Standards and Welfare Maximisation

Towards a Competitive and Innovative 5G Ecosystem in India

CUTS International

Broadband India Forum

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...enhance, expand & usher the true value of broadband

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CONTENT

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EXECUTIVE SUMMARY

Standardisation bodies, such as the 3GPP and ITU have been hard at work over the last few years in an attempt to codify the requirements and eventual construct of an ideal 5G ecosystem. At the core of such exercises is the well-founded belief that appropriately designed standardisation strategies will significantly support and accelerate the development and implementation of 5G networks.

The first section of this report establishes the context and illustrates the importance of telecommunications, in general, and 5G in particular. Current predictions of the eventual shape and form of this communications technology and specific use of cases are articulated in this section.

The second section presents a literature review of the theory and economic impacts of standardisation. Together with the first section, it establishes the overall context of this paper – that standardisation has a critical role to play in the development of 5G. The third section articulates the importance of standards for Information and Communications Technology (ICT) sectors and touches upon the importance of collaborative and democratic standards development processes, especially considering the ubiquitous value proposition of the upcoming standard for the 5G technology.

An increasingly common outlook of a future communications landscape enabled by technologies such as 5G and beyond, is one of converged marketplaces and services. The level of convergence and the increasingly blurred lines that have traditionally separated mobile network operators from edge service providers will lead to the creation of markets where service provisioning and capturing surplus is open to all stakeholders in the value chain. The observed convergence between SMS and instant messaging, PSTN and VoIP, and more generally Internet and media consumption are the seeds that have ushered the growth of communications technology towards a truly converged future. This convergence, along with a future that contains a high degree of hardware virtualisation, is addressed in the fourth section of this paper. It also presents an accounting of current standardisation efforts and challenges expected in the commercialisation of next generation technologies

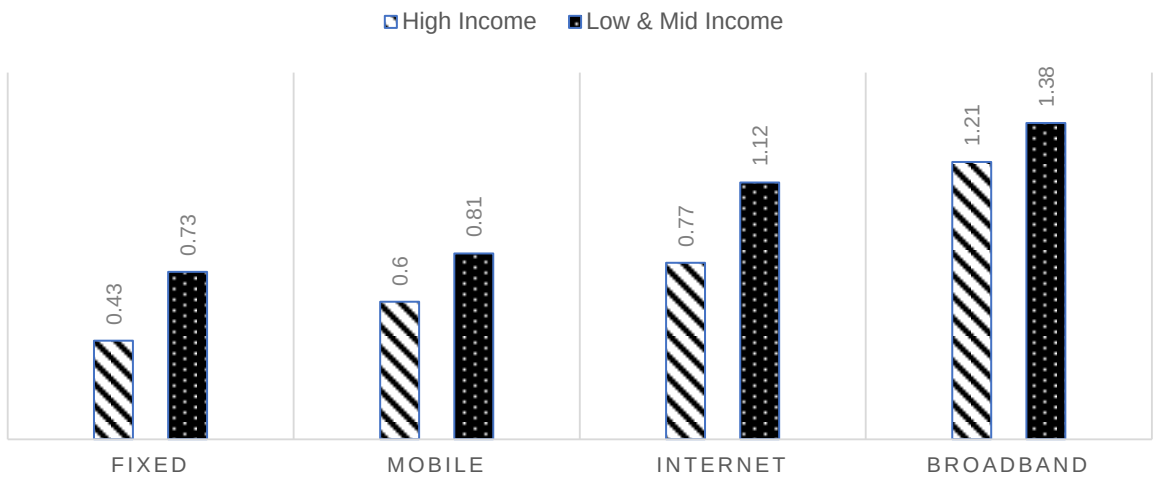
Specific policy recommendations for India and by extension, for other nations at a similar stage of development, are presented in the fifth section of this report. This includes specific recommendations *vis-à-vis* creation of an overarching robust innovation and competition-friendly ecosystem which could help building and leveraging the core technological capacities of Indian firms and start-ups. To that end, the recommendations highlight the need to incentivise specialisation of Indian firms, encouraging participation in standards development bodies and thereby building core competencies concerning development of digital communications technologies.

The appendix to this study is intended for those interested in deeper evaluation of the standard setting process and an examination of key historical events and conditions that led to the evolution of technology standards.

VISIONS OF 5G – TAKING STOCK OF KEY EXTERNALITIES

The positive externalities of telecommunications render it an absolute pre-requisite for accelerated and inclusive economic and social development of nations. Seminal studies that measure the impact of the proliferation of telecommunications have found the positive effects to be more significant in the case of developing nations[1]. From the availability of and access to basic telecommunications services to reliable, always-on, high-speed broadband, developing nations can expect to amplify and augment economic growth rates by as much as 1.38 percentage points for every 10 percent increase in the penetration of these services.

Figure 1: Economic Impact of Telecommunications



Source: Qiang, 2009

The economic impact of 5G is expected to be at least as significant as broadband, and plausibly amplified significantly, given the efficiencies that can accrue from infrastructure capable of not only providing anytime and anywhere high speed internet access, but also enabling high degrees of virtualisation across platforms, networks and devices. A recent study predicts that from 2020 to 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.[2]

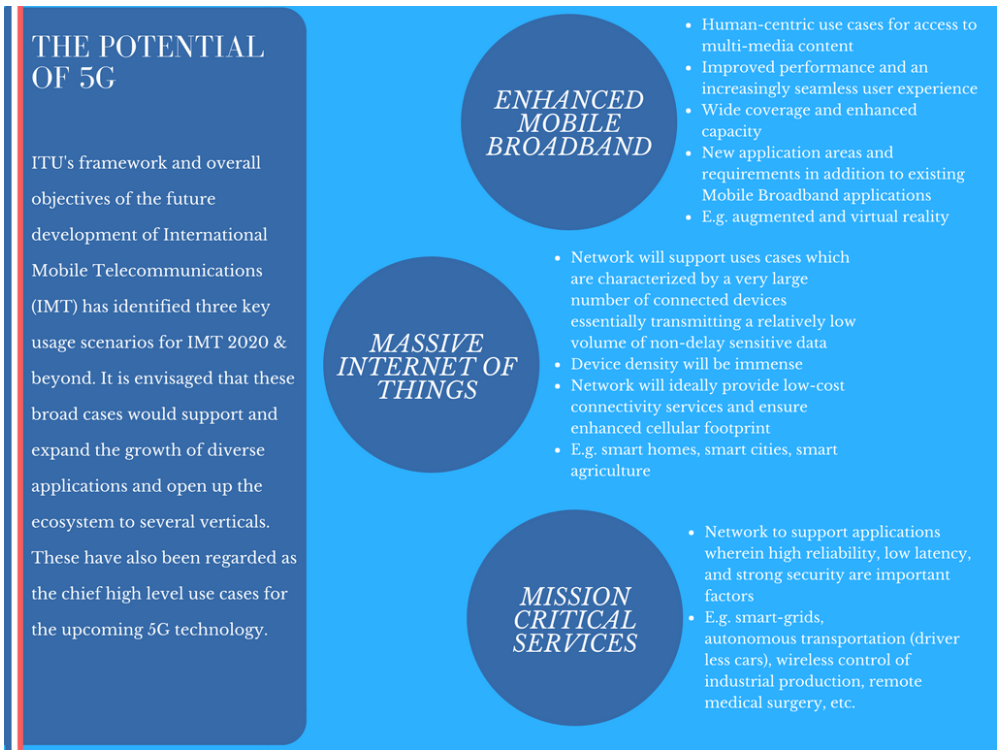
Moreover, it forecasts that '5G will enable US$12.3tn of global economic output.'[3] Its massive economic potential emerges from the fact that 5G will act as a foundation for a global innovation ecosystem which will open up industries to disruptive and novel products as well as processes, thereby enhancing global efficiency and productivity. Moreover, the potential of 5G to transform

[1] Qiang, Christine Z. 2009. "Telecommunications and Economic Growth." World Bank, Washington, DC.
[2] IHS Markit, The 5G Economy: How 5G technology will contribute to the global economy, 4 (2017)
[3] *Ibid.*

mobile technology into a General Purpose Technology (GPT) is bound to have a transformative impact on market competition across sectors.[4] Concurrently, this will profoundly enhance the capability of jurisdictions to leverage ICT for imparting sustainable societal change.[5] 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.[6]

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.[7] Broadly, its three high level use cases (Figure 2), i.e. Enhanced Mobile Broadband, Massive IoT and Mission Critical Services display the ubiquity and unparalleled nature of the upcoming 5G network ecosystem.[8]

Figure 2: The Potential of 5G



Source(s): ITU, CradlePoint, IHS Markit

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4 Supra Note. GPTs are technologies which have a wide-ranging impact on the entire economy. The layman can understand a GPT as one which drastically improves day to day functioning as well as the manner in which business is conducted (for e.g. electricity). For more, see Boyan Jovanovic Peter and L. Rousseau, Chapter 18 – General Purpose Technologies, available at http://www.nyu.edu/econ/user/jovanovi/JovRousseauGPT.pdf and The Economist, The Revolution to come, (2012), available at https://www.economist.com/blogs/freeexchange/2012/04/general-purpose-technologies

5 ICT will notably play a chief role in achievement of the Sustainable Development Goals (SDGs). See ITU, Fast-forward progress Leveraging tech to achieve the global goals, (2017) available at https://www.itu.int/en/sustainable-world/Documents/Fast-forward_progress_report_414709%20FINAL.pdf

6 Teece David J, 5G Mobile: Impact on the Health Care Sector, (2017)

7 See 5G network technology Putting Europe at the leading edge, European Parliament, Briefing Paper (2016) http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573892/EPRS_BRI%282016%29573892_EN.pdf ; Qualcomm Believes 5G Is Capable Of Tying Our Entire World Together; Snapdragon 835 At The Heart Of 5G Connectivity, (2017) available at https://www.mobipicker.com/qualcomm-believes-5g-capable-tying-entire-world-together-snapdragon-835-heart-5g-connectivity/ and http://www.huawei.com/minisite/5g/en/

8 ITU, IMT Vision – Framework and overall objectives of the future development of IMT for 2020 and beyond, 3 (2015) at p.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.[9] 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.

An internet of things (IoT) paradigm is but one future beneficiary of 5G, and once truly enabled, would drive higher orders of efficiency in rendering basic services (utilities IoT) as well as for specialised industrial and consumer applications (Enterprise & Consumer IoT). Many such applications wait in the wings for the design & rollout of a capable and functional 5G network. Such a revolutionary view of 5G involves extensive use of a number of access technologies (Fixed, Mobile, Satellite, HAPS) working in tandem to provision anytime, anywhere, high-speed and reliable connectivity. 5G is in our near future, and market trends clearly indicate a shift in usage patterns and behaviors that reinforce the need to move to this new generation. Some of these are highlighted below[10]

- Explosive growth of data traffic: Explosive growth in traffic is observed and is expected to accelerate. Global data traffic is slated to increase by more than 200 times from 2010 to 2020, and about 20,000 times from 2010-2030;
- An increase in connected devices: The number of devices, including wearable devices and MTC devices will continue to increase;
- Design and development of new services: Multiple usage scenarios and applications are expected to emerge, e.g., services from enterprises, from vertical industries and Internet companies, etc. will be exploited.

As the race to 5G intensifies, nations that build strong capabilities across the telecommunications ecosystem, stand to benefit greatly by capturing regional consumer surplus as well as creating products and services fit for global consumption.

The importance of standards, especially in pursuit of industrial goals of such magnitude, is significant for developing nations that find themselves in latecomer positions with respect to the adoption of technologies.[11] The development of 5G, regardless of the nation state that pioneers it, will depend critically on subscription and adherence to unified standards that bring together the numerous technologies and platforms experts envision being the building blocks of 5G.

[9] Jo Best, The race to 5G: Inside the fight for the future of mobile as we know it, available at http://www.techrepublic.com/article/does-the-world-really-need-5g/

[10] Whitepaper, 5G vision and requirements, IMT-2020 (5G) Promotion Group

[11] Ernst et al (2014), Standards, innovation, and latecomer economic development: Conceptual issues and policy challenges, Telecommunications Policy, 38, 853-862

STANDARDS AND ECONOMIC DEVELOPMENT

It has been repeatedly and consistently found that standards contribute at least as much to economic growth as do patents.[12],[13] In some cases, the economic impacts of standards are also observed to be more significant than patents[14]. Developing nations that find themselves behind the curve with respect to innovation in new technologies have historically benefitted from standards stepping in as an alternative to patents. The qualitative impacts of standards are essential for such nations, given and especially the propensity of a well-functioning standardiation strategy to catalyse new ideas and inventions into productivity enhancing innovations. They serve as the missing link in an ideal growth strategy that leads to high quality employment opportunities in advanced manufacturing and services.[15,16, 17,18]

The well-established contribution of technical standards to productivity growth make it a positive macro-economic catalyst that yields benefits in excess of those to companies alone. As carriers of technical knowledge, standards diffuse knowledge and contribute to overall economic development.[19] At the same time, a sole reliance on standards is not an optimal proposition. Nations and firms engaged in the race to commercialise 5G need to have their strategies formed of equal parts subscription to de jure and *de facto* standards, along with a reasonable roadmap to secure functional intellectual property (IP).

Standards are of significant importance, and in some cases, a necessary pre-requisite in the case of disruptive and highly dynamic sectors such as telecommunications (the case of the IoT). Interoperability concerns reign supreme when developing services intended to be deployed across organisations, systems, components and geographies.[20] As tech-based competition intensifies, competitive success, at regional and global levels, is critically reliant on control over Intellectual Property Right (IPR) as well as on "a capacity to control open-but-owned architectural and interface standards."[21]

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12 Supra Note 11

13 CEBR. 2015. "The Economic Contribution of Standards to the UK Economy". < https://www.bsigroup.com/LocalFiles/en-GB/standards/BSI-standards-research-report-The-Economic-Contribution-ofStandards-to-the-UK-Economy-UK-EN.pdf>

14 Blind, K. & Jungmittag, A., 2008. The impact of patents and standards on macroeconomic growth: a panel approach covering four countries and 12 sectors. *Journal of Productivity Analysis,* February, 29(1), pp. 51-60.

15 Wang, P. (2013). Global ICT standards wars in China, and China's standard strategy (manuscript). Beijing: China National Institute for Standardization

16 Suttmeier, R. P., Kennedy, S., & Su, J. (2008). Standards, stakeholders, and innovation: China's evolving role in the global knowledge economy. National Bureau of Asian Research, 2008 (September)

17 Ernst, D. (2011). Indigenous innovation and globalization: The challenge for China's standardization strategy (123 pp.). La Jolla, CA: UC Institute on Global Conflict and Cooperation; Honolulu, HI: East–West Center. ⟨http://www.EastWestCenter.org/pubs/3904⟩ Published in Chinese at the University of International Business and Economics Press in Beijing

18 Ernst, D. (2013). America's voluntary standards system – A "Best Practice" model for Asian innovation policies. Policy Studies #66, March. Honolulu, USA: East– West Center. ⟨http://www.eastwestcenter.org/pubs/33981⟩

19 Supra Note 11

20 Gasser, U., & Palfrey, J. (2013). Fostering innovation and trade in the Global Information Society: The different facets and roles of interoperability. Law, Policy & Economics of Technical Standards eJournal, 1(1), 13.

21 Ernst, D. (2002). Global production networks and the changing geography of innovation systems: Implications for developing countries. Economics of Innovation and New Technologies, 11(6), 497–523.

Increasing globalisation and the consequent fragmentation of production, has led to developing nations largely acting as contract manufacturers (China) during their initial phases of industrialisation, and in some other cases (Korea) as early adopters of innovative technologies. Developing nations and their regional firms find themselves naturally disadvantaged when engaging on standardisation-related matters, if for no other reason than the fact that they did not contribute to the core technology, and often find themselves in want of capabilities that allow them to shape system architectures. A strong market position is what is at stake for firms that lead core technology development, and commit significant resources to the pursuit of having their innovative solutions codified in standards. The discussion on standards and the critical role that they play in the larger economic context is crucial, especially for developing nations, such as India, which is currently contemplating the path for promotion of core research and development (R&D) and the possible manner in which it can develop and leverage cutting-edge innovations at the global level.

STANDARDS AND ICT

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.[22]

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,[23] 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.*[24]

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 regulate interoperability in network industries.[25] Interoperability arising through standardisation has become the key to promoting innovation, in this technology driven world, especially in the ICT sector.[26]

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.[27] This opens up

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22 Layne-Farrar, Anne, *Business Models and The Standard Setting Process*, SSRN (2010), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1718065, accessed 22 April 2017.

23 In a world of converging yet diverse technologies, complex ICT systems must communicate and interwork on all levels – this is interoperability. http://www.etsi.org/standards/why-we-need-standards/interoperability accessed on 23.12.2017

24 ISO, *Standards,* available at http://www.iso.org/iso/home/standards.htm accessed 25th December 2017

25 URŠKA PETROVČIČ, COMPETITION LAW AND STANDARD ESSENTIAL PATENTS: A TRANSATLANTIC PERSPECTIVE, INTERNATIONAL COMPETITION LAW SERIES, 42 (2014). Network industries are those wherein the experience and value of a particular product for a consumer increases with the number of people using the same (or similar) product.

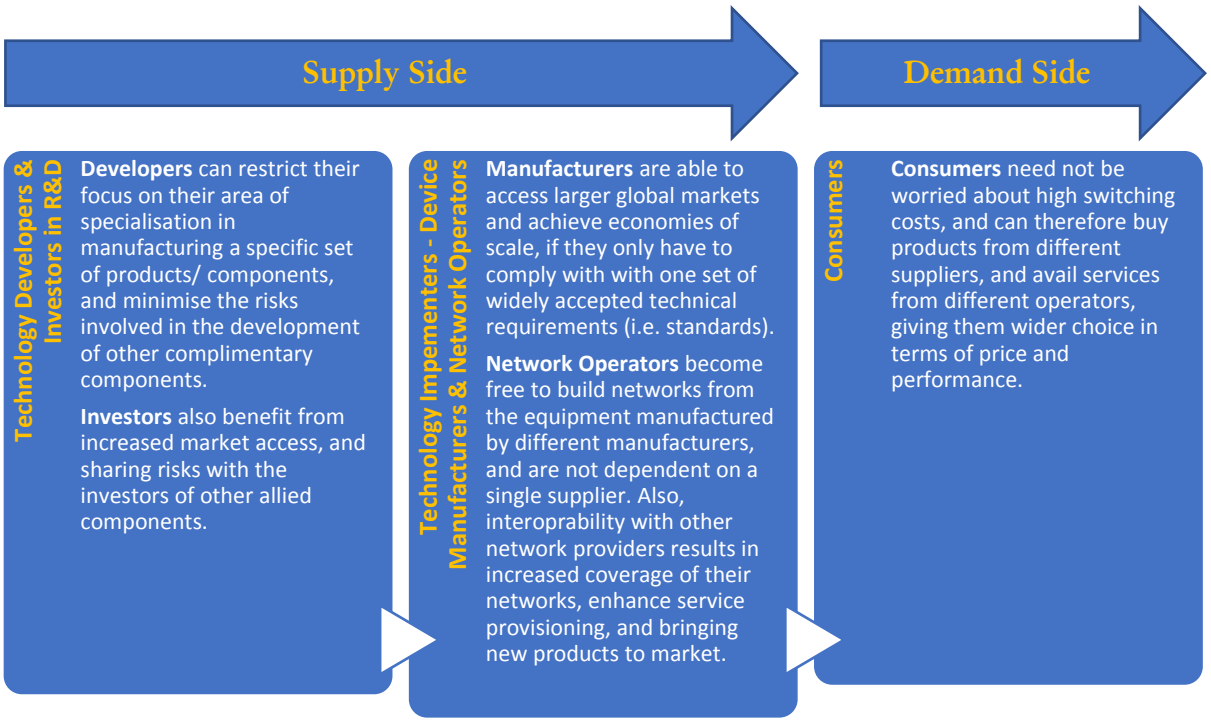
26 Geradin, Damien and Layne Farrar, Anne, *The Logic and Limits of Ex Ante Competition in A Standard-Setting Environment,* Competition Policy International, available at https://www.competitionpolicyinternational.com/assets/0d358061e11f2708ad9d62634c6c40ad/GeradinLayne.pdf, accessed on 6th April 2017.

27 ETSI, *Why we need standards,* available at http://www.etsi.org/standards/why-we-need-standards, accessed on 24th October 2017

access to established markets, provides economies of scale, encourages innovation and increases awareness of technical developments.[28] Specialisation also brings in certain non-economic advantages as well, such as: greater realisation of network effects, leading to tipping.[29] 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.[30] Buyers also remain protected from stranding, 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.[31]

In the specific context of the characteristics of the ICT sector discussed above, standards are known to become more crucial,[32] 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[33] brought forth from it have been summarised from a multi-stakeholder perspective through Figure 3.

Figure 3: Major Benefits of Standardisation (Stakeholder Perspectives)



[28] *Ibid*

[29] Tipping is the increase in a firm's market share dominance caused by indirect network effects. See Dubé Jean-Pierre H., Hitsch Günter J. et al., *Tipping and Concentration in Markets with Indirect Network Effects,* Marketing Science, Vol. 29, No. 2, March–April 2010, pp. 216–249 (2010), available at http://faculty.chicagobooth.edu/jean-pierre.dube/research/papers/216full.pdf accessed on 21st April 2017

[30] Layne-Farrar, Anne, Business Models and The Standard Setting Process, (n.22)

[31] Shapiro, Carl, Setting Compatibility Standards: Cooperation or Collusion?, Research Gate (2015), available at https://www.researchgate.net/publication/2861501_Setting_Compatibility_Standards_Cooperation_or_Collusion, accessed 8th June 2017.

[32] ETSI, What are standards?, available at http://www.etsi.org/standards/what-are-standards, accessed on 23rd December 2017

[33] ETSI, Standards for a single market, available at http://www.etsi.org/standards/why-we-need-standards/standards-for-a-single-market, accessed on 23rd December 2017

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[34] 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.

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).[35] 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

[34] ETSI, *Why we need standards*, available at http://www.etsi.org/standards/why-we-need-standards, accessed on 24th October 2017

[35] Huawei Ryan Ding: open collaboration will help bring about a single 5G standard, Huawei, (2016) available at http://www.huawei.com/ch-en/news/ch/2016/Open-collaboration-for-a-single-5g-standard, accessed on 23rd December 2017

incentives, promoting competition and ensuring market access. Notably, an optimal standard setting model needs to be timely and cost effective,[36] apart from ensuring the welfare for all the stakeholders. 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.[37]
- Standards facilitate rapid adoption of new technologies.[38]
- Emergence of standards is imminent in this sector, since they enable interoperability, network effects and connectivity, which is vital for the sector's success.

The Role of Standards in Moving to 5G

The overall purpose of a standards driven approach to 5G is to develop a systems concept that addresses the concerns and requirements for a connected information society and extend current systems to support emerging scenarios, such as Enhanced Mobile Broadband (eMBB), Massive Machine Type Communications (mMTC) and Ultra-reliable and Low Latency Communications (URLLC).[39]

Global standardisation is necessary to take the most promising research in these areas closer to implementation and deployment. Standards are critical for providing the requirements, specifications, guidelines or characteristics that can be used consistently to ensure that products, processes and services are fit for their purpose.

Cross vendor exchanges will be fundamental to 5G, and far in excess of the collaboration we observe in current networks and services. In addition to incumbent communications service providers, vendors from other industries and specialties will enter the consumer market, elevating the need to adopt or create a standards framework capable of yielding universal designs and development agendas that are fit for purpose in a global economy.

In this global and converged communications marketplace, we can observe a shift towards greater virtualisation, at platform, network and device levels.

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[36] NGMN 5G White Paper, Next Generation Mobile Networks Ltd., 11 (2015), available at https://www.ngmn.org/fileadmin/ngmn/content/downloads/Technical/2015/NGMN_5G_White_Paper_V1_0.pdf accessed on 25th December 2017

[37] Padilla et al., Economic Impact of Technology Standards, Compass Lexecon, 41 (2017), available at http://www.compasslexecon.com/highlights/economic-impact-of-technology-standards, accessed on 23rd December 2017

[38] *Ibid.*

[39] "Scenarios, requirements and KPIs for 5G mobile and wireless system," METIS, April 2013

A CONVERGED MARKETPLACE: MODERN PERSPECTIVE ON STANDARDS

An increasingly common outlook of a future communications landscape enabled by technologies such as 5G and beyond is one of converged marketplaces and services. The level of convergence and the increasingly blurred lines that have traditionally separated mobile network operators from edge service providers will lead to the creation of markets where service provisioning and capturing surplus is open to all stakeholders in the value chain. The observed convergence between SMS and instant messaging, PSTN and VoIP, and more generally Internet and media consumption are the seeds that have ushered the growth of communications technology towards a truly converged future. This convergence, along with a future that contains a high degree of hardware virtualisation are addressed in the sections that follow. An accounting of current standardisation efforts and challenges expected in the commercialisation of next generation technologies is also presented.

Telecom and internet services have evolved using distinct service architectures and in their individual pursuits have conformed to different sets of industry standards. With the evolution to next generation networks and an increasing magnitude of movement of both IT and telecom services to the cloud, we can observe greater adoption of IT technology in telecom environments as well as greater harmonisation across

Box 1: VoIP: A Standards Battle Worth Studying

With its roots in experimental projects by universities and research labs, VoIP now competes with the core revenue stream of telecommunications service providers across the world. Greater displacement of minutes is expected as we move towards better, more reliable connectivity to the Internet. VoIP is uniquely suited to this study, in that while no unified standard currently dictates a universal technical architecture, its development up to this point has certainly significantly benefitted from the work conducted by standards bodies. What started as an experimental technology, soon found application as several disparate proprietary applications, and eventually standardized by stakeholders in the communications industry along with standards bodies such as ITU and the IETF. A study of the history of VoIP can lend useful insights into how standardisation can sometimes delay time to market, but at the same build up to a paradigm that is universally acceptable. Some milestones are presented below

- Started as an experimental project at universities and research labs
- Largely relegated to academic and research pursuits till the 1990s
- First commercial application brought to market by Vocaltec in 1995
- Other providers followed suit with independent proprietary systems
- And paved the way for the development of standards such as H.323
- By the end of the century, telecom companies and stakeholders began taking note of the potential of VoIP as an alternative to PSTN
- The decentralized protocols, ITU-T's H.323 and IETF's SIP, battled bitterly during the late 1990s
- The evolving debate over these standards affected decision making in this regard at 3GPP
- In 2000, 3GPP adopted IETFs SIP for use in all IP networks
- At the same time, conflict between architectural purists and deployment pragmatics caused years of delay, specifically with respect to working around IP roadblocks – too short IP addressing space
- The purists advocated holding out for IPv6
- Pragmatists concerned themselves with the slow adoption rate of IPv6, and carefully considered alternatives such as Midcom, UPnP, STUN & TURN
- While standardisation bodies debated the best way forward, an impatient market delivered two possible commercial solutions
- Session Border Controllers (SBC), or network boxes, that mediated both signalling and media in a proprietary way allowing VoIP to traverse NATs. Market availability of this hardware eventually led to its demise
- The other answer from the market – Skype – addressed IP roadblocks and the problem of NAT by creating a proprietary peer-to-peer protocol capable of traversing NATs and firewalls
- While standardization bodies debated over an architecturally appropriate construct, skype grew exponentially in the consumer market

service architectures. A combination of open APIs, common platforms and standard technologies drove the stellar development of web services that find increasing relevance in a global economy. There are lessons to be learned from the user adoption friendly approaches of IT products and services. For instance, a keen observation of the emergence of VoIP (see Box 1) highlights that a significant delay in decision making by formal standards development organisations can actually lead to firms preferring to go for the proprietary/*de facto* route (Skype). For 5G, this can also be a lesson because a fragmented and closed ecosystem (led by efforts to establish de facto specs) can cause issues *vis-à*-vis interoperability and consumer welfare.

An IT Perspective on Standards

Convergence of IT and telecoms has been an intense area of study, research and debate over the past decade. As we move ever closer to the implementation of NGNs throughout the developed and developing world, we move ever closer to this convergence that will, and already is impacting every layer of the network. New devices, in contrast to those of yesteryear, are almost universally configured for both communication and data services. Applications that previously ran on dedicated telecom networks are now migrating to the more open Internet Protocol. As cloud services increase their fingerprint and impact, these lines that have clearly separated telecommunications service providers and data service providers will blur to the point of near non-existence. This is no more apparent than when we try to adequately define new products such as Facebook, YouTube, Twitter and many others. It is becomingly increasingly clear that future software stacks will deliver a wide range of services enabled by highly converged infrastructure. This would largely be in response to evolving consumer preferences.

- Ubiquity: Users today expect mobility by default. Anytime, anywhere, reliable and high speed access to services is perhaps the best way to describe these shifting usage patterns that stand in stark contrast to previous models where mobile services were designed and deployed over more closed mobile enabled infrastructure.
- Such demand for ubiquity necessitates separation of service and network layers. Useful products and services are already being designed to work on any network, while at the same time, take advantage of network enabled capabilities such as messaging, location, device info and billing
- The migration to cloud, for both IT services and telecom services, tends to create service software stacks that take advantage of both – IT and telecom. Economies of scale make such platforms more competitive and pervasive than TSP platforms and software stacks
- Application functionality can also be observed to be moving from server to client side implementations. This will become increasingly commonplace as they are widely adopted in enterprise environments.

Standardisation has played a critical non-replaceable role in shaping the internet and achieving harmonisation in the architecture of web services. When appropriately implemented, such web services make use of, at the least, availability of open platforms, standard device features and the global reach of the internet. APIs and open platforms have been critical for such developments,

and standardisation has been instrumental for developers to drive the adoption of their technology.

Virtualisation: The Name of the Game

As we moved ever closer and towards better more reliable connectivity, even before we had an understanding of final performance requirements of 5G, the market already responded with increasing levels of virtualisation. A reliable 5G network will accelerate the need for and efforts to virtualise an increasing amount of hardware. In the sections that follow, we take a look at how virtualisation is poised to interact at device, platform and network levels.

Devices

Converging device categories, intense competition amongst capable operating systems and increasing levels of hardware interconnection are all common features in our modern communications networks. This makes cross platform development of applications a complex proposition. A consistent and effective response to this problem has manifested in the market in the form of web applications.

The shift to web 2.0 allowed greater user participation on the Internet, paving the way for purposeful web applications that largely maintained a consistent user experience across platforms. This was due in large part to standardised technologies such as HTTP, HTML, CSS and/or JavaScript.

There are however minor inconsistencies between experiences across platforms/devices due in most cases to restrictions imposed by platform designers and device manufacturers. Projects such as webinos are hard at work with a clear mandate to solve this problem. It is attempting to do so by creating a set of standards that enable reaching all devices and platforms in terms of comprehensive application execution. Such a paradigm could be appropriately articulated as one that enables the virtualisation of devices.

Networks

While virtualised devices may still be a relatively distant commercial reality, the virtualisation of networks will precede it by quite some margin. As telecommunications service providers wrestle a highly disruptive market, new clear trajectories are indicating a significant shift in our communications environment – a change that is expected to manifest in short order. The virtualisation and the creation of a platform for supporting a continuum between real objects and their cloud doppelgangers could be a means for telcos to radically transform their service portfolios.

Networks, as can be observed, will continue to become more pervasive & dynamic, reach out to an ever-increasing universe of nodes, smart devices, nearly everything that can be equipped with a sensor, and would include a functional communications layer that integrates all of these

elements. In the future, anything will be a network node, and we'll have to contend with many billions of electronic devices connected not just to the internet, but to each other as well[40].

This evolution will have a significant socio-economic impact. It will stimulate economic development, provide useful and effective ways for public institutions to engage with citizens, build communities and social relations, act as the most effective information dissemination vehicle, ensure the privacy of citizens, and much, much more.

Platforms

IT and web companies got the jump on telecom companies and are today the top and widely preferred providers of cloud computing products and services. This assumes greater importance when considered from the simple perspective that telecom companies were always ideally suited for the pursuit of such technical outcomes – they possessed the capital, the experience of dealing with global infrastructure and scale, and owned the network – a critical component for developing reliable cloud products and services.

IT companies dominate this space and offer cloud services in a walled garden fashion creating wide segmentation in the market. Telcos can compete effectively by being disruptive at both technical and market levels.

"The National Institute of Standards and Technology (NIST) defines cloud computing as a "pay-per-use model for enabling available, convenient and on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction "[41]

According to NIST,[42] a Cloud Computing system is characterised by a set of essential characteristics, such as:

- On-demand self-service, i.e., the capability offered to a user to directly manage all needed infrastructure.
- Broad network access, i.e., the ability to access to Cloud Services by means of common (Internet based) mechanisms independently from the underlying networks (fixed, mobile) and compatibly with the most common devices (PC, Mobile phones, tablet and the like).
- Resource pooling, i.e., the Providers can dynamically integrate needed resources in order to satisfy customers' needs. Examples of resources are storage, processing, memory, and network bandwidth.
- Rapid elasticity, i.e., the capability to flexibly allocate the needed resources according to availability and customer's demand.

[40] OECD, Machine-to-Machine Communications: Connecting Billions of Devices. OECD Digital Economy Papers, No. 192. OECD Publishing (2012), http://dx.doi.org/10.1787/5k9gsh2gp043-en

[41] Mell, P., Grance, T.: The NIST Definition of Cloud Computing (Draft) Recommendations of the National Institute of Standards and Technology. Nist Special Publication 145, 7 (2011)

[42] *Ibid*

- Measured service, i.e., the Providers should make available to customers a precise accounting of resources allocated and used.

The features and capabilities of a Cloud system can be summarised into a well renowned model that foresees three majors Service Models:

- Software as a Service (SaaS), i.e., services and applications are delivered to users by means of a web browsers and /or specific client applications.
- Platform as a Service (PaaS), i.e., all the typical functionalities of a software platform (e.g., libraries, tools, services) are provided to the users by means of a browser or a client application.
- Infrastructure as a Service (IaaS), i.e. basic capabilities, like processing, storage, and connectivity, are provided to the user that can configure them (e.g., through a web browser of client applications) in order to deploy and execute his/her own services and applications.

From a deployment perspective, the NIST definition includes four options:

- Private cloud. A full infrastructure (comprising management capabilities) is offered to a single organisation.
- Community cloud. The infrastructure is offered and provisioned for exclusive use by a specific community of consumers.
- Public cloud. The cloud infrastructure is offered and provisioned for open use by the general public. This refers mainly to SMEs and residential (but not only) customers.
- Hybrid cloud. The cloud infrastructure is an integration of different cloud infrastructures that remain separated, but are capable of interoperating by means appropriated technology and business goals.

The work of standardisation bodies with respect to cloud computing should be closely monitored by telecommunications service providers – a strong contender that has remained largely absent or ineffectual in the market. Building cloud capabilities for new and existing services and products should be a priority for all stakeholders.

Internet of Things & Services

One of the most widely recognised beneficiaries of 5G is the Internet of Things. There is however little consensus on what IoT really is. In their paper titled "The Internet of Things: A survey", Atzori et al point out the differences between prevailing perceptions of the nature of the Internet of Things.[43] According to the authors, the "variety of viewpoints" stems from the location, mixing the notion of 'Internet'. The utility of the Internet is highly subjective with some finding its purpose in networking aspects and others using it as a repository of socially-meaningful data and services. The notion of 'things' is subject to even more interpretation in an IoT paradigm.

[43] Atzori, L., Iera, A., Morabito, G.: The Internet of Things: A survey. Computer Networks 54(15), 2787–2805 (2010)

A first diversion in viewpoints according to the authors is based on whether the considered actor has an Internet-oriented (i.e., focussed on communication infrastructure and mechanisms, i.e. Machine-to-Machine) or an Object-oriented view (i.e., focussed on real-world objects reflected in the network or supplemented/augmented with Information Technology (IT) services, i.e. Radio Frequency Identification (RFID). Another dimension diverges on the topic of complex distributed systems. As more heterogeneous objects get integrated into an Internet of Things, new means to manage, describe, discover, and use these connected resources and the data they produce will be required.

Embedded microcontrollers, actuators, network interfaces, sensors and the public Internet will aid in the evolution of the Internet from a network of interconnected computers to one interconnected with objects. These objects would be able to influence one another on the basis of their functionality spectrum in a context and time sensitive manner.[44]. Based on these concepts, the fundamental characteristics of the IoT are:[45]

- Interconnectivity: Any type of thing will have the potential to be interconnected with the communication infrastructure.
- Things-related services: The IoT is capable of providing thing-related services within the constraints of things, such as privacy protection and semantic consistency between physical things and their associated virtual things. In order to provide thing-related services within the constraints of things, the technologies in both the physical world and the world of information and communications will change.
- Heterogeneity: IoT devices are heterogeneous, ranging from tiny sensors and actuators to mobile devices and large computers, and based on different hardware platforms and networks. They can interact with other devices or service platforms through various networks.
- Dynamic changes: The state of devices changes dynamically, e.g., sleeping and waking, connected/disconnected, etc. as does their context, including location and speed. Moreover, the number of devices can change dynamically.
- Enormous scale: By 2020, there will be 50 billion things that will need to be managed and to communicate with each other.[46,47] Even more critical will be the management of the data generated and its interpretation for application purposes. This aspect relates to the semantics of data, as well as its efficient handling.

The momentum towards achieving 5G enabled IoT necessitates the need to seriously consider interoperability between IoT solutions. Towards such a direction, all major standardisation bodies have established working groups dedicated to this goal. Most Standards Developing Organisations (SDOs) have only recently been formed and the overall specifications are still under development. Of the few specifications that have been published, most only address overall

[44] Guillemin, P., Friess, P., et al.: Internet of Things - Strategic Research Roadmap. The Cluster of European Research Projects on the Internet of Things (CERP-IoT) Strategic Research Agenda (SRA) (September 2009)

[45] *Ibid*

[46] Evans, D.: The Internet of Things – How the Next Evolution of the Internet is Changing Everything. White Paper, Cisco (April 2011)

[47] More than 50 billion connected devices. Ericsson White Paper (February 2011)

system requirements and architecture and do not delve into the specifics of detailed solutions.[48,49] It is, however, clear once again, that standards development organizations will play a crucial role in bringing the IoT to market.

Moreover, the manner in which the standards are developed will also affect the robustness and ubiquity of the 5G network. Despite there being several models of standards development, such as the proprietary and government-led models, collaborative standards development has held a superior position when it comes to benefits regarding consumer welfare, interoperability, competition (and innovation and continues to do so). To that end, it is crucial that governments, policymakers, firms and standards development consortia recognise the importance of collaborative and democratic processes and simultaneously realise that trade wars[50] and legal disputes between developers and implementers in an increasingly converging marketplace[51] will not be beneficial for 5G rollout and for the IoT ecosystem.

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48 Yang, D.-L., Liu, F., Liang, Y.-D.: A survey of the Internet of Things, pp. 358–366. Atlantis Press (2010)

49 Krishnan, V., Sanyal, B.: M2M technology: challenges and opportunities. White paper,Tech Mahindra (2010)

50 Communications Today, The Tech Is Ready; Geopolitics Is Hindering A Global 5G Rollout, (03rd May 2018) available at http://communicationstoday.co.in/21333-the-tech-is-ready-geopolitics-is-hindering-a-global-5g-rollout

51 V. Richard, *Smartphone wars: A Phantom Menace*, (2017) available at https://www.competitionpolicyinternational.com/wp-content/uploads/2017/11/CPI-Vary.pdf

POLICY PRESCRIPTIONS & THE WAY FORWARD FOR 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 licencing 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 vs 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.[52]

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:

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

As the 5G network will act as a key enabler of the upcoming 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

[52] Padilla et al., *Economic Impact of Technology Standards*, Compass Lexecon (2017), available at http://www.compasslexecon.com/highlights/economic-impact-of-technology-standards

encourage exponential pace of change in numerous industry verticals.[53] 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.[54]

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.[55] 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).[56] Despite the challenges to standards development posed by an ever increasing level of industry convergence, there are major *advantages* for industry players and policymakers to encourage and participate in collaborative modes of standardisation (See Table 1).

Table 1: Advantages and disadvantages of collaborative versus proprietary approaches with reference to vertical 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

[53] 5GPP, *5G Innovations and New Opportunities*, (2017) available at https://5g-ppp.eu/wp-content/uploads/2017/03/5GPPP-brochure-final-web-MWC.pdf

[54] Jean-Sébastien Bedo et. A., *Making 5G a real booster for vertical markets*, available at https://5g-ppp.eu/wp-content/uploads/2015/12/5GandVerticalSectorsEUCNCpaper.pdf

[55] Sharpe Smith, *5G Standards Process Faces Possible Pitfalls — Experts*, (25th August 2016), available at http://www.aglmediagroup.com/5g-standard-process-faces-numerous-possible-pitfalls-experts/

[56] Ramjee Prasad, *Challenges to 5G standardization*, available at https://itunews.itu.int/en/4619-challenges-to-5g-standardization.note.aspx

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.[57] Hence, it is important for policymakers to first recognise aspects which make a process collaborative and open. 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 Fair Reasonable and Non-Discriminatory (FRAND) terms
- Can take place in formal setups or through informal consortia.[58]

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.[59]

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.

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

[57] It has been seen in the past that proprietary efforts can also eventually lead to collaborative setups in the form of industry consortia. For instance HDMI and USB standards were industry initiatives. Another example is the Open Handset Alliance which contains several members, varying from mobile operators, handset manufacturers, semiconductor companies etc. See https://www.openhandsetalliance.com/oha_members.html

[58] Padilla et al., *Economic Impact of Technology Standards*, Compass Lexecon, 41 (2017), available at http://www.compasslexecon.com/highlights/economic-impact-of-technology-standards

[59] Ibid., at 42

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 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 licencing of Standard Essential Patents (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 licencing for example, the Federal Trade Commission (FTC) in collaboration with the United States Department of Justice (DoJ)[60], the Japan Fair Trade Commission (JFTC)[61] and the European Commission (EC).[62] In this regard, The European Commission, which recently released its communication setting out specifically the EU approach to SEPs, is worth noting.[63] 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 licencing of SEPs, the EC took a very balanced approach by highlighting the importance of good faith negotiations, clarifying that licencing 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.[64] Noticeably, the EC's approach also puts forth recommendations which encourage maintenance of transparency *vis-à-vis* SEP exposure and support optimisation of

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[60] US DoJ & FTC, Antitrust Guidelines for the Licencing of Intellectual Property, https://www.justice.gov/atr/IPguidelines/download

[61] Available at http://www.jftc.go.jp/en/legislation_gls/imonopoly_guidelines.files/IPGL_Frand.pdf

[62] Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements, available at http://ec.europa.eu/competition/consultations/2010_horizontals/guidelines_en.pdf and Guidance on the Commission's enforcement priorities in applying Article 82 of the EC Treaty to abusive exclusionary conduct by dominant undertakings
available at http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52009XC0224(01)&from=EN

[63] European Commission, *Setting out the EU approach to Standard Essential Patents: Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee,* (2017), available at http://www.mlex.com/Attachments/2017-11-29_S0TV38CYI2RDO43O/com-2017-712_en.pdf

[64] *Ibid*., at p.6

processes of collaborative platforms such as SDOs.[65] Case laws, particularly the *Huawei v. ZTE*[66] 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 licencing) and in their endeavour to do so, the general rule should be to treat standards and licencing 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.

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.[67] 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.[68] 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.[69]

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

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65 *Ibid*., at p.3-5

66 Case C-170/13 Huawei Technologies, EU:C:2015:477

67 Gupta Kirti, Wong-Ervin et. al., *IP Leadership Brussels: Highlights and Economic Analysis*, (2017), available at https://www.competitionpolicyinternational.com/wp-content/uploads/2017/11/CPI-Gupta-Wong-Ervin-Coniglio-Naegele.pdf

68 Kjelland Kurt M., *Some Thoughts on Hold-Up, the IEEE Patent Policy, and the Imperiling of Patent Rights,* available at https://www.law.berkeley.edu/wp-content/uploads/2015/09/17-Antitrust-Kjelland1.pdf

69 *The IEEE's new patent policy one year on – the battle that's part of a bigger licensing war*, (2016) available at http://www.iam-media.com/Blog/Detail.aspx?g=e8f72d6e-a3f8-45d8-882f-3ebdd3a1d69e

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.

Opportunities for India

India currently stands 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. There are several opportunities and challenges for India in this regard.

Apart from the imperative of creating a robust and reliable communications infrastructure, there is a massive opportunity for the country to leverage its untapped innovative capacities and contribute to the growing digital ecosystem. This has also been reflected in the draft of the National Digital Communications Policy 2018, according to which one of the key missions is to propel India by enabling "next generation technologies and services through investment, Innovation and IPR generation".[70] The specific goals (to be achieved by 2022) under this mission include the "creation of globally recognized IPRs in India" and "the development of SEPs in the field of digital communication technologies".[71] However, as explained below, this remains a challenging task and requires a unified and coordinated approach by all stakeholders.

Innovation in India and Technology Outputs

Presently, there remains significant scope for India to progress in terms of contributing to Global Value Chains (GVCs) and increasing local value addition through technology generation and development. Until now, the lack of a robust innovation ecosystem for technology development and knowledge-based outputs in India has posed an immense challenge for policymakers and industry players alike.

Going by India's progress in the past three years (Table 2), it is quite evident that there is substantial scope to revisit its approach towards 'Knowledge and Technology Outputs', which constitute one of the Key Pillars of innovation. Furthermore, a cursory look at key indicators (over three years) such as Knowledge Creation, Patents by Origin, Knowledge Diffusion and IPR Receipts depicts either a stagnating or a decreasing trend (Figure 4).

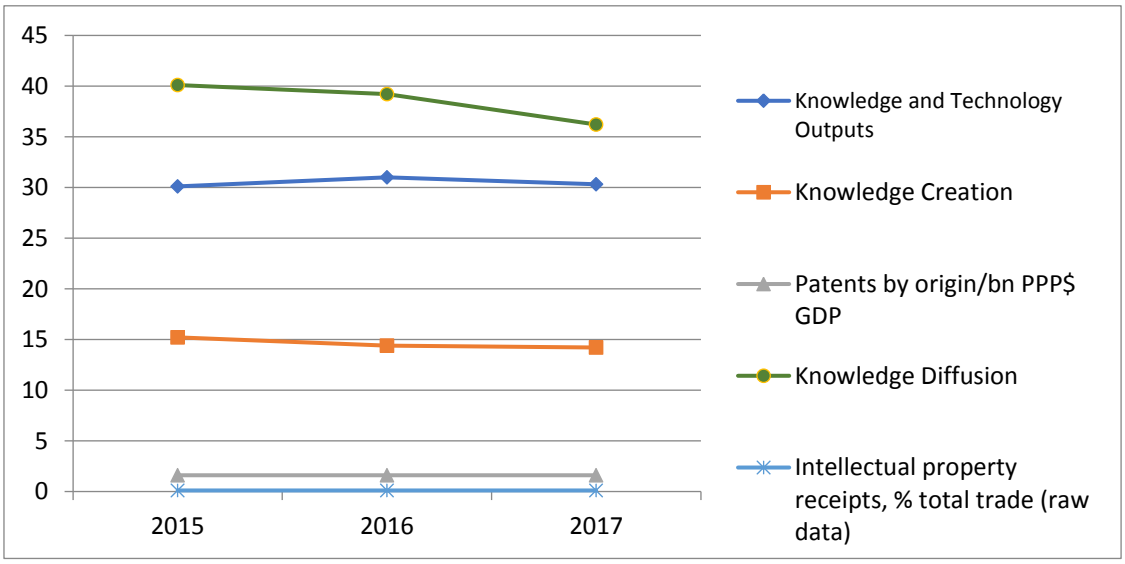
[70] Draft National Digital Communications Policy – 2018, available at http://dot.gov.in/sites/default/files/DNDCP2018.pdf
[71] *Ibid*., at p.12

Table 2: Global Innovation Index (GII) – India's Scores and Rankings[72]

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

Source: Global Innovation Index Reports (2015-2017)

Figure 4: Trends of Key Pillars/Sub-Pillars and Indicators based on GII's Value/raw data



Source: Global Innovation Index Reports (2015-2017)

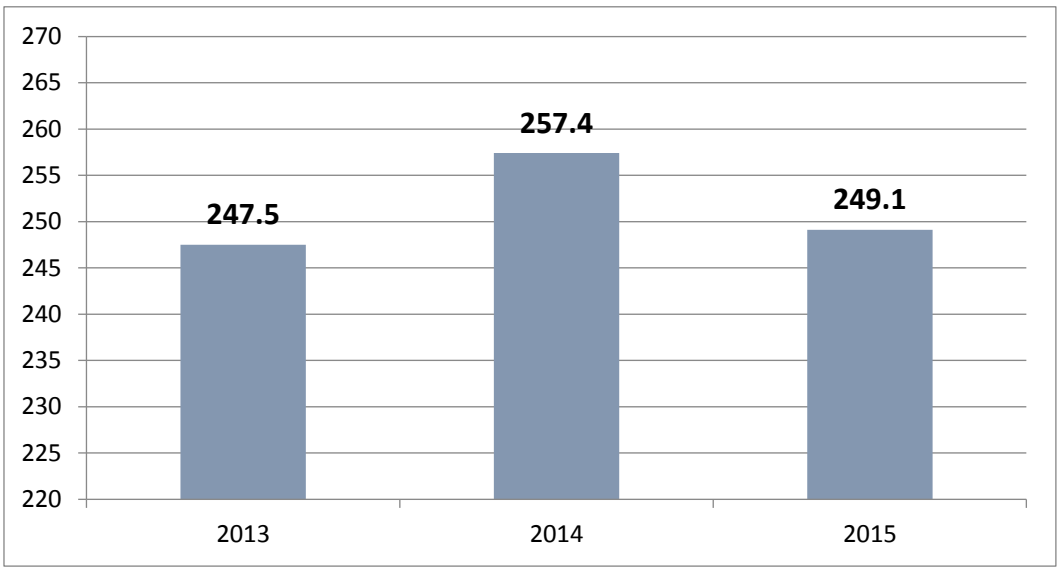
The Indian smartphone industry is a typical case in point, which personifies the aforementioned scenario. If we look at the situation of smartphone production in India, it is clear that India has been successful as far as assembling of mobile handsets is concerned, but the underlying value

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

addition has been miniscule compared to other emerging economies.[73] The general lack of innovation in the Indian smartphone industry and low competitiveness of domestic players (the reason for this stems 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) has 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 2 and Figure 4). Hence, there is substantial scope for India to develop its indigenous IP pool, especially in the ICT device manufacturing industry.

It is also evident that 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, India is trapped in being a mere consumer/follower of almost all ICT technologies, and has not managed to contribute as an implementer of technology in the global value chain. Owing to the lack of indigenous IP pool, India seems to be lagging behind its developing counterparts such as China and Korea. R&D capacity and associated investments are also weak. Moreover, stats depict that India accounts for a production of nearly 100 million mobile phones which has significantly risen from 68 million in 2014. This includes major manufactures such as Panasonic, Mitsubishi, Samsung, LG, Flextronics, along with Indian manufacturers such as Micromax, Lava, Intex among others. However, despite being a producer, India imports more handsets than its produces domestically (Figure 5).[74]

Figure 5: Number of Handsets imported in India (in millions)

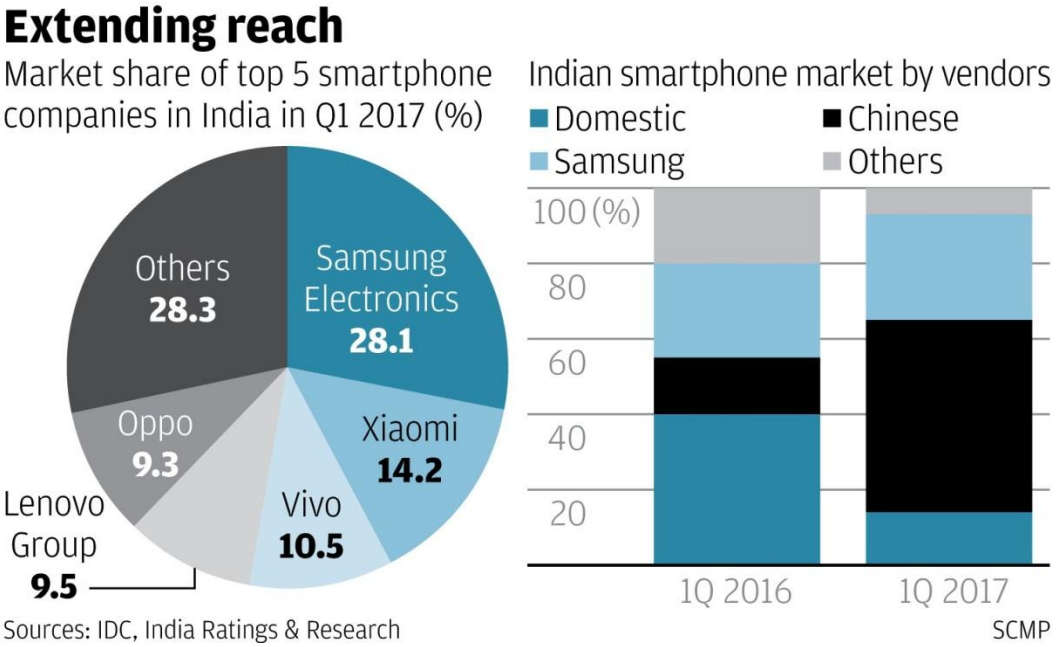


The fact that Indian origin manufacturers have not been able to innovate to meet rising competition has resulted in decreasing market shares for domestic players (Figure 6).

[73] IIM Bangalore & Counterpoint Research, *Maximizing Local Value Addition in Indian Mobile phone manufacturing: A practical phased approach,* at p.26, (2016)

[74] India imports roughly 83 percent of its local demand of mobile phones

Figure 6: Falling Market Shares of Indian Smartphone Makers



Source: Ind-Ra and IDCG[75]

Be that as it may, it is important to highlight that the Indian regulators are aware of this overarching scenario. Accordingly, in its draft inputs for the formulation of the National Telecom Policy – 2018, the Telecom Regulatory Authority of India stated,

> "*While the objectives of National Telecom Policy-2012 relating to subscription of telecommunication services have largely been met except for rural teledensity, the expected success in making India a global hub of domestic manufacturing, development of state of the art technologies through R&D, and creation and incorporation of Indian IPRs in global standards is yet to be achieved.*"[76]

Therefore, at this crucial juncture, the willingness of policymakers to make necessary adjustments in policy frameworks to foster innovation will determine whether India can utilise the powerful mechanism of ICT to achieve its developmental goals.

The Way Forward and the 5G Opportunity

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.[77] The Policy is meant to carry forward and implement its Vision of 'encouraging creativity and innovation in IP-led growth for the benefit of all'. To achieve this

[75] Available at http://www.scmp.com/business/companies/article/2100017/indians-warm-xiaomi-vivo-oppo-pushing-chinese-brands-51-cent

[76] TRAI, Inputs for Formulation of National Telecom Policy – 2018, available at https://www.trai.gov.in/sites/default/files/Recommendation_NTP_2018_02022018.pdf

[77] GOI, *National Intellectual Rights Policy, 2016*, available at http://dipp.nic.in/sites/default/files/National_IPR_Policy_English.pdf

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.[78]

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,[79] 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 Rs 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.[80]

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.[81]

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

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78 *Ibid.*

79 Because it would provide a new dimension to the Digital India, Smart Cities, and Smart Village initiatives and could potentially make huge contributions to the Make in India and Start-Up India missions as well. See Ramachandran TV, *5G – The Way Forward,* Communications Today (December 2017), available at http://communicationstoday.co.in/perspective/17812-5g-the-way-forward

80 Rathee Kiran, *Govt to create Rs 500-cr fund for R&D in 5G,* Business Standard (27th September 2017), available at http://www.business-standard.com/article/economy-policy/india-looking-to-position-itself-as-a-leader-in-5g-technology-117092600735_1.html

81 GOI, Department of Telecommunications, Notification No. 6-33/2017, *Constitution of High Level Forum for 5G India 2020*, available at http://www.dot.gov.in/sites/default/files/5G%20India%202020%20High%20Level%20Forum_1.pdf

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 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 US, China, Japan, South Korea and Germany have SEP stocks above the third quartile of all SEPs.[82] 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.[83] The underlying rationale is that it would give such firms greater bargaining power in licencing negotiations and also increase the possibilities of cross-licencing.[84]

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.[85]

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 governments 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

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82 Ramel, Florian and Laer, Maximilian et. al., *Standard Essential Patents and the Distribution of Gains from Trade of Innovation*, (2016), available at https://www.eastwestcenter.org/sites/default/files/filemanager/pubs/pdfs/5-5RamelVonLaerBlind.pdf

83 *Ibid.*

84 Contreras Jorge L., *National Disparities and Standards-Essential Patents: Considerations for India,* COMPLICATIONS AND QUANDARIES IN THE ICT SECTOR: STANDARD ESSENTIAL PATENTS AND COMPETITION ISSUES (Ashish Bharadwaj, Vishwas Deviah & Indraneth Gupta, eds., Springer, 2017)

85 *Ibid.*

voluntary standard setting activities. Also, the India EU ICT Standardisation collaboration,[86] which aims 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*" is also encouraging. It strengthens the thought process that in order to achieve its long-term ambitions, India is ready to initiate 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 (Chapter II) and the relative advantages and disadvantages *vis-à-vis* different modes of standardisation (Chapter III) 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.[87] *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.[88]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

[86] For more information, visit http://www.indiaeu-ictstandards.in/
[87] Contreras Jorge L., *National Disparities and Standards-Essential Patents: Considerations for India* (n.85)
[88] *Ibid*

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. By influencing global policy progress to the benefit of domestic firms, such institutions can practically provide the much needed impetus to domestic innovations by incentivising domestic firms to invest in specific R&D efforts and also facilitate them to compete globally.[89]

To this end, 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 Programme'.[90] 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

[89] *Ibid*

[90] For more information, see http://www.iicb.org/

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 licencing 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 licencing 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.[91]

[91] This recommendation is in consonance with EC's recent Communication which sets out the EU approach to Standard Essential Patents. See European Commission, *Setting out the EU approach to Standard Essential Patents: Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee,* (2017), available at http://www.mlex.com/Attachments/2017-11-29_S0TV38CYI2RDO43O/com-2017-712_en.pdf

APPENDIX 1

STANDARD SETTING PROCESSES AND THE EVOLUTION OF TECHNOLOGY STANDARDS: A HISTORICAL PERSPECTIVE

Since standards are indispensable in ICT sector, they eventually do emerge. 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 7.

Figure 7: Types/models of standard setting

Standard Setting Models		
Proprietary standards and subsequent industry-wide adoption.	**Government(s) imposition of a standard** is another way of standard setting.	**Standards developed through collaborative and democratic standardisation processes** via standard development organisations (SDOs) which comprise of numerous and a variety of stakeholders including consumer / user representatives, industry consortia and experts in the relevant technical fields.

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*.[92]

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.[93] The numerous possibilities vis-à-vis the use cases of 5G

[92] Heintzman Douglas, *An introduction to open computing, open standards, and open source,* (2003), available at https://www.ibm.com/developerworks/rational/library/1303.html, accessed on 23rd December 2017

[93] 5G still has a risk of specification fragmentation, available at http://telecoms.com/478151/5g-still-has-a-risk-of-specification-fragmentation/ accessed on 23rd December 2017

technology is the driving factor behind operators trying to surpass collaborative standardisation efforts, and stimulate unilateral 5G activities and testing.[94]

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[95] due to high barriers to imitation[96], 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.[97] 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.[98]

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.[99]

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

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94 Kelly Hill, *5G standards pose a challenge,* RCR Wireless News (1st December 2016), available at https://www.rcrwireless.com/20161201/test-and-measurement/5g-standards-pose-challenge-tag6

95 Lemley Mark, A. & McGowan, David, *Could Java Change Everything? The Competitive Propriety of a Proprietary Standard*, Antitrust Bulletin, Vol. 43, p. 715, (1998), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=57515 accessed on 23rd December 2017

96 West Joel, *How open is open enough?: Melding proprietary and open source platform strategies,* Research Policy 1259-1285 (2003): doi:10.1016/S0048-7333(03)00052-0, available at http://scholarworks.sjsu.edu/cgi/viewcontent.cgi?article=1003&context=org_mgmt_pub accessed on 14th November 2017

97 *Ibid.*

98 Burrone Esteban, *Standards, Intellectual Property Rights (IPRs) and Standards-setting Process*, available at http://www.wipo.int/sme/en/documents/ip_standards_fulltext.html, accessed on 13th October 2017

99 Supra Note, (n.4)

the paradigm for standardization efforts in the past[100], 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.[101]

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.[102]

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.[103]

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.[104]

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.

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.[105] 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

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100 *Ib*id

101 Supra Note 96 (n.5)

102 Padilla et al., *Economic Impact of Technology Standards*, Compass Lexecon, 41 (2017), available at http://www.compasslexecon.com/highlights/economic-impact-of-technology-standards, accessed on 23rd December 2017

103 Padilla et al., *Economic Impact of Technology Standards*, Compass Lexecon (n.11)

104 *Ibid*

105 *Ibid*

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.

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.[106] 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).[107]

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).[108] Technology R&D 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.*[109] 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.*[110]

Open voluntary cooperative standards are developed or ratified through an open, consensus-driven process, usually through a Standard Development Organization (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,

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106 *ICT standardisation*, European Union, available at https://ec.europa.eu/growth/industry/policy/ict-standardisation_en accessed on September 17, 2017

107 James Donovan, *Cellular Wireless 1G, 2G, 3G, 4G, 5G – Watch The Evolution,* Comscope, available at http://blog.commscopetraining.com/cellular-wireless-watch-the-evolution/ accessed on September 17, 2017

108 *NGMN 5G White Paper*, Next Generation Mobile Networks Ltd., 11 (2015), available at https://www.ngmn.org/fileadmin/ngmn/content/downloads/Technical/2015/NGMN_5G_White_Paper_V1_0.pdf accessed on December 25, 2017

109 *Huawei Ryan Ding: open collaboration will help bring about a single 5G standard*, Huawei, (2016) available at http://www.huawei.com/ch-en/news/ch/2016/Open-collaboration-for-a-single-5g-standard, accessed on December 23, 2017

110 ISO deliverables, available at https://www.iso.org/deliverables-all.html, accessed on 2nd November 2017

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.*[111] Clause 15.6[112] 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.*[113]

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.[114]

Economies of scale: a wider market brings with it economies of scale which greatly benefits manufacturers.[115]

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,[116] thereby fostering upstream and downstream competitive markets.[117]

Balance: due to its inherently efficient, open and inclusive process, it creates a working balance between the interests of all the stakeholders involved.[118]

Handpicking the best technologies: markets characterised by network effects, are aided by SDOs in transitioning from inferior to new superior technologies.[119]

Upstream and Downstream participation: more and implementers of mobile technology have emerged, even in developing economies like India and China, thus increasing the downstream

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111 ETSI, *Guide on Intellectual Property Rights,* available at http://www.etsi.org/images/files/IPR/etsi-guide-on-ipr.pdf accessed on March 07, 2017.

112 ESSENTIAL as applied to IPR means that it is not possible on technical (but not commercial) grounds, considering normal technical practice and the state of the art generally available at the time of standardization, to make, sell, lease, otherwise dispose of, repair, use or operate EQUIPMENT or METHODS which comply with a STANDARD without infringing that IPR. For the avoidance of doubt in exceptional cases where a STANDARD can only be implemented by technical solutions, all of which are infringements of IPRs, all such IPRs shall be considered ESSENTIAL".

113 Rao D And Shabana N, *Standard Essential Patents*, Singhania & Partners, available at Http://Www.Singhania.In/Wp-Content/Uploads/2016/04/Standard-Essential-Patents.Pdf, accessed on 8th March 2017.

114 ETSI, *Why we need standards,* available at http://www.etsi.org/standards/why-we-need-standards, accessed on October 24, 2017

115 *Ibid.*

116 Burrone Esteban, *Standards, Intellectual Property Rights (IPRs) and Standards-setting Process*, available at http://www.wipo.int/sme/en/documents/ip_standards_fulltext.html, accessed on October 13, 2017

117 Tsilikas, Haris, *Collaborative Standardization and Disruptive Innovation: The Case of Wireless Telecom Standards*, Max Planck Institute for Innovation & Competition Research Paper No. 16-06 (2016), available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2783372, accessed on November 25, 2017

118 *Ibid.*

119 *Ibid.*

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 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.[120]

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[121] thereby resulting in royalty stacking for implementers;

Lack of clarity on FRAND terms: the blurred definition of FRAND terms and royalty rates are subjective, leading to friction between the technology developers and its implementers, ultimately resulting in lengthy and expensive litigation.[122]

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.

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

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[120] *Ibid*

[121] Hemphill, C. Scott, *Intellectual Property and Competition Law*, Oxford Handbook of Intellectual Property Law (Rochelle C. Dreyfuss & Justine Pila eds. 2017). Available at https://ssrn.com/abstract=2965617 or http://dx.doi.org/10.2139/ssrn.2965617, accessed on November 16, 2017

[122] A Layne-Farrar, AJ Padilla and R Schmalensee, *Pricing patents for licensing in standard-setting organizations: Making sense of FRAND commitments*, Antitrust Law Journal
Vol. 74, No. 3 (2007), pp. 671-706, available at https://www.jstor.org/stable/27897563?seq=1#page_scan_tab_contents, accessed on November 16, 2017

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[123]	They are agreed and accepted by the whole industry as 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 fast and hassle free
Industry Perspective		
R&D Incentives	Royalty rates need to conform to FRAND commitments if accepted as a *de jure*[124] standard by an SDO	Higher returns if transformed into a *de facto*[125] 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

However, identifying and adopting one single model of standard setting for the 5G technology comes with its own complications.

[123] Difference between Proprietary and Standard Protocols, available at http://www.omnisecu.com/basic-networking/difference-between-proprietary-and-standard-protocols.php, accessed on November 17, 2017

[124] De jure standards are developed and adopted by some authorised standasation body, such as by treaty among national governments, or voluntary non-treaty organisations. 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

[125] *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,* available at http://www.informit.com/articles/article.aspx?p=352983&seqNum=5

CUTS International

Consumer Unity & Trust Society
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