8 Wireless Infrastructure

The ascendance of the wireless infrastructure was a major ICT innovation. This chapter examines the political economy of the changing governance of the wireless infrastructure by analyzing the introduction of wireless broadband (third-generation, abbreviated 3G) services.

Governments strongly influenced the wireless innovation processes because they controlled the radio spectrum, the essential wireless real estate, set general competition policy for wireless services, and often set the technical standards for the market. The traditional justification for government's central role was that radio spectrum constituted a scarce public resource that could be degraded by radio interference among competing uses. Government policies almost always over-reacted when addressing the risk of interference. "Under traditional spectrum regulation . . . it is the mere possibility of interference, not the reality of it, that governs when, where and what devices can be used. Therein lies the problem."[1] This principle of preemptive control of possible interference underpinned an unduly restrictive policy, even for traditional technology, because it relied on government command and control to resolve unlikely interference scenarios rather than on techniques routinely used to sort out other market clashes (e.g., tort law and commercial negotiations). An accompanying principle was the affirmation that spectrum was a scarce public resource under government control whose use by the private sector had to be carefully controlled. This weakened property rights, thereby limiting market flexibility.

In the traditional system, experienced radio engineers, armed with a mandate to preempt all interference, dominated the spectrum-governance community. Slow, conservative grants of spectrum allocation and assignment made their lives easier. As a result, governments usually doled out spectrum in small dollops to a few carefully specified competitors that provided a pre-approved list of services on the licensed spectrum. Three norms for spectrum policy permeated domestic and global governance. First, spectrum was allocated to specific uses (and countries coordinated on a specific band of spectrum for a designated use). Second, the number of suppliers was restricted to protect against interference. In addition, as a third norm, governments routinely dictated which technical standards would prevail. The rationale was that the standard would be the best technology to preempt interference and a single standard would also build economies of scale, thereby lowering equipment costs.

This approach to spectrum management cozily co-existed with a general market-governance system that emphasized monopoly or limited competition. The first generation (1G) and the second generation (2G) of wireless phone and data services emerged from this governance tradition. First-generation, analog wireless service was a niche market with minimal influence on the general telecom market. Governance of 2G reflected the dynamics of the managed-entry era. Governments knew 2G would be a bigger commercial market (although early adopters still vastly underestimated its ultimate import) and introduced competition in a measured way that balanced costs and benefits for former telecom monopolists and their equipment suppliers. Unlike other ICT segments, the European Union extensively shaped global market governance because the United States, with its low-price, robust wired infrastructure, lagged on the switch to 2G.

Even the prospects of a fundamentally different 3G technological architecture and service mix (high-speed data) did not initially alter the old approaches to governance. Governments and companies had charted a manageable balance between regional preferences and global coordination for 2G, and a dominant global technology, the Global System for Mobile Communications (GSM), emerged out of the mix. Europe and Japan, in particular, hoped to build on this platform. They envisioned a single technology design for 3G services deployed on one global band of radio spectrum, which would be upgraded at a predictable pace. To the shock of market leaders, their plan for 3G deployment fizzled.

Three challenges eroded traditional spectrum governance. First, the Cheap Revolution transformed the equipment and networking industry and transformed competition in telecommunications services. This created a new set of stakeholders in every major market. Second, increasing modularity gave carriers much more flexibility in the mix of spectrum and equipment to provide wireless services as services became digital and broadband.[2] Third, the United States became fully engaged in market-governance issues for third-generation broadband services. Its different approach to domestic market governance led the US to dissent from plans for a comprehensive global blueprint for 3G.

Together, these factors forced a reorganization of the delegation of authority over global market governance and a new policy approach. Instead of a single global standard for 3G, governments agreed to sanction a platform of related but disparate 3G standards. Instead of a single global band for 3G, governments came to accept a variety of frequency bands. These developments weakened the norms of government dictated standards and designation of a preferred spectrum band for services. At the same time, governments recognized that more competitors and bigger releases of spectrum for flexible uses were compatible with sound spectrum practice and contributed to larger goals for ICT markets. As a result, the rollout of 3G services (and their successors) and the business models for the market diverged sharply from early expectations. By 2008, more countries were strengthening the property rights of spectrum holders in order to encourage market transactions to swap spectrum. Cumulatively, the principles of a strong presumption of likely interference and treatment of spectrum as a scarce public resource were eroding.

As a result of an erosion of norms and principles, the authority of the ITU over standards, spectrum, and services declined. Initially there were changes in regional decision making for standards, such as the rise of the European Telecommunications Standards Institute (ETSI).[3] Later, cutting-edge standards processes were dispersed to industry associations built around each technology camp. A further change in delegation involved the World Trade Organization. The changes in global trade rules described in chapter 7 boosted competition in wireless, including competitive entry through foreign-owned carriers. The WTO also limited, but did not eliminate, how governments could manipulate technical standards associated with wireless licenses to promote industrial policy. It also made the decisions of standards bodies, even those associated with the ITU process, subject to trade policy reviews.

Property Rights, Balancing Stakeholder Interests, and the Politics of Market Transitions

Our theory emphasizes the role of the leading powers in the world market in changing global governance. Their preferences reflect the intersection of their strategic position globally and the interests generated by their domestic political economies. In the 3G case there was intense political bargaining between the United States and an entente of Europe and Japan.[4]

This case reflects a situation where market leadership was more broadly dispersed than in other ICT markets because in the 1990s mobile deployment in the EU and in Japan outpaced US deployment. Moreover, the triumph of mobile over fixed networks in many developing countries further altered global bargaining dynamics by making outcomes in those markets central to global strategies.

The next four figures provide a snapshot overview of the wireless, mobile, and broadband trends since the early 1990s. Figure 8.1 tracks the surging growth of mobile lines compared to fixed lines worldwide. The number of fixed lines increased from about 600 million in 1993 to almost 1.2 billion in 2004. Mobile lines surged from extremely low numbers in 1993 to 1.75 billion in 2004. Mobile lines surpassed fixed lines in 2002 and the gap continues to widen. Figures 8.2 and 8.3 trace the rapid growth in mobile subscribers and the penetration of mobile services across important countries and regions. By mid-2008 there were 3.3 billion mobile subscribers worldwide. About 1.2 million new subscribers were being added each day.[5]

More narrowly, figure 8.4 compares the recent growth of mobile data subscribers in different regions. By early 2007, there were about 600 million

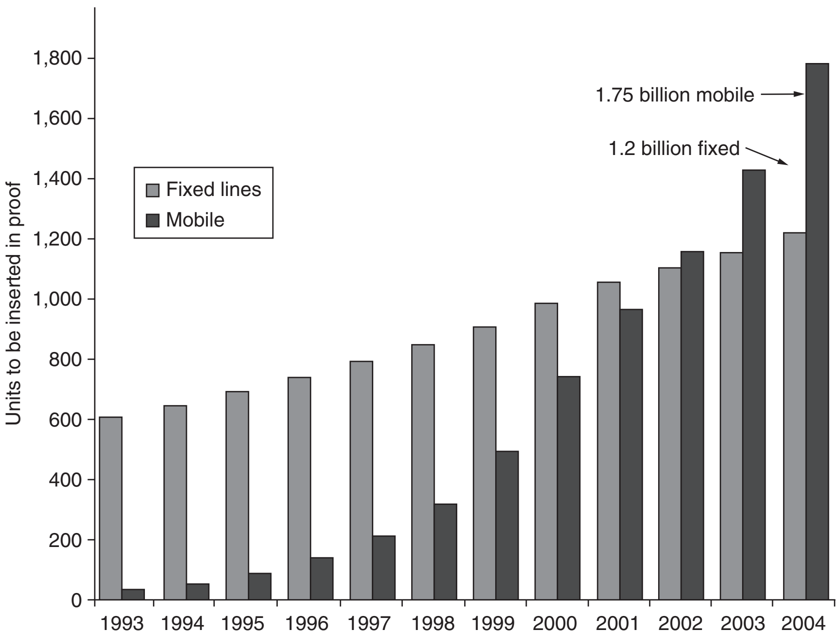

Figure 8.1
2002 was the turning point. Source: International Telecommunication Union.

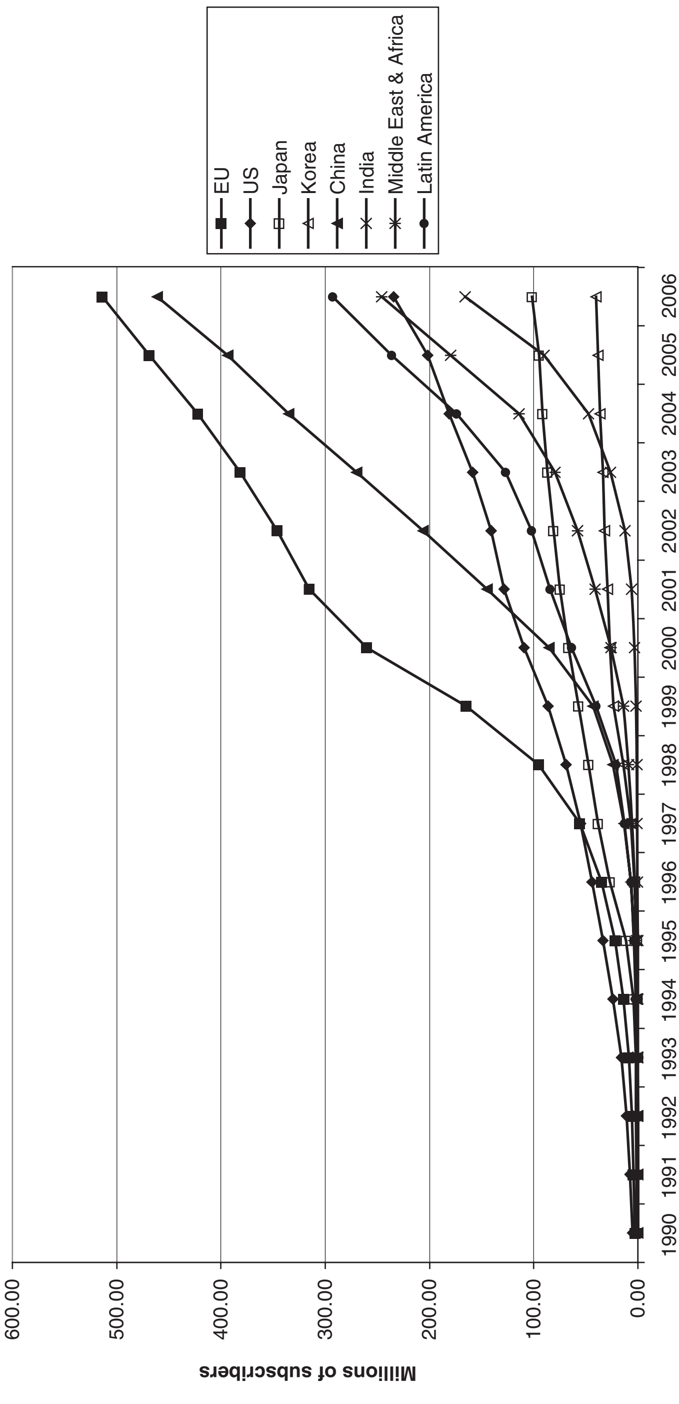

Figure 8.2
Comparative growth of mobile networks: mobile subscribers, 1990–2006. Source: International Telecommunication Union.

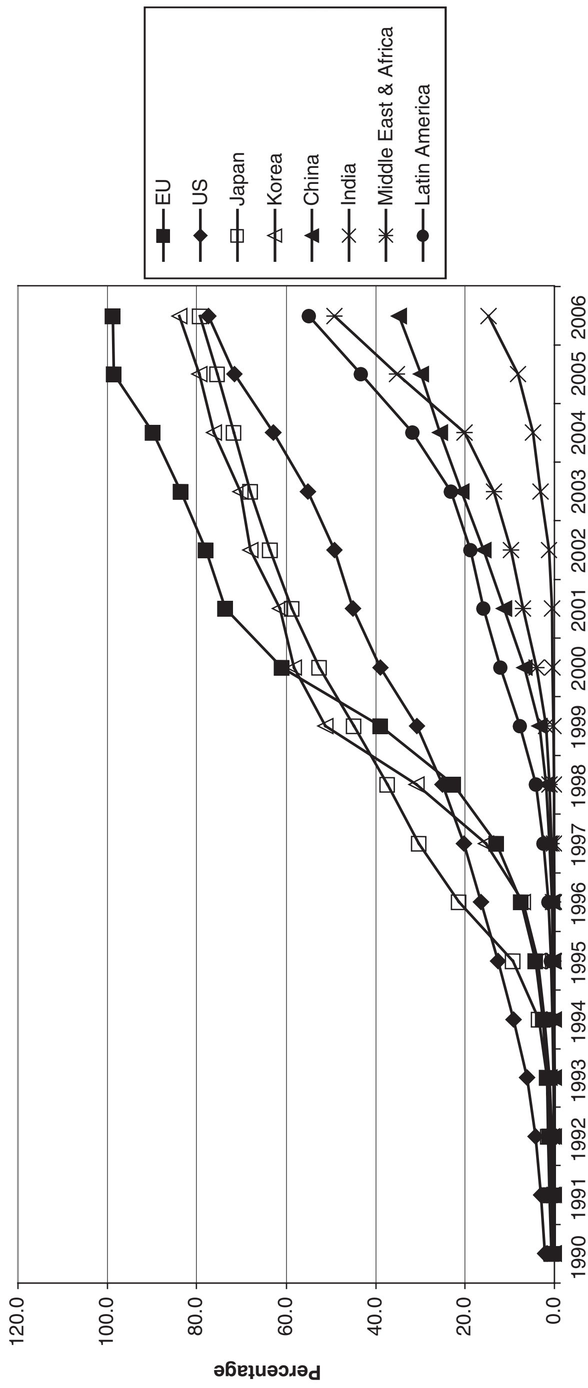

Figure 8.3
Comparative growth of mobile penetration, 1990–2006. Source: International Telecommunication Union.

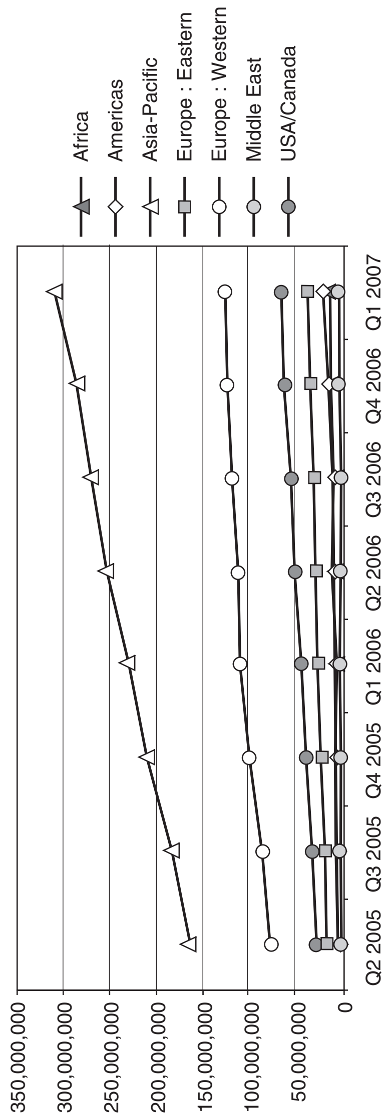

Figure 8.4
Mobile data subscribers by region. Source: Informa Telecoms and Media.

data subscribers in the world. The Asia-Pacific region leads and is widening its lead in mobile data subscribers. Western Europe is next, followed by the United States and Canada. However, as we noted in chapter 5, most of the early wireless data services (SMS or downloaded ring tones, for example) only needed limited amounts of bandwidth. As broadband wireless data emerges, the US compares much more favorably with the rest of the world. (See chapter 5.) As of July 31, 2007, Wireless Intelligence reported that there were more than 486 million 3G subscribers worldwide.[6]

The political economic import of this surge in wireless was threefold. First, wireless was a blessing for improving connectivity worldwide. It was cheaper and faster to roll out than wired networks. So governments highlighted wireless as a success story for public policy and, as a result, a focus of political attention. Second, wireless provided a growth market for former monopolies that compensated for their losses from competition in wired services. For this reason governments took a benign view of robust wireless profits and high prices. Third, Europe, Japan, and Korea could establish a strong leadership role against US companies in the markets for wireless equipment and narrow-band mobile data because of their more rapid expansion of wireless markets. The introduction of 3G posed fresh questions about global market leadership.

The political choices for 3G revolved around policies that allocated and assigned rights for radio spectrum and technical standards that influenced the choice of technologies. These choices influenced the distribution of wealth from new property rights needed to create the 3G infrastructure, the number of competitors in the marketplace for services and equipment, the terms of competition, and the overall economics of 3G. All these choices affected the fate of former monopolists as they reorganized in response to new competition.

The Political Economy of Stakeholders

Understanding the attractions of a global plan for 3G for traditional carriers and their suppliers is straightforward. The wireless industry is capital intensive and has large economies of scale, strong network externalities, and some path dependency.[7] Consequently, incumbent carriers and their equipment vendors sought favorable technology upgrades on a predictable basis.[8] They favored common planning of new technologies, such as 3G. Externalities and economies of scale meant that stakeholders tried to arrange global coordination of technology design and spectrum allocation for new services.

All the potential sources of gains from international coordination—such as non-interference and economies of scales from common standards—apply to wireless networks. There also are benefits to consumers that accrue from interoperability of equipment, mainly through common standards and/or common radio bands.[9] These coordination benefits were easy to claim while traditional monopoly carriers, their unionized, well-paid employees, and the equipment suppliers favored by the carrier collaborated to slow competition.[10] Even the entry of new competitors for services and equipment did not alter the tendency of governments to set policies to balance equities among firms, not maximize competition. The struggle between incumbents and new entrants focused on three sets of property rights—the allocation of available spectrum capacity, the assignment of spectrum to specific licensees, and the technical standards for the network.

The choices about 3G were deeply entangled with the general reorganization of the global ICT market in the first two eras of ICT. At their best, politicians can be entrepreneurial sponsors of beneficial changes in market structures, but they still are managing a contentious political process with strong stakeholders. Their temptation is to frame the choice about a market transition so that it has a few clear "punch lines" that provide highly visible benefits that yield major political credit. The popularity of wireless made it ripe for such strategies. For example, EU political leaders often justified their ICT market reforms by claiming that they would produce "good jobs" through the promotion of press-friendly technologies such as 3G. In many countries the success of a new second operator gave the illusion that the market was fully competitive—even a mild duopoly with quick network build-out looked good and ducked hard questions about how to regulate more robust competition. At the same time, when coping with difficult market transitions regulators often create competition that is friendly to large competitors rather than pushing for higher market performance. Even transparent regulatory processes tend to weigh the needs of the most active participants more heavily and time-consuming processes can facilitate slower departures from the status quo. Thus, it is politically difficult to abandon former monopolists, especially when government owns a stake in the firm. Predictably, when governments assigned new wireless licenses on the basis of corporate merit ("beauty contests"), the former monopolist had ample resources and connections to do well.

Furthermore, large stakeholders are not politically equal. Foreign producers, investors, and consumers matter less because foreigners don't vote. In politically difficult transitions formal and informal restrictions on foreign investment often transfer rents to domestic competitors or to business partners of foreign investors. Licensing policies tilting toward domestic technology firms are another favorite.

On top of raw politics, government institutions dealing with these technically complex markets faced information challenges. The stakeholders often possess information not known to the regulators, so there are incentives for trying to induce consensus through bargaining among stakeholders. Government institutions sometimes can facilitate agreement by requiring all participants to accept pre-conditions before participating in rule making. However, in the case of 3G the ITU could not restrict participation on standard setting to those agreeing beforehand to limit their IPR claims.

When consensus building stumbles, government institutions may have to choose among players, but they vary in their ability to make binding decisions. As the number of decision points or veto points in a policy process increases it becomes more likely that the status quo will persist or that the decision will be skewed to serve the needs of players with the strongest veto power.[11] Most national regulators use majority decision making to resolve deadlocks more credibly, even if they try to induce consensus-oriented outcomes. The ITU and other international institutions have more stringent decision-making rules that require unanimity. This increases veto power, although political and economic pressure may induce reluctant parties to acquiesce.[12]

Because consensus building was critical, a grand plan for 3G was supposed to please everyone by providing incumbents with the rewards of a big new market in return for accepting more competitors. In 1985, when the undertaking began, the ambitious level of global coordination envisioned by 3G planners assumed that policy decisions would be largely an insiders' game. But the consensus-driven process in the ITU broke down. The pace and complexity of standards setting increased as the Cheap Revolution got underway. Traditional standard-setting bodies seemed cumbersome and expensive, so firms and governments turned elsewhere for faster decisions.[13]

Consensus also was undermined as the number of stakeholders increased and their interests diverged. The ITU, an inter-governmental organization in which governments decide and others observe, was designed to deadlock when normal bargaining could not produce consensus. As differences in the preferences of regional groups of nations caused the interests of stakeholders to diverge, standards and spectrum plans diverged from the initial global blueprint. A single blueprint became a menu of approved choices from which players could pick and choose.

Defining Property Rights for 3G

The prominent role of government in wireless markets is the cumulative product of weak property rights because it was presumed that spectrum was a public resource leased to private operators.[14] Governments only licensed spectrum for a fixed time period, subject to many constraints. Private bargaining among property rights holders about interference broke down because government restricted many market functions (such as the ability to easily buy and sell licenses) and the regulatory process created large uncertainties about the value of spectrum licenses. For this reason, property rights were not secure, and private bargaining among companies often was ineffective. In response, the private sector encouraged government to micromanage spectrum problems in regard to three sets of decisions influencing property rights.

The first set of property rights defined intellectual property rights (IPR) in the standards for global wireless networks. A new generation of wireless services emerged from the global collaborative planning of carriers and equipment suppliers coordinated through the ITU and through regional and national standard-setting processes. Participation in these processes and the conditions imposed on the use of IPR in the standards process influenced the selection of global technology.

The second set of property rights stipulated rules governing the allocation of spectrum, including the use of licensed spectrum, for specific purposes. "Allocation" refers to the decision about how much spectrum to allot to particular services or groups of services, and on which frequency ranges.[15] Revisiting spectrum allocations opened the way for politicians to earn credit by micromanaging a valuable resource. In addition, government control made it easier to satisfy the demands for large amounts of spectrum by military and police services, which few political leaders wanted to oppose.[16]

Governments granted licenses in predictable but restrictive ways. For example, US spectrum licenses traditionally limited the ability of spectrum owners to change the type of service in three ways. First, they could not shift licenses between services from fixed to mobile wireless. Second, they restricted ownership transfer. Licenses usually were granted for a set period of time, often 15 years, although since the late 1990s this mix has been changing. Third, Asian and European governments often went further, dictating the type of technology platform that spectrum users could employ to offer services. These types of process typically favored incumbents with operational or informational advantages.[17] As a result, private property rights for spectrum were weak.[18]

The third set of property rights involved the assignment of licenses. The number of licenses, the method for selecting licensees, and the sequence of assignment of licenses shape market efficiency. After the mid 1980s, the number of licenses slowly increased, thereby creating more competition in services. But since the early 1970s the sequence of licensing decisions provided hefty market rents for the original incumbents and their initial challengers.

In short, more competition in telecommunications markets improved market performance in many countries. Yet political leaders usually eased the risks for large competitors during the transition to greater competition. The politics of transition, explored next, raised the costs of the transition to 3G and often helped some competitors at the expense of others. These challenges ultimately delayed 3G rollouts.

The Political Economy of Three Generations of Wireless Service

Property rights define the rules of the game under which economic actors pursue their interests. They influence the economics of markets and the strategies of governments and firms. Institutional structures then shape bargaining and outcomes. This section shows why this mattered for wireless.

The political economy of 3G begins in technology and policies chosen for the first two generations of wireless services. As 1G and 2G market growth soared, mobile wireless became the darling of the financial community and a strategic focus for former monopolists. Political considerations shackled the former monopolists with high costs and inefficient work forces in their traditional businesses. Fortuitously, mobile services allowed them to create new subsidiaries that earned dramatically higher revenue per employee.[19]

The reinvigorated profits for former monopolists eased some political tensions about transitions to competition. However, by the late 1990s wireless competition increased while the industry foresaw slowing market growth for voice services. This combination threatened to reduce the profitability of major carriers, so companies and regulators faced a fundamental political dilemma: how could they increase competition while also restoring growth?[20] The quick answer for many industrial countries was to license more competitors while betting that 3G networks could boost market growth in two ways. The idea was to first reenergize growth as the number of cell phones with data connections increased rapidly.[21] Second, by the late 1990s they believed that a unified global technology and spectrum plan for 3G would stimulate cross-national networks that would boost margins by charging lucrative fees for providing services to business customers when they roamed across national borders. This expectation prevailed until 2001's crash of telecom markets and began to re-emerge around 2007.[22]

Standard Setting and Intellectual Property

Governments were heavily involved in the standard-setting process until the 1980s because they owned and operated the telephone carriers. These carriers worked with a small set of preferred national or regional suppliers in a closed standard-setting process. Global standards processes at the ITU reflected this legacy of limited competition.[23] Significant variations in national standards for 1G were common; efforts to coordinate new global services and standards, such as 2G, had to accommodate these variations because ITU decision making was consensual.

Second-generation digital wireless services involved technologies that promised better quality, lower costs, and more user capacity. They promised to expand the global market significantly, thereby stirring interest in new export markets. At the same time, even as equipment market competition stepped up in the 1980s, the incumbent carriers and their preferred equipment suppliers still treated technology development as a long-term, collective planning process involving international coordination of standards and industrial policy planning. Reconciling regional policies with global coordination was the challenge.

Regional Features of 2G

The earliest major plan for coordinated 2G emerged in Europe, where political leaders saw it as a chance to dramatize the benefits of integrating European markets and policy. In 1982, European elites endorsed a single common standard: the Global System for Mobile Communications (GSM), a variant of time division multiplexing access (TDMA).[24] The process, designed to create standards for GSM, took place within the European Telecommunications Standards Institute, which used a weighted voting process to ensure a prominent role for incumbents.[25]

Motorola, the only prominent non-European firm in the market, held a wide array of GSM patents. It became locked in a dispute over the terms for licensing its intellectual property. Despite its major global position, Motorola lacked switching systems and was smaller than its EU rivals. Thus, it compromised by cross-licensing its patents to the major European incumbent suppliers, a deal that allowed it to thrive in Europe as a supplier of selective radio equipment. Predictably, second-tier and Japanese equipment suppliers complained that GSM patent pooling terms favored the largest European companies.[26] Indeed, the main purpose of the bargain was to deflect Asian challengers.

ETSI standards are voluntary, but the EU had the power to adopt an ETSI standard as a European norm. It did so by creating policies that de facto required all carriers to use GSM.[27] This built economies of scale for GSM service, allowing it to evolve into the dominant global technology for 2G, especially because of its dominance in the emerging Asian market. The EU still considers GSM to be one of its two great successes in industrial policy.

Japan's second-generation decisions took place in an era of industrial policy, so it chose standards that differed enough from those of other nations to impede foreign suppliers and favor a few Japanese suppliers.[28] The Japanese standard—Personal Digital Cellular (PDC)—made some headway in the Asian market but never flourished outside Japan. Still, the big, closed Japanese market provided large-scale economies and high profit margins that financed Japanese suppliers as they adapted their equipment for sale in foreign markets.

In the 1980s, when Japan's exports of telecommunications equipment to the United States surged and US importers had little success in Japan, raucous trade disputes proliferated. Initially the US government worked to force Japan to reform its standard-setting and procurement systems. Then the US insisted that Japan license a Japanese wireless carrier that proposed to use Motorola technology. Next, Japan was pushed to reallocate spectrum to make the new competitor viable in the Tokyo market.[29] Still, despite this foothold for Motorola, the rest of the Japanese equipment market was not compatible with US and European standards.

The strategy of the United States focused on market competition rather than global coordination. Its continent-size national market allowed the US to create large economies of scale for whatever standard it chose. By the 1970s, a few industry associations, not an individual carrier, dominated the standards process. The Telecommunications Industry Association (TIA) and the Cellular and Telecommunications Industry Association (CTIA) featured open membership and voluntary standards. The US satellite and cellular industries regularly clashed over spectrum policy. As a result, US deployment of 2G lagged Europe and Japan. Even when 2G was licensed, the FCC's norm of technology neutrality resulted in two dominant technology camps: CDMA (code division multiple access) and TDMA (time division multiple access) and some variants of the latter.[30] This division slowed the initial rollout of a cohesive national network while creating intense pressure for competition between technologies. This weakened American influence on 2G markets, while setting the stage for the disruption of global planning for 3G.

The Challenge of 3G

In the 1990s, the technology of a new player added another wrinkle to the process. By charging large sums for spectrum, the American 2G spectrum auctions made carriers keenly appreciative of any technology that could allow more traffic on less spectrum. Qualcomm emerged as a rising technology star when its CDMA technology was selected by Verizon, Sprint, and other US carriers because of its efficient use of spectrum.

Except for 3G, CDMA might have remained just another regional technology, similar to Japan's PDC. European and Japanese companies decided to base the 3G successor to GSM on CDMA (or a variant, W-CDMA) rather than on TDMA because CDMA's spectrum efficiency extended to transmitting large amounts of data.[31] This decision created a huge problem, which was underestimated at the time, because a single US company, Qualcomm, controlled the essential intellectual property rights of CDMA. A series of patent suits did not weaken Qualcomm's IPR supremacy.[32]

Qualcomm's control over critical IPR ultimately undercut the typical arrangements for telecom networks in global standards bodies. Traditionally, major suppliers cross-licensed their intellectual property rights on a cost-free basis while developing major new standards. Rather than deadlock about the precise distribution of payments, the top-tier suppliers benefited by using low-cost or zero-cost licensing to grow the market on their preferred terms. (Second-tier suppliers paid significantly more for licenses.) These arrangements proliferated so rapidly that by the late 1990s large regional bodies would not embrace a standard unless everyone agreed to license the relevant IPR to every IPR holder under the standard.

With 3G, the International Telecommunication Union faced a new problem. The formal ITU licensing rules are artfully ambiguous about expected licensing terms, but no standard can emerge unless all of the significant IPR holders consent.[33] In this case Qualcomm controlled the essential IPR. As with many newer ICT firms, this IPR was its main competitive asset. If Qualcomm gave it away, it could not survive because in the 1990s the company was too new and too small to win a competition that hinged on advantages in global economies of scale in manufacturing, distribution, and marketing. So Qualcomm insisted on collecting royalties and playing a central role in designing the emerging 3G architecture, even though it was quite new to the inner corridors of global standard setting. Nonetheless, Qualcomm had virtually no profile in Europe, where ETSI dominated. This meant that the strategic information available to all major players was spottier than normal. It was easy to miscalculate during the bargaining process. Nobody expected that Qualcomm could strike a tough bargain.

Major players slowly recognized the implications of Qualcomm's claims. European and Japanese incumbent suppliers wanted business as usual and therefore wanted to erode Qualcomm's licensing position. They introduced W-CDMA, a variant of CDMA that incorporated design features from GSM that they claimed would improve 3G's performance. They intended that these features also generate new intellectual property to weaken Qualcomm's control and provide the Japanese and Europeans with IPR bargaining chips to obtain improved licensing terms.[34] Qualcomm considered these design features arbitrary and predicted (correctly, as it turned out) that the design changes would make the transition to 3G more complex and time consuming. Qualcomm also worried that the numerous changes incorporating features of GSM architectures would undermine a principal advantage of its 2G CDMA systems, the promise that it could be upgraded cheaply and quickly to 3G. Qualcomm was concerned because 2G systems would continue to be a large part of the world market for wireless equipment for years.[35] In view of the high stakes, the major carriers soon chose their version of 3G depending on their 2G architectures. Second-generation carriers with a base in TDMA or GSM, mainly from Europe and Japan, supported W-CDMA. Those with a CDMA base, mainly in North America and Korea, supported extending CDMA to 3G.[36]

The European Union recognized that any attempt to dictate a mandatory standard for 3G had potential liabilities under new WTO telecom rules. For this reason, it crafted a position that required each member country to ensure that at least one carrier in its market would employ W-CDMA (called UMTS in Europe). In this way the EU allowed for multiple 3G-technology standards, but the rule was intended to "tip" the market toward W-CDMA because of network externalities. The guarantee of comprehensive European coverage for one standard gave an incentive to all carriers to deploy it so that their customers had European coverage while traveling.[37]

Carriers in markets with multiple technology standards for 2G had to resolve conflicting interests. In Canada, the dominant incumbent chose CDMA. Other countries championed Qualcomm in the ITU process. Usually one of the newer entrants favored CDMA. Competitive business reasons persuaded most dominant incumbents to favor W-CDMA. NTT's DoCoMo urged the ITU to designate W-CDMA as the only 3G option. Had the ITU done so, this would, for technology reasons, have rendered the 2G network of its rival DDI (now KDDI) less valuable for 3G.[38] As Korea and China introduced greater competition, similar stories with their own national nuances appeared. In short, the potential for gain in 3G influenced the positions of the players.[39]

At the ITU, the European Union and Japan favored a single 3G standard, arguing that this would yield the largest economies of scale and simplest interoperability of systems worldwide. They favored W-CDMA, the version of 3G backed by their largest carriers and equipment vendors. The European Commission understood how standards bodies could be strategic for the market.[40] Qualcomm responded by refusing to license its IPR to this proposed ITU standard.[41] It was then that the logic of the ITU mattered. Under ITU rules, without Qualcomm's agreement it became nearly impossible to set a global standard.

The ITU uses a "one country, one vote" system for decision making. It avoids deadlock because government and commercial interests seek common ground on standards and spectrum allocation. Although informal polls sometimes gauge relative standings of positions on some spectrum allocation debates, in practice consensus is needed to make progress. Member governments also have committed to work within the ITU on spectrum allocation, but major market powers can paralyze ITU decision processes.

Support from the United States and a few other governments strengthened Qualcomm's position. Qualcomm worked intensively with Lucent (which had virtually no sales in Europe and had not yet merged with Alcatel) and US carriers using CDMA to rally political support in Washington.[42] It won strong support from the US government despite objections from GSM carriers, in part because CDMA and Qualcomm had become a political poster child for the FCC spectrum auctions. The Clinton administration viewed the emergence of US-brewed CDMA in the technology-neutral auctions as proof that its policies could induce new technological successes and US exports.

The CDMA dispute illustrates how high-level politics goes beyond interest-group dynamics. Any free-trade-oriented Democratic administration had to appear to resist manipulation of the global market by rival technology powers. The Clinton administration liked to portray its trade policy as "tough love" globalization—the United States would further open its markets but would hammer misconduct by its trading partners. This approach made the Clinton administration doubly resolute. The CDMA story also showed how its market-oriented reforms, the auctions, could benefit American exports. Of course, the policy divisions dividing US companies required careful navigation by the White House. The executive branch justified intervention by reverting to its time-tested position that standard setting and licensing should be technologically neutral. It was inappropriate for any country to specify that its 3G licensees must embrace a specific technology. Therefore the US government pushed the ITU to adopt either a single standard acceptable to CDMA operators or multiple standards.[43]

The strong regional component of the ITU decision-making process ultimately amounted to a veto of any plan centered on a single standard. GSM was the dominant system. Most of Europe and Africa, large parts of Asia, and a few South American countries relied on GSM and supported its successor, W-CDMA.[44] However, solid support by important CDMA operators in Latin America and Asia meant that the W-CDMA camp could not paint the bargaining as a "North America versus the world" issue.[45] Even the Spanish firm Telefónica, which did not use CDMA in its home markets, embraced CDMA in many of its robust South American ventures. Therefore, GSM's relative strength was not decisive.

In time, a compromise emerged. The major suppliers recognized Qualcomm's IPR. Ericsson, the last major company to license from Qualcomm, purchased Qualcomm's network supply business to shore up its CDMA position. Reversing its previous position, Qualcomm compromised on its 3G design, so the GSM camp could build W-CDMA, its own version of 3G. When the dust settled, contrary to the ITU's original 3G plan, three major versions of 3G were sanctioned.[46] First, CDMA2000, was a direct descendent of Qualcomm's 2G cdmaOne technology. Second, W-CDMA (wideband-CDMA, or UMTS, standing for Universal Mobile Telecommunications System, or, recently, 3GSM) had elements of GSM while relying on a CDMA infrastructure. Third, TD-SCDMA (time division synchronous code division multiple access) was an idiosyncratic blend of CDMA and TDMA whose fate largely depended on China's support.[47] China delayed the deployment of 3G until 2008 when this technology was deemed ready to roll out.

In sum, regional patterns of standard setting and IPR regulation developed that played into domestic and global rivalries. The choice of 3G technology could help some local carriers and penalize others. And the battles among technology camps opened the way to changing competitive standing among equipment suppliers. Spectrum allocation accentuated the tensions.

Allocation of Spectrum

Spectrum is a second form of critical property rights. The ITU's radio regulations are meant to provide "an interference-free operation of the maximum number of radio stations in those parts of the radio frequency spectrum where harmful interference may occur." Regulations that supplement the ITU treaty have the "force of an international treaty."[48] Every 3 years, a World Radiocommunication Conference (WRC) makes decisions on new spectrum allocations and other policies to avoid interference among spectrum uses. As with standard setting, the WRC requires consensus decision making.

The global end game at the ITU influences national responses, but the roots of spectrum allocation are national. First-generation service relied on analog technology and most countries adopted idiosyncratic spectrum plans for local customers. It was nearly impossible to use a phone outside its home country because of the different national spectrum bands. Once established, spectrum allocation was difficult to unwind because it instantly created vested interests. Still, 2G technology reopened allocation choices because 2G required larger allocations in a different band than 1G services. As in standard setting, the EU and the US moved in different directions. The EU's choice was to standardize around GSM technology. This was half of the battle. The EU also bridged national differences in plans for spectrum. For GSM the Council of Ministers issued an EU directive requiring the use of a single band. Two factors permitted this outcome. First, European operators and equipment makers believed that spectrum harmonization would grow the mobile market more quickly if the EU had a single band for business users. Second, European political leaders used GSM as a flagship project to show the benefit of reforms that unified the EU market.[49]

Despite agreeing on a single band plan for 2G, EU member states retained control over spectrum planning and licensing to keep a close political hand on the market. This gap in the EU's powers had major consequences for 3G licensing.

On one level, the European experiment was successful; the GSM technology thrived. Consumers responded enthusiastically to truly continental service. During the 1980s, the market-oriented features of wireless were appealing when compared to the moribund marketing for traditional phone service. The European success fueled the growth of global mobile services and thus emphasized international harmonization of band plans. African administrations, long tied to European suppliers, again agreed to follow Europe. Asia adopted a mixture of band plans, but the European consumer success led national governments to tilt toward the European plan.[50]

The United States took a different path toward spectrum management. Unlike the EU, the US already enjoyed unified spectrum band allocations. A single analog network covered the US, and its continental market generated large economies of scale in equipment supply even without global harmonization. Its political economy tilted against a consensus on a single technology option. Not only did powerful players already occupy the European 2G bands, the US satellite industry had ambitious plans for mobile satellite services using low-earth-orbit systems that needed spectrum overlapping with possible 2G and 3G systems.[51] The administrations of George H. W. Bush and Bill Clinton selected more flexible bands for 2G. Canada followed the US plan because Nortel, its flagship equipment firm, depended on US sales. Other countries in the western hemisphere followed the US allocation decision, at least in modified fashion.

Regional dynamics determined the bargaining positions of actors during 3G spectrum planning. European suppliers and carriers began the 3G process hoping to create a uniform global band and a homogenous network environment (W-CDMA).[52] The dominance of GSM in Asia meant that Asian 3G spectrum bands approximated those in the EU. Therefore, from the start, many European and Asian carriers systematically considered building a global footprint. In contrast, beginning at the 1992 World Radiocommunication Conference, the US backed a plan to facilitate mobile services that gave no special priority to 3G over 2G or mobile satellite services. Other countries were irritated that until late 2002 the US did not clear the spectrum designated elsewhere for 3G.[53] Even then, the US declared that 2G spectrum could be used for 3G, thereby creating diversity in the global spectrum band. Critics of the US approach argued that it would reduce global economies of scale in equipment while raising the costs for consumers who desired global roaming with their mobile phones. (If band plans differed, even phones on the same standard would require chips designed to work on two sets of frequencies.[54])

Assignment of Licenses

Licenses are the third form of property rights. As in standard setting and spectrum allocation, regional patterns of market behavior held steady in the assignment of licenses. Predictably, the United States led the charge for more competition in license assignment. Each of the original seven regional Bell operating companies received one of two wireless licenses in its home territory. As had previous creators of duopoly, the US embraced non-market-based criteria for awarding the second wireless license. Methods for selecting licensees varied, but lotteries and administrative selection of a sound company promising good performance ("beauty contests") were popular. This practice helped equipment suppliers that were clamoring for new customers. Some of these new entrants became prominent players in the regulatory process, helping to determine future spectrum allocation and assignment policies.

In a major policy innovation, the 2G US spectrum licenses were auctioned off. Winners could choose which services to offer and which technology to use. By the mid 1990s the US had at least five competitors and rival technology camps in every region. However, foreign investors were barred from controlling interests in wireless carriers until the 1997 WTO telecom services agreement liberalized foreign investment rights.[55]

One consequence of US licensing policies was that, if the operator wished, 3G could be deployed on 2G spectrum. Thus, 3G could be deployed on a band not recommended by the ITU. When the additional spectrum conforming to ITU band plans for 3G was made available, it also was assigned by auction with technology-neutral licenses. Incumbents that already were heavily invested dominated the bidding. (This pattern held true in the auction completed in March 2008 for valuable spectrum previously held by analog television broadcasters.)

Around 1983, when wireless mobile phones became possible, most European governments licensed the traditional operator. Competitors gradually were introduced through the assignment of a second license using "beauty contests," especially in the 2G era.

The EU hoped to recreate the success of GSM through quick deployment of 3G using uniform spectrum and standards. The goal set in 1998 was extensive deployment by 2002. As with 2G, the EU required separate licenses for 3G services on a single designated band.[56] Thus, a 2G carrier could not upgrade to 3G on its old 2G spectrum. The net effect on the equipment side was to reinforce the dominance of European suppliers for the GSM family of mobile network equipment. For example, in 2004 Lehman Brothers calculated that Ericsson, Nokia, Siemens, and Alcatel held

81 percent of the market for 2G and 2.5G in the GSM family. Their combined share for W-CDMA was 84 percent, although Siemens and Alcatel teamed with Japanese partners (NEC and Fujitsu respectively).[57]

Because 3G was designed to operate on "virgin" spectrum, incumbents had to win new licenses in major markets in order to participate. By now the EU had embraced general telecom competition and several major countries, including the United Kingdom, France, Germany, and the Netherlands, chose to auction licenses by a more competitively neutral approach. More than $100 billion was spent in EU 3G auctions. In Europe, four traditional incumbents (British Telecom, Deutsche Telecom, France Telecom, and Telefónica) and two newer supercarriers (Vodafone and Hutchinson) commanded the largest share of the critical licenses.[58] This was preordained by the high cost of auction licenses and the advantages the large carriers might reap by spanning multiple national markets.

In 2001, 3G temporarily imploded, especially in Europe, under the weight of the collapse of the Internet and telecommunications bubble. The collapse of European carriers' stock market valuations and their heavy debt burdens foreshadowed possible deep job cuts. Bankruptcies became possible. The downturn dramatically increased pressure on many European countries to revisit their licensing strategies. Some began to seek ways to ease the financial burdens on carriers deploying 3G.[59]

In general, Asia relied less on auctions, allowed fewer competitors, and often dictated the choice of technology in its service licenses.[60] Fewer competitors generally translated into less financial pressure on carriers during the telecom slump of 2001. For example, when Japan allowed expanded entry in the mid 1980s, the government explicitly reviewed technology plans of applicants when selecting 2G licensees in a "beauty contest."[61] This helped Japan to indirectly steer the equipment and services markets. For 3G, Japan again opted for a "beauty contest" to advantage its three largest wireless carriers.[62] The government fashioned a dual market by selecting companies on both sides of the 3G-technology debate. The KDDI group, a descendant of the carrier involved in the Motorola trade war, adopted the cdmaOne and cdma2000 standards. DoCoMo, NTT's mobile wireless group, embraced W-CDMA, as did the group affiliated with Vodafone. In 2005, when Softbank acquired the Vodafone license and Japan licensed a fourth 3G competitor, eMobile, both companies selected an evolved version of W-CDMA technology.

Major emerging economies usually made explicit policy choices over the choice of permitted technology. But variety slowly won the day. Korea allowed only three competitors (KTF, SK Telecom, and LG Telecom). It required CDMA for 2G to build its export position in the CDMA equipment market. More variety emerged in 3G licensing. Hong Kong and then China carefully split their operators' licenses for 2G so that the largest went to the GSM camp while CDMA was assigned to a newer entrant. China then took until 2008 to reorganize its telecom carriers in an effort to create three major competitors, each equipped with a wired and mobile network. Each competitor had a different version of 3G, including one using TD-SCDMA (the Chinese-promoted standard).

India gave the earliest 2G licenses to GSM carriers but a myriad of regulatory disputes slowed the market's growth. The correction of these problems plus licenses for CDMA to two major companies stimulated market growth to the point that India emerged as the largest growth market for wireless by 2008. GSM and CDMA carriers furiously battled over transition plans to 3G with rival claims over how spectrum should be allocated among different 3G technologies. The decision to license 3G finally emerged in 2008, but by then the largest carriers were also contemplating complementary networks utilizing WiMAX.[63]

In sum, the licensing for 3G in most countries permitted or mandated more than one 3G standard.[64] Nonetheless, by March 2008 W-CDMA, like GSM, had emerged as the major approach to 3G. GSM reached 1 billion users by 2004, 2 billion by June 2006, and 2.5 billion by June 2007.[65] The Global Mobile Suppliers Association identified 211 W-CDMA operators in 91 countries. It calculated that during 2007 80 million new W-CDMA subscribers were added worldwide, a year-to-year growth rate of 81 percent.[66] More important, the worldwide crossover point on wireless infrastructure spending tipped in 2005 as spending on 3G exceeded 2G for the first time. The number of 3G customers reached parity with 2G customers in Western Europe in 2005. Moreover, the total number of 3G customers surpassed 2G by 2006 in Japan and Japan introduced a new carrier, eMobile, which only supported a 3G network.

Implications for the Next Transition

Delays in 3G build-out plans had important consequences for the economics of the market and its political economy. The delays altered technological options, policies of spectrum allocation, and assignment. This may change how the global ICT regime handles wireless policies that are central to the inflection point.

The delay in 3G opened more technological options. As was argued in chapter 3, modularity and the Cheap Revolution has created more versatile choices at realistic price points for networking, applications and terminals. For example, initially, 2.5G emerged as a transition offering because it could be deployed on 2G networks as an upgrade without a 3G conversion. Each camp had its own version of 2.5G. These systems usually downloaded data at around 50 kilobits per second.[67] Simultaneously, various paths to new wireless infrastructure opened up. Politically the most salient option was WiMAX because of the striking promise, heavily promoted by Intel, Nortel, and Samsung that a mobile version of WiMAX could be much faster than 3G (up to 70 megabits per second) and it claimed to be much cheaper, partly because it might not pay royalties to Qualcomm.

Carriers faced a major dilemma when considering 3G and its successors. As table 8.1 shows, most of the traffic on leading global wireless and wireline carriers still is derived from voice. At the same time, in the United States, voice revenues per user were declining quarterly especially in highly

Table 8.1

Leading global wireless/wireline carriers (average revenue per user). Source: Morgan Stanley Telecom Research, Global Internet Trends, 2006. (Data from CQ4:05. Vodafone estimated on UK, Spain, Germany, Italy, and UK average. For Telefonica Moviles and Telecom Italia Mobile, only domestic operations considered. Orange estimated on UK and French averages. Verizon and AT&T do not break out average revenue per unit (ARPU) for wireline segments.)

	Type	ARPU	Voice ARPU	Data ARPU	% revenue from voice	% revenue from data
Sprint/Nextel	Wireless	$62	$56	$6	90	10
NTT DoCoMo	Wireless	$59	$43	$16	74	26
T-Mobile	Wireless	$52	$47	$5	83	17
Cingular	Wireless	$49	$44	$5	90	10
Verizon Wireless	Wireless	$49	$45	$4	90	10
Telefónica Moviles	Wireless	$40	$34	$6	86	14
Orange	Wireless	$38	—	—	—	—
Vodafone	Wireless	$37	$30	$7	82	18
Telecom Italia Mobile	Wireless	$35	$29	$6	74	16
NTT	Wireline	$23	—	—	—	—
America Movil	Wireless	$15	$14	$1	90	10
China Mobile	Wireless	$10	$8	$2	80	20
China Unicom	Wireless	$6	$5	$1	86	14
AT&T	Wireline	—	—	—	—	—
Verizon	Wireline	—	—	—	—	—

competitive markets. In contrast, data—in the form of SMS, ring tones, and other new services—proved extremely profitable because it was charged at premium rates. (This premium was even charged by the largest 3G data carrier, Japan's DoCoMo.[68]) However, the market for data was rapidly moving toward applications that would require much larger data bundles, and this raised the question of whether carriers had enough spectrum with the right cost structure.[69] Moreover, some of the big new carriers (whether in India or the emerging pan-African carriers) had no particular links to equipment suppliers.

Big carriers, still largely in control of the wireless market, feared the declining margins on voice, and were looking for ways to grow the data market without fierce discounting and high capital expenditures. One idea was to boost speed and bandwidth to make more video applications available while getting others to absorb more of the capital expenditures. This led to interest in hybrid 2.5 or 3G/WiFi networks (epitomized by the iPhone from AT&T), and it set the stage for looking at alternative technologies built on WiMAX and other companies with deep pockets. In short, carriers became interested in more diverse supply options than in the past. At the same time, the US experiments with new forms of spectrum policy (described in chapter 5) highlighted to both carriers and governments that the old principles and norms of spectrum policy did not exploit the sweet spot of technological opportunities.

The excitement about WiMAX quickly became entangled in a controversy over precisely how to define its specifications and the spectrum for its deployment. The same decisional challenges as in 3G are leading to likely regional variations in the standard and its supporting spectrum. For example, WiMax is really a brand name for one branch of the less glamorously named family of 802.16 technology.[70] Korea is putting its national technological champion, the WiBro technology, under the same 802.16e umbrella as WiMAX, thus creating variation under the proposed standard.[71] Underscoring the diversity in technologies, in 2007 the ITU recognized the WiMAX family as another part of the 3G portfolio. This qualified WiMAX for use of spectrum reserved for 3G in many countries, but the WiMAX bands are still likely to vary. For example, by 2008 WiMAX supporters were close to getting approval for inclusion in 3G licenses in the 2.6-gigahertz band in the EU that was set aside for 3G. But, as a practical matter, prior licensing in this band means that many of the practical opportunities for WiMAX will be in the 3.5-GHz band. This band does not have ideal characteristics for mobile and is not available in the US.[72] Sprint-Nextel planned on WiMax for its 2.5-GHz spectrum in the US. In 2007, Japan used a "beauty contest" to award WiMAX licenses on the 2.5-GHz band to KDDI and Willcom (a small second-generation operator). Korea's WiBro deployment was on 2.3 GHz, a spectrum band that is heavily crowded in the US.

At the same time, 3G innovation sped up markedly because of continuing rivalry among the different 3G camps. Various revisions are evolving 3G to provide high-quality video and multi-media for large numbers of users.[73] A reliable, minimum symmetric speed of around 2 megabits per second is scheduled, and one upgrade announced in 2007 has peak download speeds of 9.3 megabits per second, more than ample for simultaneous mobile television and VoIP uses on a terminal.[74] The 3G vendors claim that even higher speeds will be possible as a set of hybrid technologies—some overlapping with features from alternatives to 3G—are melded into 3G. The magic number of 70 megabits per second for WiMAX is touted by some 3G plans. (Proponents of "4G" are arguing that 100-MB/s systems are a proper goal.[75])

For technologies to provide very high speed for large numbers of users requires huge swaths of high-quality spectrum and sophisticated engineering. Not surprisingly, the further variations in evolved 3G open the door to more efforts to manipulate markets. The Japanese communications ministry worried, for example, that DoCoMo would attempt once again to build a slightly idiosyncratic standard for Japan. This would ultimately make Japanese equipment suppliers less competitive on world markets while forcing DoCoMo's smaller rivals to adapt at added expense to the DoCoMo standards if they wished to roam on DoCoMo's network.[76]

The race for high-speed, wireless broadband—fixed and mobile—will feature a newer but less tested set of technological alternatives, backed by Samsung, Intel, Nortel, and other technological giants, as well as by the Korean government, against a rapidly evolving 3G architecture that itself may be somewhat fragmented. If newcomers' performance and cost margins are compelling, they may make substantial inroads if they do not bicker over standards. If the performance of new technologies is only as good or slightly better, it will be harder to challenge 3G leaders, which have a head start in the market.

The political economy tale of this market remains as much about business models as it is about engineering. Despite the bewildering array of acronyms for the various 3G upgrades, all 3G systems (except WiMAX) are based on CDMA. Critics complain that Qualcomm charges a royalty, but this is economically irrelevant for understanding the total cost of the system. The cost of R&D, including profits on the investment, is included in every technology development whether by a royalty or by bundling it into the price of the end product. The royalty is significant only for how profits are distributed, not for the total level of costs for consumers (unless Qualcomm has the ability to charge much higher rents than other producers).

More significantly, the economics of modularity and multi-sided platforms are complex. So long as 3G, or its descendants, is organized on its current business model, everyone pays Qualcomm about the same fee (about 5 percent of the price of a handset) for licensing its IPR.[77] For Qualcomm this builds a complementary, highly competitive ecology of end system providers. It also removes a traditional economic advantage enjoyed by top system vendors (which cross-licensed their IPR for little or nothing). (Removing this advantage allowed Korean vendors to crack the top ranks of world suppliers of CDMA terminals.) Qualcomm claims that its present royalty level will optimize total returns on the platform. Its critics counter that the royalty is far too high to achieve this goal.[78] But even the "correct" royalty rate automatically creates tensions with the largest equipment suppliers that seek every cost advantage. They face increasing competition from modular innovation systems with more specialized ODMAs and design shops plus the formidable Chinese entrant, Huawei.[79] Besides forcing further consolidation to build scale and cut costs (such as the Alcatel-Lucent merger), this gives industry giants an interest in experimenting with technologies where royalty arrangements might be more advantageous.[80]

The continual evolution of competition also changed the close alignment of carriers and equipment vendors. Since prices remain under pressure, carriers are examining options that reduce costs and multiply revenue alternatives. They are discovering that much of the promise in data markets requires multi-media capabilities. Loyalty to their traditional equipment vendors matters less as they seek to expand capabilities quickly and reduce costs. This has expanded opportunities for Huawei and other Chinese vendors. Critically, they are discovering that the expanded broadband capabilities require more spectrum, used more flexibly, than in the past. Since companies cannot flexibly buy and sell spectrum or rededicate the services on a spectrum band freely, they must assemble capabilities by combining available spectrum through "smart terminals" operating on more than frequency and technology format. The decreasing cost of engineering these terminals is prompting a rapid evolution in networking. For example, television on wireless devices is being delivered on a different band than the one for data and voice. Terminals combine the services and bands seamlessly. Samsung has designed a terminal that will use an advanced version of 3G for voice while employing mobile WiMAX for data.

Significantly, the latest chip sets for wireless devices only need about 20 percent of their space for radio functions. The rest can provide advanced functions, and in view of the modularity of terminal design there is ample room for co-invention of functions on the terminals as it approaches the capabilities of a personal computer. Arguably, the most important advances for ICT will now be on the terminal, as it becomes an anchor for the many new applications. Leaders in information technology, such as Intel, already view mobile terminals as a key growth market. Conversely, telecommunications firms may use their expertise on terminals to take aim at information technology markets.

In short, modularity and the Cheap Revolution grew in importance during the delay in rolling out 3G. The traditional principle of a presumption that interference was likely and had to be dealt with preemptively weakened. Digital smart terminals could reduce (not eliminate) spectrum risks and allow more spectrum flexibility. This flexibility also meant that spectrum was not quite so scarce because more bands of spectrum could support a particular use. Digital radios used spectrum more efficiently and Internet protocols could allow for more service mixing on the same terminal. Thus, the norms of government restricting users and uses heavily to protect against interference began to fade. And, above all, modular terminals meant that operators wanted flexibility in technological formats to seize opportunities to utilize different bands spectrum. For example, European carriers quietly backed more flexible use of spectrum and technology licensing polices as they transitioned to broadband after 2001. The Northern European group of Norwegian, Swedish, and Danish carriers deployed cdma2000 in 2006 on the 450-MHz band. Moreover, the enthusiasm for more spectrum flexibility and property rights that began in the US quickly migrated to the United Kingdom.[81] Beginning in July 2003, the EU even permitted 3G licensees to trade spectrum and licenses as a way of providing financial relief to carriers.[82] Eventually, the EU decided to generalize some of the spectrum policy models created by Britain while expanding its power over spectrum policy.

As old principles and norms weakened, the mix of expertise changed in the United States, in Europe, and in other market centers. Economists' influence on spectrum allocation increased. They preferred to release larger blocks more quickly to promote market entry and innovation. To assign spectrum, a growing number of economists favored auctions, which conferred stronger property rights and allowed for flexible choices of technology and services. They also preferred substantial leeway to trade and resell spectrum. (Alternatively, when technological ingenuity substantially erased scarcity and interference problems for certain applications, many economists preferred no license at all.) Their analysis of spectrum markets reflected the forces of modular innovation at the inflection point. This shift in North American and Europe domestic markets may force further changes in global governance toward a more market-driven, bottom-up model of change.

Still, major government intervention in markets continues in India, China, and Japan even as they introduce more competition and technological variety in their wireless markets. Outside of the US and the EU, most countries agreed to introduce more wireless technologies but governments selected preferred technologies for licensees in an effort to create an optimal mix of technologies. They also tried to balance advantages among competitors, not to maximize competition or technological flexibility.[83] Thus although countries were clearly embracing the view that they should allow more technologies and license them more quickly, no clear alternative principle and norms emerged by 2008. The ITU's control over standards and competition has diminished while the WTO and other standards organizations play a larger role in the decision landscape.

Through 2008 concerns over non-interference and the possible gains from a single spectrum band for a wireless application to build economies of scale kept the elaborate process of regional and world ITU spectrum coordination meetings in place. The ambiguity of the WTO obligations related to spectrum policies also restricts its role. However, the inflection point creates incentives in more markets (starting with the US and the EU) to inch toward domestic trading-rights systems to enable multi-technology, multi-band networks that do not fit easily fit within traditional spectrum planning. If this projection is correct, the current international discussions about planning 4G are unlikely to yield a single technology or market model. Although 3G offered the opportunity to integrate multiple standards, 4G may create the possibility of integrating multiple technologies. As chipsets become more powerful and more complex devices with integrative capacity through technology becomes more realistic. For many of the 4G advocates, 3G was the right idea but failed because of bad timing (prematurely pushing for high-speed wireless before better technologies were available) or poor execution (including the corporate battles over rollouts). This misses the big picture.

Third-generation technology assumed that timely, extensive global coordination of spectrum, standards, and licensing policies was possible. But the stakeholders in wireless communications, even insiders, have diversified significantly. Digital technology made it easier to get cross-entry across segments of the communications and information technology market. Cisco, Intel, Microsoft, Samsung, LG, Google, and Qualcomm are major players on the wireless scene—a far different roster of players than in 1990. The ITU standards process will likely certify only functional benchmarks for 4G subject to weak rules on IPR sharing. This work is only in its early stages as of 2008 and the real action is in the standards groups tied to each global technology candidate.

Analysts typically estimate that 4G will require peak speeds of 100 megabits per second and have technologies including elements of Orthogonal Frequency-Division Multiple Access (OFDMA). The primary 4G technologies are expected to be descendants of Long Term Evolution (LTE, backed by Ericsson), Ultra Mobile Broadband (UMB, championed by Qualcomm), and IEEE 802.16 m (WiMAX, advocated by Intel).[84] But these are likely to be mixed with unlicensed systems and complementary technologies in ways to be determined by trial and error. For example, how will broadcast technologies for mobile terminals (for which the US and the EU are already deploying along different paths) fit?

Meanwhile, the global coordination mechanisms remain relatively weak. Even these mechanisms may be in trouble. The US and most European spectrum management systems may change radically by 2025. By creating stronger property rights, supporting flexible markets in spectrum and services, or by expanding the "commons" for spectrum (unlicensed bands and use of temporarily unutilized licensed bands with smart low-power devices), the amount of spectrum and freedom of its use will increase. Global spectrum coordination at the ITU, with its biennial "swap meets" for bargaining among countries on spectrum allocation, may not accommodate the flexibility made desirable by the new national regimes.

Further, the goal of 4G assumes that the ideal future is known. This taxes anyone's ability to forecast in any competitive innovation market. One possible model for the future is closer to the modal type of the information industry. Collective efforts on standardization of technologies and supporting business processes have a pluralistic view of the future. In view of the speed of innovation and the diversity of players, no single authoritative source of information or decisions for all related technologies is possible. There are competing models of the future and various collective efforts to advance those visions.[85] Through markets, technology communities such as the Internet Society, or, occasionally, governments a single standard for particular important parts of the landscape may develop. But the goal is not to have a general consensus model of the future. Instead, different decision rules for setting standards and sharing IPR exist in different forums, and the ability of a forum to craft a rule that is ex ante acceptable to all major participants is part of its appeal or failure. Thus, the capabilities associated with 4G can be nurtured through more vigorous test bed processes and narrow, specialized standard setting. Spectrum coordination globally would identify recommended "reference" bands that governments would ensure are open to licensees for a new technology. Governments would not, however, reserve these reference bands exclusively for the technology. Developments conforming to those ideas would move the world toward a new system of global wireless governance.

This approach also recasts the competition questions for wireless technology. Today, the EU and Korea worry about companies (e.g., Qualcomm) that control new "platforms" that can be leveraged; they see the blunting of platforms as a way of closing the market gap that US companies opened up in the 1990s using such strategies. However, as was argued in chapter 3, at today's inflection point the production and innovation system is weakening the advantages of these platforms. The advantages of firms with strong specialist advantages will be narrower than previously. The priority for competition policy should be to figure out how to allow new technological alternatives to more easily be created and tested in the marketplace. To this end, rules encouraging competition among wireless carriers, flexible spectrum policy, technology neutrality, and some form of freedom for users to select wireless terminals and application software are significant tools for governance. As domestic market governance moves in these directions, it opens the space for changes in global market governance.