance processes

Source: TAIPA, media article and TRAI

Glossary

AR/VR	Augmented reality/virtual reality
BBNL	Bharat Broadband Network Limited
BIS	Bureau of Indian Standards
CPSU	Central public sector
CSS	Centrally sponsored scheme
DG	Diesel generators
EV	Electric vehicles
FAME	Faster adoption and manufacturing of hybrid and electric vehicles
FTTH/B	Fibre-to-the-home/ building
GHG	Greenhouse gas
GP	Gram panchayat
IBS	In-building solutions
IoT	Internet of Things
IP-1	Infrastructure providers category-1
Li-ion	Lithium-ion batteries
LP-WAN	Low-power wide area networks
MSA	Master service agreement
NCR	National capital region
NDCP	National digital communications policy
NEMMP	National Electric Mobility Mission Plan
NLD	National long distance
NOFN	National Optical Fiber Network
OOH	Out of home
PPP	Public private partnership
RESCO	Renewable energy service companies
RoW	Right of way
ToC	Tower operations centre
VRLA	Valve regulated lead acid

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