

## Spectrum policy in India

By Shamika Ravi and Darrell M. West

### INTRODUCTION



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**T**he mobile sector continues to see dramatic growth around the world. Usage of cellphones, smartphones, and tablets is increasing at a rapid pace. With the growing popularity and ease of use of mobile devices such as iPhone, Android phones, tablets, and other portable devices, new mobile applications are coming online that increase access and capability, particularly in areas such as education, health care, transportation, and commerce.

But the tremendous increase in wireless utilization is coming up against the constraints of radio spectrum availability and telecommunications infrastructure. Radio spectrum refers to the parts of electromagnetic frequencies that are available for wireless transmissions. Different parts of the spectrum are used for different technologies and applications. A spectrum frequency band is a small section of the spectrum in which channels are used for a defined purpose. For example, the mobile broadband technologies utilized by smartphones and tablets, allows for high-speed access to the internet and other data services over mobile networks.



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Generally, frequencies from 30 kHz to 300 GHz are used as radio spectrum and governments allocate radio frequency bands for particular uses. It is important to note that spectrum is a scarce natural resource, since allocated spectrum cannot simultaneously be used for other purposes. Limitations in spectrum and mobile networks can create environments where consumers experience dropped calls, reduced wireless availability, or high prices. This, in turn, can cause slower mobile growth in many countries.

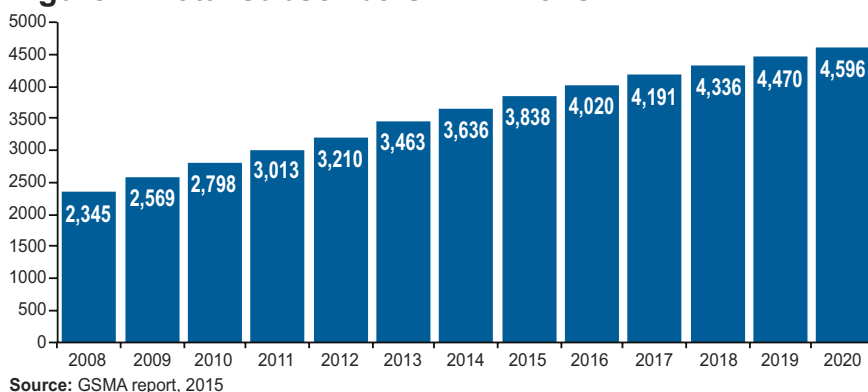
In this paper, we examine mobile technology in India. In particular, we study the crucial role of spectrum policy in facilitating wireless growth. The availability of devices, high telecommunications costs, and taxes on mobile usage make it difficult for consumers and businesses to take full advantage of the mobile revolution. India has enormous potential for growth in mobile applications as is reflected in its massive number of mobile customers. Many estimate that India will become the first mobile-first Internet market in the world. This is because nearly 80 percent of Internet users are doing so through mobile phones and for approximately 60 percent of Internet users, mobile is the only source of Internet access.

The Indian government recognizes the potential of this sector in advancing financial access, improving information, and raising productivity in the economy. It has therefore launched major flagship programs like Digital India and Smart Cities which fundamentally depend on telecommunications infrastructure. India, however, needs to improve its wireless infrastructure and spectrum policy for this potential to be fully realized. While spectrum availability is a global challenge faced by all economies, it is a particularly severe issue in India. Given the crucial role of the telecommunications sector in India's future, solving these challenges is vital for economic growth and societal inclusion.

## GLOBAL GROWTH IN MOBILE TECHNOLOGY

Mobile broadband usage is rising rapidly throughout the world. According to a GSMA report, the number of mobile Internet subscribers has risen dramatically since 2008 and is expected to grow even further in the next few years (see Figure 1). It has gone from 2.3 billion in 2008 to 3.8 billion in 2015 and is predicted to rise to nearly 4.6 billion by 2020.

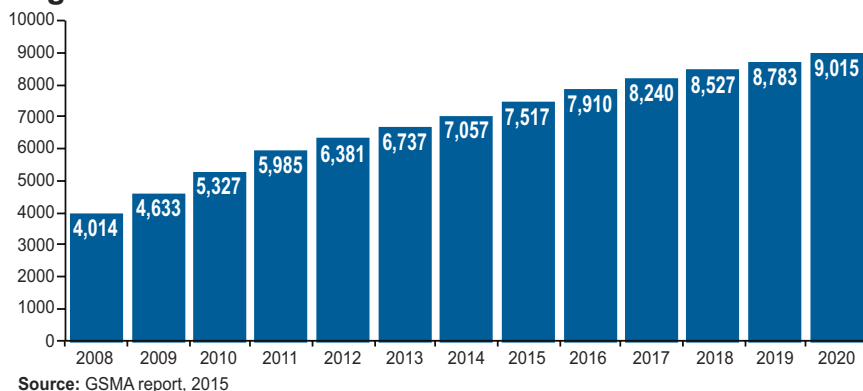
**Figure 1: Total subscribers in millions**



In fact, the GSMA analysis finds that global mobile broadband connections surpassed fixed connections in 2010. People like the convenience and ease of use associated with smartphones and tablets. Handheld devices enable people to access information and services around the clock, wherever they happen to be.

If one examines the number of mobile devices, the figures are even more dramatic. Many people have more than one cellphone, smartphone, or tablet. The total number of cellular connections was more than 7.5 billion in 2015 (see Figure 2). That figure is expected to increase to over 9 billion by 2020.

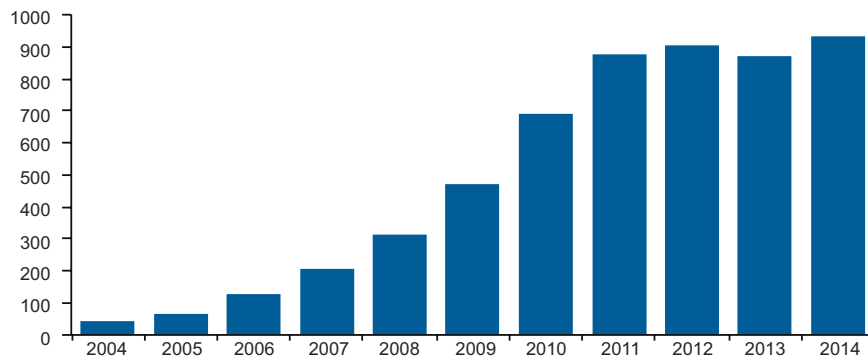
**Figure 2: Total mobile connections in millions**



## MOBILE TECHNOLOGY IN INDIA

As is true in many places around the world, mobile technology has grown rapidly in India. The country has seen a rapid increase over the last decade. As Figure 3 shows, there were nearly 915 million subscribers in India in 2014, increasing from less than 50 million in 2004. The latest numbers from the Telecom Regulatory Authority of India (TRAI) show that mobile customers are more than 30 times the number of fixed line customers in India.

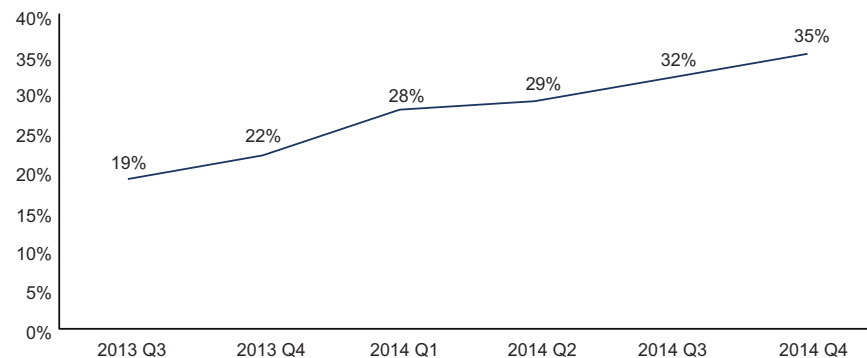
**Figure 3: Number of mobile subscribers in millions**



Source: TRAI, 2014

There is also a rapid shift occurring in the type of devices that make up these numbers. As figure 4 shows, from 19 percent in 2013, smartphone market share had grown to 35 percent by the end of 2014. This trend is expected to continue, signaling a shift in the type and amount of usage of spectrum by mobile devices.

**Figure 4: Smartphone market share in India**



Source: TRAI, 2014

Looking ahead, these numbers are projected to rise even further as future mobile growth takes place in the Asian Pacific. The latest report of the Cellular Operators Association of India (COAI) states that more than 80 percent of Internet users in India are using a mobile phone for access, and that for nearly 60 percent internet users, the mobile phone is the only medium of Internet access.

Overall, according to an Ericsson report, the number of mobile subscribers is expected to rise to 1.145 billion by 2020. And the smartphone penetration level is projected to increase to 45 percent or around 520 million devices. Ajay Gupta of Ericsson India said that “smartphones and MBB services are becoming more affordable. As a result, we are seeing the advent of a new Networked Society in India as in other parts of the world that will benefit consumers and businesses alike.”

## THE IMPORTANCE OF SPECTRUM FOR SOCIAL AND ECONOMIC DEVELOPMENT

In recent years, advances in mobile technology have led to innovative applications in education, health care, transportation, and commerce. In education, there is growing interest in mobile learning, personalized education, and massive online courses which will augment India's poorly resourced education infrastructure. Technology represents a way to overcome rural/urban disparities and bring content-rich resources to underserved areas.

There is a close tie between innovations in these areas and spectrum availability and allocation. Spectrum is the foundational feature that will allow new applications to flourish or languish. Without the capacity to transmit through radio waves, it will be nearly impossible to take advantage of these new developments.

In the health care area, there are applications that track health and fitness, and remote monitoring devices that record vital signs and electronically transmit them to physicians. Mobile applications empower health workers who are crucial to the delivery of care for people around the world. For example, mobile solutions were a vital part of the fight in Africa against the spread of the Ebola disease.

Mobile technology also has been helpful in regard to maternal health care. An mPowering Frontline Health Workers project found that "mobile broadband can help lower health-related costs, facilitate remote care and increase efficiencies. It allows communities unparalleled opportunities to track health data from anywhere, at any time, providing public health policymakers with timely information about the needs of their communities in order to improve performance of health workers as well as tweak intervention strategies."

Research by Miguel Tirado demonstrates that mobile technology can improve health care through better access and medical service delivery. Mobile devices offer the potential to improve affordability of health care and more efficient reimbursement for health-related services. Mobile phones provide a means to deliver medical reminders and diagnostic information to patients and physicians. Protocols for mobile health enable better health data collection and analysis, which contributes to the overall medical system.

Many urban areas are exploring "smart city" applications that help with efficient use of resources and improvement in the level of services provided. For example, smart city initiatives enable efficient public water and power supplies, waste management, integrated urban planning, traffic management, and affordable housing. They seek to harness the convenience and efficiency of mobile solutions to improving day-to-day life in metropolitan communities. These applications require mobile networks, wireless applications, and sensors that monitor, supply, and manage smart city improvements.

One flagship program of the Prime Minister Narendra Modi government has been the creation of 100 "Smart Cities" to handle rapid urbanization in India. The key features of this program are to use technology extensively to manage complexity, increase efficiency, reduce expenses, and improve overall quality of life. The goal is to use "information and digital infrastructure to manage the energy and water use in buildings to the creation of intelligent transport networks to minimize congestion." Major urban areas have been advised to hire a chief innovation officer, rely on local innovation capabilities, and scale innovation and foreign investment, among other recommendations.

Research by Shamika Ravi on India demonstrates that investments "in physical and financial infrastructure have contributed significantly more to growth of entrepreneurship in India." Using data from all the states in that country

between 1991 and 2006, she shows that infrastructure improvements stimulate increases in the output and total employment of micro, small, and medium enterprises. Those firms are vital for the overall economy because they harness the energy of small businesses for economic development and create jobs and prosperity for millions of people.

Due to the extensive public and business interest in these subjects, mobile broadband is the key for future economic growth. Having sufficient spectrum enables people to take advantage of new applications and stimulate creativity and innovation.

Data compiled by the Boston Consulting Group (BCG) finds that mobile technologies stimulate considerable growth. Through investments in research and development as well as infrastructure, this sector contributes around 3 percent to global gross domestic product. Overall, the mobile area is expected to grow more than 10 percent each year.

In India, the BCG analysis finds that mobile accounts for 2.2 percent of India's Gross Domestic Product. Between 2009 and 2014, the mobile sector generated a 12.4 percent compound annual growth rate. It clearly is one of the most dynamic industries in the country and one that will drive future economic development.

Telecommunications has been one of the most transformational technologies in India over the last two decades. The latest COAI data indicate that telecom is the second largest private sector investment in infrastructure in India. It is also one of the largest contributors to the government exchequer with an average of over Rs.14,500 crores per year in the form of license fees and spectrum usage charges.

As the government of Prime Minister Modi works to create the platform for Digital India - one of the most ambitious initiatives of the government - its basic prerequisite is quality broadband highway with extensive coverage in urban as well as rural areas. As part of the initiative, connectivity has to be provided and improved to nearly 600,000 villages in India in order to achieve complete administrative implementation. The construction of that network will help leaders provide a wide range of government services electronically to its citizens and make high-speed Internet service available to those without access.

But to take advantage of these growth opportunities, mobile technology requires sufficient access to spectrum and robust and widely available mobile infrastructure. Spectrum is the bedrock for wireless devices. Users need high-speed networks that link communities across the country. Without far reaching and reliable mobile networks, it will be impossible for anyone to take advantage of these new tools.

## THE CHALLENGES OF INDIA'S SPECTRUM POLICY

With demands for mobile technology expected to rise rapidly, it is vital that the country deploy spectrum for commercial utilization.

India needs more spectrum to take advantage of new possibilities for social and economic development. With demands for mobile technology expected to rise rapidly in future years, it is

vital that the country deploy spectrum for commercial utilization in order to make possible the expansion of mobile broadband.

With so many opportunities available in India, it is crucial to address current barriers. There are a number of difficulties in terms of India's spectrum policy. This includes challenges such as availability, cost, fragmentation, inflexibility, and past auction problems. The following sections outline each of these issues in greater detail.

(I) LACK OF AVAILABLE SPECTRUM

**Table 1: Summary of total licensed spectrum in various countries (in MHz)**

Country	Current	Pipeline	Hz/Subscriber
USA	608	55	2.1
Australia	478	230	22.8
Brazil	554	0	2.0
China	227	360	0.5
France	555	50	9.3
Germany	615	0	6.2
Italy	540	20	5.9
Japan	500	10	3.3
Spain	540	60	11.8
U.K	353	265	7.9
India	221	10 (estimate)	0.2

Source: International data – FCC (2013), Indian data from COAI (2015), subscriber data from World Bank

Availability is a problem because there are insufficient bands for the growing mobile demands in India. The dramatic growth of smartphones and tablets has outpaced the ability of some providers to offer reliable connectivity. As shown in Table 1, the availability of licensed spectrum in India is much lower than the U.S. and Europe, and also significantly lower than other developing countries like Brazil and China. While spectrum availability is a larger global problem, it is particularly acute in India. According to the COAI Annual Report, operators in India possess significantly smaller amount of spectrum, approximately 13 MHz on average, compared to international standards. This is low even in comparison to other Asian countries, such as Bangladesh (37.4 MHz) and Malaysia (75 MHz).

What is notable from Table 1, is the near absence of a pipeline for future growth of spectrum in India. Despite having extremely low levels of licensed spectrum, there is no effort to catch up.

This is in stark contrast to China

which is at a comparably low level of spectrum availability as India, but has a significant pipeline. The advanced economies too have serious expansion plans, despite higher spectrum availability today.

One measure of spectrum capacity in a country is the amount of spectrum per subscriber. As Table 1 highlights, India has very low capacity at 0.2 Hz per subscriber.

**Table 2: Spectrum availability in commonly deployed bands**

Band	Europe	USA	India
900 MHz	70	64	12.4
1800 MHz	150	130	97.6
2/2.3 GHz	120	90	60
2.6 GHz	190	194	20
800 MHz	60	70	27.5
<b>Total</b>	<b>590</b>	<b>548</b>	<b>217.5</b>

Source: FCC and DoT India

Table 2 lists spectrum availability in various bands, based on data from the Federal Communications Commission (FCC), U.S.A. and Department of Telecommunications (DoT), Government of India. At every level, India lags the United States and Europe in available space. Overall, India has 217.5 amount of spectrum, far behind the 548 in the United States and 590 in Europe. For a country with a large population and rapidly growing mobile usage, this is an enormous problem that constrains the country's ability to offer mobile solutions. The consequence is high incidence of call drops and interruptions. In June this year, the Telecom Minister, Ravi Shankar Prasad, however, asked the mobile operators to walk the extra mile to reinforce their systems as they have enough spectrum to provide quality telephony services. The existing data, unfortunately, confirm the severity of spectrum shortage in India for all commonly deployed bandwidths.

## *(II) HIGH COSTS*

Analysts have documented that “spectrum cost in India is one of the highest in the world.” Its spectrum pricing runs around “25 times costlier than the countries such as U.S., France, Singapore, Germany, Spain and Sweden.” Business leaders complain that spectrum is scarce, fragmented, overpriced, and inflexible. By having licenses that run just for 20 years, government policies force firms into expensive infrastructure investments without sufficient time to reap the financial rewards of those costs.

India also suffers from high telecommunications costs. For example, a 2014 report from Merrill Lynch Global Research compares the Herfindahl-Hirschman Index (HHI) for various countries and India has the lowest market concentration at 0.22. The high levels of competition that result from low market concentration is reflected in the significantly lower tariffs and difficulties firms have in generating profits. The rate per minute (Call Charges per Minute, in USD) in India is 0.01 while Malaysia and Australia report 0.07 and 0.06 per minute respectively. This is probably the reason why Indian consumers report one of the highest average minutes of usage per subscriber per month, at 365 minutes, only second to China at 392 minutes.

While low tariffs and high usage reflect high consumer surplus, the cost structure in the Indian telecom business predicts that these benefits will be short lived. With increased congestion and limited spectrum capacity, there is likely to be a serious decline in quality. From the business perspective, we should expect consolidation. Allowing and facilitating mergers and acquisitions in the telecom sector will lead to a healthy evolution of this sector in the long run. Policy should be designed to make usage of the scarce and valuable spectrum more efficient. Another market mechanism that should be a policy priority is trading and swapping of spectrum. This is required to free spectrum that might be trapped in inefficient firms, and policies must be put in place that allow and encourage such transactions.

In a highly competitive environment such as India, it has been challenging to balance the need for operators to realize a profit while continuing to promote innovation and the public sector's interest in boosting government revenues through spectrum auctions. Government authorities have sought to raise large amounts of revenue through recent auctions. This has created revenue problems for leading telecommunications companies, and therefore limited their investment capital. The telecom sector in India also faces taxes and levies which amount to 30 percent of revenues in the sector, which is significantly higher than most other emerging countries. Despite this situation, the data show that the Indian telecom sector generates the second largest private sector investment in infrastructure at Rs.1,53,000 crores during the 10th and 11th plan. The impact of these high costs however might partially explain the decline in service quality as measured by increased incidence of call drops and interruptions. Improvements in quality will require Telecoms to innovate and invest in new infrastructure such as mobile towers.

## *(III) FRAGMENTED AND INFLEXIBLE USAGE*

The quality of spectrum is an issue because certain bands are reserved for specific applications. Some businesses note that too much spectrum is occupied by the Defence Ministry and therefore is underutilized, and that this limits private sector access to these resources. When government agencies sit on unused spectrum, it creates an artificial scarcity for companies that wish to innovate and squeezes the spectrum that is available for consumer and commercial applications.



The Indian Defence Ministry is a big player in the spectrum space because of the country's legitimate security worries. Going back decades, the Ministry has gotten large blocks of contiguous spectrum and not been required to relinquish any of it. Even though a lot of it is unused or underutilized, it is not available for commercial development. This keeps prices high for the remaining spectrum. There have been some encouraging announcements from the Telecom Ministry in January 2015 on swapping spectrum away from Defence for commercial use.

Beyond the issue with defense, too much of the current spectrum has been allocated in a fragmented and inflexible manner. Some of this has been done through auctions, the so called "liberalized" type, while others have been assigned administratively (the "un-liberalized" type) with very little flexibility in terms of kind of service or technology.

The government is technology agnostic and does not require the adoption of any specific technology. But in some cases, the government decides specific uses for various bands and it is difficult for firms to adjust to new demands or deploy new solutions. They have to operate within the confines of existing policies, and this has limited their options for innovation. Consumers end up with fewer choices and products that lag the market.

#### (IV) AUCTION OUTCOMES

Past spectrum auctions have contributed to cost and availability problems. In 2008, for example, the 2G (second generation of mobile technology) spectrum awards generated considerable political controversy and legal action. After examining the government's decisions, the India Supreme Court condemned them as "arbitrary," "unconstitutional," and "illegal." Analysts complained that billions in potential revenue were lost because 2G licenses were sold at below market prices.

Since then, there is near consensus among economists and policymakers in India that auctions are a superior mechanism for allocating spectrum that allocation that are administratively determined. Given the twin objectives of spectrum auctions - efficient allocation of spectrum to the best use and maximize government revenue - it is critical that auctions are designed appropriately. The fundamental process of auction is one of price discovery. Given rapid changes in technology and markets in developing countries, determining the true value of scarce resource that is spectrum, becomes a sophisticated exercise which requires scientific capacity. We have seen in the past that mistakes can lead to serious losses to state revenue, example in New Zealand spectrum licenses worth \$100,000 was sold for paltry \$6.

In 2010, India organized 3G spectrum auctions that generated 677.1 billion rupees (around \$14.7 billion) from bidders. Among the successful firms were Bharti Airtel, which spent 122.95 billion rupees on 13 circles, Vodafone, which spent 116.18 billion rupees in nine circles, Reliance Communications (85.85 billion rupees) on 13 regions, Aircel (65 billion rupees) on 13 circles, and Idea Cellular (57.69 billion) on 11 areas. The last two spectrum auctions held in 2014 and 2015 led to state revenues of Rs.61,200 crores and Rs.1,10,000 crores respectively.

But wireless operators complained that the government auction raised prices to unreasonable levels and forced them to take on high debt levels. According to a Bharti analyst, "the auction format and severe spectrum shortage along with ensuring policy uncertainty drove the prices beyond reasonable levels. As a result, we could not achieve our objective of a pan-India 3G footprint in this round." Another analyst, Manesh Patel of Ernst & Young, explained that "the fact that most of the companies have not gone and done blanket bidding [for all circles] ... clearly shows



that each operator has invested in circles where they ... have a strong presence.” Still another one predicted it would “take 8-10 years for operators to recover their 3G investment.”

Later auctions also suffered from high prices. According to a report by Coleago Consulting, 15 percent of the 850MHz and 1800MHz bandwidth auctioned between 2012 and 2014 was “unutilized,” despite pressing industry needs. The auctions suffered from “high reserve prices, technology bias, regulatory uncertainty, [and] historic spectrum fragmentation.” The result was lost revenue to government and unsatisfactory outcomes for business and consumers. The high reserve prices and fragmented band packaging “presented a significant risk to auction participants of being stuck with an unwanted sub-set of a target spectrum package. Given the concerns about spectrum packaging, this introduced a heightened risk of buyer inefficiency.”

In 2015, the government auctioned spectrum in the 800, 900, 1,800, and 2,100 MHz bands which are used for mobile broadband applications and services. Telecommunications companies bid aggressively because the bandwidth was central to their business models. In the case of the Indian company, Aditya Birla, its “900 MHz spectrum in nine circles accounts for a whopping 72 percent of its revenue.” With so much of its revenue dependent on a relatively small number of geographic areas, it put the company (and many other firms) in a vulnerable position as it moved into the future.

The auction also resulted in unreasonable prices, high debt levels for companies, and expensive charges for consumers. Many firms complained that they were forced into costly decisions that harmed their competitiveness and made it impossible to innovate in ways that consumers need in the 21st century. This has made it difficult to reach the stated “National Telecom Policy that set out to reach broadband speeds of 2 Mbps by 2015 and at least 100 Mbps thereafter.”

As a result of these problems, TRAI recommended that a 2015 auction involve all 15 MHz of 3G at the same time as the 2G airwaves. The 3G space had been opened up by a 2009 spectrum swap agreement with the Defence Ministry. The regulator’s hope was that offering a large amount of spectrum would keep prices reasonable and enable medium-sized firms to compete effectively with larger companies.

Yet the government cabinet rejected this agency recommendation and decided to include only 5 MHz of the 2.1 GHz 3G spectrum along with 800 MHz, 900 MHz and 1,800 MHz 2G bands in the spectrum auction. The government announced that it would set a high reserve price of 38.99 billion rupees (\$635.8 million) and save 10 MHz of the 2,100 MHz spectrum for a later auction.

GSMA chief regulatory officer Tom Phillips “criticized the government’s decision to set the reserve price at almost 36% higher than that recommended by regulator TRAI.” The agency had suggested a reserve price of 27.2 billion rupees. Continuing, he pointed out that “while high auction prices may generate short-term revenues for the government, in the longer term they will negatively impact the development of India’s mobile networks and delay investment in infrastructure, resulting in higher retail prices and an inferior mobile experience for consumers.”

TRAI officials also criticized the government decision. Responding to the cabinet decision, its administrators noted that “the decision to include only 5 MHz of 2.1 GHz 3G spectrum in the first of the planned auctions could restrict competition, unfairly benefit incumbents and discourage future investments in the sector.” According to the

regulator, the government decision would make it difficult for medium-sized firms to compete in the auction and would reinforce the market power of large firms.

India's past experience with spectrum auction has often revealed that the focus of the government has been overwhelmingly on short run revenue maximization. This has been at the expense of long run healthy growth of the sector and possibly also long run revenue maximization for the government through higher tax earnings from a thriving telecom sector. Exorbitant reservation prices for spectrum raise the fixed cost for firms and together with high levels of competition in the sector will necessarily impact consumer surplus adversely in the long run. It would result in low innovation within the sector and eventually poor quality of service. Since the current government policies do not allow mergers and consolidation of telecom business, this will lead to sick firms and trapped spectrum. Government policies must felicitate consolidation for healthy growth of the sector and long term benefit of consumers.

## RECOMMENDATIONS FOR FUTURE ACTION

The experience of other countries demonstrates that investments in mobile infrastructure and sound spectrum policies can create significant economic growth. Through affordable devices, reasonable telecommunications fees, and low mobile taxes, the digital sector can prosper and propel the overall economy. Improvements in these areas can boost Internet access and provide access to affordable services and diverse content.

In order to obtain those benefits, however, it is important to build mobile networks and improve spectrum access. A McKinsey Global Institute study found that if India takes certain actions, it could boost mobile Internet penetration from its current 8 to 10 percent up to 50 to 60 percent by 2025. Along with other technology improvements, that would boost that country's Gross National Product from between \$550 billion to \$1 trillion. To get that kind of growth, though, requires capital infusions, mobile prices that are affordable to a large number of consumers, and effective spectrum policies.

### *(I) OPENING UP SPECTRUM ACCESS*

The government should continue to free up available spectrum for commercial development. This includes vacating certain bands held by the Defence Department and holding auctions that have reasonable reserve prices. Unless there is sufficient licensed spectrum, it will be hard for India to achieve its goals of higher economic growth and greater social inclusion.

One of the reasons for acute spectrum shortage in India is the large share of commercial spectrum held by government departments and defense. This is unlike other parts of the world where, for example, NATO countries and several NATO allies have adopted the "NATO-Band" of the spectrum for their defense requirements, while the non-NATO Band accommodates most of the commercial telecom in these countries.

Some countries, including India, have not adopted the "NATO Band" for their defense spectrum requirements. This has resulted in a situation where the cost-effective commercial equipment bought by India from these countries fall in a non-NATO spectrum band of which a significant part of this overlaps with the Indian Defence spectrum bands. This is therefore a crucial reason leading to serious conflict of commercial public telecom services with the defense spectrum bands.

The Cabinet approved swapping of 15 MHz of 3G spectrum in 17 out of the 18 circles in the country between Defence Ministry and Telecom Ministry. This means that more spectrum would be available for commercial use. The government needs to create dialogues across the ministries of telecom, defense, and finance to resolve this problem. Fragmented and inflexible rules need to be reformed so that businesses have more spectrum available for commercial applications. That will help India gain the benefits of new mobile solutions in education, health care, transportation, urban planning, and energy.

## *(II) KEEPING COSTS REASONABLE*

High telecommunications and spectrum costs represent substantial barriers in many parts of the developing world. They keep consumers from being able to access the Internet and use digital services. They also make it difficult for businesses to develop products and services that will be affordable to their users. Without affordable services, telecommunications costs remain high and businesses are not able to deploy new products.

The Indian telecommunications sector has witnessed high subscriber growth and a rapidly evolving demand for new and advanced technology, but it has been stressed by low margins, limited spectrum availability, stringent taxes, and shrinking profitability. In order to promote innovation and quality of services to consumers, the government will have to rationalize its taxes and levies, and make them more competitive to global standards. The government at the national and local levels needs to resolve issues related to having adequate, contiguous, and interference-free spectrum. There needs to be predictable policies regarding spectrum availability and cost.

## *(III) AUCTION DESIGN AND CAPITAL AVAILABILITY*

The structure of spectrum auction rules makes a big difference in cost as well as availability. High reserve prices can keep costs high and create advantages for large over medium-sized and small companies. Bidding rules also make a substantial difference in the affordability of spectrum and the resulting costs for consumers. The government needs to balance its need for revenue with auction prices that are affordable to the telecommunications sector.

The high auction amounts paid by the telecoms mean that they have incurred heavy fixed costs. At the same time, though, firm profitability has dropped due to the high levels of competition and the very low average revenue per subscriber. This is problematic even though there is a rapid growth in mobile subscribers.

To enhance growth in the sector, it is important to address the capital and financial needs of firms. Many banks and financial institutions are wary of lending to the telecoms, and this has impeded their growth. The government recognizes this obstacle and it has proposed a Special Finance Arm to address the funding requirements of this sector. It needs to move quickly to implement this reform.

## *(IV) SPECTRUM SHARING AND TRADING*

The Indian government has moved to approve spectrum sharing among mobile operators. Firms that have under-utilized capacity will be allowed to share it with other companies. For example, if an operator is not using some of its spectrum, it can for a period of five years offer it to other operators for a fee. This will help firms deal with fragmented holdings and therefore lead to faster speeds and fewer dropped calls.

This decision will help improve management of spectrum bands. It is hard to manage spectrum when rights can't be reallocated to their highest uses. In this situation, spectrum is underutilized and kept in areas that don't really need it or aren't using it.

Another possible remedy is allowing spectrum mortgage. Under this plan, businesses can retain spectrum ownership but use their holdings to leverage capital formation. This would help telecommunication companies raise capital and create more flexibility for the sector as a whole.

There also can be liberalized rules on mergers and acquisitions in the telecommunications area. Subject to reasonable rules, companies should be able to combine, sell spectrum, and acquire some competitors. This would help them create the economies of scale that would enhance sustainability and spur long-term growth.

#### (V) *HARMONIZING REGIONAL RULES*

Expanding the benefits of mobile broadband is dependent on the use of similar band plans on a regional and global scale. Global harmonization of spectrum bands to support the same application ensures efficient spectrum use, seamless communication services over wide areas, and improved overall usage quality. It also ensures economies of scale in network and end-user equipment, which helps drive down costs.

Lower frequency bands, especially those in the range below 1 GHz, propagate over longer distances and are able to penetrate further into buildings and trees. These bands are well suited for addressing network coverage objectives, especially in rural areas. In contrast, there is more available bandwidth in higher frequency bands, those above 1 GHz, and this spectrum is well suited for providing capacity objectives in urban and suburban environments.

Efforts are underway on regional harmonization of lower band spectrum. The 13th ASEAN Telecommunications and Information Technology (IT) Ministers Meeting (TELMIN) which took place in November, 2013 urged ASEAN Member States to work towards strengthening regional cooperation. It included the harmonization of the 700 MHz frequency band for mobile broadband services to make it in line with the Asia-Pacific Telecommunity (APT) 700 MHz Band Plan. This recommendation would accelerate the shift from analog to digital television broadcast and free up spectrum capacity for wireless broadband.

The 3rd Generation Partnership Project unites globally recognized standards development organizations, and it has standardized the spectrum in the 800 and 900 MHz range as band classes 5, 8, 26 and 27. Band classes 5 and 8 are already allocated to mobile in Malaysia and there are efforts underway to re-farm these bands to enable mobile broadband services using 3G/LTE technologies. Band classes 26 and 27 represent additional spectrum that could be realized for the delivery of mobile broadband services.

## THE NEEDS OF NEW TECHNOLOGIES

To summarize, it is clear that the Indian government is committed to a digital transformation through various flagship programs such as Digital India and Smart Cities. There are efforts to extend inclusive and affordable Internet access to every Indian because of a fundamental belief that information communication technologies (ICTs) can empower the masses and become the critical avenue for accessing public services. For these reasons, government

authorities need to be sensitive to the impact of their decisions on long-term innovation. In order to have a viable digital ecosystem, it is crucial to have policies that promote competition and affordability.

Emerging technologies require greater access to and usage of spectrum. With the rollout of 4G LTE services, LTE-U (unlicensed) is an innovation that is being worked on in other regions. It is an improvement the Indian government should maintain awareness of as it works to provide increased coverage and capacity in addition to seamless mobility. This technology will work in coordination and within the same unlicensed bands as “Wi-Fi”.

Greater use of unlicensed spectrum could be helpful to businesses and consumers. One step to improve wireless access is through the parts of the radio waves having no exclusive licenses. Users can operate Wi-Fi devices over short distances and gain access to particular services at an affordable price. In the developing world, this is a valuable way to provide affordable services for poor people and help them utilize digital products.

As the industry moves towards 4G rollout, work has already begun on the 5th generation of mobile technology. Defining what is 5G is currently under discussion within global standards organizations but key to its success will be a unified design across spectrum bands—licensed, unlicensed, and shared alike.

New uses of mobile technology will require greater access to spectrum. One of the expected growth areas is machine-to-machine communications. Smart appliances are on the market that track energy usage and optimize for the most efficient utilization. Sensors allow people to tabulate calories burned during exercise or transmit vital signs to health care providers. Remote monitoring devices can show where traffic is heavy or parking spots are available.

These kinds of applications require ubiquitous and reliable broadband connections. Managing automotive connectivity, health care records, energy utilization, and smart power grids means that wireless connections have to operate around the clock. Down time can threaten health, consumer safety, and access to electricity. Spectrum must allow online services to operate efficiently and without signal interference.

Microcells and high altitude balloons facilitate mobile technology by improving infrastructure in remote geographic areas. Some rural areas lack wireless access because there are no cell towers and therefore no means to access mobile devices. However, as opposed to waiting for these transmission channels to be developed, it is possible to use other means that enable access. This includes cells which transmit wireless signals over short geographic areas, and high altitude balloons, which can provide wireless access in remote areas. For underserved areas that lack sufficient connectivity, these actions can help develop the infrastructure necessary for mobile technology.

Innovations in mobile network technology generate significant increases in data usage and mobile device functionality. Expanding the benefits of mobile broadband services depends in large part upon the availability of, and access to, adequate and appropriate spectrum. While industry must continue to push the envelope of innovation and find more efficient ways to utilize spectrum, governments need to allocate and assign spectrum to the highest value consistent with national priorities, including support for commercial mobile broadband services and applications.

To summarize, several things are needed in India. The country needs to open up spectrum space, revamp auctions, make sure that costs are affordable so that consumers don't pay high telecom prices, enable the trading and management of spectrum, and harmonize regional rules.

Mobile broadband provides an unprecedented opportunity to empower individuals around the world. In order to have a viable digital ecosystem, it is crucial for India to have policies that promote competition and widespread, affordable adoption. Without this commitment, mobile growth will stagnate and it will be difficult to obtain the benefits of the mobile revolution.



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