Standards Development and the 5G Opportunity

Mapping the way forward for India's telecommunications industry

CUTS International

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Background

The rapid growth of global mobile communication networks has primarily been due to advancements in mobile generation technologies (1G to 4G) and the lightning fast diffusion of the Internet. With networks getting more robust and the ever-increasing reliance on the digital economy, the penetration of electronic communications devices such as smartphones is on the rise.

This is especially true in the context of populous developing nations such as India where the potential of the digital economy remains untapped. Apart from the evident consumer benefits, robust communications infrastructure and rising demand for communications devices has concurrently spurred business opportunities across value chains. Electronics hardware manufacturing plays a critical role in value chain addition and has emerged as one of the largest and fastest growing industries globally. With 5G around the corner, communications device and equipment manufacturing will naturally pick up pace, that too in an unprecedented manner.

Make in India – the opportunities that lie ahead

Recognising the potential benefits of a robust communications ecosystem, Indian policymakers have laid down an overarching policy vision for the telecom sector generally and the electronics manufacturing sector specifically. An important component of the Nation Telecom Policy (NTP) 2012 was the vision to "make India a global hub of domestic manufacturing". It provided a broad roadmap for Indian telecom manufacturing and sought to promote cutting edge, state of the art technology development through R&D, and the creation and incorporation of Indian IPRs in global standards. This goal also resonated in the Draft National Digital Communications Policy (NDCP) 2018, which calls for focussing on 'development of SEPs, and increasing India's contribution to GVCs in the digital communications sector, apart from attracting Global OEMs and generic component players to setup manufacturing base in India'.

Since the launch of the "Make in India" initiative, mobile phone manufacturing has been touted to be a success story for India. The country has emerged as the second largest mobile phone producer in the world (second only to China) with an annual production of 11 million units in 2017. Along with the rise in domestic production, imports have decreased substantially and the number of manufacturing units in India has increased manifold.

Our study reveals that a major chunk of the manufacturing activity in India is akin to assembling the components of mobile handsets and there is significant scope for Indian firms to shift gear by starting to add value through research and development.

This scope is visible through crucial indicators related to value addition in local production and investment in R&D activities.

This renders the Indian industry a unique position and poses several opportunities of growth including: (a) the opportunity to generate and leverage indigenous Intellectual Property (IP) and increase competitiveness of Indian start-ups and firms, thereby enabling economic growth and job creation; and (b) building an innovation and competition friendly ecosystem for emerging digital technology players, thereby enhancing consumer welfare.

In order to make the most of the opportunities posed, there is an urgent need to frame a holistic innovation ecosystem for Indian manufacturers to thrive in. Adequate attention needs to be given to building and developing core technological capabilities and thereafter generating leverage of Indian manufacturers in GVCs.

5G and standards development: Identifying growth prospects for India

It has been widely recognised that 5G enabled ICT is set to fundamentally change the way we live, work, interact with each other and with the inter-connected *things* around us. Moreover, virtualisation and market convergence at the device, network and platform levels is inevitable. Furthermore, the potential economic impact of 5G is expected to be unprecedented. It is set to act as the foundation for a global innovation ecosystem which will open up industries to disruptive and novel products as well as processes, thereby enhancing global efficiency and productivity. Concurrently, this will profoundly enhance the capability of jurisdictions to leverage ICT for imparting sustainable societal change.

In such a super-connected society, standards and standards development have become more crucial than ever before. Historically, India's participation in development of standards has been sub-optimal. However, in consonance with the broad policy initiatives mentioned above and acknowledging the massive opportunity of 5G, the Indian government is working to create a holistic ecosystem for development and deployment of 5G networks. Government officials have reiterated that India will not miss the '5G bus'. With the aim of becoming a leader in 5G, the government has announced a dedicated fund of ₹500-crore for R&D of the underlying technology and has also created a high-level committee to work on a roadmap for the roll-out of 5G by 2020. Standardisation efforts have also picked pace and the collaborative initiative by India and EU on "India-EU Cooperation on ICT-Related Standardisation, Policy and Legislation" (2015 – 2019) is a welcome step towards bringing in increased specialisation and policy harmony.

However, to realise the goals set by the NTP and the NDCP, devising and implementing policies that encourage technology generation and incentivising innovators to invest in R&D will be crucial. In order to do so, participating in and leveraging standards development holds immense importance, since they bring forth various economic, technological and competitive benefits for relevant stakeholders. The same is also recognised by the NDCP, and becomes more crucial in light of the emerging 5G technology. However, many implementers and manufacturers in India have advocated for the need to regulate licensing of the underlying patented technology of the standard, which takes the form of Standard Essential Patents (SEPs). The primary concern is that after the standard has been set through the collaborative process, licensing of SEPs is prone to abuse by its owners and SEP users are at a competitive disadvantage in the market.

In light of such resentment towards SEPs, which are products of collaborative standards development processes, we conducted an objective comparison between the underlying ways of approaching standards development, which included: proprietary standards, government-led standards and the current collaborative standards. Keeping in mind the interests of various stakeholders (i.e. technology developers & investors in R&D; technology implementers & network operators and end consumers), and based on various parameters of comparison, such as: the standard development process, R&D incentives, competition, innovation, interoperability, economies of scale, etc. our study highlights the relative superiority of collaborative standard setting processes.

Based on this analysis, the report further highlights that instead of mulling sub-optimal regulation of SEPs, there is a need for policymakers and domestic players in India to utilise the collaborative standards development process as a ladder for growth and leverage it fully to compete in the global market.

The Way Forward

For the successful commercial roll-out of the 5G mobile communication technology globally and in India, the report elaborates on the way forward with various recommendations.

Following are some key recommendations specifically applicable to the current Indian context which might help in implementation of the broad policies in the near future, especially in the ICT sector:

Recommendation 1: Increase specialisation, investment and provide incentives for firms to move up the Global Value Chain

Although India has attracted a number of Original Equipment Manufacturers (OEMs) to set up plants, their role has largely been restricted to that of an assembler, and not even a manufacturer. A major part of the manufacturing value chain (MVC) is still happening in other countries such as China, Taiwan, etc. where there is a well-built component ecosystem, which supports its manufacturing. Furthermore, evidence suggests that there are enormous differences in the SEP stocks between different countries and there is a distinct dichotomy therein, i.e. some countries (the 'Haves') like the United States of America (USA), China, Japan, South Korea and Germany have SEP stocks above the third quartile of all SEPs. India is amongst the 'Have-Not' jurisdictions that hold only a few or no SEPs.

Notably, due to the fact that patented and standardised technology confers considerable competitive advantage to firms (which is possessed by the 'Haves'), some have suggested that it would benefit local firms to increase their own SEP portfolios through extensive investment in R&D or through strategic acquisitions. The underlying rationale is that it would give such firms greater bargaining power in licensing negotiations and also increase the possibilities of cross-licensing.

However, while this conclusion seems to be theoretically correct, it may oversimplify the correlation between patents and innovation. This is because the acquisition and ownership of patents is not an end in itself, but is in fact a consequence of technological innovation. In this context, emerging and 'Have-Not' economies such as India ought to take note of the fact that much of the technical development naturally occurs within international SDOs and institutions and firms in India need to play a more participative and competitive role therein (in consonance

with the General Principle elucidated in the previous section). This would increase their capacities in terms of understanding the process and content of standards development. In the long term, it will allow them to focus their R&D efforts towards achieving specialisation in technical development and then leverage their IP to move up the GVC. The Indian government's 5G initiative is a welcome step and the funds allocated therein should be utilised to further encourage and incentivise local firms to develop their internal capacities and compete in voluntary standard setting activities. Alongside this, the present market players as well as the government should think about how to collectively invest in R&D so that Indian firms become globally competitive.

Hence, to achieve long-term ambitions, India needs to turn around this situation by initiating specific policy interventions which targets to increase its own competitiveness vis-à-vis SEP portfolios rather than undermining those of the current 'Haves'.

Recommendation 2: Avoid unilateral standard setting initiatives and encourage participation in international SDOs

The historical perspective on standards development and the relative advantages and disadvantages vis-à-vis different modes of standardisation advances several arguments which should ideally encourage jurisdictions such as India to vigorously pursue participation in international standard development processes. Lessons from other jurisdictions which have sought to increase the competitiveness of domestic market players by either introducing protectionist policies or by developing their own standards unilaterally have not been successful and they too have moved towards international fora. Take the case of China, which realised the near absolute dominance of western firms in the wireless telecommunications standards field, and the high royalty rates charged by them from Chinese firms and adopted a proprietary approach to 3G standardisation. Their efforts resulted in TD-SCDMA, which was a Chinese standard developed by the Chinese Academy of Telecommunications Research (CATT) and its state-owned affiliate Datang in collaboration with German equipment vendor Siemens. Though the standard cannot be considered to be a market success, it surely advanced China's goal of building in-house technical expertise, thereby enhancing their domestic manufacturing capacity for advanced ICT products. Considering the high cost of developing these standards, coupled with their lack of international adoption, China has now moved towards international interoperable standards, through significantly increased participation in international SDOs.

Participation in international fora has several benefits for firms which currently lie in the 'Have-Not' category. *First*, the embodiment of proprietary technology in the industry standards itself give an early advantage to contributory firms which can thereby utilise SEPs to gain strategic advantages over competitors. *Second*, participation in international standards development is the only viable process through which local companies and domestic firms in different jurisdictions can influence the direction of standardised technologies by voicing their opinions and putting forth their special requirements. This is a crucial component of standardisation which can simultaneously guide new entrants in terms of finding specific research vacuums in technology development and focussing their R&D efforts to plug the same. *Lastly*, apart from the economic arguments in favour of participation, it is also important to view standardisation from the policy perspective.

National standards development authorities such as Telecom Standards Development Society of India (TSDSI) which have started to participate in SDOs such as 3GPP can play a crucial role in influencing their underlying policies and practices. The collaborative initiative by the Indian and EU government on "India-EU Cooperation on ICT-Related Standardisation, Policy and Legislation" (2015 – 2019) is also a welcome step towards bringing increased specialisation and

policy harmony. The objective of the initiative is to '*promote closer alignment between India and Europe with regard to the production and use of ICT standards and to harmonise the exchange of statistical data, thereby facilitating trade, increasing interoperability and the ease of doing business for companies, and adding additional weight to European and Indian ICT standardisation efforts at the global level*'. Initiatives such as these will help India to influence global policy progress to the benefit of domestic firms and provide the much needed impetus to domestic innovations. It will help enable domestic firms to invest in specific R&D efforts and also facilitate them to compete globally.

In furtherance of the aforementioned recommendation, the following specific steps can be taken:

- **Capacity building of domestic firms**
  Recognising the principle that standardisation is a highly knowledge-intensive activity which requires well-capacitated individuals and technical experts, India must undertake local capacity building efforts to support greater international SSO participation by representatives from its domestic forms. However, the requisite training and skill development for such capacity building does not come cheaply. Therefore, domestic firms may require significant financial and institutional support in the absence of internal resources, from the government or multi-governmental organizations (e.g., the World Intellectual Property Organization (WIPO)), as well as non-governmental organizations (NGOs).

- **Leverage support initiatives of various SDOs**
  Many SDOs offer support to firms from developing countries, which demonstrate their eagerness to participate and even contribute to the standardisation efforts. The Internet Society (ISOC), which is a US/Switzerland-based NGO which oversees the Internet Engineering Task Force (IETF), a major developer of Internet standards, is good example. It regularly supports Fellows from developing countries to participate in IETF meetings and other activities. One of its programs is also running in India: "Indian IETF Capacity Building Program". Various other SDOs also sponsor participation by consumer advocates and other civil society organisation members, which help in broadening the overall participation and ensuring inclusive representation in global organizations.

- **Educate relevant personnel about standardisation**
  The Country must also inculcate and emphasize the need of imparting knowledge and skills for standards education and training. India can adequately utilise its higher educational institutions in providing greater education in the area of standardisation.

- **Increase firm-level awareness about standards and exposure to SEPs**
  Apart from the general IP awareness programmes run by the Indian government as a part of the National IPR Policy, 2016, there is also a need to create a sense of awareness about the increased exposure to standards and SEPs. With the upcoming 5G standard acting as the all-pervasive bedrock for countless use cases, it is but natural that device makers and implementers will have to utilise the standard, thereby getting exposed to SEPs. With the IoT ecosystem growing by leaps and bounds, it can be assumed that the implementer base would grow and even SMEs and small start-ups would be exposed to SEPs along with its requisite licensing requirements. This can pose a serious challenge for small businesses as lack of awareness can lead to unintentional infringement of SEPs on the implementer's part and/or put implementers in a situation where licensing negotiations prove to be complex and perplexing. Hence, awareness generation and capacity building activities can play a crucial role, especially for jurisdictions such as India which are currently net implementers of standards and SEPs.

Chapter 1
Evolution in Mobile Communications and India's Untapped Innovation Potential

1.1 Evolution in mobile communications and prospects of the Indian market

The Information and Communication Technology (ICT) landscape has evolved drastically from the earlier invention of the telephone to today's sophisticated smartphones (which essentially play the role of mobile handheld computers for all practical purposes). Pathbreaking innovations have stimulated exponential growth of the global ICT sector and have consequently enabled numerous functionalities through technological advancements such as wireless communication. This has also marked the transition from the traditional use of ICT technology for basic person-to-person communication, to unprecedented possibilities (such as automated transportation and two-sided mobile platforms to run businesses) which even the most forward looking innovators of a decade or two ago, could not have predicted.[1]

The rapid growth of global mobile communication networks has primarily been due to advancements in mobile generation technologies (1G to 4G) and the lightning fast diffusion of the Internet. With networks getting more robust and the ever-increasing reliance on the digital economy, the market for and penetration of electronic communications devices such as smartphones is also on the rise. This is also expected to be fuelled by the advent of the 5G mobile communication technology.

This is especially true in the context of populous, developing nations such as India where the potential of the digital economy remains untapped. So much so, that it has been estimated that in 2018, India will have 530 million smartphone users, second only to China's 1.3 billion.[2] Moreover, overall mobile phone penetration in India is set to rise to 85-90 per cent by 2020, which in turn will drastically benefit the well-being of consumers and bring in economic efficiencies.[3] As mobile phones are starting to reach the masses, competition between handset manufacturers is increasing and consumers are benefitting through improved choice and competitive prices.

Apart from the evident consumer benefit, robust communications infrastructure and rising demand for communications devices has concurrently spurred business opportunities across value chains. Electronics hardware manufacturing plays a critical role in this value chain and has emerged as one of the largest and fastest growing industries globally.[4] Reportedly, the global production in the area of communications devices and components increased from USD 260 billion in 2006 to USD 530 billion in 2016.[5]

In India, the total production of electronics hardware goods is estimated to cross the USD 100 billion mark by 2020.[6] With 5G around the corner, communications device and equipment

manufacturing will naturally pick up pace, that too in an unprecedented manner. This makes India one of the most sought-after markets for ICT products and services.

Recognising the potential benefits of a robust mobile communications ecosystem, Indian policymakers (*inter alia* the Telecom Regulatory Authority of India (TRAI), NITI Aayog and relevant government departments) have laid down an overarching policy vision for the telecom sector generally and the electronics manufacturing sector specifically through documents such as the Telecom Policy 2012 (the drafting process of the National Telecom Policy, 2018 is currently on-going).[7] An important component of the 2012 vision was to "make India a global hub of domestic manufacturing". It basically provided a broad roadmap for Indian telecom manufacturing and sought to promote cutting edge, state of the art technology development through Research and Development (R&D), and the creation and incorporation of Indian IPRs in global standards.[8]

However, as will be discussed in this chapter, the noble policy goal has remained a pipe dream, thereby highlighting the urgent need to foster a holistic innovation ecosystem, which is conducive for Indian manufacturers to thrive in. In order to do so, the first step is to analyse the current state of affairs of innovation in the Indian mobile manufacturing sector and then to carefully weigh the policy options available.

1.2 The innovation scenario in India and status of mobile handset production

India currently lies at a crucial juncture as the government is looking to successfully reap the immense potential benefits of an increasingly digitised economy, especially in light of the not-so-distant roll-out of the 5G technology. However, the lack of a robust innovation ecosystem for technology development and knowledge-based outputs in India poses an immense challenge for policymakers and industry players alike.

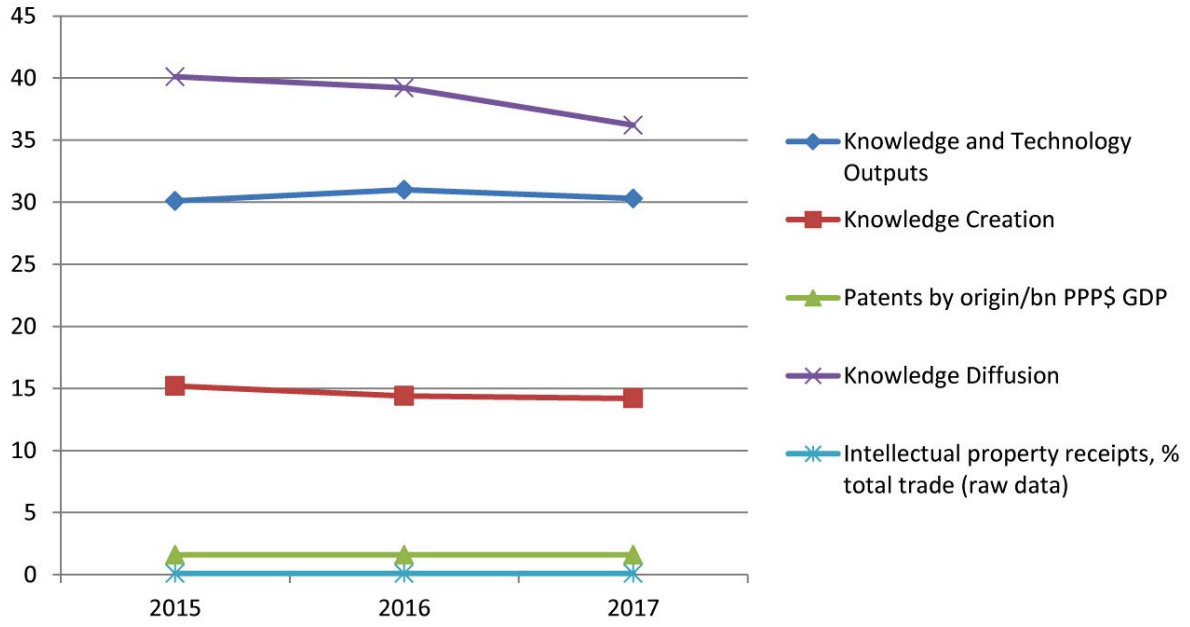
Going by India's progress in the past three years (Table 1), it becomes evident that there is substantial scope for a complete overhaul when it comes to 'Knowledge and Technology Outputs',

Table 1. Global Innovation Index (GII) – India's Scores and Rankings

Global Innovation Index (2015-2017)[9]				
Year—»		**2015**	**2016**	**2017**
Pillar 1	Score (0-100) or value (raw data)	30.1	31.0	30.3
Knowledge and Technology Outputs	Rank	49	43	38
Sub-Pillar 1.1	Score (0-100) or value (raw data)	15.2	14.4	14.2
Knowledge Creation	Rank	59	57	55
Indicator 1.1.1	Score (0-100) or value (raw data)	1.6	1.6	1.6
Patents by Origin/bn PPP$ GDP	Rank	53	54	53
Sub-Pillar 1.2	Score (0-100) or value (raw data)	40.1	39.2	36.2
Knowledge Diffusion	Rank	34	26	26
Indicator 1.2.1	Score (0-100) or value (raw data)	0.1	0.1	0.1
Intellectual Property receipts, % total trade	Rank	57	45	53

Source: Global Innovation Index Reports (2015-2017)

Figure 1. Trends of the Scores of the Indicators based on GII's Value/Raw Data



Source: Global Innovation Index Reports (2015-2017)

which is one of the Key Pillars of innovation. Furthermore, the key indicators (over three years) of a robust innovation ecosystem, (such as Knowledge Creation, Patents by Origin, Knowledge Diffusion and Intellectual Property Rights (IPR) Receipts, etc.) depict either a stagnating or a decreasing trend (Figure 1).

The Indian mobile handset industry is a typical case in point, which personifies the aforementioned scenario.

Before analysing the current state of affairs in the Indian mobile handset industry, it is important to first note that the foundation of the communications ecosystem is reliant on four chief components/stages:

1. Development of technology standards
2. Manufacturing of devices
3. Distribution and retail
4. Infrastructure development and mobile telecommunication services[10]

The first two stages are economically most crucial. This is because the highest level of product related innovation occurs for inclusion of technologies in standards and subsequent economic value is added through production or manufacturing of devices.

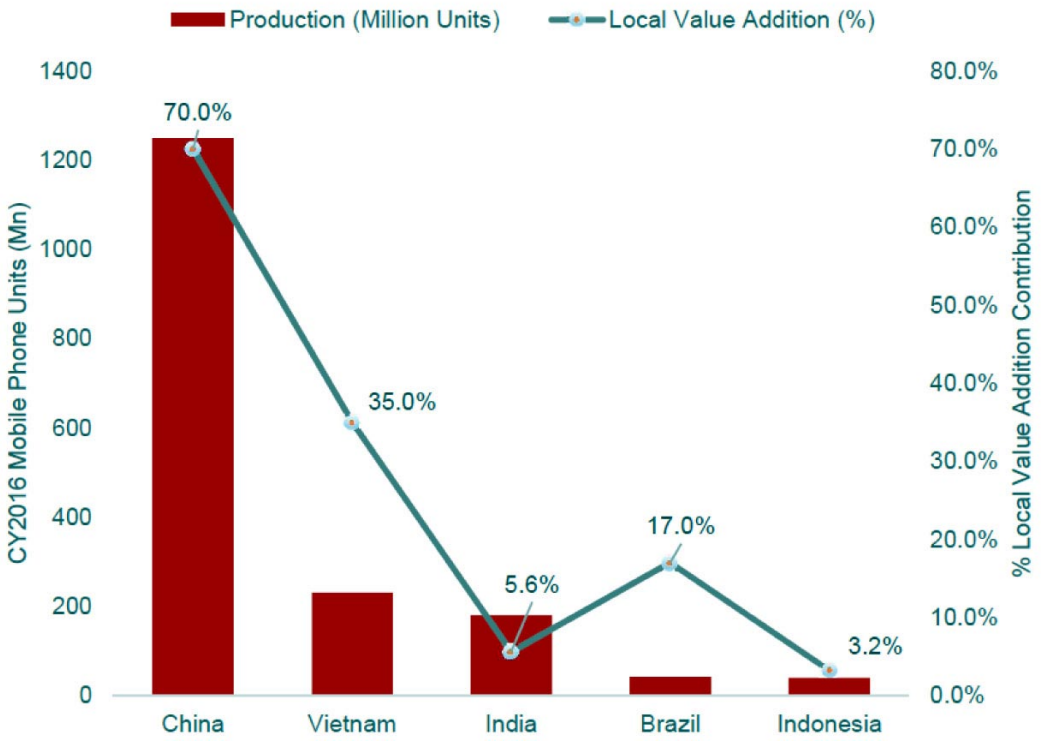
It is important to acknowledge here, that since the launch of the 'Make in India' initiative by the Government of India (GoI), mobile phone manufacturing has picked up pace and the nation has emerged as the second largest mobile phone producer in the world (second to China) with an annual production of 11 million units in 2017.[11] Alongside the rise in domestic production, imports have decreased substantially and the number of manufacturing units in India has increased manifold.[12] It has been estimated that by 2020, almost 96 percent of the mobile phones that will

be sold in India would be manufactured domestically.[13] Naturally, domestic mobile production has been a significant contributor to the economy and as per one estimate; the total contribution of mobile handset manufacturers to the Gross Domestic Product (GDP) was to the tune of INR 170 billion in 2016.[14]

However, it is also important to go deeper and look beneath this success story. To that end, facts related to value addition in local production and investment in R&D activities are crucial indicators. In 2016, the local value addition of India in the production of mobile phones was a meagre 5.6 percent, which is significantly lower compared to many other jurisdictions (Figure 2).[15] Also, studies have concluded that Indian mobile manufacturers invest very little in R&D and have almost negligible returns from patent royalties due to a general lack of patent ownership.[16]

This effectively means that presently, a major chunk of the manufacturing activity in India is akin to merely assembling mobile handsets and Indian firms are not able to truly add value. The general lack of product innovation in the Indian smartphone industry and low competitiveness of domestic players (the reason for this seems to stem from the low domestic capacities of firms to invest in specialised R&D efforts required to develop technology such as semiconductors and the general lack of specialised skills) have resulted in the absence of India's participation in the global value chain of ICT products and its components. India's royalty and license fees receipts and domestic patent application statistics have remained stagnant over the past three years (See Table 1 and Figure 1). The absence of technological expertise and a concurrent lack of a unique patent pool have rendered India as a laggard in standards development activities, which is one of the most important stages of innovation competition in the global telecommunications value chain.

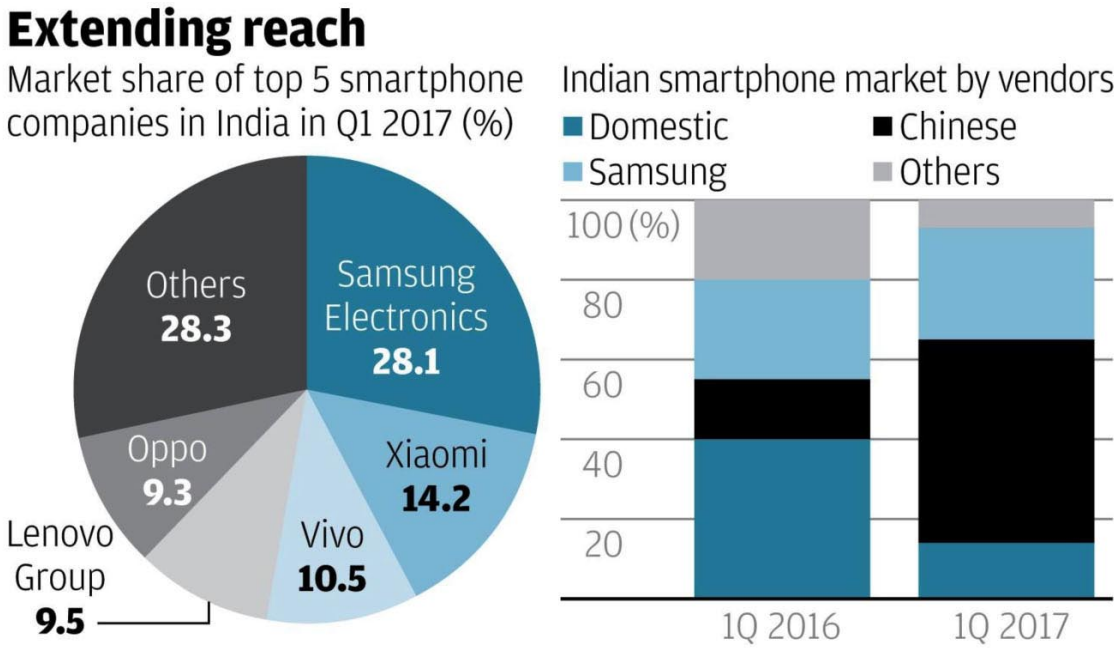
Figure 2. Mobile Phone Production and Domestic Value Addition



Source: Counterpoint and IIM Bangalore, 2016

As a result of this, despite being the second largest market for mobile connections and smartphones, and having hundreds of suppliers of ICT products, none are actually being '*made*' in India in the true sense. Resultantly, the Indian market is practically acting as an implementer of almost all ICT technologies, and has not managed to contribute as a technology generator, especially in the global communications network. R&D capacity and the associated investments are weak, as a result of which Indian mobile manufacturers have restricted their activities to assembly and have ended up on the losing side due to increased innovation competition (Figure 3).[17] The fact that Indian-origin manufacturers have not been able to innovate to meet rising competition has resulted in decreasing market shares for domestic players.

Figure 3. Falling Market Shares of Indian Smartphone Makers



Source: Ind-Ra and IDCG[18]

This implies that an approach which focuses on mere production without value addition might not be sufficient for sustainable economic growth in the long run and might also be sub-optimal for India's developmental objectives.

Hence, there is a clear need to focus on building and developing core technological capabilities and thereafter generating leverage of Indian manufacturers in Global Value Chains (GVCs).

This brings us to an important question: how can Indian firms compete effectively with foreign players in the domestic market, and also enhance their exports?

1.3 Tapping the innovation potential: The imperative and available options

Innovation has been the driving force of growth and development of the global communications network. Technology developers vigorously compete by investing in R&D and subsequently participating in the standards development processes to leverage their technologies in the global marketplace. Moreover, with the expected advent of the 5G standard, increasing digitisation and growing prevalence of the Internet of Things (IoT), it has become a socio-economic imperative

to innovate and move up the GVC. Being a mere implementer of communications technology would mean that India would become a net-importer and would not be able to effectively maximise its economic value through technology and optimally utilise it for developmental efforts. Therefore, at this crucial juncture, the willingness of the domestic industry to make necessary adjustments to foster innovation will determine whether India can utilise the powerful mechanism of ICT to achieve its developmental goals.

From the government's perspective, devising and implementing policies which encourage technology generation and incentivising innovators to invest in R&D will be crucial to such an exercise. In order to do so, participating in and leveraging standards development holds immense importance.

Endnotes

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9 Pillars are identified by single digit numbers, sub-pillars by two digit numbers, and indicators by three-digit numbers.

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Chapter 2
The Importance and Manner of Standards Development

2.1 What are standards and why are they needed?

The growing ubiquity of the rapidly evolving ICT ecosystem is overwhelming. It lies at the heart of the Fourth Industrial Revolution and will act as an enabler of the Internet of Things (IoT). This includes broad use cases such as massive machine to machine, and machine to person communication. The global society is moving towards a common super-connected future and ICT is set to fundamentally change the way we live, work, interact with each other and with the inter-connected *things* around us.

However, in order to develop and realise the true potential of such a super connected and complex communications ecosystem, a ubiquitous and standard baseline for devices to connect with each other is required. Past experiences have shown that this has been made possible through specialisation and enhanced collaboration between various technology developers and implementers across the globe.

In this era of specialisation, where production of a product is no longer concentrated in one firm, but involves an orchestrated effort of multiple firms around the globe, these firms are able to channelise their resources on what they do best, without wasting energy on lower quality or less efficient attempts on the other steps involved in the production process. Such specialisation was enabled through a transition of the developed world from manufacturing-based economies, towards more knowledge-based ones. Due to such a transition, what used to be the output of one, large, integrated firm is now often the combined output of many, specialised, smaller firms working in concert in the ICT sector.[1]

The task of facilitating the coordination between numerous specialised firms to produce an integrated workable product, led to the setting of standards which enables interoperability,[2] compatibility and comparability between complex technical products. As defined by the International Organization for Standardization (ISO):

> *A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose.*[3]

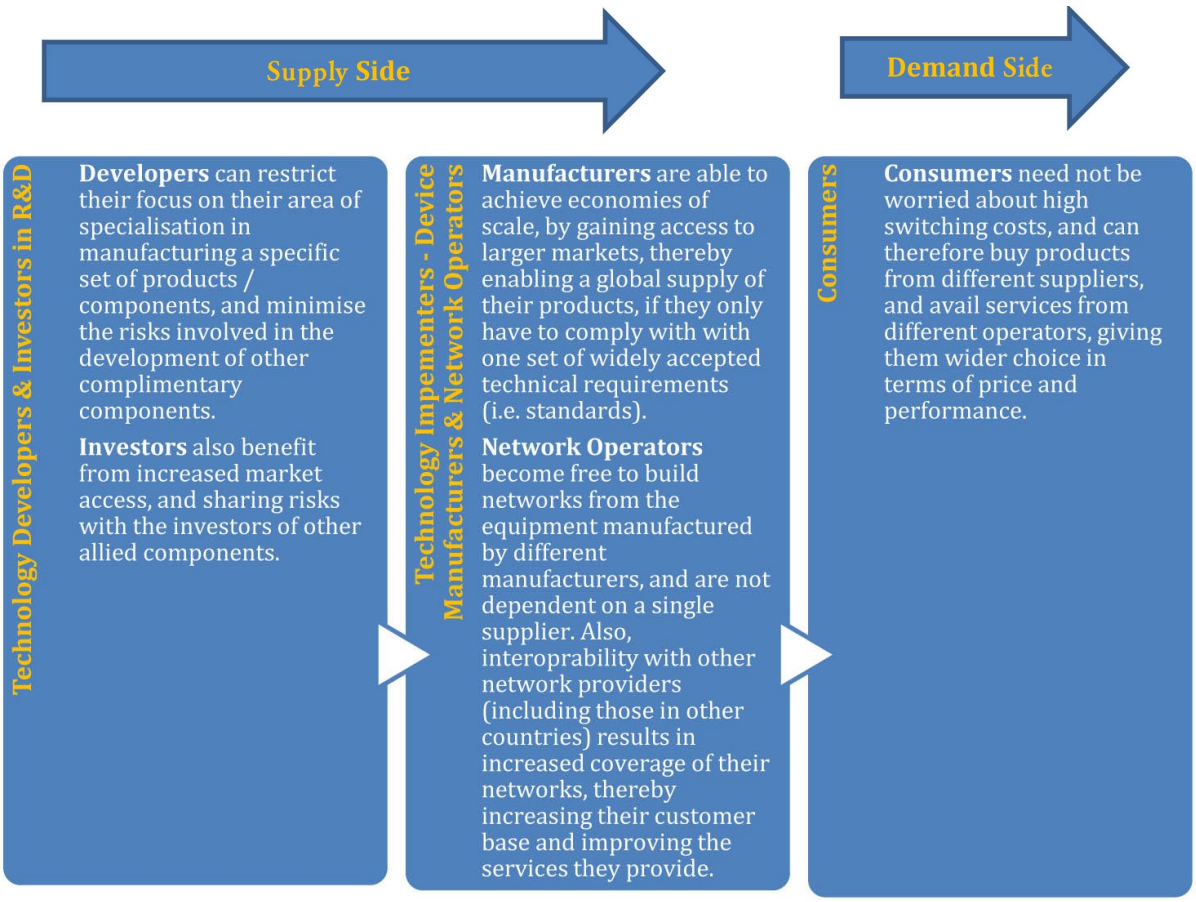
Standardisation of products in industries relying on technological expertise is quite common. The objective of laying down industrial standards is to encourage manufacturers to adhere to

some minimum quality requirements. Apart from ensuring availability of high quality products, standards also help to regulate interoperability in network industries.[4] Interoperability arising through standardisation has become the key to promoting innovation, in this technology driven world, especially in the ICT sector.[5]

Moreover, standardisation has immense economic utility for technology developers, implementers and consumers alike. Broadly, standardisation provides a platform upon which industry players can develop new technologies and enhance existing practices.[6] This opens up access to established markets, provides economies of scale, encourages innovation and increases awareness of technical developments.[7] Specialisation also brings in certain non-economic advantages as well, such as: greater realisation of network effects, leading to tipping.[8] Due to the fact that firms get access to a larger market for their products (thereby facilitating market entry, access and competitiveness), consumers naturally get to benefit through competitive prices, increased choice and enhanced quality of products.[9] Buyers also remain protected from stranding,[10] i.e. when various products are compatible with each other, a consumer does not have to fear about being stranded, whenever he or she decides to purchase a product from a particular supplier.[11]

In the specific context of the characteristics of the ICT sector discussed above, standards are known to become more crucial,[12] since they facilitate interoperability in a multi-vendor, multi-network and multi-service environment. The need for interoperable standards in the ICT sector, i.e. the major benefits[13] brought forth from it have been summarised from a multi-stakeholder perspective through figure 4.

Figure 4. Major Benefits of Standardisation (Stakeholder Perspectives)



Standardisation has occasionally been criticised for being anti-competitive on the grounds of limiting variety and innovation, and imposing limits on firms' product design choices.[14] This has been argued to be leading to dynamic losses, since it incentivises firms to direct their R&D efforts towards producing innovative products which necessarily cater to or comply with a particular standard. However, this theoretical argument does not make much economic sense as the advantages listed above substantially outweigh these incidental possibilities.[15] This is also corroborated by several studies that highlight the benefits of standards development such as: (a) industry growth and reduced prices of products based on the standard[16] (b) lower barriers to entry, economies of scale, gains in productivity and efficiency[17] and (c) higher competition.[18]

Furthermore, it is important to note that the scope of standards is not merely limited to technical specifications and rules, but is much wider. This is because standards also provide a roadmap to determine the nature and range of future development of technologies. Standards play a major role in determining the technology that implements the Information Society and defines the manner in which technology would impact consumers, businesses and other relevant stakeholders. This makes standardisation an economically important process, not just for technology developers and innovators but for economies at large.[19]

Therefore, standards are imperative for successful evolution of the ICT sector, the absence of which would have various negative impacts on the society at large. A few such implications[20] have been listed below:

- Different components of complex products will not work in synchronisation, due to the likely absence of interoperability.
- Stand-alone products will be developed, which shall be incompatible with other complimentary products due to possible lack of inter-connectivity.
- Customers would more often than not get restricted and tied to one manufacturer or supplier, due to increased switching costs.
- Downstream market players would also have to invent their own individual and proprietary technology solutions of each component thereby enhancing the burden of investing in R&D, which may result in increased prices of products for consumers.
- Lack of specialisation in limited number of product components may also result in inferior quality of products.

Before delving into a comparison of different kinds of standard setting models, it will be important to take note of the various benefits brought forth by standardisation:

- Economists have established that industries based on patented technology incorporated in standards, have resulted in lowered costs and enhanced product performance, in contrast to industries making no or little use of standards.[21]
- Standards facilitate rapid adoption of new technologies.[22]
- Emergence of standards is imminent in this sector, since they enable interoperability, network effects and connectivity, which is vital for the sector's success.

Despite these benefits, the manner in which such standards are presently being developed has attracted immense criticism from policymakers as well as technology implementers. The underlying concern is that standardisation is prone to abuse by technology developers who own the underlying patents over the standard essential technology. This includes the theory of 'patent-holdup', which proposes the view that once patented technology becomes part of a particular communications standard, the standard essential patent (SEP) holder tends to demand excessive royalties from the implementers who are mandated to adhere to a particular standard (and have to mandatorily attain a patent license to manufacture products and compete in the market).

Despite plethora of economic and legal evidence that questions the underpinnings of the theory of patent holdup,[23] implementers and manufacturers in India have since long held a dissonant view of SEPs and standards development and accordingly advocated for regulation of SEP licensing in order to attain Fair, Reasonable and Non-Discriminatory (FRAND) royalty rates for patented technology. Further, considering the global litigation trend against technology holders by technology implementers, the global collaborative standards development process has been scrutinised and has expounded negative sentiments of domestic manufacturers towards them.

Considering the importance of widening the penetration of communications devices and also spurring business opportunities in India, it is quite obvious that developing technology to be utilised in standards is thus crucial.

However, there are several ways of approaching standards development, the collaborative model being one. With rising criticism of collaborative standards development processes, regulating SEP licensing and devaluing SEPs through regulatory interventions which favour domestic implementers might appear to be a beneficial approach. Also, the process of standards development through other modes such as the unilateral proprietary mode might seem lucrative. On the other hand, regularly participating in global standards development activities and contributing towards the existing and evolving global communications ecosystem might be a viable alternative. This approach basically utilises the collaborative mode of standards development as a ladder to effectively compete and move up in Global Value Chain (GVC).

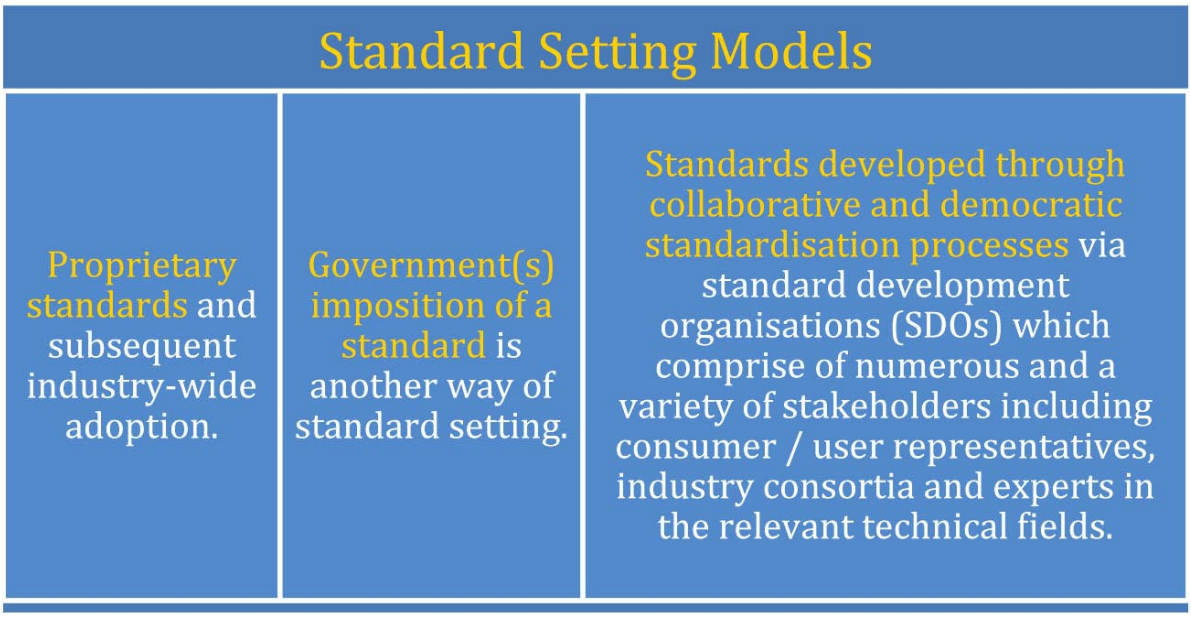
However, before thinking of selecting an alternative, it is important to conduct an in-depth analysis of various forms of standard setting activities and to assess the implications of regulating the underlying processes. Through this analysis, India's yet to be achieved vision of becoming a global hub of domestic manufacturing, developing state-of-the art technologies through R&D, along with creating and incorporating Indian IPRs in global standards can be achieved.[24]

2.2 Standard setting processes and the evolution of technology standards: A historical perspective

Standards are indispensable to the modern economy generally and the global communications ecosystem specifically. This can be evidenced by delving into the history of the evolution of various communication technologies. Also, it is not just mobile communication which has made use of standard setting for successful technological advancements, but various other industries have also relied on standards development.

There are three major models or processes of setting standards which have been briefly mentioned in Figure 5.

Figure 5. Types/Models of Standard Setting



2.2.1 Proprietary standards

Proprietary standards lead to *interfaces that are developed by and controlled by a given company and have not been made freely available for adoption by the industry. When an interface is non-public, the owner of the proprietary interface controls it, including when and how the interface changes, who can adopt it, and how it is to be adopted*.[25]

In the context of 5G technologies it seems that developers are seeking to establish their proprietary technologies as essential constituents of the standardised 5G network, to get ahead in the race by laying down unilateral standard specifications, thereby enhancing the risk of industry fragmentation, replication of R&D efforts, contradicting specifications, incompatible variants and delays in development.[26] The numerous possibilities vis-à-vis the use cases of 5G technology is the driving factor behind operators trying to surpass collaborative standardisation efforts, and stimulate unilateral 5G activities and testing.[27]

Minimising fragmentation in standardisation would be even more crucial for developing an effective 5G network which is touted to become the backbone of the IoT ecosystem. This is because increasing propensity of operators to indulge in proprietary efforts of standardisation would presumably hamper connectivity and interoperability, obstruct consumer choice and quality, obscure the scope of the Information Society and limit competition and innovation in the future.

Proprietary standards come with their own set of benefits, some which have been mentioned below:

- Potentially lucrative returns: network markets offer lucrative rents to firms, if they are successful in establishing their proprietary technology as a standard in the market, or in aftermarkets for complementary goods[28] due to high barriers to imitation,[29] thus incentivising R&D.

However, there are a few disadvantages of proprietary standards, especially in context of network industries. These have been elucidated below:

- Restricts competition: a single platform enjoys sustained market share dominance, especially if vertically integrated, and rivals have trouble competing with such a proprietary strategy, due to their smaller market share and lack of minimum efficient scale to recover their fixed R&D costs.[30] Moreover, if patented technology is incorporated into a proprietary standard, i.e. without an agreement to share its patent rights on FRAND terms, then such proprietor may be the only entity able to control the standard, thus stifling horizontal as well as vertical competition through tipping or exclusionary effects from market entry.[31]
- Reduced social welfare: firms managing to force the adoption of a proprietary standard instead of an open one, thereby reducing intra-standard competition, resulting in reduced social welfare.[32]
- Non- inclusive: any single firm accorded with a proprietary product used as a standard, would not be driven by the need to achieve inclusive consensus through cooperation, thereby going against the paradigm for standardisation efforts in the past,[33] which may in turn led to a winner takes all scenario.
- High switching costs: late entrants may face obstacles in gaining market share for their innovations, due to high switching costs from proprietary platforms which have been standardised.[34]
- Standards war: the emergence of a de facto / proprietary standard will often be through a 'standards war' between the competing standards. Though this can provide enhanced consumer choice of technology, but may also result in slower adoption. Standards wars can also result in the wrong technology becoming standard.[35]
- Stifles innovation: wireless standards create opportunities for handset and other equipment makers. Innovation and investment by these complementary suppliers is often the most important driver of industry success and the way in which the standard is governed will be crucial for this. If a standard is closed so that only the proprietor can supply products, innovation will suffer.[36]
- Suppliers of complements are utterly dependent on the standard proprietor: to maintain compatibility as it introduces new versions, to inform them about its technology so they can make best use of new features and above all not to exclude them from the market.[37]
- Restricts opportunities for suppliers of complimentary products: a proprietary or a closed standard leads to a situation in which only the proprietor of the technology can supply products, resulting in restricting innovation.

2.2.2 Government set standards

An alternative is for governments to set standards, which was prevalent in post-war Europe, where standard setting was dominated by state providers. Even in the US, federal agencies have often been responsible for setting standards.[38] The rationale behind this was more towards gaining temporary advantages through trade protectionism, rather than the economic dynamics of standardisation. A few disadvantages of government led standard setting have been listed below:

- Standard not necessarily based on technical merit: government led standard setting choices have backfired in certain instances, resulting in losses to the industry. Many such standards are eventually reversed, considering the favourable market response towards other industry standards.
- Standards may be set for political reasons: government-led standards may in certain instances be motivated and led by political influences and objectives. A good example of this could be seen in the 2G standard.

2.2.3 Open and collaborative standards

The collaborative standard setting model has gained substantial momentum in the past and it has been recognised that most of the commonly used ICT technical specifications and standards are produced by collaborative forums and consortiums. This has eventually led to the growing prominence of several ICT standards development bodies.[39] Due to the growing prevalence of open and collaborative standard setting, the ICT sector has grown at an exponential rate and has undergone major evolutionary changes. This is evident from the drastic shift from the erstwhile First Generation (1G) wireless networks to the existent Fourth Generation (4G).[40]

Nonetheless, with the ever-increasing demands of new-age products in the upcoming era of the Internet of Things (IoT), industry players as well as policymakers have recognised the need and significance of development of the next generation of wireless network, i.e. the Fifth Generation (5G).[41] Technology research and development for 5G is already underway, with estimates for network availability in 2020 and beyond. Industry experts have noted that *since 5G will be one of the cornerstones of industry digitalization, a single global standard is vital.*[42] It therefore becomes imperative, that a global consensus is achieved on the technical specifications being developed for 5G technology. As per ISO, *a Technical Specification addresses work still under technical development, or where it is believed that there will be a future, but not immediate, possibility of agreement on an International Standard. A Technical Specification is published for immediate use, but it also provides a means to obtain feedback. The aim is that it will eventually be transformed and republished as an International Standard.*[43]

Open voluntary cooperative standards are developed or ratified through an open, consensus-driven process, usually through a Standard Development Organisation (SDO). Admission/membership to most SDOs is generally open to all, and they usually follow an open and transparent Intellectual Property Rights (IPR) policy, asking contributors to license essential IPRs/Patents (SEPs) to implementers on Fair Reasonable and Non-Discriminatory (FRAND) terms, with or without any royalties/fees. As per ETSI, *An essential IPR is an IPR which has been included within a standard and where it would be impossible to implement the standard without making use of this IPR. The only way to avoid the violation of this IPR in respect of the implementation of the standard is therefore to request a license from the owner.*[44] Clause 15.6[45] of its IPR Policy has defined an Essential IPR. Therefore, SEPs may be considered to be *patents essential to implement a specific industry standard. This implies that to manufacture standard compliant mobile phones, tablets and other electronic devices, such manufacturers will have to use technologies that are covered by one or more SEPs.*[46]

Few benefits of open and collaborative standards have been given below:

- Facilitates interoperability: open ICT standards facilitate interoperability between various products in a multi-vendor, multi-network and multi-service environment resulting in wider choice of products for consumers.[47]
- Economies of scale: a wider market brings with it economies of scale which greatly benefits manufacturers.[48]
- Reduced competition concerns: the need for consensus among competitors, each of whom having their own proprietary technology, lessens the chances of exercise of undue market power by them,[49] thereby fostering upstream and downstream competitive markets.[50]
- Balance: due to its inherently efficient, open and inclusive process, it creates a working balance between the interests of all the stakeholders involved.[51]
- Handpicking the best technologies: markets characterised by network effects, are aided by SDOs in transitioning from inferior to new superior technologies.[52]

- Upstream and downstream participation: more and implementers of mobile technology have emerged, even in developing economies like India and China, thus increasing the downstream participation in handset manufacture. Upstream, the successful transition from successive generations of wireless technology has seen wider ownership of such standardised standards has wider technology ownership.
- Creates opportunities for suppliers of complimentary products: wireless standards are known to create market opportunities for handset and other allied equipment manufacturers. Innovation and investment by such complementary product suppliers is an important driver of the industry's success.
- Ensuring democracy and balance of power: the governance mechanism of many SDOs is set to balance the interests of all participants, i.e. if there are a handful of companies on one side of the market with presumable market power they are effectively outnumbered by other smaller participants through their voting power.

However, there are a few perceived limitations associated with the collaborative standard setting process, some of which have been mentioned below:

- Slow, resource-draining and intensive: even after a standard is formally adopted by an SSO, it may take several years for it to be commercially deployed.[53] However, this can also been seen in positive light as the process takes time due to the high level of rigour involved and the underlying democratic structure.
- Collusion to influence: larger stakeholders may collude or individually influence SDOs in adopting their technologies in a given standard, or may resort to other anti-competitive practices such as patent pooling in an exclusionary manner[54] thereby resulting in royalty stacking for implementers;
- Lack of clarity on FRAND terms: the blurred definition of fair, reasonable and non-discriminatory(FRAND) terms and royalty rates are subjective, leading to friction between the technology developers and its implementers, ultimately resulting in lengthy and expensive litigation.[55] However, it is important to note that the lack of specific definition of FRAND in the IPR policies of SDOs provide them the flexibility to balance the interests of developers and users of technology and keep them invested in the process of standards development.[56] In the same vein, the European Commission also acknowledges that "*there is no one-size-fit-all solution on what FRAND is: what can be considered fair and reasonable can differ from sector to sector and over time. Efficiency considerations, reasonable license fee expectations on both sides, the facilitation of the uptake by implementers to promote wide diffusion of the standard should be taken into account*".[57]

Apart from the above limitations, another crucial element which needs to be factored in for a successful standard developed through a collaborative process is the coordination and sharing of efforts between different regional and international SDOs.

2.2.4 Contrast between a proprietary standard setting model and an open and consensus driven standard setting process

Based on the analysis of the various standard setting processes, it may be safe to assume, that government led standard setting is not a viable / realistic probability in the case of 5G. Accordingly, the Table 2 lists key differentiators between a proprietary standard setting model and an open and consensus driven standardisation process, from the perspective of different stakeholders.

Table 2. Comparison between Collaborative and Proprietary Processes of Standard Setting		
Differentiator	**Collaborative Processes**	**Proprietary Processes**
Standardisation Perspective		
Development & Acceptance[58]	They are agreed and accepted by the whole industry and they are not vendor specific	Usually developed by a single company and are vendor specific
Standardisation Process	Consensus driven, but slow and cumbersome	Market adoption driven, therefore relatively faster and hassle free
Industry Perspective		
R&D Incentives	Royalty rates need to conform to FRAND commitments if accepted as a *de jure*[59] standard by an SDO	Higher returns if transformed into a *de facto*[60] standard since no cap on royalty rates
Economies of Scale	Enhances economies of scale for all implementers	Does not permit economies of scale for other implementers
Competition	Increases competition amongst developers and relies on open and free collaborative processes which is good for new entrants	May give rise to market concentration, thereby making industry susceptible to anti-competitive practices. Might also raise entry barriers.
Follow-on innovation	Leaves scope for follow-on innovation	Follow-on innovation may get restricted due to proprietorship over the technology
Consumer Perspective		
Consumer Choice	Wider choice of products for consumers at lower prices	Higher chance of abuse of dominance thus adversely impacting consumer welfare
Interoperability	Facilitates interoperability	Often restricts interoperability

2.2.5 Propounded need for participation in standards development of the 5G technology

From an Indian perspective, apart from generating IP and reaping its economic benefits, the country's participation in standardisation also becomes crucial in light of the advent of the global 5G technology standard. Its many benefits and use cases have been discussed in the subsequent chapter, along with the global challenges that it poses.

2.2.6 Scope and impact of standardisation for 5G technology

The success of standardisation can be gauged from the successful commercial deployment of the 3G and 4G technology, which is being tailed by 5G. The proposed 5G network, which is posed to be the next technology intervention in the ICT sector, is expected to have more advanced capabilities, as compared to its predecessors (3G and 4G), and will be instrumental in bringing a transformational change throughout the globe by enabling the IoT, i.e. the evolution of inter-connected ecosystems and devices, such as smart cities, smart cars, smart tech and homes. This will be made possible primarily through its broad technical advancements such as enhanced network speeds (i.e. 10 times faster than 4G), enhanced coverage, significant reduction in latency and increased capacity (i.e. 1,000 times the capacity of 4G).[61] 5G is expected to revolutionise connectivity and benefit the consumers in unimaginable ways.

However, the not so distant future, which will be governed by machine learning and the IoT, is highly dependent on the ability of present-day technology developers and innovators to cultivate a 5G standard which is truly global. Notably, achieving enhanced connectivity and enabling fluid interoperability will be possible if the fundamental mechanism of all devices adheres to a universal standard. Since, the mobile wireless value chain is characterised with the involvement of several players (including service providers, innovators and implementers among others) and their numerous patented technologies, which come together to form one standardised technology, the process of standardisation is extremely complicated and demands a high degree of collaboration and interdependence.

A standardisation paradigm which is optimal for the successful development of the 5G technology and simultaneously effective in ensuring consumer welfare, maintaining innovator incentives, promoting competition and ensuring market access. Notably, an optimal standard setting model needs to be timely and cost effective,[62] apart from ensuring the welfare for all the stakeholders.

However, identifying and adopting one single model of standard setting for the 5G technology comes with its own complications. The same have been discussed in the following chapters.

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59 De jure standards are developed and adopted by some authorised standardisation body, such as by treaty among national governments, or voluntary non-treaty organizations. General examples include the International Organization for Standardization (ISO) and the National Institute of Standards and Technology (NIST). De jure standards develop in the absence of underlying technology, dominant or proprietary, needed for implementation. See Murch, Richard, *Why Open Standards Lead to Innovation,* available at http://www.informit.com/articles/article.aspx?p=352983&seqNum=5, accessed on November 15, 2017

60 De facto standards evolve from a product line or specific vendor, and develop when there is widespread acceptance by a broad base of customers or users. The standard, based on a dominant technology produced by a single company, is designated as proprietary or exclusive. Murch, Richard, *Why open standards lead to innovation,* (n.36)

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Chapter 3

Challenges and Opportunities vis-à-vis Standardisation of the 5G Technology and Identifying an Optimal Policy Approach

3.1 The need for 5G and its socio-economic potential

Mobile technologies have ushered in significant technological advancements which have shaped the underlying socio-economic ecosystems of jurisdictions across the globe. Furthermore, mobile technology has evolved from chiefly being an enabler of person-to-person communications (1G-3G) to a more robust and interoperable platform which interconnects people with *things* and enables information exchange (4G), amongst and between them. This rapid evolution in mobile technology was a necessary prerequisite to address the growing requirements of an increasingly globalised and digital world and to subsequently reconcile the deficiencies of previous network generations. For instance, the 4th Generation (4G) built upon its predecessor to infuse Internet Protocol (IP)-based services, faster broadband speed and lower latency; thereby addressing several

Table 3. Evolution of Technology Generations in Terms of Services and Performance

Generation	Primary services	Key differentiator	Weakness (addressed by subsequent generation)
1G	Analogue phone calls	Mobility	Poor spectral efficiency; major security issues
2G	Digital phone calls and messaging	Security, roaming, mass adoption	Limited data rates – difficult to support internet/e-mail demand
3G	Phone calls, messaging, data	Better Internet experience	Real performance failed to match hype; failure of Wireless Application Protocol for internet access
3.5G	Phone calls, messaging, broadband data	Broadband Internet, applications	Tied to legacy, mobile-specific architecture and protocols
4G	All-IP services (including voice, messaging)	Fast broadband Internet, lower latency	Not optimised for IoT scaling; limited flexibility to support bespoke services across industry verticals; inadequate for next generation services
5G	All-IP services, new technology sectors, verticals and end-users	Faster and higher-capacity broadband Internet, lower (real time) latency, multi-access, multi-layered	

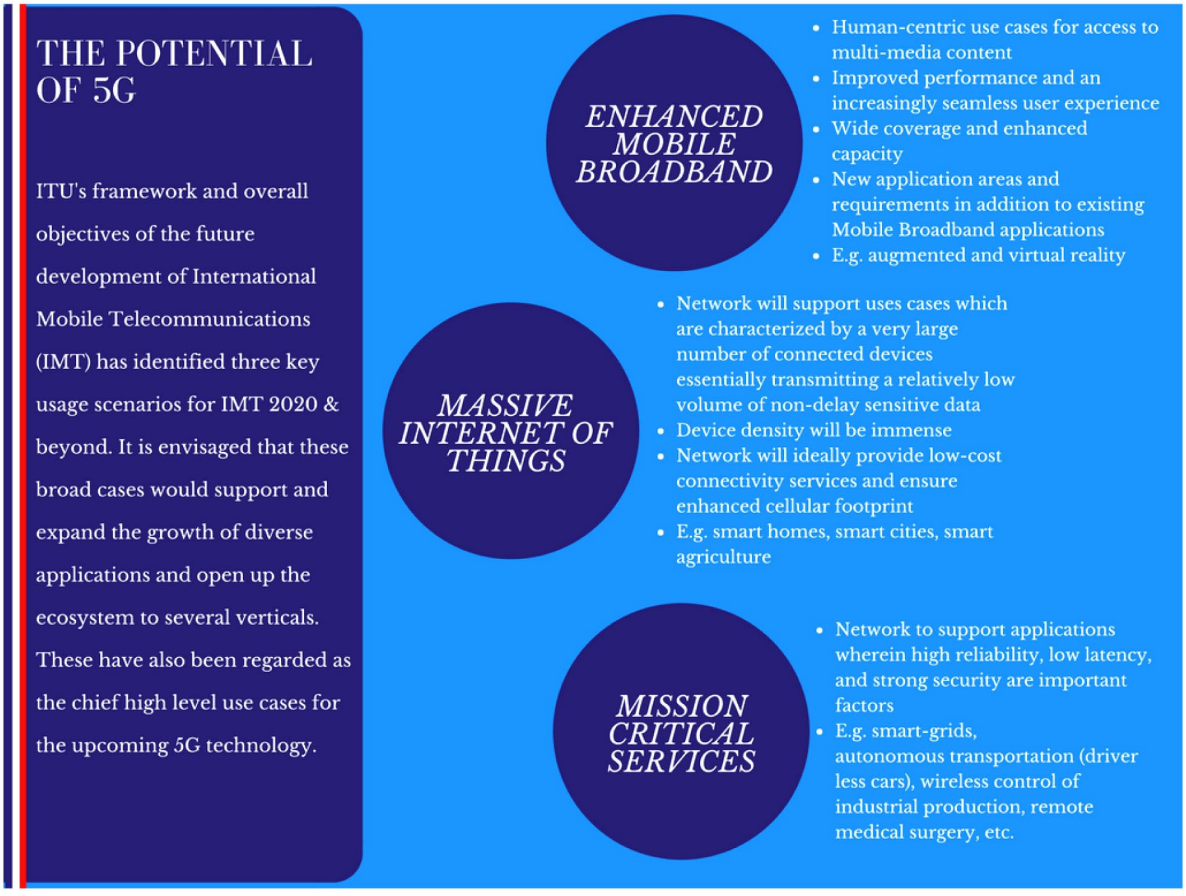
Source: GSMA (2016)

inherent weaknesses of 3G (see Table 3). However, with the need for a ubiquitous wireless network at the horizon, (5G) mobile technology is set to introduce a revolutionary transformation which will make interconnection and data utilisation of billions of devices a reality.[1]

The 5G technology will reportedly lay down the architecture for the Internet of Things (IoT) and will support the emergence of new use cases, which would understandably require substantially higher data rate communications, ultra-low latency and high reliability.[2]

The potential economic impact of 5G will be unprecedented. A recent study predicts that from 2020 and 2035, 5G technology's contribution to the real global Gross Domestic Product (GDP) will approximately be the equivalent to that of the current economy of India.[3] Moreover, it forecasts that "5G will enable USD 12.3 trillion of global economic output".[4] Its massive economic potential emerges from the fact that 5G will act as a foundation for a global innovation ecosystem which will open up industries to disruptive and novel products as well as processes, thereby enhancing global efficiency and productivity. Moreover, the potential of 5G to transform mobile technology into a General Purpose Technology (GPT) is bound to have a transformative impact on market competition across sectors.[5] Concurrently, this will profoundly enhance the capability of jurisdictions to leverage ICT for imparting sustainable societal change.[6] Its critical social relevance should also not go unnoticed. For instance, 5G enabled ICT will allow public and private entities to provide public welfare services such as healthcare in a much more seamless, efficient and personalised fashion.[7] Moreover, the telecom industry, especially device manufacturers are relying on the release of the 5G technology as it is expected to reignite demand

Figure 6. The Potential of 5G



Source(s): ITU, CradlePoint, IHS Markit

of new devices.[8] In this vein, experts have highlighted that this demand will pick up pace by 2022 and it is expected that emerging markets such as India will play a central role in reinvigorating business opportunities for smartphone makers.[9]

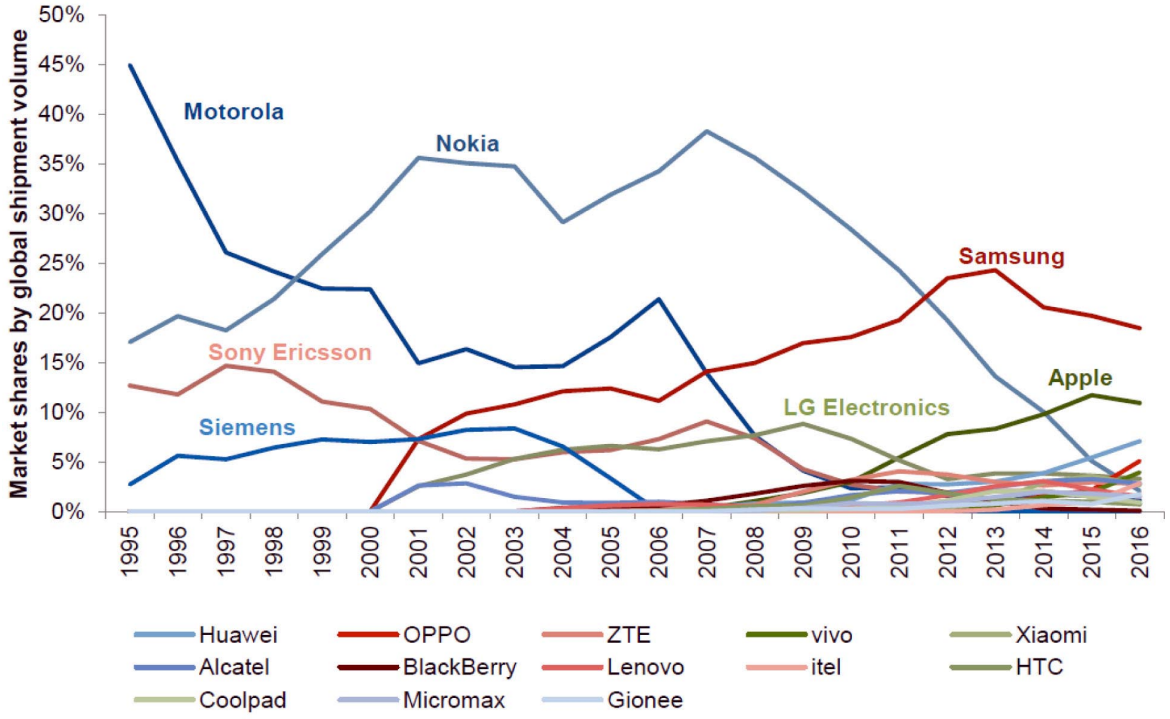
As depicted above, the potential utility and possible applications of 5G technology are unimaginable and its role in enabling our common super-connected future has widely been recognised as an indispensable one.[10] Broadly, its three high level use cases (Figure 6) i.e. Enhanced Mobile Broadband, Massive IoT and Mission Critical Services display the ubiquity and unparalleled nature of the upcoming 5G network ecosystem.[11]

This essentially means that the underlying standard attributed to the 5G technology will not just have to cater to the rising demands of smartphones, PCs and tablets but would have to satisfy the vast requirements of numerous other inconceivable *things* or possible applications within its ecosystem.[12] This sets 5G apart from its predecessors and makes the case in favour of a common, flexible and user-oriented global standard, stronger than ever before.

3.2 Standardisation of the 5G technology and related challenges

Naturally, standardisation of the 5G technology will determine the manner and extent to which the aforementioned high-level use cases will be utilised and to what extent can the vast potential of the 5G technology be exploited. Accordingly, industry players along with national standards organisations and government actors are currently working together through various Standard Development Organisations (SDOs) such as the International Telecommunication Union (ITU), 3rd Generation Partnership Project (3GPP) and the European Telecommunications Standards Institute (ETSI) to develop a standard for 5G. Initially, mobile technology relied on proprietary and government led processes of standards development and as the industry moved towards an approach of collaboration and generating consensus for global standards, the mobile industry saw a concurrent increase in competitiveness and dynamism (See Figure 7).

Figure 7. Market Share of Handset Manufacturers (1996-2016)



Source: Compass Lexecon (2017)

The above figure also displays the benefits of having a common global benchmark which the device manufacturers (handsets in this case) need to maintain while producing standard-compliant products.

However, as discussed in the previous section, the shift from the erstwhile generations to the upcoming 5G standard is set to be a unique one. This is primarily because in comparison to the vast device-specific application prospects of the would-be 5G standard, the scope of the earlier generations seems to be relatively limited (earlier generations focussed primarily on mobile handsets and similar devices whereas the scope of 5G is much wider). Hence, achieving the ubiquity of and ensuring product-interoperability through the envisaged standard might become challenging and arduous.

Moreover, it is important to recognise that the internal policies (including IPR policies) devised for self-governance by SDOs play an integral role in ensuring that technology developers are incentivised to take part in the collaborative processes and bring their best technology to the table while standards are being set. They also play a crucial role in providing an attractive platform for technology users to benefit from collaboration. For instance, to provide maximum incentives for participants on both sides of the market, a fundamental aspect of almost all SDO policies is governance of licensing of Intellectual Property, which ensures that patents and other IP which become part of a particular standard are licensed on FRAND terms.[13] However, due to industry-wide conflicts arising globally vis-à-vis the FRAND aspect of SEP licensing, one of the largest SDOs, i.e. Institute of Electrical and Electronics Engineers-Standards Association (IEEE-SA) significantly revised its IPR policy in 2015 and *inter alia* tried to define FRAND. Some suggest that this might have affected the incentives to collaborate.[14] Such amendments might also be akin to interference with the post standardisation negotiation process, which - according to some - should not the prerogative of the SDOs but that of the parties.[15] This challenge might also obscure the otherwise bright prospects of the 5G technology by causing an imbalance between the interests of technology developers and technology implementers.

In order to discuss the aforementioned issues, this section delves deeper into challenges vis-à-vis standardisation of 5G and seeks to assess the possible impact that consumers and industry players would face if these challenges are not tackled optimally.

Challenge 1: Industry convergence and diverse demand

The evolution of mobile technology standards has facilitated substantial improvements in quality and speeds of cellular networks across the globe. For instance, from 2G to 4G, we can clearly see that cellular networks have been able to offer wireless data which is as fast (if not more) as a wireline internet connection (and at more affordable rates).[16] This was made possible because as these standards evolved over time, several distinct industries converged with each other.[17] The creators of the fast wireless data connection, i.e. the mobile phone industry converged with the computer and consumer electronics industries.[18] This convergence made the omnipresent smartphone a reality and brought several benefits to society. Similarly, as we move towards super-connectivity and the IoT, several other industries will naturally converge to form a denser ecosystem (industries such as smart tech, automation will be converging with computing and smartphones). This ecosystem is expected to be infinitely richer and more complex than ever before, both in terms of the requisite level of connectivity and underlying infrastructure.[19] The ecosystem's success will rely on the pace of development of International Mobile Telecommunications (IMT) system, which is envisioned to be "a communication tool for people and a facilitator which assists the development of other industry sectors."[20] The underlying

technology base therein will expectantly be provided by the 5G network, which does not only represent a shift from the previous network standards, but is purportedly expected to bring in unimaginable network and service capabilities across sectors.[21]

As the 5G network will act as a key enabler of this ecosystem of converged industries, it will naturally have to cater to diverse number of verticals and allow heterogeneous technologies to connect with each other in a seamless fashion. If deployed correctly, the network has the potential to spur innovation across sectors and encourage exponential pace of change in numerous industry verticals.[22] Moreover, if compared with its preceding generations (which were designed with the general purpose of communication), the desired ability of the underlying 5G standard to cater to the specific network needs of various vertical industries imparts it a distinct character.[23]

However, this distinct character also adds substantially to the challenge of developing a ubiquitous standard which facilitates flexibility, interoperability, connectivity and ensures consumer welfare. This is reinforced by experts who also argue that the eventual 5G standard will have to support a variety of market needs and provide a high degree of flexibility within its framework to operators.[24] Collaborative standardisation as a result, is bound to become more complicated and technical as the interested stakeholder base broadens to cover more than just mobile network carriers and Original Equipment Manufacturers (OEMs).[25] Experts from SDOs have also highlighted this challenge and mentioned that difficulties vis-à-vis involvement with other verticals could prove to be one of the biggest risks to the timely development of a common 5G standard.[26]

Another related challenge could be the possibility of increasing litigation due to SEP exposure. As new users from diverse industries would become part of the existent value chain, they will be exposed to standards and SEPs and will have to get licenses from innovators who naturally hold patents over the underlying technologies.[27] In the smartphone industry, disagreement over royalties and patent licensing agreements has already resulted in a surge in patent infringement lawsuits and competition enforcement actions, which have snowballed into substantial costs for the industry and regulatory interventions. Collectively, this challenge might pose a threat to the benefits of collaborative standardisation viz. competition and innovation. From this follows discussion on the second major challenge, which has been elucidated below.

Challenge 2: Incentivising stakeholders to collaborate for a ubiquitous standard and maintaining the incentives to invest in underlying R&D

It is important to recognise that the interrelationship between patents and standards is crucial for innovation and growth.[28] Technology which forms the foundation of technical interoperability standards is usually patent protected.[29] The patent system incentivises technology developers and ensures that they receive an adequate return on investments. Furthermore, once a patented technology becomes part of a particular standard, SDO policies ensure that SEPs are available for possible implementers on FRAND terms. The FRAND provision/requirement, which is an essential part of IPR policies of SDOs, ensures that a balance is maintained between the interests of technology developers and implementers. It decreases friction in the process of patent licensing and ensures that developers are adequately rewarded and implementers get FRAND access to standardised technology. Insofar as FRAND is concerned, it can be seen as a facilitator of patent licensing negotiations. However, in cases where an alleged FRAND commitment violation has taken place, enforcers and regulators across jurisdictions have scrutinised it from the lens of contract law, patent law as well as competition law.[30]

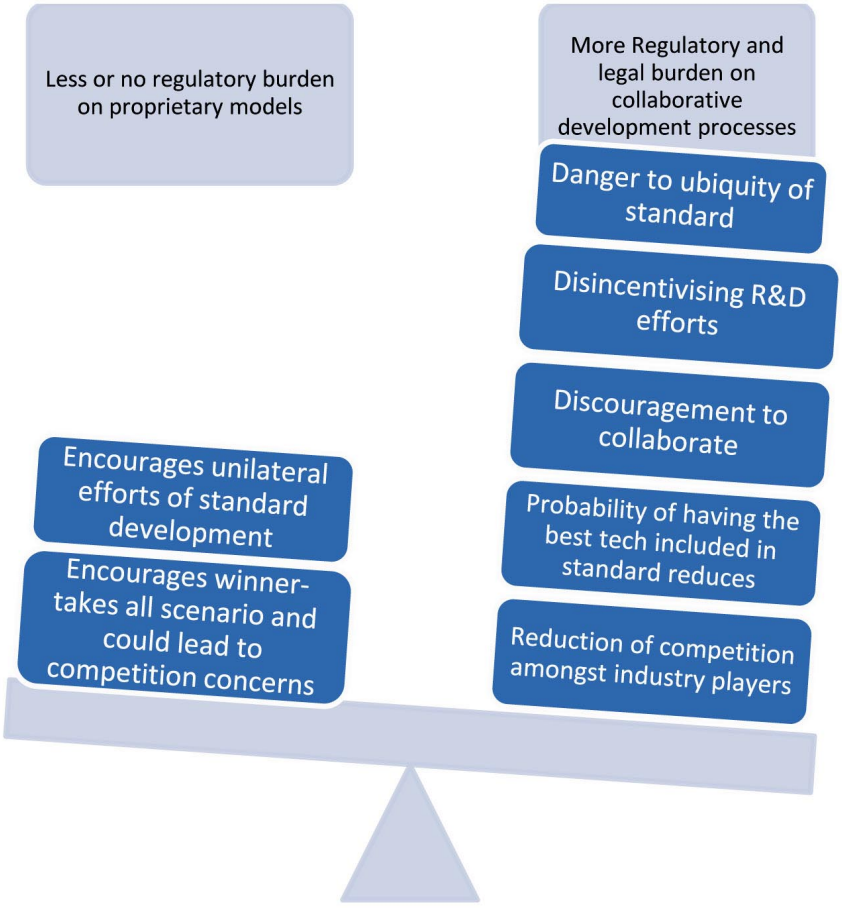
Notably, complications with regard to FRAND licensing have increased the prevalence of industry and governmental belligerence towards the legality, manner and form of licensing of SEP technology. As a result, institutions across the globe have tended to enter into the realm of licensing of Essential Intellectual Property.[31] Although these institutions have done so with the bona-fide intent of ensuring that technology transfer is undertaken in a fair and reasonable manner, they have incidentally also tried to ordain the manner in which industry players practice their rights over intellectual property in an ex-post manner (after the standard has been set).[32] This has the potential to adversely impact the collaborative standard development process as it could deligitimise the massive R&D efforts of technology developers and disincentivise them from taking part in collaborative standards development processes. Also, such interferences which lack actual evidentiary support of competitive harm can have a negative impact on competition in the market.[33] Legal interventions which are also not informed through economic evidence can distort market conditions. For instance, the case of *Apple, Inc. v. Motorola, Inc.,* among others relied on the theory of patent-holdup, which has been a disputed by experts on the basis of lack of economic evidence.[34]

For instance, the amendment of the IEEE-SA policy reportedly led to a decrease in the licensing commitments given by patent owners for licensing their SEPs on FRAND terms (called non-duplicate Letters of Assurances or LoAs").[35] The amendment in effect *inter alia* seeks to define FRAND and states that SEP holders may charge a reasonable royalty that is based, among other things, on the value that the patented technology contributes to the smallest saleable component of the overall product.[36] The amendment's intention to define FRAND comes at the cost of causing a significant imbalance between the interests of technology developers and implementers.[37]

Furthermore, such ex-post interventions after a standard has been set might delegitimise the standardisation process itself and thereby increase policy and regulatory uncertainty (PRU). Literature suggests that increasing PRU has a negative impact on investments.[38] Besides, uncertainty in one region and/or over-regulation may adversely impact foreign firms' decision to invest in that particular economy, which can further diminish the prospects of emerging economies to make the most of technology transfer and subsequent generation of local R&D.[39] Although jurisdictions which are net implementers of technology standards (like India) might feel that protectionist policies in the form of regulating patent licensing and/or domestic efforts of standards development might benefit the domestic players' capacity to innovate and compete in the global market, literature suggests that such policies might in fact have the opposite effect.[40]

Such regulatory and legal interventions might pose as impediments to the value proposition of the otherwise effective collaborative standardisation platforms. Moreover, the fact that the proprietary mode of standardisation is not subject to similar regulatory and legal scrutiny poses a genuine challenge as to how incentives to innovate and participate in collaborative standardisation could be maintained and promoted (see Figure 5). Understandably, regulation of collaborative models through an approach which is not based on evidence of actual harm might encourage industry players to unilaterally go for proprietary models of standard development and might lead to industry fragmentation in 5G. This hampers the ubiquity of a particular standard and can be especially detrimental in the 5G context. In the long run (beyond 5G), it can lead to possible competition issues wherein a winner-takes-all scenario could emerge making market entry for new players difficult. These inherent costs on the collaborative standards development model emerge from an apparent regulatory imbalance, which is not necessarily a good sign for consumer welfare and innovation (depicted in Figure 8).

Figure 8. Possible Impact of Regulatory Interventions



3.3 Identifying an optimal policy approach

The aforementioned discussion feeds into the proposition that the need to collaborate for a ubiquitous standard has never been so acute and policies which dissuade collaborative approaches can seriously impact the universality and potential of the upcoming 5G network. It might seem that proprietary systems have been successful in the past in some industries (such as PCs, but to the chief benefit of the *de facto* standard setter), collaborative standards hold a superior position when it comes to benefits regarding consumer welfare, interoperability, competition and innovation.

To this end, it is critical for policymakers and market regulators to understand the value of collaborative standard setting procedures and to recognise the important role that they play in infusing market competition and innovation. Moreover, enforcement actions and regulatory interventions need to be synced so as to maximise incentives of all participants of the collaborative process and should simultaneously work to protect its inherently competitive process. Lastly, policymakers, industry players and other stakeholders need to recognise that their ability to encourage and support collaborative and open processes will determine the technical ability and universality of the proposed 5G standard. This will further impact socio-economic growth in the digital era and would be an integral factor which directly influences penetration (horizontal and vertical) of technology in an increasingly hyper-connected society.

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Chapter 4

Mapping the Way Forward and Identifying Policy Considerations and Opportunities for Emerging Economies such as India

Considering that the global ICT ecosystem is at a crucial juncture and pre-standard 5G trials have already started to kick-off, it is important for policymakers, market regulators and industry stakeholders to map a common way forward. Notably, establishing policy harmony and regulatory certainty across borders will go a long way in attracting investments for speedy development and uniform deployment of the 5G network. More importantly, policy frameworks and regulatory actions are key blocks in the innovation ecosystem due to the fact that they influence the working of SDOs (particularly their IPR policies) and also impact firm-level decisions to invest in R&D.

In this regard, there is an urgent need to devise policy approaches and/or reconcile enforcement interventions (such as through competition law), vis-à-vis standardisation and licensing of standardised technology by relying on certain evidence-based principles. Such a principles-based approach to governance of standard setting would ensure that all participants are provided a level-playing field to participate and compete in the process. Furthermore, an approach of this kind will ensure that economic evidence is taken into consideration and biased, entity-based regulatory interventions are avoided. This argument holds water and is based on the juxtaposition of challenges with the value propositions of collaborative approaches to standardisation versus the ones that lean towards proprietary models (See Table 1). There is ample reason and evidence for industry stakeholders, policymakers and regulators to collectively encourage principles-based approach which supports open and consensus-driven processes.[1]

Such an approach would also help industry players to trust the collaborative process which currently drives standardisation and help attach a continuous sense of fairness to it. This Section explores what the fundamental blocks of the 'principles-based approach' could be, so as to provide a broad architectural framework for consideration of policymakers. Before delving deeper, our expectation is that these principles will especially be beneficial for policymakers in emerging economies which are looking towards 5G as a game-changer for their economies and/or looking to advance their capacities in terms of competing in the global milieu of developing standards for ICT:

4.1 Principle 1: Recognise the benefits and opportunities of collaborative and open processes

For instance, let's take the first challenge identified in the previous section, i.e. increasing industry convergence and vertical integration. Despite the fact that the level of industry convergence in

Table 4. Advantages and Disadvantages of Collaborative versus Proprietary Approaches with Reference to Certical Integration			
Collaborative and Open Approaches		**Proprietary and Closed Approaches**	
Advantages	**Disadvantages**	**Advantages**	**Disadvantages**
Democratic and open. Does not restrict vertically placed stakeholders to participate	Rigorous processes and commitments to maintain procedural fairness makes the process slow-paced	Easier for users to collaborate with OEMs and network carriers	Standard not ubiquitous
Gives vertically placed stakeholders/ implementers equal opportunities to voice their opinions and influence the nature and scope of standard		Developer can focus on specific needs of vertically placed stakeholders.	Limits market entry and may not cater to needs of all implementers
Universality and ubiquity of emerging standard, irrespective of sector			Lack of interoperability
Enables possibility of achieving network effects and reaching economies of scale			Standard might limit innovative capacity of users. Developers will not be able to achieve network effects
			Standard cannot be exported or applied elsewhere

the upcoming ICT ecosystem looks daunting, there are major *advantages* for industry players and policymakers to encourage collaborative measures of standardisation (See Table 4).

Notably, collaborative and open processes of standardisation are generally understood to be the ones that are followed by formal SDOs. However, it is important here to understand that even without formal, legalistic and rigorous processes (which SDOs generally follow) collective industry initiatives in the form of industry consortia can also be collaborative and open. Hence, it is important for policymakers to first recognise aspects which make a process collaborative and open.[2] These generally include the following:

- Decisions are made through consensus of participants
- The process is transparent and voluntary
- Membership is open to all competitors who are affected by the standard
- Follows due process and the standard is recognised by a specification or standardisation organisation
- Ensures that access to standardised technology, including essential IPR is available on FRAND terms
- Can take place in formal setups or through informal consortia.[3]

Keeping these factors in mind, it is recommended that policies and regulatory approaches should generally support and encourage organisations and initiatives which adhere to the aforementioned broad fundamental principles. This is because there is substantial evidence to prove that such

approaches have relatively been much more favourable for market competition and innovation in several ways which include *inter alia* selection of efficient technology through a competitive process, reduction of possibilities of monopolisation, avoiding emergence of multiple standards, ensuring a level-playing field for all competitors and most importantly offering better choice, value and quality of products for consumers.[4] Moreover, due to the fact that such platforms provide an opportunity for all possible interested firms to compete, there is always a constant competitive pressure on incumbent firms to innovate and improve further. The FRAND condition which is generally present in IPR policies of almost all SDOs or consortia also adds to the value proposition of collaborative and voluntary processes and safeguards the competitive process by ensuring unconstrained access for implementers.

4.2 Principle 2: Maintain a fine balance between IP protection and competition

Innovation, competition and IPR are intrinsically related to each other, especially so in the context of standardisation. Robust competition ensures that present competitors and upcoming market entrants constantly innovate to attain better returns from product differentiation and thereby add value to the process of standards development. On the other hand, IP protection aims at incentivising innovators by rewarding them for their effort and providing legal protection to their intellectual yield, which becomes the bedrock of the technical standard. Absence of adequate IPR protection may discourage firms to invest in research and development (R&D) and may negatively impact their incentive to innovate which might trickle down in the form of consumer harm (by hampering prices and choice of products). Although competition law and IP protection aim to achieve the same goal – that is – innovation – apparent contradictions between the two and their disparate application across jurisdictions tend to cause several policy and regulatory ambiguities, which may hinder the natural progress of innovation.

This is especially challenging in the context of standards development as the subsequent licensing of SEPs and conflicting views on FRAND royalties have led to several conflicts between technology developers and implementers. In order to address these issues, several market regulators across jurisdictions have released general guidelines on application of competition/antitrust laws on IP licensing for example, the Federal Trade Commission (FTC) in collaboration with the United States Department of Justice (DOJ)[5], the Japan Fair Trade Commission (JFTC)[6] and the European Commission (EC).[7] In this regard, The European Commission, which recently released its communication setting out specifically the EU approach to SEPs, is worth noting.[8] Keeping in mind the global relevance of standardisation of 5G and IoT, the EC highlights that

"The Commission considers that there is an urgent need to set out key principles that foster a balanced, smooth and predictable framework for SEPs. These key principles reflect two main objectives: incentivising the development and inclusion of top technologies in standards, by preserving fair and adequate return for these contributions, and ensuring smooth and wide dissemination of standardised technologies based on fair access conditions."

With specific reference to licensing of SEPs, the EC took a very balanced approach by highlighting the importance of good faith negotiations, clarifying that licensing terms of SEPs have to bear a clear relationship to the economic value of the patented technology and stating that FRAND valuation should ensure continued incentives for SEP holders to contribute their best available technology to standards.[9] Noticeably, the EC's approach also puts forth recommendations which encourage maintenance of transparency vis-à-vis SEP exposure and support optimisation of processes of collaborative platforms such as SDOs.[10] Case laws, particularly the *Huawei v. ZTE*[11]

judgement have also been successful in putting forth a balanced view on the delicate issue of patent injunctions.

However, jurisdictions such as India which do not have such a rich ecosystem of technology developers but are seeking to develop their domestic innovation ecosystems to tap in the developmental benefits of 5G and IoT, it might be first beneficial to focus on advocacy efforts that generate awareness about standards, SEP exposure and the importance of investing in R&D (as opposed to making relevant changes in regulations and policies to favour domestic firms). Moreover, they need to focus on harmonising the enforcement of competition law and IPR (especially in context of SEP licensing) and in their endeavour to do so, the general rule should be to treat standards and licensing of underlying essential-IP as efficiency improving, welfare-enhancing, pro-innovation and pro-competition. In addition, it is in the interest of emerging jurisdictions to establish policies and practices which facilitate participation of domestic firms and institutions in international SDOs or industry consortia. This will eventually increase their exposure to standard setting activities and will help local firms to commercially leverage their technologies in the global value chain.

4.3 Principle 3: Foster evidence-based optimal regulation and policy formulation

While policymakers seek to achieve the aforementioned fine balance to foster innovation, it is quintessential for them to first understand the dynamics of standard reliant and patent intensive markets such as ICT. Ill-informed interventions which lack a strong economic footing might have an adverse impact on market dynamics resulting in distortions to competition and disincentives to invest in R&D.[12] For instance, in the smartphone industry, despite economic evidence which points towards dynamic competition, growing output, falling market concentration ratios and decrease in prices of wireless telecom services, still theories of harm to competition (such as patent hold-up) have pervaded the global smartphone industry.[13] Moreover, SDOs have gone to the extent of defining FRAND royalties with the bona-fide intention of bringing in much needed certainty, but have done so at the cost of imparting an imbalanced approach towards the crucial principle of reconciling the interests of developers and implementers.[14]

Competition regulators have also relied on the prevalent theories of harm such as patent hold-up and have tried to determine (through ex-post enforcement) the manner in which SEP holders license their essential technology.

Due to lack of evidential backing, such interventions might have in effect resulted in sub-optimal and distortionary market outcomes, thereby undermining the efficiency gains produced by standards. Eventually, apart from impacting the quality and ubiquity of the underlying standard, ill-judged regulatory actions might cause unnecessary burden on voluntary standard setting activities and on the contrary, incentivise industry players to shift to proprietary modes of standard setting.

4.4 Opportunities for India

The government of India has in fact recognised the need to bolster the present innovation ecosystem and has accordingly framed the National Intellectual Property Rights Policy (the Policy), 2016 which envisages a long-term vision to encourage creativity and innovation in IP-led growth for the benefit of all.[15] The Policy is meant to carry forward and implement its Vision of 'encouraging

creativity and innovation in intellectual property (IP) led growth for the benefit of all'. To achieve this Vision, the Mission of the Policy is to 'establish a dynamic, vibrant and balanced IP system in India to foster innovation and creativity in a knowledge economy; accelerate economic growth, employment, entrepreneurship; enhance socio-cultural development; and protect public health, food security and environment, among other areas of socio-economic importance. To achieve this Mission, the Policy sets out certain objectives which are:

- IP Awareness and Promotion;
- Creation of IP;
- Legal and Legislative Framework;
- Administration and Management;
- Commercialisation of IP;
- Enforcement and Adjudication; and
- Human Capital Development.[16]

Moreover, it provides for policy coordination and integration with other major initiatives of the Government of India, such as 'Make in India' and 'Digital India' campaign. Incidentally, the Make in India (MiI) initiative envisages transforming India in to the next global manufacturing powerhouse, with specific focus on the ICT sector.

In consonance with these broad policy initiatives and acknowledging the massive opportunity of 5G to be a game changer,[17] the Indian government is working to create a holistic ecosystem for development and deployment of 5G networks. With the aim of becoming a leader in 5G, the government has announced a dedicated fund of ₹500-crore for R&D of the underlying technology and has also created a high-level committee to work on a roadmap for the roll-out of 5G by 2020.[18]

The chief objectives for setting up the High Level 5G Forum for India include:

1. To position India as a globally synchronised participant in the design, development and manufacturing of 5G based technology, products and applications.
2. To develop the vision, mission, and goals for 5G India 2020, and
3. To evaluate, approve roadmaps and action plans for 5G India 2020.[19]

With the policy vision in place, it seems that the Indian government has acknowledged the need to provide a significant boost to the broader innovation regime and has also embraced itself for the roll-out of 5G.

Following this discussion and based on the broad principles mentioned in the previous section, following are some key recommendations specifically applicable to the current Indian context which might help in implementation of the broad policies in the near future, especially in the ICT sector:

Recommendation 1: Increase specialisation, investment and provide incentives for firms to move up the global value chain

Although India has attracted a number of Original Equipment Manufacturers (OEMs) to set up plants, their role has largely been restricted to that of an assembler, and not even a manufacturer. A major part of the manufacturing value chain (MVC) is still happening in other countries such as China and Taiwan where there is a well-built component ecosystem, which supports its manufacturing. Furthermore, evidence suggests that there are enormous differences in the SEP stocks between different countries and there is a distinct dichotomy therein, i.e. some countries

(the Haves) like the United States of America (USA), China, Japan, South Korea and Germany have SEP stocks above the third quartile of all SEPs.[20] India is amongst the 'Have-Not' jurisdictions that hold only a few or no SEPs.

Notably, due to the fact that patented and standardised technology confers considerable competitive advantage to firms (which is possessed by the Haves), some have suggested that it would benefit local firms to increase their own SEP portfolios through extensive investment in R&D or through strategic acquisitions.[21] The underlying rationale is that it would give such firms greater bargaining power in licensing negotiations and also increase the possibilities of cross-licensing.[22]

However, while this conclusion seems to be theoretically correct, it may oversimplify the correlation between patents and innovation. This is because the acquisition and ownership of patents is not an end in itself, but is in fact a consequence of technological innovation.[23] In this context, emerging and 'Have-Not' economies such as India ought to take note of the fact that much of the technical development naturally occurs within international SDOs and institutions and firms in India need to play a more participative and competitive role therein (in consonance with the General Principle elucidated in the previous section). This would increase their capacities in terms understanding the process and content of standards development. In the long term, it will allow them to focus their R&D efforts towards achieving specialisation in technical development and then leverage their IP to move up the GVC. The Indian government's 5G initiative is a welcome step and the funds allocated therein should be utilised to further encourage and incentivise local firms to develop their internal capacities and compete in voluntary standard setting activities. Alongside this, the present market players as well as the government should think about how to collectively invest in R&D so that Indian firms become globally competitive.

Hence, to achieve long-term ambitions, India needs to turn around this situation by initiating specific policy interventions which targets to increase its own competitiveness vis-à-vis SEP portfolios rather than undermining those of the current 'Haves'.

Recommendation 2: Avoid unilateral standard setting initiatives and encourage participation in international SDOs

The historical perspective on standards development and the relative advantages and disadvantages vis-à-vis different modes of standardisation advances several arguments which should ideally encourage jurisdictions such as India to vigorously pursue participation in international standard development processes. Lessons from other jurisdictions which have sought to increase the competitiveness of domestic market players by either introducing protectionist policies or by developing their own standards unilaterally have not been successful and they too have moved towards international fora. Take the case of China, which realised the near absolute dominance of western firms in the wireless telecommunications standards field, and the high royalty rates charged by them from Chinese firms and adopted a proprietary approach to 3G standardisation. Their efforts resulted in TD-SCDMA, which was a Chinese standard developed by the Chinese Academy of Telecommunications Research (CATT) and its state-owned affiliate Datang in collaboration with German equipment vendor Siemens. Though the standard cannot be considered to be a market success, it surely advanced China's goal of building in-house technical expertise, thereby enhancing their domestic manufacturing capacity for advanced ICT products. Considering the high cost of developing these standards, coupled with their lack of international adoption, China has now moved towards international interoperable standards, through significantly increased participation in international SDOs.

Participation in international fora has several benefits for firms which currently lie in the 'Have-Not' category. *First*, the embodiment of proprietary technology in the industry standards itself give an early advantage to contributory firms which can thereby utilise SEPs to gain strategic advantages over competitors.[24] *Second*, participation in international standards development is the only viable process through which local companies and domestic firms in different jurisdictions can influence the direction of standardised technologies by voicing their opinions and putting forth their special requirements.[25] This is a crucial component of standardisation which can simultaneously guide new entrants in terms of finding specific research vacuums in technology development and focussing their R&D efforts to plug the same. *Lastly*, apart from the economic arguments in favour of participation, it is also important to view standardisation from the policy perspective.

National standards development authorities such as Telecom Standards Development Society of India (TSDSI) which have started to participate in SDOs such as 3GPP can play a crucial role in influencing their underlying policies and practices. The collaborative initiative by the Indian and EU government on "India-EU Cooperation on ICT-Related Standardisation, Policy and Legislation" (2015 – 2019) is also a welcome step towards bringing in increased specialisation and policy harmony. The objective of the initiative is to "*promote closer alignment between India and Europe with regard to the production and use of ICT standards and to harmonise the exchange of statistical data, thereby facilitating trade, increasing interoperability and the ease of doing business for companies, and adding additional weight to European and Indian ICT standardisation efforts at the global level*".[26] Initiatives such as these will help India to influence global policy progress to the benefit of domestic firms and provide the much needed impetus to domestic innovations. It will help enable domestic firms to invest in specific R&D efforts and also facilitate them to compete globally.

In furtherance of the aforementioned recommendation, the following specific steps can be taken:

- **Capacity Building of domestic firms**
  Recognising the principle that standardisation is a highly knowledge-intensive activity which requires well-capacitated individuals and technical experts, India must undertake local capacity building efforts to support greater international SSO participation by representatives from its domestic forms. However, the requisite training and skill development for such capacity building does not come cheaply. Therefore, domestic firms may require significant financial and institutional support in the absence of internal resources, from the government or multi-governmental organisations (e.g., the World Intellectual Property Organization (WIPO), as well as non-governmental organisations (NGOs).

- **Leverage support initiatives of various SDOs**
  Many SDOs offer support to firms from developing countries, which demonstrate their eagerness to participate and even contribute to the standardisation efforts. The Internet Society (ISOC), which is a US/Switzerland-based NGO which oversees the Internet Engineering Task Force (IETF), a major developer of Internet standards, is good example. It regularly supports Fellows from developing countries to participate in IETF meetings and other activities. One of its programs is also running in India: 'Indian IETF Capacity Building Program'.[27] Various other SDOs also sponsor participation by consumer advocates and other civil society organisation members, which help in broadening the overall participation and ensuring inclusive representation in global organisations.

- **Educate relevant personnel about standardisation**
  The Country must also inculcate and emphasise the need of imparting knowledge and skills for standards education and training. India can adequately utilise its higher educational institutions in providing greater education in the area of standardisation.

- **Increase firm-level awareness about standards and exposure to SEPs**
  Apart from the general IP awareness programmes run by the Indian government as a part of the National IPR Policy, 2016, there is also a need to create a sense of awareness about the increased exposure to standards and SEPs. With the upcoming 5G standard acting as the all-pervasive bedrock for countless use cases, it is but natural that device makers and implementers will have to utilise the standard, thereby getting exposed to SEPs. With the IoT ecosystem growing by leaps and bounds, it can be assumed that the implementer base would grow and even SMEs and small start-ups would be exposed to SEPs along with its requisite licensing requirements. This can pose a serious challenge for small businesses as lack of awareness can lead to unintentional infringement of SEPs on the implementer's part and/or put implementers in a situation where licensing negotiations prove to be complex and perplexing. Hence, awareness generation and capacity building activities can play a crucial role, especially for jurisdictions such as India which are currently net implementers of standards and SEPs.[28]

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