COMMUNICATION STANDARDS ADOPTION IN DEVELOPING ECONOMIES: ISSUES AND OPTIONS FOR INDIA[1]

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1. Introduction

Given the importance of communications in today's world, its spread in developing economies is critical for their development. Emergence of standards reduces market and technological uncertainty and lays the foundation for market creation. This in turn enhances the diffusion of communication technologies partly through economies of scale advantages. Due to these network externalities, adoption of standards is very important for developing countries. A variety of approaches to standard adoption exist. Which approach is most suitable for a country like India? What are the critical issues that are relevant for standards adoption? Can we come up with some broad parameters of a framework that can be used to analyse various issues relating to setting of communication standards?

Standardisation has become increasingly important with the rise in cross-fertilisation between information technology (IT) and other technologies, especially in communications. Large-scale use of PCs by the corporate sector, government departments and households has created new needs to link the PCs within networks. This is essentially because the consumers are increasingly demanding compatibility and inter-operability. At the same time growing diversity of satellite and other telecom equipment and of software make standardisation processes very complex and difficult. Moreover, rapid changes in IT related technologies has put the standardisation system under pressure: while standards have become urgent to create markets, consensus among interested groups is more difficult to achieve due to uncertainties and the magnitude of vested interests.

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Under these circumstances, strategic implications of IT standardisation are huge because standards can determine the growth potential of individual firms, affect the competitive advantage of nations and even development of technologies and their diffusion. It is recognised that market mechanisms do not provide adequate assurance that the best technology will prevail or that an obsolete one be replaced at the right time.

Implementation of communication networks, with competing networks poses a challenge in choosing an appropriate standard. The standard selection is not a straightforward decision of choosing the standard promising the best performance. When standards compete, the best possible standard may lose out in the market. Customers locked into losing standard may face the situation of slow or no upgradation. The critical choice is between remaining standard neutral and specifying a standard to be deployed. Each policy decision has its advantages and disadvantages. For example, one of the advantages of implementing a single standard is market creation and the associated faster technology diffusion. At the same time, there exists a possibility of being stranded with a standard that might lose out in the standard war (technological lock-in) or with an inefficient standard (regulatory failure). In the same vein, some of the advantages of remaining standard neutral are that the market determines the standard and there is no regulatory inefficiency in the standard setting. However, standard neutrality may mean that an inefficient standard may win the battle (market failure). Neutrality may also lead to problems arising from the refusal by network operators to make their networks compatible to some applications. Similar problems may exist in implementing a single standard if owners of intellectual property (IP) that goes into making a standard may refuse to license it to others.

Given the advantages and disadvantages for each policy decision, it becomes imperative to follow a dynamic strategy towards standard adoption. The standard setting also has to take into account the interdependence of various technological domains so that it can facilitate innovation in the ICT related technologies. This paper will explore these questions in the context of the experience of standard setting elsewhere in the world and identify key issues and options for India. The rest of the paper is divided into 4 sections. The next section briefly discusses the general approaches to standard setting and highlights the role of standards in network industries. This is followed, in section 3, by a discussion on standard setting approaches adopted by Europe, the United States and South Korea in the context of mobile standards. Section 4 pools together the key issues related to the standard setting process and identifies policy options for India, once again in the context of cellular standards. The final section broadens the scope of the discussion and raises some general issues with respect of standardisation processes and IT in India.

2. Standards and Networks[2]

Standards can be broadly defined as an *agreed* upon set of specifications that define a particular product or that *allow products to inter-operate.* Standards can be achieved through market selection, a regulatory process of the government or a voluntary consensus process.

2.1 Standard Setting Processes

When the market operates effectively, appropriate standards are expected to emerge at the right time through the process of supply and demand. Producers will agree on the best standard in the face of competition from other suppliers and the demand of users. Producers may press for the adoption of their own standards or select strategically from among other competing standards, evaluating each in terms of its potential impact on costs of production, profitability and market share. Users on the other hand may demand standards that reduce purchasing prices, improve utility and are easily integrated with other products and systems. The market may, however, fail when appropriate (efficient) standards do not emerge in a timely fashion. Some kinds of technologies are subject to greater market failures then others. For example, networked technologies-such as information and communication technologies-often have large installed bases, making it particularly costly for users to shift to new, more technologically advanced standard. Thus, they may fail to adopt the socially optimal standard, due to sunk costs and the technology or standard "lock-in". At the same time, these technologies also exhibit increasing returns to adoption, a situation that occurs when the benefits to the user of a technology increase with the number of users. Under these circumstances, the wrong standard might be chosen due to excess momentum. Not wanting to be left out of the network when a major adopter moves to new standard, users may rush too quickly to jump on the bandwagon.

Regulatory Standards are established by legitimate government authorities and mandated from the top. If the market standards are established by exchange relationships, regulatory standards are based on authority relationships. The government for a number of reasons might set standards. For example, if the market structure is non-competitive, economic outcomes may be inefficient. Some market decisions might fail to incorporate or account for environmental, safety and other social externalities. Regulatory standards play a crucial role when standards are needed in a short span of time, because the decisions based on authority can be made and implemented fast. To create standards governments use a variety of mechanisms.

Standards can also be set through organisational processes that reduce transaction costs and facilitate information exchange and negotiation among key players. Such a process known as Voluntary Consensus Process can provide for better co-ordination than the market when levels of uncertainty are high, when there are frequent recurring exchange activities among the parties and/or when information exchange is complex. Organisations may participate in the voluntary standards development process for a number of reasons. They may, for example, want to influence the development of standards, or may wish to keep abreast of technological developments. The incentive to participate in such exercises is likely to vary by industries. In industries such as telecommunications, for example, the incentive to participate in standards setting is likely to be high. If communications systems fail to work together, there can be no services to sell.

2.2 Network Externalities, Economies of Scale and Scope

As mentioned, in the case of networked technologies the standards become very important. To understand the importance of networked technologies, it is essential to understand he concepts of "network externalities" and the economies of scale and scope[3].

There are many products for which the utility that a user derives from consumption of the good increases with the number of other agents consuming the good. There are several possible sources of these externalities. The consumption externalities may be generated through a direct physical effect of the number of purchasers on the utility of the product. The utility that a consumer derives from purchasing a telephone, for example, clearly depends on the number of other households or businesses that have joined the telephone network. These network externalities are present for other communications technologies as well. Significant diffusion of specific products and/or technologies can result in the development of a wider variety of related products and technologies. Consumers can also hope to get better post purchase services.

There may be other indirect effects that give rise to consumption externalities. The central feature of the market that determines the scope of the relevant network is whether the products of

[2] This section draws extensively from Ramadesikan and Basant (2001).
[3] The discussion on network externality builds on Liebowitz and Margolis (1994).

different firms may be used together. For communications networks, the question is one of whether consumers using one firm's facilities can contact consumers who subscribe to the services of other firms. If two firms' systems are inter-linked or compatible then the aggregate number of subscribers to the two systems constitutes the network. If the systems are incompatible, such as cable and telephone, then the size of an individual system is the proper network measure for users of that system. These can also be seen as 'consumer side scale and scope economies (Morris, 2002).

Due to network externalities co-existence of incompatible products in network markets is often unstable, with a single winning standard dominating the market. Given demand side economies of scale and scope, expectations about the ultimate size of a network are crucial. Buyers who join what turns out to be a losing network must either switch, which may be costly, or else content themselves with smaller network externalities than those associated with the winner. Since buyers' purchase decisions are therefore strongly influenced by their forecasts of future sales, there can be large rewards to affecting these expectations. And these expectations can be generated strategically by firms or by governments by mandating/preferring certain standards.
In these circumstances, victory need not go to a better or cheaper product: An inferior product may be able to defeat a superior one if it is widely expected to do so. For example, the initial success of MS-DOS is usually attributed not to any technical superiority, but to the fact IBM supported it.

Just as communications or IT technologies (hardware as well as software) exhibit large consumer side scale and scope economies, supply side economies are also widespread. This is particularly so for software, where the marginal cost of producing an additional unit is extremely low (Morris, 2002). Thus, if standards creation can facilitate rapid growth of the market, both supply and demand side economies can be reaped and costs can decline significantly. But, as mentioned, consumers can get locked in to specific technologies. Add to this the learning by doing effects and 'sunk' investments of producers and the lock-in becomes complete. Consequently, specific technologies and standards can get locked-in for a long time.

Thus, the main problem with standards is that once a standard is established it may be very difficult to modify or replace. The standards gain value by the sheer size of the installed base. Therefore, superior technology (standards) may not be able to enter the market as network effects may carry over from one generation of the entrenched technology to the next, defining the future path of development of the market. This path dependence creates entry barriers for new technologies.

While standardisation has lock-in related problems, multiple standards can have their own problems. Fragmentation in the market can lead to small (but viable) poorly supported standards. Network economies are not reaped and users locked into standards having small installed-based get orphaned not having the benefit of new complements to their standards. Besides the costs can remain high, as economies of scale and scope are not reaped. The key advantage of multiple standards is that the market retains variety. Retention of the variety is important because better standards may lose out to an inferior standard in the standardisation process. Given high technological uncertainties some competition among standards is desirable. However, the issue of the trade off between loss of variety and fragmentation is difficult to resolve.

3. Standard Setting Processes: Some Experiences

The earlier section has highlighted the importance for standard setting. Many countries have recognised this importance and have given it a significant policy focus. This section discusses some cases of setting cellular standards to highlight key issues. These cases involve elements of a variety of standards setting processes, market driven, regulatory as well as consensual.

3.1 The European Experience: Political, Economic and Technology Imperatives

In the early 1980s, European governments recognised the problems associated with a plethora of standards. Given the small markets for customer and network equipment, the costs for the same were high, as economies of scale could not be achieved. Besides, the use of mobile equipment and access to network services were limited to national boundaries, making it difficult for the travelling population. Thus, network externalities were not being reaped. In 1982, the Conference of European Posts and Telegraphs (CEPT), an inter-governmental organisation that comprised national telecommunications administrations of European countries, formed a study group to develop a pan-European public land mobile cellular telephone system. It was mandated that the new system achieve (1) spectrum efficiency, (2) good speech quality, (3) low mobile and base station costs, (4) ability to support new services and facilities, and (5) compatibility with integrated services digital network. Subsequently, European Telecommunications Standards Institute (ETSI) got involved in this exercise which resulted in a digital standard called Global System for Mobile standard called Global System for Mobile Communications (GSM) that was commercialised in 1991. The process of creating this standard brought out a variety of issues that are relevant for developing countries.[4]

The European governments realised that localised solutions for mobile communications did not make long term economic sense. Given the high R&D costs for operators and manufacturers it was essential to exploit economies of scale afforded by global market penetration. Home market revenue simply would not justify sustained investment in a specific technology. While the governments recognised that protection of their national industries may constrain the standard setting process,[5] the national interests could not be ignored. For example, the choice between narrow band and broad band alternatives brought to the fore the conflicting interests of Scandinavian (Ericsson/Nokia and Franco-German firms (SEL, AEG & Alcatel). The deadlock would have derailed the standardisation process if the European Commission had not worked hard to develop a political consensus and persuaded member states to reserve a frequency band (900 MHz) for the pan-European digital standard. This was critical as interoperability depends not only on the use of the same digital technology but also on the system operation in the same frequency bands. The formation of ETSI by the Commission further facilitated the standardisation process.

Eventually, a narrow-band architecture was used for the proposed GSM standard but several features or Franco-German proposal were also incorporated. In fact, the standard was derived from eight candidate proposals submitted by the European Industry Consortia. This 'basket' standard provided just returns to the opposing camps as the initial competitive advantages were in GSM subsystems, not in the entire system. Thus, the narrow band architecture could have given an initial small advantage to Nokia and Ericsson over their French and German counterparts in some subsystems of the GSM network, no manufacturer commanded hegemonic advantage. Besides, given the monopolies in their domestic telecom markets French and German governments were free to order GSM equipment from the manufacturers of their choice (e.g., Alcatel, Siemens and SEL), ensuring that these firms would get a fair share of the new market. The only requirement was that EU members use European standards in public procurements.

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[4] For details see Ramadesikan and Basant (2001).

[5] Earlier efforts for setting analog standards had failed due to these 'nationalist' tendencies shown by UK, France and Germany, while the Scandinavian countries were able to achieve common standards and were able to benefit from it. In fact, in 1985 Scandinavian firms (Nokia and Ericsson) controlled about one fifth of the world market of mobile phones, when all other European manufacturers together held a share of less than 10 per cent.

Although GSM is a communication system designed by Europeans for deployment in Europe, the system has been exported to countries all over the world. In 2001, the number of GSM subscribers was 564.6 million, while Code Division Multiple Access (CDMA) the closest competitor technology had a subscriber base of only 99.8 million.[6] The dramatic success of GSM has been attributed to the early rollout of the technology and the tremendous economies of scale GSM enjoyed due to the single standard in Europe. The dramatic success of GSM can also be partly attributed to the entry of non-European equipment manufacturers, notably Motorola, which got entrenched into this market through the ownership of many essential patents necessary for the implementation of GSM. Subsequently, Lucent and Nortel also entered the fray. The interests of a wide spectrum of manufacturers made the market competitive, which combined with economies of scale led to higher penetration with lower costs.

3.2 US Experience: A Case of Market Determination

In 1987 the US Federal Communications Commission (FCC) began the transition from Analog (AMPS) to digital technology by declaring that the cellular operators can employ any technology as long as it does not interfere with the operations of other operators. In 1988, Cellular Telecommunications Industry Association (CTIA) came up with a set of User Performance Requirements (UPR) for the new cellular technologies. These included (1) a ten fold increase in system capacity compared to the analog systems, (2) dual mode (AMPS/digital) capability, (3) new data feature capabilities (e.g. fax, short message service), (4) early availability of equipment, and (5) standard for high quality of service.

The actual task of setting the standard was left to the Telecommunications Industry Association (TIA), the industry body of the equipment manufacturers. Responding to the UPR, after considerable debate, the TIA adopted IS-54, a Time Division Multiple Access (TDMA) standard. Despite apparent shortcomings of IS-54 standard vis-à-vis the UPR it was formalised in 1991 and the equipment was tested the same year. Three months after the adoption of this standard, Qualcomm proposed another standard based on CDMA. In 1993, the Qualcomm's CDMA based mobile standard was modified and adopted by the TIA and the first system based on CDMA was tested in 1995 and commercial operation began in 1996. The IS-54 standard was also modified to a standard named IS-136 and released in 1996.

A few aspects of the US standardising system are worth highlighting. The FCC believes in market determined standards. Therefore, the TIA approved both CDMA and TDMA proposals, subject to the satisfaction of performance requirements. The spectrum auction winners can deploy wireless networks with technology of their choice including GSM. Since there is no obligation to have US earned revenue, US and European firms can participate equally, Finally, the voting process in the TIA is open to all members with each member having only one vote. The votes are weighted at ETSI. Ceteris paribus, the policy of standards neutrality makes the US market more contestable. The large market size combined with absence of local manufacturing requirements probably allows various standards to co-exist without losing out on economies of scale.

3.3 The South Korean Experience: The Role of Industrial Policy[7]

When the Korean firms and the Korean government considered development of the Cellular phone system, the analog system (AMPS) was dominant in the USA and the GSM system was dominant in the Europe. The Korean Ministry for Information and Telecommunications focused on the CDMA system that was emerging in the US due to the efforts of Qualcomm. The Korean government was interested in CDMA mainly because of its efficiency in frequency utilisation and higher quality and security in voice transmission. Korea concentrated on CDMA when there was great uncertainty over CDMA. Korean government also overruled the reservations expressed by telephone service providers and system manufacturers like Korea Telecom, Samsung and LG. The Ministry along with Electronics and Telecommunications Research Institute (ETRI) decided to go along with the CDMA. One of the main reasons reported to be of main consideration was that if Korea just followed already established TDMA (GSM), the gap between Korea and its forerunners would never be reduced and, thus catching-up would take even longer. Although the first CDMA test system was available only in 1995, the Korean government had declared the CDMA system development as a national project in 1989. In 1991, the contract to introduce the core technology and also to develop the system was signed with Qualcomm. In 1993 the Ministry declared CDMA as the national standard. As of early 2000 Korea had more than 6 million CDMA subscribers. The success of this technology strategy is evident from the fact that Korean companies have 15-20 % of the US cellular handset market.

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[6] Other Time Division Multiple Access (TDMA) standards (GSM is also a TDMA based standard) had 81.3 million subscribers and PDC a second generation Japan specific technology had a base of only 54.7 subscribers.

[7] The discussion in this sub-section is based on Lee and Lim (2001).

3.4 The 3G Standardisation Process

The standard creation process for the third generation (3G) wireless communication technologies under the auspices of International Telecom Union (ITU) has brought to fore a variety of issues similar to the ones discussed above. Ten proposals were submitted, including two by TIA and ETSI. Obviously, the proposals by TIA and ETSI proposed standards closer to the dominant standards in the two regions, CDMA in the US and GSM (WCDMA) in Europe. The proposals also led to a bitter feud between Ericsson and Qualcomm regarding CDMA patents, the latter accusing the former of infringement. The strategic intent of the firms was similar to that observed at the time of GSM standardisation process where many companies, especially Motorola used their patent portfolios to their strategic advantage.

To push the essential elements of their proposals ETSI and TIA initiated alliances.[8] The idea was to evolve a consensus around a set of standards and harmonise their proposals. Interestingly, representatives from many countries were present in the two partnership projects, Japan and South Korea being most noteworthy. The 'dual' memberships reflected the fact that many countries were not clear which standard would emerge as the winner. ITU finally recommended five standards. These included W-CDMA (also known as Universal Mobile Telecommunications System - UMTS) standards recommended by the ETSI sponsored group (3GPP), CDMA2000 recommended by the TIA group (3GPP2), TDWCDMA, a standard proposed by China but close to the ETSI proposal and two other non-CDMA standards.

The choice of standards made by various countries is interesting. The European Union has mandated the use of WCDMA and two other standards that are compatible with the existing GSM networks. In Japan, where a unique second-generation standard was used, the dominant players (e.g., NTT DoCoMo) decided to adopt WCDMA to capture the world market of user-producer equipment. At the same time they are trying to protect the domestic market. Some smaller rivals (e.g., KDDI) however, opted for CDMA2000. South Korea, which had invested heavily into the CDMA and related technologies, has decided to move into GSM compatible (WCDMA) standards. Despite the heavy cost in the form of incompatibility with the existing infrastructure, Korean firms expect a larger and faster growing user base in GSM compatible technologies. In any case, once the new investments are made, they would be well positioned to deal with both types of standards. While the Japanese and the Korean behaviour seems to be guided by the huge

[8] The ETSI initiative was known as Third Generation Partnership Project (3GPP) and the one initiated by TIA was known as 3GPP2.

market for terminals and hand held devices that is likely to be generated by 3G networks, China has opted for a separate standard to benefit from a huge GSM market at home. The Chinese probably wish to leverage the scale economies in the home market to become an important player in the equipment and hand held markets at a subsequent stage. They have used the same strategy for several other electronic products.

4. Policy Options for India

When the Indian government opened mobile services for private participation in 1992, the policy makers were significantly influenced by the spread of the GSM in Europe. Consequently, the tender conditions specified that the digital mobile services should fully conform to GSM standards. The services were also to conform to system inter-working and interface with the existing Public Switched Telephone Network (PSTN). However, the introduction of other standards was taken cognisance of when the tenders for the fourth license were issued in 2001. By then the tenders had become technology neutral. In spite of the shift to technology neutrality, it was unlikely that the license winners would adopt any standard other than GSM. This was so because all the operators had already sunk in investments in GSM networks. Besides, they would like to provide roaming facilities between circles they currently operate in and the circles they are to start operations. This facility would not be possible if different standards are selected.

Given the fact that most mobile operators have sunk in their investments in the second-generation (2G) GSM networks, what options India has vis-à-vis 3G standards? India seems to have lost out on the manufacturing of telecom equipment and the hand set market. Nor are we in a position to enter the components market in any significant manner. Therefore, strategies adopted by the players in Europe, US, Japan, South Korea and China to penetrate these markets is not very relevant for India. In fact, the bidding points allocated for the use of domestic equipment has been low about 3 per cent) in the recent telecom related bidding processes. This was presumably due to the inability of the Indian manufacturers to deliver the latest technologies. (Singh, 1999). This low weightage brought to an end the saga of domestic equipment manufacturing that had resulted in many controversies during the 1980s and delayed the entry of foreign equipment manufacturers.[9] Unlike China, India has failed to become a large base telecom equipment

[9] Singh (1999) provides an interesting account of how foreign equipment manufacturers were discriminated against during the phase when C-DOT was developing switches indigenously. While this experiment was immensely successful in developing small robust switches for Indian conditions, large switches could not be developed. During this period, C-DOT not only avoided any tie-ups with firms like Alcatel, AT&T and Phillips, it scuttled DOT's attempts to join with multinationals to manufacture switches. It was only after

manufacturing. There is still a potential to attract equipment/hand set manufacturing firms to India to develop a manufacturing base. Equipment orders for the cellular industry were estimated to be worth $ 10 billion for the 1995-2005 period (Singh, 1999: 186). While the roll out has been not as rapid as expected, India by no means is a small market. The current trends do not suggest any major improvement on the manufacturing front. Even if we are able to attract manufacturing related FDI in telecom or become part of the global production networks of telecom equipment manufacturing, it does not seem desirable that we should get tied to specific telecom standards. While we need to make efforts to become part of the global production networks, given the technological uncertainties and other concerns, discussed below, it may be useful for India to keep its options open vis-à-vis telecom equipment manufacturing. A technologically diversified manufacturing base may be more useful for both hardware and software industries as Indian firms can be part of alliances to make software (embedded and others) for telecom equipment following different standards. A policy of neutral telecom standards makes sense at this stage from the perspective of broad-based learning through alliances and networks. A large and growing telecom market in India can support such a strategy without compromising economies of scale.

The other strategic concern identified in the earlier discussion related to intellectual property rights (IPRs) that are relevant or essential for specific standards like the GSM or CDMA. Unlike Motorola or Qualcomm, no Indian firm owns intellectual property that is important for specific standards.

Given these conditions India's standards policy cannot be strategically based on the interests of the existing domestic manufacturers or IP holders. There is one segment, however, that can potentially benefit from the policy vis-à-vis telecommunications standards. And that is the IT sector. Many Indian IT firms can actively participate in the solutions business. In fact, some of them have been actively participating in the ITU standard setting fora including those initiated by European and American interests to get exposure and penetrate the market for solutions. Telecom software market is large and growing and this can be an important area for growth for the Indian IT industry. Moreover, the price of mobile telephony has been declining, and the population of mobile phones is expected to cross the PC population by 2004 (NASSCOM, 2002). If standards policy facilitates further reduction of these prices and enhances usage of this low cost access devices, R&D in areas of embedded software and mobile commerce can take place in the

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liberalisation initiatives introduced in 1992 that five large foreign equity owned joint ventures by AT&T, Siemens, Alcatel, Fujitsu and Ericsson were set-up. Subsequently, 100 per cent ownership was allowed on country. This in turn may enable the software firms in India to tap these rapidly growing segments in the international markets. Given the scope of for working with different standards, Indian firms may even be able to get IPRs in important subsystems of different networks through developments in the solutions business.[10] Adherence to a single standard may reduce learning possibilities for the IT firms and may eventually result in some kind of a lock-in.

One could argue that persistence with GSM standards, instead of shifting to technology neutrality would have reduced future uncertainty and enlarged the market faster. However, the supremacy of GSM and GSM compatible standards like WCDMA has not yet been established. Some comparisons, in fact, show that CDMA technologies may be better (Ramadesikan and Basant, 2001). Given this, and the fact that technologies are changing very rapidly, possibility of regulatory failures is high. Therefore, technology neutrality seems justified. Technology neutrality vis-à-vis mobile standards (especially 3G) also seem desirable because of a variety of reasons.[11]

Large volumes of GSM have been a major driver for declining costs of GSM related equipment. Countries like Japan and South Korea that stayed away from GSM compatible technologies will be present in the WCDMA market. There is, therefore, a possibility of WCDMA equipment and handset costs being lower than the other competing technologies. This is expected to benefit the existing GSM operators and enhance their user base. However, recent trends world-wide show that the transition from GSM to WCDMA has been rather slow. In fact, CDMA 2000 is selling more handsets than WCDMA. This trend is expected to continue for another five years giving economies of scale advantages to CDMA2000 instead of WCDMA. Even in Japan, where the dominant player had opted for WCDMA, the user base was only 127,400 in July 2002 as against the user base of 1.64 million of CDMA2000.[12]

Moreover, India is not entirely locked into the GSM legacy. The Wireless in Local Loop (WLL) operators who have deployed CDMA base for the local loop can eventually graduate to 3G standards by using CDMA based advance technologies. Thus, the existence of WLL CDMA

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a case by case basis.

[10] I understand that something of this kind is already happening on a small scale and might increase with larger scales of operation.

[11] Ramadesikan and Basant (2001) provide technical and other details.

[12] The data on the CDMA2000 and WCDMA roll out reported in this paragraph is based on a press briefing by Irwin Jacobs, the Chief Executive of Qualcomm (Reuters, September 4, 2002). Qualcomm not only

provides an opportunity for CDMA2000 to be introduced in the country. Effectively, therefore, both GSM and non-GSM based operators can compete to provide 3G services. This will enhance contestability in the market and avoid lock-in.[13] Given the possibilities of "entry" into 3G services and the fact the superiority of either the two major standards is yet to be established, technology neutrality seems desirable. Besides, a new operator interested in rolling out 3G networks and services with other technologies is also possible in this scenario. If technological superiority and lower costs due to competition of CDMA based equipment does not emerge as a viable option, operators will automatically discard it.

Finally, it can also be argued that it is too early for India to start worrying about 3G standards, as we are yet to fully utilise the potential of the second-generation technology. Since applications for 3G that require high data speeds will take some to develop the need for 3G may not occur in India for sometime. Besides, it is possible to enhance data speeds of the existing second-generation networks with some modifications.

5. Some Concluding Observations

Several characteristics of effective regulation have been have been identified in the literature. These include independence, accountability, transparency, fairness, simplicity & clarity, speed, consistency etc. In general, the regulation relating to telecommunications standards also needs to satisfy these criteria. In addition, any regulation in the telecommunications sector also has to deal with technological convergence in this sector. Given the natural monopoly characteristics of telecommunications (especially local fixed) networks, ensuring effective competition in this segment has been an important regulatory problem. Since inter-network competition is difficult to obtain, the focus has been on fair access and reasonable interconnection arrangements. The emerging convergence in telecommunications technology may change this condition. Telecommunications networks that were highly differentiated in what services they could deliver (e.g. broadcasting v/s voice technology) are now somewhat equivalent in terms of services they can deliver to customers. Different ways of providing the same type of services and the provision of totally new type of services are developing rapidly. These are changing the rules of competition; not only the competition across networks is emerging with various networks becoming close substitutes, competition in service provision is also on the rise. Broadly, technological changes are leading to growing demand (especially of internet services) and

owns most of the patents for the CDMA technology standard, it also collects royalties from the usage of rival WCDMA technology.

innovations are significantly modifying the structural features of telecom industry with emerging convergence across fixed and mobile and across IT and media sectors.

What implications do these developments have for the policy vis-à-vis standards? The final impact of the technology convergence is still largely unknown. Meanwhile, these developments cut across the existing set of regulatory rules and regulations challenging the conventional definitions of telecom industry. In such a scenario, a heavy handed and inconsistent regulation across different delivery mechanisms, arbitrary service classifications, and narrow choices of standards can distort markets. If the regulation is unnecessarily restrictive, it may also result in economic inefficiency with customers failing to get the full benefit of technological convergence.

While convergence is bringing different types of network closer to equivalence, it is not making them the same. At least, not as yet. The particular points of bottleneck (e.g. scarce resources like radio spectrum), incumbency dominance, natural monopoly in some elements in the local loop or the particular way customers are locked into specific network by their purchase of equipment will continue to vary due to economic and technical reasons. Broadly, issues relating to network interconnection will remain very significant in terms of policy due to persistence of (a) fixed costs of a subscriber being connected to a network (both for fixed and mobile networks); and (b) network externalities between subscribers. In other words, anti-competitive behaviour in terms of setting excessive access and inter-connection charges will remain a reality and will have to be dealt with. The issue of standards would also have to be seen in this broader context. Insistence on narrow standards may create possibilities of anti-competitive situations. Given the technological uncertainties and convergence possibilities it can also result in significant regulatory failure.

The problems associated with market and government failures have led to a rise in interest in functional standards. These include standards such as 'Open System Interconnection, which define performances to be achieved at different levels (or layers) of technological systems, but retain important degrees of freedom in deciding how the standards will be met' (OECD, 1991: 7-8). The implementation of open standards, however, remains difficult, as with rapid technological change two machines that satisfy functional standards may not be able to satisfy the need for inter-operability and compatibility (OECD, 1991: 8). These two conditions, may therefore be an essential part of the acceptable standards, apart from performance requirements so that the

[13] The recent developments in the telecom market in India provide further support to this argument.

consumers can keep pace with the evolving technologies. One essential feature for the standardisation processes needs to be that one technology is able to interact with another. The Indian government and firms should participate in the standard creating procedures at the ITU and other fora to insist on more open standards and get exposure and learning for market entry/penetration in the solutions market.

The key need for the Indian economy is that the telecom infrastructure should grow rapidly. This requires among other things rapid decline in the cost of equipment. Recent reductions in the customs duties on the telecom equipment have already resulted in lower prices; the tariffs declined from over 40 per cent in 1997-98 to 5-15 per cent on various types of telecom equipment in 2001-02. In general, the prices of telecom equipment have been falling very rapidly in recent years.[14] Given the developments referred to above, a neutral standards policy with insistence of inter-operability and certain performance requirements is unlikely to create an upward pressure on price in the future. Costs are going to fall for all equipment using the widely used standards.

A rapid increase in telecom infrastructure and a decline in costs of mobile and other types of telephony will create new opportunities for IT firms in the solutions and embedded software business. E-governance can be given a boost, as more people would have access to low cost Internet access devices. A large base would also boost the development of localised content, which can further boost usage and revenues from telephony (NASSCOM, 2002: 85). This would not only lead to further price reductions but also create potential for growth and learning for the IT firms. Moreover, widespread use of mobile telephony may also facilitate the growth of the IT Enabled Services (ITES) market. With a drastic fall in equipment prices, employees can be given access to mobile phones in case trouble shooting is required. This would enhance the quality of service and provide flexibility to ITES workers, especially women.[15]This is very important in the current context. Employment in the ITES markets was estimated to be of the order of 106,200 in 2001-02 with a revenue stream of Rs 6,960 crores. The forecast is that this market can provide employment to about 1,100,000 persons in 2008 and generate revenues worth Rs 81,000 crores (NASSCOM, 2002: 41). For this to happen, maintenance of high quality of service would be critical. And access through mobile phones or other wireless devices can go a long way in ensuring quality in this industry.

[14] For example, high-end routers, which were priced at US $ 120,000 per OC-48, are projected to cost $ 20,000 in 2003. Throughput costs per Gbps has declined from US $ 210 in 1994 to US $ 4 in 2001 (NASSCOM, 2002: 84).

[15] I am thankful to Rekha Jain for pointing this out to me.

Recent controversy around provision of mobile services through WLL has created market uncertainty for GSM service providers and equipment manufacturers. But it has also added to contestability in the market. Apparently, a better allocation of spectrum can partly ameliorate the concerns of the GSM operators.[16] While this needs to be explored, it highlights a general issue vis-à-vis standardisation. It has been found that dominant/formal standards obtain better terms (especially in Europe) in the allocation of radio frequency spectrum, network operator licensing practices, terminal equipment type approval rules and procurement rules. Thus formal (globally dominant) standards have a much higher chances of success. This leads to a strategic increase in the licensing fees for the essential IPRs. (Bekkers et al, 2002). This in turn enhances costs of equipment. The Indian policy makers should avoid such tendencies and also lobby for removal of such practices in other countries through international fora. After all, lower costs of equipment are what we are interested in.

Finally, there are problems specific to our own economy, or other similar economies. These problems may not be important enough for global R&D. Usually, market players are unwilling to experiment or deliberately search for information. Search for technology options other than those, which are easily accessible, and which are known to be profitable elsewhere, is typically not done. If policy makers can facilitate and support such experimentation, especially for problems that are typical of one's economy, more information will get generated and choices of standards may be more rational. If such experiments succeed, local entities may be able to create "standards" for specialised problems and commercialise it in the domestic and other economies with similar problems.[17] Such experiments also have a potential of creating IPRs for domestic entities in small subsystems of a network. The Web flourished into a new medium on the basis of freely accessible communications standards of the Internet. More recently the wireless data technology, Wi-Fi has been made possible because the US federal government decided a few years ago to set aside a strip of unlicensed radio frequencies and allowed everyone who followed a simple set of rules to share among themselves (Markoff, 2002). Today, Wi-Fi has opened up a variety of options to reach inaccessible areas with a multitude of applications.

I understand that researchers at the Indian Institute of Technology (IIT), Kanpur are working on the Wi-Fi technologies to tackle the "last mile" and other problems that face countries like India.

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[16] Thanks are due to Partha Mukhopadhyay for pointing this out to me.
[17] This idea emerged from a discussion with Partha Mukhopadhyay.

They may be able to come up with very interesting solutions as IIT, Chennai did with their CorDECT technology. Our standards and spectrum allocation policies need to facilitate all such experiments and more to build domestic capabilities in these domains.

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