

# Notes

## Introduction

1. The Internet decisively moved networking to schemes in which the intelligence organizing the network and its applications moved from centralized telephone switches to millions of computers at the edge of a decentralized, digital packet network. This accelerated innovation, because the programming of the telephone switched network no longer was a roadblock to new applications. It also began true convergence among applications, because (to paraphrase the popular Internet slogan) every application—voice calls, emails, or video—is just a digital bit on a packet network.

## Chapter 1

1. Other estimates vary. See, e.g., “Global telecom markets to hit \$3 trillion by 2010,” at <http://www.telecomasia.net>.

2. Andrew S. Grove, *Only the Paranoid Survive* (Doubleday, 1996).

3. Michael Mann, *The Sources of Social Power*, two volumes (Cambridge University Press, 1986 and 1993).

4. For good syntheses of the economics, see the following: Catherine Mann and Daniel Rosen, *The New Economy and APEC* (Institute of International Economics, 2002); Catherine Mann, *Accelerating the Globalization of America* (Peterson Institute of International Economics, 2006); Marc Levinson, *The Box* (Princeton University Press, 2006).

5. “The winner takes all economy,” *McKinsey Quarterly*, August 28, 2007.

6. Economists see this second strand of competition as a Schumpeterian battle for control of innovative markets. At any moment, there may be dominant suppliers but the nature of the market can change before their eyes. This phenomenon is not new, but the inflection point will make it more important.

7. Even a little bandwidth can go a long way. Innovation in the use of wireless networks in rural areas of China suggests a different pattern of use and development is possible and highly valuable. See “Rural push boosts China Mobile profit,” *Financial Times*, August 16, 2007.
8. By 2007, GPS navigation systems for cars had evolved to introduce constantly updated information on road congestion based on real-time feedback from other GPS systems on the road and data analysis made possible by a hybrid of cellular data networks. See “Navigating with feedback from fellow drivers,” *New York Times*, October 18, 2007.
9. For a report on recent spending, see Cara Garretson, “Venture funding reaches five-year high in Q1: Investors empty pockets as start-ups eye public markets,” *Networked World* (<http://www.networkworld.com>), April 24, 2007.
10. Social scientists call the outcome to be explained the *dependent variable*. Market governance and its consequences are the dependent variable in this study.
11. There is still worry in some quarters that competing jurisdictions create a “race to the bottom” in the quality of regulation, but there is little evidence to support this general proposition.

## Chapter 2

1. IBM was late to the party. In 1977, the Apple II, Commodore International’s PET, and Tandy’s TRS 80 were the first successful pre-built minicomputers. The Computer History Museum identifies the Kenbak-1 (introduced in 1971) as the first personal computer, but only about 40 were ever built.
2. The FCC unanimously found that the AT&T tariff preventing interconnection was illegal and ordered AT&T and other phone companies to allow interconnection of devices to their networks that did not cause actual harm. See Gerald W. Brock, *Telecommunication Policy for the Information Age* (Harvard University Press, 1994), pp. 84, 85.
3. Electronic switching began to supplant mechanical switches. The first digital electronic switch, an AT&T 4ESS, was put into service in Chicago on January 16, 1976 (source: <http://www.corp.att.com>.)
4. The advent of satellite communications services in the 1960s led to great improvement in long-distance telephone service and, later, broadcast transmission into the home. At first such services did little for data transmission. Fiber-optic transmission began to enter the network in 1977, when AT&T installed fiber telephone systems in Chicago and GTE began providing service in Boston (source: <http://www.fiber-optics.info>).
5. AT&T licensed the transistor to other companies in 1952. In 1959, Texas Instruments and Fairchild introduced the integrated circuit. During the 1960s, integrated

circuits became microprocessors. In 1971, Intel created the microprocessor. IBM introduced its Personal Computer in 1981. In 1986, Cisco introduced the TCP/IP router. Source: Alfred D. Chandler Jr., *Inventing the Electronic Century* (Free Press, 2001), pp. 262–265.

6. The 1956 antitrust decree created the IBM “plug compatible” industry worldwide. In 1963, the Digital Equipment Corporation made its first meaningful impact in the marketplace with a mini-computer that made putting computers on the factory floor practical. Source: Chandler, *Inventing the Electronic Century*, p. 104.

7. Prices might have decreased more precipitately if the regional Bell Companies initially had been allowed to provide long-distance services. See Robert W. Crandall, *After the Breakup* (Brookings Institution, 1991), p. 48.

8. Even with increased transmission capacity, most Quality of Service guarantees were done on specialized network overlays (virtual private network or private network). Megabits and megabytes are frequently confused. In most instances bits are used to talk about data transfer rates. Bytes generally are used to talk about storage size calculations. Specifically, 1 kilobit = 1,000 bits, 1 byte = 8 bits, 1 kilobyte = 1,024 bytes, and 1 megabyte = 1,024 kilobytes. If an Internet provider offers a “1-Mb” connection, it is megabits, not megabytes. To determine approximately how much is being downloaded, divide by 8—for example, a speed of 1 megabit per second will result in downloads of 128 kilobytes of data. Source: <http://wiki.answers.com>.

9. On personal computers, see Chandler, *Inventing the Electronic Century*; Charles H. Ferguson and Charles R. Morris, *Computer Wars* (Times Books, 1993).

10. This trend, praised by most leading analysts, occurred in both the US and the EU. See Pamela Samuelson and Susan Scotchmer, “The law and economics of reverse engineering,” *Yale Law Review* 11 (2002), no. 7: 1577–1633.

11. Tim Berners-Lee, *Weaving the Web* (Harper, 1999).

12. Shane Greenstein, “Markets, standardization, and the information infrastructure,” *IEEE Micro, Chips, Systems, and Applications* 13 (1993), no. 6: 36–51.

13. The global electronics market and the telecommunications equipment market were under pressure from Japanese and later Taiwanese and Korean exporters that relied on scale economies. The semiconductor challenge moved the US closer to industrial policy than at any time except wartime. The strategy was to shore up US firms by two strategies. First, the US tried to increase its firms’ market penetration in Japan, so they could build scale economies and pressure Japanese price margins at home. This was the point of the US-Japan Semiconductor Agreement. The second goal was to share the cost of maintaining the supplier infrastructure for integrated American chip producers. The proposed idea was Sematech, a consortium jointly funded by industry and the US government. On the US-Japan Semiconductor Agreement, see Peter Cowhey and Jonathan Aronson, *Managing the World Economy*

(Council on Foreign Relations, 1993), pp. 139–145. See also Leslie Berlin, *The Man Behind the Microchip* (Oxford University Press, 2005).

14. John Richards and Timothy F. Bresnahan, “Local and global competition in information technology,” *Journal of the Japanese and International Economies* 13 (1999), no. 4: 336–371.

15. The effort in the late 1990s to force incumbent local-service carriers to share their network elements on an unbundled, cost-related basis was the ultimate effort to achieve disintegration through government intervention. Competition in most countries diverged from the US model of splitting the local and long-distance elements of the monopolist. Those with vigorous regulators, such as the EU, did focus on these carriers’ local-service networks as the most enduring part of their former market control.

16. For example, Korea and Taiwan used industrial policies to steer high national savings rates into subsidies for specialized entry into capital intensive and lower return segments of the memory chip industry. Source: *International Production Networks in Asia*, ed. M. Borrus et al. (Routledge, 2000). See also Michael Borrus, *Competing for Control* (Ballinger, 1988).

17. Eric von Hippel, *Democratizing Innovation* (MIT Press, 2005).

18. In Japan, this innovation storm—driven by lower costs, flexible networking, and user co-invention—was absent. Japan continued to favor vertical integration anchored on the technological planning of the dominant carrier, NTT. Although Japan also introduced telecom services competition, it limited the impact of competition by placing all new entrants under a micro-managed price umbrella set by NTT. Network expansion plans need ministry approval because the government wished to sustain its subsidy scheme for electronics firms Japan required the licensing of value-added networks. It did not license a network embracing Internet protocols until 1992. Sources: Roger Noll and Frances Rosenbluth, “Telecommunications policy: Structure, process, and outcomes,” in *Structure and Policy and Japan and the United States*, ed. P. Cowhey and M. McCubbins (Cambridge University Press, 1995); Shane Greenstein, “The evolution of market structure for Internet access in the United States,” draft, Northwestern University, 2005; Robert E. Cole, “Telecommunications competition in world markets: Understanding Japan’s decline,” in *How Revolutionary Was the Digital Revolution?* ed. J. Zysman and A. Newman (Stanford University Press, 2006).

19. Peter Cowhey, “Telecommunications,” in *Europe 1992*, ed. G. Hufbauer (Brookings Institution Press, 1990); Computer Science and Telecommunications Board, *Realizing the Information Future* (National Research Council, 1994), pp. 270–277.

20. OECD Information and Communication Technology, “OECD broadband statistics to June 2007,” at <http://www.oecd.org>. Broadband data related to penetration,

usage, coverage, prices, services and speed are updated regularly and are available at <http://www.oecd.org>. Comparable figures are not kept for large corporate and research center users of large broadband, but the US remains dominant in this market segment.

21. Peter Cowhey and Mathew McCubbins, eds., *Structure and Policy and Japan and the United States* (Cambridge University Press, 1995); Roger Noll and Frances Rosenbluth, "Telecommunications policy: Structure, process, and outcomes," in *ibid.*; Charles R. Shipan, *Designing Judicial Review* (University of Michigan Press, 2000).

22. In political science this is called a *veto point*. See George Tsebelis, *Veto Players* (Princeton University Press, 2002).

23. The split between presidential and parliamentary systems on incentives for delegation of authority is fundamental. However, the systems differ in their behavior based on such factors as the design of electoral voting systems. And some countries use hybrids systems. See Royce Carroll and Matthew Søberg Shugart, "Neo-Madisonian Theory and Latin American Institutions," in *Regimes and Democracy in Latin America*, ed. G. Munck (Oxford University Press, 2007).

24. A final form of control over the FCC is the division of some of its powers with other branches of the government. The most important of these is the shared power over competition policy with the Antitrust Division of the Justice Department. In view of the strength of US antitrust laws, both political parties are sensitive to the possibility of the rival party politicizing competition policy when it controls the federal government. As a result, the career officials in the Antitrust Division enjoy a relatively high level of protection from routine political oversight. Decisions on the general criteria for when to prosecute are subject to guidance by a political appointee, but the president is generally circumspect on antitrust matters. The shared power of Justice and FCC over telecom mergers leads the FCC to be careful not to conflict with Justice. It can happen, however, as the late 2006 ATT-SBC merger decisions show.

25. For a candid account by a point person for the Clinton administration, see Reed Hundt, *You Say You Want a Revolution* (Yale University Press, 2000).

26. Noll and Rosenbluth, in *Structure and Policy and Japan and the United States*, ed. Cowhey and McCubbins. Between 1900 and 1933, as national industrial and network markets took form, state authorities used antitrust actions to shelter local competitors from national competitors that held advantages over them. Most senators from these states were wary of nationally dominant firms. America's veto-oriented system and Congress's distrust of sweeping regulatory powers dampened impulses toward national economic planning. Industrial policy that might have concentrated firms into a few national champions was difficult to pass.

27. Peter Cowhey, "States and politics in American foreign economic policy," in *Blending Economic and Political Theories*, ed. J. Odell and T. Willett (University of Michigan Press, 1990).

28. James Cortada reports various estimates of ICT as the costs of the largest banks (*The Digital Hand*, volume 2, Oxford University Press, 2005, pp. 33 and 89–90). His estimates are in the range of 7–15% of the total costs of the banks. As late as 1992, after networking costs had declined dramatically from the 1970s, networking costs were 10% of the total. Interviewing and documents supplied to the authors in the 1980s showed that during the 1970s networking costs were much higher.

29. As described in chapter 3, these changes were part of the broader transition to a service economy that eventually made sophisticated manufacturing into a part of service product schemes, as clearly has happened in ICT since 2000.

30. Gerald Brock, *Telecommunication Policy for the Information Age* (Harvard University Press, 1994), pp. 65–74.

31. Cowhey, "States and politics in American foreign economic policy."

32. Large customers sought volume discounts and customized service packages for internal private networks. Computer services, including networking, were profitable but were on a smaller scale than today. Sales of IBM computers in 1984 were \$22.2 billion. The combined revenue of the top five computer services firms was \$3.4 billion. (Computed from Datamation figures reported on pp. 118–119 of Chandler, *Inventing the Electronic Century*.) On the high level of oligopsony in communications use, see Peter F. Cowhey, "The International Telecommunications Regime: The political roots of regimes for high technology," *International Organization* 44 (1990), no. 2: 169–199.

33. Eventually, the FCC ordered AT&T to create a separate subsidiary for terminal equipment because of issues about cross-subsidies in the competitive equipment market. The FCC did not think that these decisions would cause local phone rates to balloon. See Brock, *Telecommunication Policy for the Information Age*, pp. 79–98.

34. Linda Cohen and Roger Noll, *The Technology Porkbarrel* (Brookings Institution, 1991). The funding of research leading to the Internet was not an exception. Nobody saw the Internet as commercial data architecture until late in its deployment.

35. We thank Gerry Faulhaber for this point.

36. Brock, *Telecommunication Policy for the Information Age*, p. 118.

37. Steve Coll, *The Deal of the Century* (Athenaeum, 1986), pp. 18–19, 169–171.

38. Stephen Breyer, *Regulation and Its Reform* (Harvard University Press, 1982).

39. The classic account of White House thinking in this matter is Coll, *The Deal of the Century*.

40. All major telecom carriers, including the new entrants, were unionized. Thus, a decline in employment at AT&T was partly offset by new employees at MCI and other firms. This reduced the resistance of organized labor, a major constituency of the Democrats.

41. The Bells got the licenses from AT&T as a sop at the breakup. See Leslie Cauley, *End of the Line* (Free Press, 2005), pp. 36–37.

42. R. Preston McAfee and John McMillan, “Analyzing the airwaves auction,” *Journal of Economic Perspectives* 10 (1996), no. 1: 159–175.

43. We thank Reed Hundt for this observation.

44. The Democrats also wanted to distinguish new forms of subsidy for consumers from programs identified with the welfare of the Bells. Despite grumbling from the Republican Congress, the FCC used its discretion to institute a new fee for telecom services to fund the establishment of Internet access for schools, libraries, and hospitals. This was a conscious decision to meet the political demands to keep service widely distributed to all areas, but the Democrats designed the subsidy so that it went as much to poor urban neighborhoods as it did to rural areas. Inevitably, coverage of middle class areas was part of the political bargain.

45. There were divisions in each party, but the median point of each party’s congressional caucus was significantly different. Conservative Republicans cast this as enhancing competition by taking regulatory shackles off the Bells. Clinton Democrats stressed enhancing competition by letting new entrants attack the local transmission bottleneck on the network.

46. Representative critiques: Thomas Willett, “The political economy of cable ‘open access,’” working paper 00-09, AEI-Brookings Joint Center, 2002; Jerry A. Houseman and J. Gregory Sidak, “Does mandatory unbundling achieve its purpose? Empirical evidence from five countries,” working paper 04-40, MIT Department of Economics, 2004. For a nuanced analysis, see chapter 5 of Jonathan E. Neuchterlein and Phillip J. Weiser, *Digital Crossroads* (MIT Press, 2005).

47. The collapse of Global Crossing after it completed fiber-optic submarine cables linking the US and Asia allowed for the outsourcing revolution in India and elsewhere. See Thomas L. Friedman, *The World Is Flat* (Farrar, Strauss and Giroux, 2005), pp. 103–106.

48. Timothy F. Bresnahan and Shane Greenstein, “Technological competition and the structure of the computer industry,” *Journal of Industrial Economics* 47 (1999), no. 1: 1–40.

49. For a review, see Gerald R. Faulhaber, “Policy-induced competition: The telecommunications experiments,” *Information Economics and Policy* 15 (2003), no. 11: 73–97.

50. For instance: How much time should be required for quality children's programming? How much control local broadcast content should be mandated?

51. This section relies on several sources. Neuchterlein and Weiser succinctly analyze broadcast policy in chapters 11 and 12 of *Digital Crossroads*. Also see Mark Robichaux, *Cable Cowboy* (Wiley, 2005), pp. 72–74, 117–119, and 208–278. For an opinionated, erratic, but fascinating polemic, see Stephen Keating, *Cutthroat* (Johnson Books, 1999).

52. Another effort to promote international competition was the decision to introduce competition in satellite communications. Intelsat, formed in 1964 at US instigation to manage global satellite communications, was a “monopoly of monopolies” for international satellite services. Each national telecom monopolies owned a share of Intelsat proportionate to its international use. The US was a partial exception. It created a private national satellite monopoly, Comsat, to represent its interests instead of tapping AT&T. But in 1983, as domestic deregulation was gaining momentum in the US, a new venture, Orion Satellite Corporation sought permission from the FCC to launch a transatlantic satellite service in competition with Intelsat. Overcoming fierce opposition by Comsat and Intelsat, in late 1984 President Reagan determined “that separate international communication systems are required in the national interests,” but promised it would consult and coordinate with Intelsat to make entry smooth. The FCC then ruled that private firms should be allowed to provide international satellite communication services in competition with Comsat and Intelsat. In 1988 PanAmSat finally broke the Intelsat/Comsat stranglehold on international satellite services. For a detailed account, see Aronson and Cowhey, *When Countries Talk* (Ballinger, 1988), pp. 116–135.

53. An ongoing battle between the Ministry of Post Telecommunications (MPT) and the Ministry of International Trade and Industry (MITI) eventually prompted the Japanese government to mandate facilities competition. (The Diet passed new telecom laws in December 1984 that went into effect on April 1, 1985.) See Chalmers Johnson, Laura D'Andrea Tyson, and John Zysman, *Politics and Productivity* (Harper Business, 1989), pp. 211–215.

### Chapter 3

1. See “Winner-take-all: Google and the third age of computing” at <http://www.skrenta.com>.

2. Nicholas Carr, *The Big Switch* (Norton, 2008). Carr sees Google as an epitome of the change, but not as a potential monopoly.

3. There are disputes over the definitional lines. We use “the Grid” to indicate an architecture that joins multiple computing platforms within a predefined organization. It is a subset of “the Cloud,” a virtual “on demand” approach that allows decentralized users to tap networked computing and storage as needed. Interfaces

must be open but we do not assume that they must be produced by open-source code. See Heinz Stockinger, "Defining the Grid: A snapshot on the current view," *Journal of Supercomputing* 42 (2007), no. 1: 3–17.

4. Marketing is still moving faster than execution. "Virtualization" of blades is still imperfect—as of early 2008, three well-financed start-ups were trying to close this performance gap according to our interviews. Yet the impetus for the vision is clear. Since the early 1980s large companies' use of powerful computers has increased more than tenfold and perhaps as much as a hundredfold because they assigned a separate server to each new application. Consequently, these companies use only 10–15% of the effective capacity of their computers. Large financial institutions are key early adopters of the Grid. See Alan Cain, "Silver bullet or snake oil—is grid computing a money-saver?" *Financial Times* September 20, 2006 8; Alan Cain, "Virtualisation can bring an end to 'server sprawl'," *Financial Times*, September 20, 2006 8.

5. Enterprises are operating in more heterogeneous environments (hybrid Windows/Linux environments, with some mainframe and Unix flavors added) that rely on huge amounts of data in enterprise resource planning (ERP) and other systems. During the 1990s, SAP, PeopleSoft (Oracle), and related systems were deployed. Recently enterprise buyers focused on efforts to broaden the impact of these investments across the business. Customer demands for data interoperability and ease of use required changes in products and approach from software vendors. The use of xml file formats in Microsoft Office 2007 is one example of this trend. System vendors to enterprises have to support at least three major operating systems with the Web browser as the common interface.

6. Robert Cringely argues that Google holds more fiber-optic capacity rights than any other US organization and is building new giant data centers. Industry interviews suggest that Google's extensive fiber holdings do not come close to large cable operators like Comcast. But its server growth is stunning. See Cringely, "When being a verb is not enough: Google wants to be YOUR Internet," at <http://www.pbs.org>.

7. Robert Hahn and Robert Litan have noted that dominance might emerge because scale is a barrier to effective rivals for online ads ("Some Internet mergers deserve a careful look," AEI-Brookings Joint Center, 07-17, 2007).

8. We thank Michael Kleeman for showing us how this might be done.

9. "Nokia sets sights on Google," [www.telecoms.com](http://www.telecoms.com).

10. Rishad Tobaccowala, cited in "Deal that may create more, not less, competition," *New York Times*, February 2, 2008.

11. The effort to promote a "Google phone" does not foresee the phone as a significant source of profit, but as a commodity whose chief value is driving traffic to the Google search engine and related online services.

12. Robert A. Burgelman and Andrew Grove, "Strategic dissonance," *California Management Review* 38, no. 2 (1996): 8–28.

13. This builds on Joseph Farrell and Philip Weiser, "Modularity, vertical integration and open access policies: Towards a convergence of antitrust and regulation in the Internet age," *Harvard Journal of Law and Technology* 17 (2003), no. 1: 85, 100–105. Modularity is an idealized characterization of several important underlying properties. Today, some end systems, like personal computers, approximate the pure ideal. So the overall vector of the ICT networked infrastructure is toward modularity. Pierre de Vries pointed out to us that a purely modular architecture for ICT would be partial (no module is self-sufficient for the end service), separable (each module is self-contained and detachable), and substitutable (another module can be substituted). Andrea Ottolia and Dan Wielsch, "Mapping the information environment: Legal aspects of modularization and digitalization," *Yale Journal of Law and Technology* 6 (2003–04), no. 174: 176–276.

14. There are both production and consumption externalities in digital environments. The quotation is from D. Evans, A. Hagiu, and R. Schmalensee, "A survey of the economic role of software platforms in computer-based industries," RIETI discussion paper 04-E-032, 2004. Assuming that the platform can manage the price structure, it has incentives to avoid many traditional anti-competitive strategies found in vertical markets, such as foreclosure. See Jean-Charles Rochet and Jean Tirole, "Two-sided markets—An overview," March 12, 2004, at <http://faculty.haas.berkeley.edu>. Thinking on multi-sided platforms overlaps with the Farrell-Weiser analysis of complementary efficiencies in their discussion of modularity and on the concept of complementary products. See Antonio Ladron de Guevara, Anita Elberse, and William P. Putsis, "Diffusion of Complementary Products With Network Effects: A Model and Application," April 24, 2007, at <http://www.people.hbs.edu>. For a critical analysis of the related "serial monopoly" hypothesis, see Gerald R. Faulhaber, "Bottlenecks and Bandwagons: Access Policy in the New Telecommunications," in *Handbook of Telecommunications Economics*, ed. S. Majumdar et al. (Elsevier, 2005), pp. 506–510.

15. On shifts in Microsoft's strategy, see Suzanne Scotchmer, *Innovation and Incentives* (MIT Press, 2004), pp. 302, 303.

16. Microsoft Windows was a multi-sided platform, but Windows, according to antitrust complaints, had an essential facility that gave it power over others, the incentive to exploit this advantage, and an active strategy to profit from the centrality of the platform. The litigation ultimately produced a major antitrust consent decree requiring changes in Microsoft's conduct. For a sophisticated review of the state of "predation" analysis, see Joseph Farrell and Michael L. Katz, "Competition or predation? Consumer coordination, strategic pricing and price floors in network markets," *Journal of Industrial Economics* 53 (2005), no. 2: 203–231.

17. Voice-over-Internet is commonly called VoIP. The abbreviation stands for "Voice-over-Internet Protocol."

18. Slash Lane, "Google iPhone usage shocks search giant," *AppleInsider* (<http://www.appleinsider.com>), February 14, 2008.

19. Christian Hogondorn, "Regulating vertical integration in broadband open access versus common carriage," *Review of Network Economics* 4 (2005), no. 1: 19–32.

20. Examples include the iPod Nano (which maintains a cloud store that the user chooses a subset to "sync" with the tiny Nano) and Amazon's Kindle (which comes pre-configured with your Amazon account information for easy access to additional content).

21. Rich Karlgaard coined the phrase in "The big cheap chance," *Forbes*, April 28, 2003. We have extended the categories covered by the phrase.

22. For summaries of changes in terminals that illustrate our interview data, see *The Economist*, November 30, 2006. See also "The phone of the future" and "What's a cellphone for?" *Wall Street Journal*, March 26, 2007.

23. RFIDs and sensor chips are lumped together for convenience sake. However, RFIDs are more driven by the economics of specialized printing while sensors respond directly to Moore's Law. A RFID's average cost (about 20 cents in 2006) was forecast at 10 cents by 2007. RFIDs allow trucks, trains, ships, and planes to be treated as moving warehouses by yielding precise information about the time and location of inventory. Smaller firms can operate global supply chains using companies that can outsource this function because of less expensive information networks provided by innovations like RFIDs. See "A Survey of Logistics," *The Economist*, June 17, 2006, p. 17. We learned of the one-cent goal in interviews, but note the skepticism of Eric Haseltine, "RFID: How the next big thing could be small," Strategic News Service, August 1, 2007.

24. To eliminate paperwork and speed delivery, a partnership of Heineken and IBM along with Dutch, British, and US custom agencies plans to use RFIDs combined with satellite and cellular networks to track and document shipments. The OECD estimates the current shipping system generates thirty different documents per cargo container. This effort would cut the number significantly. See Brad Smith, "IBM brews with Heineken," *Wireless Week*, October 27, 2006.

25. We thank Larry Smarr for this example.

26. John Hagel III and John Seely Brown, *The Only Sustainable Edge* (Harvard Business School Press, 2005), p. 12. In 1981, 256 megabytes of memory cost \$200,000 (in 1981 dollars). In 2001, that capacity sold for less than \$50 (in 2001 dollars). Source: <http://www.littletechshoppe.com>.

27. By 2009, household markets for storage of 500 gigabytes and above is expected to soar, led by the North American market. See “Consumer network storage: heavy hitters enter market” at <http://www.instat.com>.

28. For many in the developing world, the first experience of the Web will be on phones, not personal computers.

29. Lisa Endlich, *Optical Illusions* (Simon and Schuster, 2004). Dan Bieler estimates that the one European carrier’s 1.5 billion Euro investment in next generation networks will save several hundred million dollars in operating expenses each year starting in 2010 (“KPN’s next-generation network takes shape,” at <http://www.ovum.com>).

30. Martin Cave, Luigi Prosperetti, and Chris Doyle, “Where are we going? Technologies, markets and long-range public policy issues in European communications,” *Information Economics and Policy* 18 (2006): 242–255. The minimum capacity of broadband for home users will permit high-definition video downloading (around 12 megabits per second) and significant upstream speeds in the medium term.

31. Using 2004 cost data published by NTT, and allowing a 20% margin on NTT’s average monthly revenue per user for fiber service, it would take NTT more than 8 years to recoup its capital costs. NTT’s data for 2004 are reported at <http://www.rbbtoday.com>. Interviews in November 2007 confirmed the decreasing price of fiber to the curve. But NTT scaled back its plan to extend fiber to the home in 2007 by one third because it would take more than 8 years to recoup capital costs based on NTT pricing in 1997. Analysts question the financial viability of Verizon’s residential fiber scheme. See “Big thinking on small caps: Cable’s new technology roadmap,” Bernstein Research, September 28, 2007.

32. “AT&T has done the deals. Now it needs results,” *New York Times*, March 27, 2007.

33. In conversation François Bar suggested to us that functional characteristics like latency and reliability, not broadband speed, initially might be most crucial for ubiquitous networks.

34. According to interviews we conducted in 2007, early deployment of “battlefield of the future” systems being prepared by Boeing will require an average throughput capacity of 70 megabits per second to provide stable rich depictions of tactical developments for each unit in combat.

35. MSV, a new satellite system, combines satellite and terrestrial wide band wireless to serve these regions and target markets with broadband. An incumbent, Inmarsat, is planning a similar system.

36. On the John Deere tractor, see Jessie Scanlon, “The way we work: On the farm,” *Wired*, May 2003, p. 40. Another example is the discussion of remote monitoring

of bridges and other infrastructure in the wake of the collapse of a bridge in Minnesota in July 2007.

37. Optimizing traffic may lead many of these sensors to be in local peer-to-peer relationships that do not lead to traffic on the general Internet backbone. See David D. Clark et al., “Making world (of communications) a different place,” *ACM SIGCOMM Computer Communication Review* 35 (2005), no. 2: 91–96. Also see Exploring the Business and Social Impacts of Pervasive Computing, report on a conference organized jointly by IBM Zurich Research Laboratory, Swiss Re Centre for Global Dialogue, and TA-SWISS, 2006.

38. Krishna Nathanson, “From RFID to the Internet of things: Bridging the gap between research and business in the on demand era,” presentation to EU IST Conference, 2006.

39. European Commission, “Radio frequency identification (RFID) in Europe: Steps toward a policy framework,” COM(2007) 96 final and [SEC(2007) 312].

40. The motes currently operate on the 900-megahertz and 2.4-gigahertz unlicensed bands (source: <http://www.dustnetworks.com>). Many sensors can now do a preliminary assessment of the data to see if performance is within acceptable parameters. A “smart sensor,” according to the IEEE, “provides extra functions beyond those necessary for generating a correct representation of the sensed quantity.” See F. L. Lewis, “Wireless Sensor Networks,” in *Smart Environments*, ed. D. Cook and S. Das (Wiley, 2004); David Culler, Deborah Estrin, and Mani Srivastava, “Overview of sensor networks,” *IEEE Computer* 37 (2004), no. 8: 41–49.

41. Neil Gershenfeld and Danny Cohen, “Internet 0: Interdevice internetworking—End-to-end modulation for embedded networks,” *Circuits and Devices Magazine* 22, no. 5 (2006): 48–55.

42. CalIT2 director Larry Smarr notes that this is essentially a dedicated light wave, a revolution in architecture compared to the shared system of the Internet. It represents the ability of a packet-switched network to create a virtual circuit switched route on demand. See <http://www.nlr.net>.

43. Gershenfeld and Cohen, “Internet 0.”

44. Launched in 1984 at 56 kilobits per second, it reached 1.5 megabits per second in 1988 and topped 44 megabytes per second (a T-3 capacity) in 1992. Japan and Korea deployed ADSL for consumers at 45 megabits per second by 2005. Histories of NSFNET are available at <http://communication.ucsd.edu> and at <http://www.livinginternet.com>.

45. The architecture of the Internet may have to evolve to take full advantage of the transmission capacity. See Geoff Huston, “Gigabit TCP,” *Internet Protocol Journal* (<http://www.cisco.com>) 9, no. 2.

46. Data use now exceeds voice use on the network. Data use includes surges in peak demand tied to peer-to-peer media applications downloaded by human users. Still, there is a limit to how many data search requests and YouTube videos anybody can absorb. Although “human in the loop” traffic will be important, new forms of “last stop is human” and “no human in the loop” applications will emerge to drive data traffic. Pilot deployments of the latest network-centric war-fighting applications suggest that large data requirements will emerge in which machines generate traffic without humans in the loop at all times. New traffic management systems have car GPS systems provide real-time feedback to traffic monitors on congestion and speeds that is then aggregated and displayed to individual drivers.

47. Figure 2.6 extrapolates from 2005, but interviews in 2007 corroborate the continuing trend.

48. This is a central observation of James W. Cortada’s study of the use of ICT. See especially *The Digital Hand*, volume 2 (Oxford University Press, 2005).

49. In contrast, in the IBM mainframe era and in the Windows era, developers wrote applications designed to run in a specific operating environment. Thus, Win32 APIs were strategic for Microsoft and generated huge backward compatibility efforts so that no applications “broke” as Windows upgrades were released. More focused standards, like SIP for Internet Messaging and efforts to deliver “Services Oriented Architecture” inside the corporate firewall also contributed to more modular software infrastructure and solutions.

50. “Web 2.0” is an imprecise term that refers to the growing ability of the Web to support interactive user communities through such arrangements as social networks, hosted services, and wikis. Another key feature is that mash-ups use content from multiple sources to create a new service. Examples can be found at [www.programmableweb.com](http://www.programmableweb.com) and at <http://googlemapsmania.blogspot.com>. Also see “The mash-ups will let companies get creative with data,” *Financial Times*, September 5, 2006.

51. A description of RSS is available at <http://en.wikipedia.org>.

52. The best-known ad network is Google’s AdSense, but there are others (Yahoo, Microsoft, and various specialized networks), and there is a vibrant start-up community in “ad networks” for more specialized applications and end points (i.e., mobile). At a press conference on October 10, 2006, Sun Microsystems cited Second Life as an example of what it is now “calling the Participation Age, and the next evolution of the network as the computer.”

53. Enthusiasts argue that the open-source communities lower the cost of entry barriers for operating systems, particularly through the creation and use of Linux. Some Linux applications offer cheaper and easier delivery. Yet as of 2006 Linux was more important for cannibalizing the pre-existing Unix market than challenging

proprietary software. Still, open-source models inevitably will impact platforms and applications development. See Steven Weber, *The Success of Open Source* (Harvard University Press, 2004).

54. On “Slingbox Mobile,” see <http://us.slingmedia.com>.

55. Spencer Reiss, “Here comes trouble,” *Wired*, February 2007: 94–99.

56. Anita Elberse, “A taste for obscurity: An individual-level examination of ‘long tail’ consumption,” working paper 08-008, Harvard Business School, 2007.

57. Some analysts claim that Google is pessimistic about having effective search algorithms for video, so its purchase of YouTube was a switch in direction for search engines. It will rely on social networking to “search” video. See “Two Kings Get Together,” *The Economist*, October 14, 2006, pp. 67–68. On a different approach to people-search, see [www.spock.com](http://www.spock.com).

#### Chapter 4

1. Don Tapscott and Anthony Williams believe that IBM primarily seeks to leverage its programmers by embracing open-source innovations. This may be a collateral benefit, but neutralizing rivals at the customer interface could be a powerful driver. See Tapscott and Williams, *Wikinomics* (Portfolio Press, 2006).

2. In 2008 a senior executive of a major competitor to IBM in this market showed us an analysis of his firm’s margins (about 7% on sales) and their analysis of likely returns for IBM and other rivals. His point was that desired levels of profitability came off items like hardware, not most of the systems services and integration businesses. This confirmed other industry interviews in the preceding year.

3. “Good enough” refers to a line of thinking that argues that most end users only require some small subset of the features and capabilities delivered in current (or past) software solutions—suggesting that there is little need to upgrade to the latest or more complex offerings because that what users are already using is “good enough” to meet most needs. On the “good enough” point, see Steven Baker, “Why good enough is good enough,” *Business Week*, September 3, 2007. Industry interviews confirmed that this is IBM’s view—even in areas where they cooperate with leading Web-based vendors they view these primarily as short-term opportunities to learn but not as real threats to more complex requirements of critical IBM customers.

4. The mobile phone handset business is the closest to the fashion industry today. For example, in 2005 the fastest-selling phone in the UK during the Christmas season was the Motorola Razr in pink.

5. In 2008, for example, Microsoft announced the Internet Explorer 8 would adhere to important Internet standards, something that had not been the case in previous versions.

6. The Cloud also changes the economics of distribution in ways that help smaller firms. “Software as a Service,” an alternative to packaged software, gradually emerged as a driver in enterprise ICT because of the ease of deployment and management. No new client code is necessary to manage and upgrade it because the data and application logic reside primarily on a Cloud server.

7. Amazon has a strategy that invests in building innovative infrastructure (its development tools are prized in the software community) so as to build an ecology that can sustain rapidly updated services in a state-of-the-art e-commerce marketplace. Amazon resells its infrastructure and development tools to others, thereby defraying costs. Amazon’s Web services bandwidth now exceeds the bandwidth used for all of its global commercial portals—an indication of significant size, according to Josh Catone, who argues that the primary customers are small to medium-size Web firms (“Amazon Web services: Bigger than Amazon,” at <http://www.readwriteweb.com>).

8. Level 3 was the most successful of the first-generation carriers with different financial and technology models. We think that hybrid network models will expand if policy is favorable. See Robert Cringely, “Oh Brother Where Art Thou?” at <http://www.pbs.org>.

9. Sources: interviews by the authors with various industry sources, 2007 and 2008.

10. See “Apex code: The World’s First On-Demand Programming Language,” at <http://www.salesforce.com>.

11. Analysts use the analogy to the fashion industry to explain why Motorola’s Razr V3 phone declined from a status symbol sold at \$500 to a \$30 commodity in slightly more than 2 years (“Cellphone envy lays Motorola low,” *New York Times*, February 3, 2007). It was no longer unique and fresh. Industry interviews in 2007 revealed that Motorola was losing money net on the Razr.

12. For a discussion of the supply chain for personal computers, see “Inside Lenovo’s search for the perfect laptop,” *Business Week*, February 14, 2008.

13. Even though we think that modularity encourages multi-sided platforms, Apple specifically rejected this approach for the iPod. Apple made a strategy decision to make it “one-sided” by controlling every aspect of the platform and thus beat rivals using a multi-sided approach.

14. In 2007 the Norwegian consumer ombudsman declared iPod’s DRM scheme illegal because it restricted the hardware that could be used to play legally obtained music. Some speculate that Steve Jobs’ public protests against the insistence on DRM schemes by record companies is to show that content providers force the restrictions on Apple. See <http://www.buzzbums.com/buzz/norway-declares-itunes-illegal>; “Europe cool to Apple’s suggestions on music,” *New York Times*, February 8, 2007.

15. The labels may state that it is acceptable to move a user's iTunes Store music collection from an iPod to a competing device, but Apple still must grant permission. This may be one reason that EMI and Universal are moving away from a DRM to an MP3 format. Otherwise Apple could control the retail channel so that as users bought more Apple music the cost to switch to a competitor's device soars. We thank Cory Doctorow for this point. The rapid adaptation to the iPod strategy by the record labels, however, contributes to the potential of new rivals to iPod. We thank Cory Ondrejka for this observation.

16. Michael Borrus, *Competing for Control* (Ballinger 1988); Dieter Ernst, "The new mobility of knowledge: Digital information systems and global flagship networks," in *Digital Formations*, ed. R. Latham and S. Sassen (Princeton University Press, 2005).

17. ODMs are just one part of what is now a distributed and complex value chain that delivers almost all components necessary for new entry. Consider the highly specialized, proprietary technology shops that design components for systems producers and systems users. These companies control system segments characterized by fast innovation, deep intellectual property, and extreme specialization. Some firms, like Qualcomm, are pure specialists. Others players are divisions of larger conglomerates like Samsung's operations on large display systems. Samsung may choose to control its own display panel manufacturing, but this is a strategic choice, not a necessity for a specialized innovation strategy. Qualcomm is a purer example than Samsung of a technology input specialist because it does not also sell end-product systems.

18. For a complementary line of analysis, see John Zysman, "Creating value in a digital era: How do wealthy nations stay wealthy?" in *How Revolutionary Was the Revolution?* ed. J. Zysman and A. Newman (Stanford University Press, 2006).

19. Integration creates network effects and lock-in. Even cheating on digital rights management is easier in the iPod-to-iPod transfer world. Only a technological or business model shift will knock off a dominant leader that holds 80% of the US digital music market. Ad services, like Universal's SpiralFrog, offer one approach, but its users must renew downloads monthly on Universal's system. In Asia the growth of mobile phone music systems may rival Apple through cell phones. See "Apple's sound strategy can keep the iPod as number one," *Financial Times*, September 2-3, 2006.

20. See "NBC, Fox launching video site Hulu.com" at <http://www.usatoday.com>.

21. The Big Three suppliers (Nokia, Ericsson-Sony, and Motorola) in the \$70 billion handset market (2006 estimate) were critical to the major carriers' innovation and marketing plans. They dominated a complex design and manufacturing business. But original design manufacturers like BenQ, Arima, and Compal of Taiwan are

eroding their edge. They supply Ericsson, Motorola, Siemens-Sony, and Toshiba. The ODMs' market share grew from 9% in 2002 to about 30% in 2005. Customized ODM phones for Orange allowed tighter hardware-applied service integration for Orange in France and raised revenues by \$18 per month. ODMs also allowed Microsoft to circumvent the Big-3 backed Symbian operating system. Since mobiles have key open standards at the network layer, the industry may be heading to a model like that of the automobile industry, where a "system integrator" like Honda may combine horizontal layers of value added so no player dominates any layer. See "Mobile phones battling for the palm of your hand," *The Economist*, May 4, 2004, pp. 71–73.

22. These include desktop computers, cellular phones set up for television or, much anticipated, "free" ad-funded hardware.

23. Modularity also allows new online ways to sell and place ads and permits more rapid choices of dynamic delivery platforms. A US trade association earmarked \$50 million to set up such a market for ads. See "Silicon Valley prepares to take the revolution offline," *Financial Times*, May 24, 2006.

24. "In raw world of sex movies, high definition could be a view too real," *New York Times*, January 22, 2007.

25. Hal R. Varian, Joseph Farrell, and Carl Shapiro, *The Economics of Information Technology—An Introduction* (Cambridge University Press, 2004), pp. 74–77.

26. For Apple's position, see <http://www.apple.com/hotnews/thoughtsonmusic/>.

27. For example, the Indian TV and film industry is experiencing a golden era. The potential for local storylines and content serve a growing national audience—even if a large part of this "national audience" is part of a global diaspora. See "In India, the golden age of television is now," *New York Times*, January 11, 2007.

28. See *Personal, Portable, Pedestrian*, ed. M. Ito et al. (MIT Press, 2005).

29. Source: <http://www.video-games-survey.com>.

30. "World of Warcraft Reaches New Milestone: 10 Million Subscribers," at <http://www.blizzard.com>.

31. Among US Internet users, 79% (100 million) use social network sites. The Korean market is growing at 45% annually. See "Korean site tackles might of MySpace," *Financial Times*, September 1, 2006, p.16.

32. YouTube had more than 83 million unique visits in July 2006, an increase of nearly 2200% over July 2005. The second largest site for video was iTunes, with about 56 million visits but a much lower annual growth rate ("Wal-Mart sets stage for digital action," *Financial Times*, September 13, 2006, p. 17). In early 2007, YouTube accounted for about 43% of all video views on the Internet ("Xeep Video on the Net," at <http://www.xeep.net>).

33. Traditional television programs devote substantial time to support user forums where community content about the show becomes part of its value. Fan magazines are not new. What is new is the ease and scale of consumer feedback and complementary programming.

34. New media face substantial monetization challenges. The management of intellectual property rights on YouTube remains controversial; see, e.g., "Viacom tells YouTube: Hands off," *New York Times*, February 3, 2007.

35. Chris Anderson, *The Long Tail* (Hyperion, 2006).

36. Korean subscribers to SK Communications' Cyworld number 18 million, or 40% of the population. More than 90% of all users in their twenties are registered on Cyworld which reported sales of \$168 million and a profit of \$21 million in 2005. It generates 80% of its revenue from sales of digital items decorating its members' home pages. It launched ventures in China, Japan, the US, and Taiwan, and established a joint ventures to enter Europe. Global expansion required customization of the avatars and navigation tools. Cyworld withdrew from Europe in March 2008, citing cultural differences. Immediately, Korea's Pandora TV, the dominant firm for video sharing in Korea (about 10 times more Web hits than YouTube in Korea) announced plans to launch in Japan, China, and the US with local language services. See "Korean site tackles might of MySpace." *Financial Times*, September 1, 2006; "Pandora sees hope in global labyrinth," *Korea Times*, March 13, 2008.

37. On March 18, 2007, Eric Schmidt, CEO of Google, suggested that language translation programming was likely to be a disruptive force in the coming years. See "Eric Schmidt, CEO of Google, on iinnovate" at <http://www.youtube.com>.

38. Source: [www.entertainmentasia.com](http://www.entertainmentasia.com).

39. John Hagel traces the origins of the term to a 1971 article in which Herbert Simon noted that "a wealth of information creates a poverty of attention" (Hagel, "The economics of attention," at <http://edgeperspectives.typepad.com>).

40. Interviews with industry participants suggest that the rates paid by most standard ad networks cannot deliver the ad revenue required to build and deliver more sophisticated online applications.

41. Michael Arrington. "These crazy musicians still think they should get paid for recorded music," at <http://www.techcrunch.com>.

42. On aggregation, see "How to create your own TV channel," *Business 2.0*, February 12, 2007.

43. We thank Paul Maritz for his observations.

44. It also changes the architecture of corporate ICT networks. See David Strom, "How instant messaging is transforming the enterprise network," *Internet Protocol Journal* (<http://www.cisco.com>) 9, no. 2.

45. See Robert McMillan, "Corporate data slips out via Google calendar," at <http://www.computerworld.com>.

46. GPS on phones will allow routine updating of plans. In 2007, Nokia announced plans to embed GPS in all cell phones ("Nokia plans to install GPS chips in all handsets," at <http://www.dailytechrag.com>). Nokia is pushing the idea of "augmented reality," which uses GPS to locate a building and bring up third-party information on its "content" ("What's New in Wireless," *Wall Street Journal*, March 26, 2007). See also "Nokia to buy Navteq for \$8.1 billion," *New York Times*, November 16, 2007.

47. [http://www.motoqwiki.com/index.php?title=Motorola\\_Q\\_Wiki](http://www.motoqwiki.com/index.php?title=Motorola_Q_Wiki).

48. On Yahoo's purchase of online applications provider Zimbra, see "Yahoo buys e-mail software firm Zimbra" at <http://www.news.com>.

49. There are already rules governing some aspects of privacy in the workplace, most notably EU Framework Data Protection Directive (95/46/EC). The Directive on Privacy and Electronic Communications (2002/58/EC). The latter requires an opt-in system by users before direct marketers with email can solicit them. This could be handled by a PNP. Social networking data, another element of a PNP, has also drawn European regulatory attention (EurActiv, "EU Web security watchdog sets sights on MySpace," at <http://www.euractiv.com>).

50. We thank Michael Borrus for suggesting this phrasing.

51. See "China Mobile's hot signal," *Business Week*, January 25, 2007.

52. Anderson, *The Long Tail*.

53. We thank Cory Doctorow for this insight. He also cites the parallel case of the London transport system which "now charges a 100% premium to ride the bus on an anonymous cash fare, and will not sell" passengers a weekly or monthly pass unless they agree to use an RFID card that can be used to keep track their travel forever.

54. The movement to online medical records raises substantial privacy challenges, as HIPAA compliance rules are not required once individuals have granted permission to non-medical providers to store and share their data. See "Google Health makes its pitch" at <http://healthcare.zdnet.com>.

55. Eric Haseltine, "RFID: How the next big thing could be small," Strategic News Service, August 1, 2007.

56. Important privacy and related issues must be resolved to make this a reality.

57. Wikipedia defines "bleeding edge" as "a term that refers to technology that is so new (and thus, presumably, not perfected) that the user is required to risk reduc-

tions in stability and productivity in order to use it. It also refers to the tendency of the latest technology to be extremely expensive.”

58. David E. Culler and Hans Mulder, “Smart sensors to network the world.” *Scientific American* 290 (2004), no. 6: 85–91.

59. Markus Endler, “Large scale body sensing for infectious disease control,” position paper submitted to Sentient Future Competition, Department of Informatics, Pontifícia Universidade Católica do Rio de Janeiro, 2005.

60. Haseltine, “RFID: How the next big thing could be small.”

61. Robert Litan, “Catching the Web in a net of neutrality,” <http://www.washingtonpost.com>.

62. Tapscott and Williams, *Wikinomics*, pp. 24–27, 163–168.

63. These may include electric load management forecasts, pricing the cost of an auto trip on new toll roads, or water systems in drought-stricken countries.

64. Report from NSF Sponsored Workshop, Environmental Cyberinfrastructure Needs for Distributed Networks, Scripps Institution of Oceanography, August 12–14, 2003. See Tim Wark et al., “Transforming agriculture through pervasive wireless sensor networks,” *IEEE Pervasive Computing* 6 (2007), no. 2: 50–57.

65. Von Hippel, *Democratizing Innovation*, chapters 8 and 11; William J. Baumol, Robert E. Litan, and Carl J. Schramm, *Good Capitalism, Bad Capitalism, and the Economics of Growth and Prosperity* (Yale University Press, 2007).

66. There are many other challenges in these countries, especially the lack of skilled IT labor forces and laws that impair ICT-focused business. But this is not the focus of our study. For an overview, see Ernest J. Wilson III, *The Information Revolution and Developing Countries* (MIT Press, 2004).

67. Source: interviews conducted by the authors.

68. Source: interviews conducted by one of the authors in 2005 and 2006.

69. See Memorandum and Order of AT&T Inc and BellSouth Corporation, FCC 06-189, December 29, 2006, paragraph 36. See also Simon Wilkie Ex Parte on behalf of ACTEL June 14 2005, FCC dockets 05-65 and 05-75.

70. In November 2007, Bernstein Research estimated that even on triple-play customers Verizon runs a negative present value on fiber to the home. Strategists for a major fiber-optic carrier suggested the pattern of cable and Bell upgrade strategies to us.

71. Joseph Farrell and Philip Weiser, “Modularity, vertical integration and open access policies: Towards a convergence of antitrust and regulation in the Internet age,” *Harvard Journal of Law and Technology* 17 (2003), no. 1: 85, 100–105; Eli Noam,

"How telecom is becoming a cyclical industry, and what to do about it," working paper, Columbia University, 2002; Cave et al., "Where are we going?"

72. The European road traffic system is an example of a vertically integrated solution that relies on low turnover infrastructure and a narrow solution. Turnover is low because transaction costs are high. Building agreement on a system is politically complex. Initially, competition may be inefficient in many comparable niches. See Peter F. Cowhey and Jonathan David Aronson, "Wireless standards and applications—Industrial strategies and government policy," Annenberg Research Network on International Communication, 2004.

73. Although asset specific solutions for business processes may be stable in particular niches, controlling an expensive, hard to replace facility may not be enough to guarantee this result. Consider the situation of telecom carriers that still control local transmission facilities. Despite this control, prices of voice packages are decreasing and likely will continue to do so. The reasons are that there is substitution among modes of communications to provide the specific user service (a phone call) and that multi-sided platform economics makes the phone call into just one of several uses and prices on the platform. However, new entrants leverage modular software and the installed capital stock to deliver tailored multi-sided platform offerings quickly. For a general treatment, see Varian et al., *Economics of Information Technology*, pp. 21–28.

74. There are ways of attacking complex legacy systems. For example, the software code for telephone switches was costly to create. Once established, the code that permitted reliable phone service was huge and difficult for competitors to understand. Vendors still sell this equipment at huge discounts in anticipation of customer lock-in for service and upgrades because it was so hard to crack the code. Today more powerful computational devices offer service applications built on relatively open software standards, like the marriage of routers to VoIP software, thereby pressuring traditional producers of network equipment.

75. We thank Robert Pepper for pointing out the parallel between the Ofcom and FCC concerns. Holders of key content, like ESPN, may prefer to make an exclusive deal with the dominant network. So the government cannot bank on some form of countervailing strategy on the content side. See Christian Hogondorn and Ka Yat Yuen, "Platform competition with must have components," working paper, Wesleyan University, 2006.

76. Lawrence Lessig, *Free Culture* (Penguin, 2004); Jonathan D. Aronson, "Protecting International Intellectual Property Rights," in *Power, Interdependence, and Nonstate Actors in World Politics*, ed. H. Milner and A. Moravcsik (Princeton University Press, 2008).

77. An early exploration was examined by Anne Wells Branscomb in *Who Owns Information?* (Basic Books, 1994). Also see Viktor Mayer-Schönberger, "Beyond copy-

right: Managing information rights with DRM," *Denver University Law Review* 84 (2006), no. 1: 181–198.

## Chapter 5

1. Europe taken as a whole is a larger market than the United States. Although there is unity in some spheres, others remain contentious.
2. Moore's Law focuses on silicon capacity, throwing little light on how semiconductor firms entice customers to their more powerful chips. See Amar Bhidé, "Venturesome consumption, innovation and globalisation," presented at CESifo and Centre on Capitalism and Society conference, Venice, 2006.
3. Hundt, *You Say You Want a Revolution*, pp. 134–136.
4. For a typical list of examples including 3G and RFIDs, see "Changing China—Will China's Technology Standards Reshape Your Industry?" Global Technology, Media and Telecommunications Industry Group. Ernst and Young.
5. Scott Kennedy, "The political economy of standards coalitions: Explaining China's involvement in high-tech standards wars," *Asia Policy* 2 (2006): 41–62.
6. Calculated from data provided on pp. 76–78 of OECD, *ICT Report 2007*.
7. Accounting for these markets is imprecise. See Andrew Bartels and Andrew Parker, "European enterprise IT spending 2006 to 2007: Looking up, still lagging behind the US," Forrester Research, October 2, 2006.
8. Sources: "Digital Planet 2004" (September 2005) and "Digital Planet 2006" (WITSA, May 2006); data provided by Global Insight.
9. Based on table of "gross domestic expenditures on R&D" in OECD Factbook 2007: Economic, Environmental and Social Statistics.
10. Data on the capital stock and the role of US multinationals are from Nick Bloom, Raffaella Sadun, and John Van Reen, "Americans do IT better," Stanford Institute for Economic Policy Research Policy Brief, 2007, available at <http://siepr.stanford.edu>.
11. Source: <http://ww.jetro.go.jp>.
12. We thank Cory Doctorow for pointing out that the rules governing liability for network content are constantly being contested and that an inappropriate set of rules could offset other US advantages in regards to content markets.
13. "US jumps to 24th in worldwide broadband penetration," at <http://www.websiteoptimization.com>. However, the 23 higher-rated countries include Monaco, Macau, Guernsey, and Luxembourg.

14. OECD Directorate for Science, Technology and Industry, "OECD broadband statistics to December 2006," at <http://www.oecd.org>.
15. "Mobile phones battling for the palm of your hand," *The Economist*, May 4, 2004, pp. 71–73.
16. "Mobile set to become a trillion dollar industry in 2008," at <http://www.cellular-news.com>.
17. Mobile video reaches 2% of US subscribers, which is dwarfed by Japan and South Korea. In-Stat predicts that by 2010 mobile video will reach \$3.1 billion market in Asia. The major US carriers are now launching video services on large scale. Source: "What's new in wireless," *Wall Street Journal*, March 26, 2007.
18. Information and Communication Technologies, *OECD Communications Outlook 2007*, p. 76.
19. Manuel Castells noted to us that the language of national competition is more and more outdated. Global network competition matters greatly now and will only increase. Still we believe that for reasons of history and structure the US will remain the critical player in efforts to shape global agreements at least until 2025.
20. Merrill Lynch, "Beyond subscriber growth," *Global Wireless Matrix*, 3Q 2007 (December 24, 2007), pp. 54, 57.
21. Reuters, "In 2008 there are close to 300 million subscribers to 3G technologies worldwide," March 3, 2008.
22. Interviews with executives of wireless start-ups and venture capitalists, San Diego and Silicon Valley, fall 2006.
23. Although the broader obligation to interconnect with any network also was challenged, the primary focus of concern was unbundling. See Howard Shelanski, "Adjusting regulation to competition," *Yale Journal on Regulation* 24 (2007): 56–105.
24. Analysts associated with the Democratic Party, including Rob Atkinson, president of the Information Technology and Innovation Foundation, eventually came to praise this restraint. For a sample of opposing views, see *Antitrust Policy and Vertical Restraints*, ed. R. Hahn (AEI-Brookings, 2006).
25. After accounting for the largest users of ICT infrastructures (e.g., the Fortune 500), the level of competitive provision of fiber decreases significantly. See Simon Wilkie Ex Parte on behalf of ACTEL, June 14 2005m FCC dockets 05-65 and 05-75.
26. At the end of 2007, the 19 largest US cable and telephone firms, accounting for 94% of the broadband market, had 61.9 million subscribers. Telcos had 28.4 millions subscribers and cable companies had 33.5 million broadband subscribers. Source:

Multichannel News (<http://www.multichannel.com>), "Broadband connects with 8.5 million US customers in 2007," March 3, 2008.

27. Shelanski, "Adjusting regulation to competition"; Mark L. Del Bianco, "Voices past: The present and future of VoIP regulation," *ComLawConspectus* 14 (2006): 365–401.

28. Other technologies, including the use of electric power lines for communications transmission, were highlighted but had less commercial focus than wireless.

29. A related goal was to permit "underlay" networks that used idle capacity in licensed bands, including the "guard bands" that buffered a band from interference. This was accomplished through the use of "smart terminals" and some government mandates of best practices (performance requirements) for devices. See Neuchterlein and Weiser, *Digital Crossroads*. On the debate over the use of white space on television demands, see Pierre de Vries, "Populating the vacant channels the case for allocating unused spectrum in the digital TV bands to unlicensed use for broadband and wireless innovation," working paper 14, New America Foundation, 2006.

30. The FCC retained network sharing and interconnection obligations for traditional telephone networks and ADSL. See "Appropriate framework for broadband access to the Internet over wireline facilities," FCC docket 02-33 September 23, 2005.

31. "Microsoft urged the FCC to allocate additional spectrum below 2 GHz and at 5 GHz for unlicensed broadband uses. It argued that such spectrum could supplement cable and DSL services and 'jump-start' the creation of competitive wireless US broadband networks. Cingular, Cisco, the Consumer Federation of America, Ericsson, the Information Technology Industry Council, Motorola, Proxim, the Rural Telecommunications Group, and the Wireless Ethernet Compatibility Alliance also expressed support for additional unlicensed spectrum. In their joint reply comments, the New America Foundation, Consumers Union, et al. state that there is tremendous support in the record for the allocation of additional frequency bands of spectrum for unlicensed use, particularly to facilitate broadband wireless networking." Federal Communications Commission, Spectrum Policy Task Force, "Report of the unlicensed devices and experimental licenses." Working Group 11, November 15, 2002.

32. This assumes that some technological issues involving VoIP and wireless systems are overcome. See John Blau, "T-Mobile CEO: VOIP will have no major impact," *InfoWorld* (<http://www.infoworld.com>), February 13, 2007.

33. FCC, Broadband Wireless Network as an Information Service, March 22, 2007.

34. Jon M. Peha, "Emerging technology and spectrum policy reform," ITU Workshop on Market Mechanisms for Spectrum Management, Geneva, 2007. See also Thomas Hazlett, "Assigning property rights to radio spectrum users: Why did FCC

license auctions take 67 years?" *Journal of Law and Economics* 41 (1998), no. 2: 529–578; Yochai Benkler, "Overcoming agoraphobia: Building the commons of the digitally networked environment," *Harvard Journal of Law and Technology* 11 (1997–98): 287; De Vries, "Populating the vacant channels"; William Lehr, "Economic case for dedicated unlicensed spectrum below 3 GHz," available at <http://itc.mit.edu>.

35. There is well-established precedent for this approach as well. Part 15 spectrum is "unlicensed." Anyone who complies with the conditions of operations can transmit and operate in this spectrum with appropriate certified devices that do not cause harmful interference to others. They also must accept interference. Operators in Part 15 spectrum obtain no superior rights; while anyone may use the spectrum, no one may exclude others from using the spectrum. In terms of property rights, this spectrum is a "commons." Source: "Wireless:: WiFi: Unlicensed: Part 15," at <http://www.cyberte telecom.org>.

36. The most important legislation came when a Republican Congress and a Democratic president extended immunity from liability for content posted on websites to Web portals under section 230(c) of the Communications Decency Act of 1996. This mirrored the broad protections that common carriers in telecom traditionally enjoyed. For liberal Democrats this was free speech. For conservative Republican this was defense of the marketplace from litigation. For both it catered to the virtually unanimous demands of the Internet commerce industry.

37. Robert D. Atkinson and Phillip J. Weiser, "A 'Third Way' on Network Neutrality," Information Technology and Innovation Foundation, 2006. Available at <http://www.itif.org>.

38. Cisco is prominent in this arena, but other companies and equipment segments also are pursuing these strategies.

39. Christian Hogondorn, "Regulating vertical integration in broadband open access versus common carriage," *Review of Network Economics* 4 (2005), no. 1: 19–32.

40. "Video road hogs stir fear of internet traffic jam," *New York Times*, March 13, 2008.

41. Matthew Lasar, "Comcast, net neutrality advocates clash at FCC hearing," *ars technica* (<http://arstechnica.com>), February 25, 2008. The perception of the issue might have been quite different if Comcast had waited until customer complaints about slow service mounted before they acted to filter content.

42. "Comcast paid to pack FCC hearing," *New York Post*, February 27, 2008.

43. Mark Cooper ("The Economics of Collaborative Production in the Spectrum Commons," working paper, Stanford University Center for Internet and Society, 2006) argues that this opens the way to a peer-to-peer community and policy coalition to gain the benefits of collaborative productive. Our point is narrower. Regard-

less of battles over the precise contours of copyright or peer-to-peer video distribution, mainstream, IPR-oriented industries have bet on a new ICT infrastructure model.

44. The Open Internet Coalition does not object to tiered pricing for consumers based on bandwidth. Google, Amazon, Yahoo, eBay, and IAC finance this broad coalition in support of network neutrality.

45. “[T]he FCC’s Policy Statement fails to address a critical issue: discrimination by broadband providers against unaffiliated Internet content, services, and applications. . . . [AT&T] ‘shall not discriminate in their carriage and treatment of Internet traffic based on the source, destination or ownership of such traffic.’ . . . [This would] prohibit tiering schemes that impose additional surcharges on Web companies to ‘deliver’ Internet content. . . .” (comments of The Open Internet Coalition, “In the Matter of AT&T Inc and BellSouth Corporation applications for approval of transfer of control,” FCC WC docket 06-74, filed October 24, 2006. This proposal allowed for network prioritization based on type of traffic and nondiscriminatory network management. Also see Kodak Corporation, “Net neutrality: Principles,” in Advisory Committee to the Congressional Internet Caucus, Briefing Book, June 8, 2006.

46. Testimony of Gary R. Bachula, Vice President, Internet2, Before the US Senate Committee on Commerce, Science and Transportation, Hearing on Net Neutrality, February 7, 2006. Bachula endorsed a national goal of 100 megabits per second in 5 years and 1 gigabit per second in 10 years for households. Tim Berners-Lee and Larry Lessig were among the prominent researchers. For a critique of relying solely on bandwidth, see Michael Kleeman, “Point of disconnect: Internet traffic and the US communications infrastructure,” policy brief, Center for Pacific Economies, University of California, San Diego, 2007.

47. The Department of Justice had approved the merger without conditions. Because one commissioner disqualified himself to avoid the appearance of a conflict of interest, Republicans were unable to muster the three votes needed for FCC approval.

48. The House Commerce Committee Chair and Senators Byron Dorgan (D) and Olympia Snowe (R) introduced bills backing net neutrality. See Marc S. Martin, Henry L. Judy, and Benjamin Oxley, “Update: Net neutrality back on the political agenda,” *E-Commerce Law and Policy*, January 2007: 10–11.

49. Former FCC Chairman Michael Powell promoted these goals as the “Four Freedoms” of networking. The fourth freedom was the customer’s right to obtain full information on the service plan. The FCC advanced these goals in a non-binding policy statement. Nicholas Economides questions the likelihood of these competitive risks in “The economics of the Internet backbone,” in *Handbook of Telecommunications Economics*, volume 2, ed. S. Majumdar et al. (North-Holland, 2005).

50. This is Carterfone revisited. (The Carterphone case was the policy battle on connecting third-party terminals to the AT&T network that in 1968 led the FCC to

open the way to connect non-AT&T devices to the network.) See Gerald Brock, *Telecommunication Policy for the Information Age* (Harvard University Press, 1994), pp. 84–85.

51. TechNet, a coalition of tech CEOs, strongly urged the FCC to endorse non-discrimination on access to content and websites. It also argued that broadband networks should be required to enable websites to prioritize delivery of their content according to the plans of websites. But it supports tiered pricing and other network options to enhance the delivery of services and finance the network. Large users in the financial industry are cautious about committing on net neutrality. (Source: <http://www.hillnews.com>)

52. For strong evidence that competitive local exchange carriers (CLECs) differentiated themselves from incumbents, see Shane Greenstein and Michael Mezzo, “The role of differentiation strategy in local telecommunication entry and market evolution: 1999–2002,” *Journal of Industrial Economics* 54 (2006), no. 3: 323–350.

53. Marguerite Reardon, “FCC approves AT&T-BellSouth merger,” CNET News.com, December 29, 2006. After months of partisan deadlock, the Federal Communications Commission approves the merger valued at roughly \$86 billion.

54. Scott Moritz (“Cisco Shreds ‘Net Neutrality,’” *TheStreet.com*, January 4, 2007) suggested that Cisco decided that the FCC principles did not block its network security offerings that would prioritize packets after deep packet inspection.

55. John Blau, *InfoWorld*, February 2007.

56. Timothy Wu, “Wireless Carterfone,” *International Journal of Communication* 1 (2007), February: 389–426. Also see Skype, “Petition to confirm a consumer’s right to use Internet communications software and attach devices to wireless networks,” submitted to FCC February 20, 2007.

57. In many countries, consumers routinely buy a phone and the SIM card of their preferred service provider as two different purchasing decisions.

58. Janice Obuchowski (R) and Reed Hundt (D) were the bipartisan team’s leaders. See Comments of Frontline Wireless LLC, FCC Public Safety proceeding, February 26, 2007. The company failed in these efforts, and in January 2008 it went out of business.

59. Frontline’s proposal contained detailed provisions about preemption of the private network capacity for public safety when necessary. It also allowed the licensee to make secondary, preemptive use of the public-safety network.

60. There were also disputes about the FCC auction rules. If not properly designed, auctions can allow incumbents to foreclose new entrants by making it easier for incumbents to bid a premium to foreclose entrants. Critics of the rules claimed that the FCC rules enabled the foreclosure strategy although FCC economists try to avoid

such risks. We based this section on discussions with participants involved in the auction.

61. This policy episode also shows the risks of policy innovation. The FCC set a high minimum bid for the winner to show that this was not a political giveaway. Then, the 2008 auction began just as the credit market meltdown took place. Front-line could not secure its financing and declared bankruptcy. No other bidder was willing to meet the FCC's reserve price.

62. Anne Broache, "Google lobbies for open wireless networks," CNET Networks (<http://news.com>), June 14, 2007; Elizabeth Woyke, "Google likely out, and happy," [www.forbes.com](http://www.forbes.com), February 6, 2008.

63. See Farrell and Weiser, "Modularity, vertical integration and open access policies," *Harvard Journal of Law and Technology* 17 (2003), no. 1: 85, 100–105. Dominant firms may value long-term profits from maintaining their market power; see Dennis W. Carlton and Michael Waldman, "Why tie an essential good?" in *Antitrust Policy and Vertical Restraints*, ed. R. Hahn.

64. In *Digital Crossroads* Neuchterlein and Weiser show why pricing freedom may not lead to the predicted behavior of efficient network sharing, but pricing irrationalities make the problem less tractable.

65. Someone will profit. VeriSign, for example, is building a business by operating the Object Name Server, the new root directory for Electronic Product Codes, that is vital to the growth of RFIDs as a commercial application.

66. Simon Moores, "Prepare for some 'digital tension,'" September 27, 2006, at <http://silicon.com>.

67. Bill Gates, testimony before US Senate Committee on Health, Education, Labor and Pensions, March 12, 2008, available at <http://www.computerworld.com>. Gates said: "The federal government needs to increase funding for basic scientific research significantly. . . . We should seek to increase funding for basic research by 10% annually over the next 7 years. Congress should consider other innovative ideas as well, such as (1) new research grants of \$500,000 each annually to 200 of the most outstanding early career researchers; (2) a new National Coordination Office for Research Infrastructure to manage a centralized research infrastructure fund of \$500 million per year; (3) establishing and providing funding for Advanced Research Projects Agencies in various departments, similar to DARPA of the 1970s; and (4) ensuring that research projects are communicated to the private sector so that companies can collaborate more effectively with recipients of public research funds."

68. This included favorable regulations for VoIP. See Del Bianco, "Voices Past"; Robert E. Cole, "Telecommunications competition in world markets: Understanding Japan's decline," in *How Revolutionary Was the Digital Revolution?* ed. Zysman and

Newman; Martin Fransman, "Introduction," in *Global Broadband Battles*, ed. M. Fransman (Stanford University Press, 2006).

69. Shun Sakurai, "Japan's best practice for telecommunications market," presentation to WTO, February 20, 2008. Sakurai is a senior official in Japan's Ministry of Internal Affairs and Communications.

70. Ibid.

71. Interviews in Tokyo, June 2007.

72. Phedon Nicolaidis, "The political economy of multi-tiered regulation in Europe," *Journal of Common Market Studies* 42 (2004), no. 3: 599–618.

73. On unbundling network components in order to stimulate DSL roll-out, see W. Distaso, P. Lupi, and F. Manenti, "Platform competition and broadband uptake," *Information Economics and Policy* 18 (2006), no. 1: 87–106. The cable infrastructure is greater in the UK due to regulatory policy in the 1980s. The German cable infrastructure is extensive (passing nearly 60% of households), but it is technically obsolete. German regulatory restrictions make it hard to invest in upgrading. Italy's broadcasters successfully managed to stunt the growth of cable. France Telecom owns a significant share of the cable television industry in France. Martin Fransman.

74. Martin Cave and Pietro Cicioni, "Does Europe Need Network Neutrality Rules?" *International Journal of Communication* 1 (2007): 669–679; J. Scott Marcus, "Is the US Dancing to a Different Drummer?" *Communications and Strategies* no. 60, fourth quarter, 2005: 39–58; Tom Kiedrowski, "Remarks on net neutrality," CEPS-PFF Conference, February 22, 2007.

75. See the discussion of the European Commission on the priority for embedding broadband policy into a broader ICT policy in order to correct the EU's weaknesses in global competition (available at <http://europa.eu/i2010>).

76. Nicolas Economides, "Commentary of the EU Microsoft antitrust case," at <http://www.stern.nyu.edu>.

77. For a historical review, see Paul Goldstein, *Copyright's Highway* (Stanford University Press, 2003).

78. Coherence does not mean vast power. For example, the formidable lobbying power of local television broadcasters required a congressional decision on the deadline for turning back the 700-MHz band spectrum held by broadcasters as they rolled out high-definition television services.

79. Of course, other parts of the US government, including the Office of the US Trade Representative and the Department of Commerce, actively argue for strict intellectual property protection for American movies, music, and other cultural

industries. The US also provides significant funding for public broadcasting and public radio.

80. Eli Noam, "What regulation for Internet TV? Telecommunications vs. Television Regulation," 2006. Available at <http://www.london.edu>.

81. This also leads to softening of news content. See James T. Hamilton, *All the News That's Fit to Sell* (Princeton University Press, 2004).

82. The EU Parliament reacted to broadcasting on the Net with alarm. They worry about its impact on the Audiovisual Media Services directive. The 1989 Television without Frontiers directive helped ensure free flow of programs and broadcast while protecting consumers. New proposals may include online gaming and delivery of content to mobiles. Britain's Ofcom thinks that may include video-blogging and content on YouTube. Critics charge that a proposed EU directive would ban ads as downloadable specialized programs (such as cooking shows downloaded from food company website). See "A truly nonsensical law for television," *Financial Times*, September 6, 2006.

83. In 2007, Google held 74% of the French search market. Google's plan to put English books online was last straw for President Jacques Chirac. He directed his Culture Minister and the head of the national library to create a similar project for French books with a new search engine that rejects Google's premise of ranking by popularity. The French effort will rely on a committee of experts to guide search links. Source: "Google a la française," *The Economist*, April 2, 2005, pp. 45–46.

84. The US is engaged in a long-standing WTO dispute over online gambling. It won the right to ban Internet gambling for public welfare reasons, but was found to be in violation of WTO rules for allowing some exceptions solely for US providers. On IP TV regulation, see Noam, "What regulation for Internet TV?"

85. Changing pricing schemes might entail charging more for content without embedded digital rights management (DRM). Some claim that various DRM systems can reduce the availability or dissemination of copyrighted material.

86. A notable example was "The Grey Album," the work of a music producer named Brian Burton who went by the name Danger Mouse. He never asked permission to use material from the Beatles that he mixed with material by the rapper Jay-Z. Although Jay-Z's material was copyrighted, it was released for the implicit purpose of encouraging mash-ups and remixes.

87. Bruce Abramson, *Digital Phoenix: Why the Information Economy Collapsed and How It Will Rise Again* (MIT Press, 2005), p. 221. This is inducing innovations like the Copyright Clearance Center's plan to charge a single per-student fee annually to universities for the unlimited use of copyrights controlled by its licensing control. See Brock Read, "Copyright Center will let colleges pay blanket fees to reuse print material," *Chronicle of Higher Education*, June 29, 2007.

88. Scotchmer, *Innovation and Incentives*, pp. 182–185.

89. Source of data: <http://www.techcrunch.com>.

90. See “Mix08: Kawasaki grills Ballmer in lively Q&A” at <http://www.computerworld.com>.

91. Tim O’Reilly, “What is Web 2.0: Design patterns and business models for the next generation of software,” 2005, at <http://www.oreillynet.com>.

## Chapter 6

1. Similarly, a clear danger of over-fishing global fisheries exists, but it is difficult for each nation to restrain its own fishing industry if others refrain. Indeed, the fishing fleet would do better in the short run if it kept fishing while everyone else limited its catches. In short, often it is logical not to cooperate even if there are long-term gains to be realized.

2. For game theorists these examples represent the prisoners dilemma tied to collective goods and the “battle of the sexes” problem in regard to coordination. See Stephen D. Krasner, “State power and the structure of international trade,” *World Politics* 28 (1976): 317–347; “Global communications and national power: Life on the Pareto frontier,” *World Politics* 43 (1991): 336–366. The literature introduced other important distinctions about collective goods, externalities, and strategic behavior reflected informally in this book. See Duncan Snidal, “The Limits of hegemonic stability theory,” *International Organization* 39 (1985), no. 4: 579–614; Lisa Martin, “The Political Economy of International Cooperation,” in *Global Public Goods*, ed. I. Kaul et al. (Oxford University Press, 1999).

3. Even in the US Congress it is the power to block new initiatives that is the strongest form of agenda control for the majority party. See Gary Cox and Mathew McCubbins, *Setting the Agenda* (Cambridge University Press), 2005

4. Bargaining theorists use the concepts of bargaining trees and “spatial models” of decision making. The tree starts at the end in a bargaining game and then works inductively backwards. Implicitly or explicitly, strategic actors think about the end game and shape current decisions in light of it. Spatial models consider policy choices in one or two dimensions (e.g., more or less money and more or less centralization of authority) and then map player preferences on them. The decision rules (does a player have a veto, for example) plus the preference clustering allow predictions about the range of outcomes. This analysis uses these insights informally.

5. Sophie Meunier, *Trading Voices* (Princeton University Press, 2005).

6. Ancient Greece and China are examples. See David Landes, *The Wealth and Poverty of Nations* (Norton, 1998).

7. John Zysman, "Creating value in a digital era: How do wealthy nations stay wealthy?" in *How Revolutionary Was the Revolution?* ed. Zysman and Newman.

8. Jeffrey Legro, *Rethinking the World* (Cornell University Press, 2005); Judith Goldstein and Robert O. Keohane, eds., *Ideas and Foreign Policy* (Cornell University Press, 1994); Peter Haas, "Social constructivism and the evolution of multilateral environmental governance," in *Globalization and Governance*, ed. J. Hart and A. Prakash (Routledge, 1999); William J. Drake and Kalypso Nicolaidis, "Ideas, interests, and institutionalization: 'Trade in services,'" *International Organization* 46 (1992), winter: 37–100.

9. Ideas combined with transnational social networks are an important variant of this argument. See Margaret E. Keck and Kathryn Sikkink, *Activists Beyond Borders* (Cornell University Press, 1998); Kathryn Sikkink, *Mixed Message* (Cornell University Press, 2004).

10. Thomas Schelling, "The legacy of Hiroshima: A half-century without nuclear war," *Philosophy & Public Policy Quarterly* 20 (2000), no. 2/3, available at <http://www.puaf.umd.edu>.

11. The cost of ignoring a good idea can be high. Communism stumbled badly because Marxist economists never accounted properly for the cost of capital.

12. For a classic early work on interest groups, see Mancur Olson, *The Rise and Decline of Nations* (Yale University Press, 1982). On bureaucratic politics, see I. M. Destler, *Presidents, Bureaucrats, and Foreign Policy* (Princeton University Press, 1972).

13. Economists and policy makers differ about how to conceive of these interests. Should the focus be on specific companies like Microsoft vs. Google, on industry segments such as computers versus telecommunications, on sectors of the economy (like agriculture versus services versus high tech), or on the factors of production (labor, capital, and land)? See Jeffrey Frieden, "Invested interests: The politics of national economic policies in a world of global finance," *International Organization* 45 (1991), no. 4: 425–451; Michael J. Hiscox, *International Trade and Political Conflict* (Princeton University Press, 2002).

14. Another version of bureaucratic politics views governments as large complex organizations with fallible but possibly improvable operating procedures and problem solving capabilities. Bureaucrats, at their best, champion rationality or uphold shared values and beliefs that might improve public welfare. See John Kingdon, *Agendas, Alternatives and Public Policy* (Harper Collins, 1995).

15. With modifications these concepts apply to non-democratic countries. Political scientists refer to "voters" within Communist Parties (members of the Central Committee) as the "selectorate" and then examine rules for winning dominance within the selectorate. See Susan Shirk, *The Political Logic of Economic Reform in China*

(University of California Press, 1993); Philip G. Roeder, *Red Sunset* (Princeton University Press, 1994).

16. A more formal theory would point to any major disruptive influence, including war or global depression. But we simplify our exposition by sticking to the disruptive force most important for these markets.

17. Robert O. Keohane and Joseph S. Nye Jr., *Power and Interdependence*, third edition (Little, Brown, 2001).

18. Based on our experiences as consultants in the 1980s and 1990s even when telecom companies pursued large global accounts before 2000, they really meant upgrades on a service structure that provided no cohesive infrastructure, cost structures that were inefficient, and price discounts that reduced margins from the exorbitant to the lucrative.

19. The high salience of the issue and the relatively small number involved (a few dozen firms dominating a few hundred firms, compared to millions of consumers) makes mobilization for political action easier than for many actors (such as household consumers) which have a smaller proportional stake in the issue. See Sam Peltzman, "Toward a more general theory of regulation," *Journal of Law and Economics* 19 (1976), no. 2: 211–240.

20. A central feature of the modern study of political parties is that they are policy entrepreneurs seeking to invest in building positions to build their reputations to appeal to voters and interest-group stakeholders.

21. John Zysman, *Governments, Markets, and Growth* (Cornell University Press, 1983); Herbert P. Kitschelt, "Industrial Governance Structures, Innovation Strategies, and the Case of Japan," *International Organization* 45 (1991), no. 4: 453–493; Peter Hall, *Governing the Economy* (Oxford University Press, 1987); Jonah Levy, ed., *The State after Statism* (Harvard University Press, 2006).

22. This is policy diffusion. EU market leadership exerted a powerful influence on wireless policy globally. China may become the source of future unilateral disruptive change. See Beth Simmons and Zachary Elkins, "The globalization of liberalization in the international political economy," *American Political Science Review* 98 (2004), no. 1: 171–189.

23. International arrangements may induce domestic political actors to enforce and advance international commitments to cooperate. See Xinyuan Dai, "Why comply? The domestic constituency mechanism," *International Organization* 59 (2005), no. 2: 363–398.

24. Larger numbers of smaller market powers facing disruption might successfully push for change using cleverly organized collective action. This route is complicated, but international institutions may facilitate such initiatives. The proper specification

of the power hypothesis is that a single dominant or a small number of major market powers can more easily initiate change than many small market countries. The success of a large coalition of small countries probably depends more on the ability of international institutions to facilitate their coordination.

25. Robert Keohane, *After Hegemony* (Princeton University Press, 1984). See also Stephen Krasner, ed., *International Regimes* (Cornell University Press, 1983); Mark Zacher with Brent A. Sutton, *Governing Global Networks* (Cambridge University Press, 1995); Lisa Martin, "The Rational state choice of multilateralism," in *Multilateralism Matters*, ed. J. Ruggie (Columbia University Press, 1993).

26. International NGOs can play a role in building publicity and pressure that may sometimes influence powerful governments. The anti-landmine treaty was one example. Prominent NGOs played major roles in the governance of the Internet. Still, the general proposition should hold true.

27. David Lake and Mathew D. McCubbins, "Delegation to international agencies," in *Delegation and Agency in International Organizations*, ed. D. Hawkins et al. (Cambridge University Press, 2006).

28. One exception to this rule occurs when one stumbles upon a virtual "free lunch" where efficiency gains are huge and costs are trivial. An example was the original "hot line" agreement. Khrushchev proposed the idea. Kennedy asked a Department of State staffer to draft language. Kennedy sent the draft language back to the USSR, which accepted it without changes. The agreement was signed and implemented in 1963.

29. Andrew Mertha and Robert Pahre, "Patently misleading: Partial imperfection and bargaining leverage in Sino-American negotiations on intellectual property rights," *International Organization* 59 (2005), no. 3: 695–729.

30. This reduces uncertainty and informational asymmetries. For example, the OECD gathers reams of market data to clarify the real interests of governments regarding complex issues. The WTO has elaborate conventions on how to make "market access" offers for communications services to reduce uncertainty about what is pledged.

31. Competition was introduced to Intelsat during the 1980s; it was privatized in July 2001.

32. Barbara Koremenos, Charles Lipson, and Duncan Snidal ("The Rational Design of International Institutions," *International Organization* 55, 2001: 761–799) distinguish between soft and hard legal arrangements among countries depending on the governance challenge.

33. Hawkins et al. (*Delegation and Agency in International Organizations*, p. 11) distinguish between international cooperation as either a mutual adjustment of

national authorities or as a delegation (conditional grant of power) from governments to an international institution.

34. Helen Milner and Marc Austin, "Product standards and international and regional competition," *Journal of European Public Policy* 8 (2001), no. 3: 411–431; George Tsebelis and Xenophon Yataganas, "Veto players and decision-making in the EU after Nice: Policy stability and judicial/bureaucratic discretion," *Journal of Common Market Studies* 40 (2002), no. 2: 283–308.

35. Shane Greenstein, "Markets, standardization, and the information infrastructure," *IEEE Micro, Chips, Systems, and Applications* 13 (1993), no. 6: 36–51.

36. Miles Kahler, "Multilateralism with small and large numbers," *International Organization* 46 (1992), no. 3: 681–708.

37. Sometimes bureaucrats are foolish, corrupt, or pig-headed. Still, in most industrial democracies they are in control. They respond to well-developed mandates of an earlier era that were deliberately entrusted to bureaucrats to insulate them from easy modification by future skeptics.

38. These arrangements are called "fire alarms" in the literature. See Mathew McCubbins, Roger Noll, and Barry Weingast, "Political control of the bureaucracy," at <http://mccubbins.ucsd.edu>.

39. Problem-solving communities are sometimes called epistemic communities because social scientists love jargon with ancient Greek origins.

40. Theorists disagree about how to account for the "learning" that goes on globally within effective governance arrangements. Is there direct or indirect coercion? Do poorer nations learn how to adapt to the conventions of the strong, as during the spread of the Napoleonic code throughout Europe? Or do actors learn from competitive pressures to match rivals or emulate respected peers? Do social and institutional networks enhance "channeled learning"? These causal strands intertwine in complex ways. The argument here resembles "channeled learning" but is agnostic about the precise mix. For an overview of the literature, see Beth Simmons, Frank Dobbin, and Geoffrey Garrett, "The international diffusion of liberalism," *International Organization* 60 (2006), no. 4: 781–810.

41. Max Weber highlighted the importance of organizing principles for efficiency.

42. Lawrence Lessig pushed this logic in *Code and Other Laws of Cyberspace* (Basic Books, 2000), arguing that in a digital era the software contains the "code" for the marketplace. His analysis is insightful, but it is not necessary to go as far as he does for the point to hold true.

43. This follows from theories of delegation.

44. It can also alter the power of national governments or the degree of decision making equality among states, among other outcomes. But this analysis is interested in the impact on markets.

45. Cowhey, "Telecommunications," p. 177.

46. Gary Libecap defines property rights as "the social institutions that define or delimit the range of privileges granted to individuals to specific assets" (*Contracting for Property Rights*, Cambridge University Press, 1989, p. 1).

47. The discussion of property rights draws on the following works: John Richards, "Toward a Positive Theory of International Institutions: Regulating Postwar International Aviation Markets," *International Organization* 53 (1999), no. 1: 1–37; Hendrik Spruyt, *The Sovereign State and Its Competitors* (Princeton University Press, 1994); Douglas C. North and Barry R. Weingast, "Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in 17th Century England," *Journal of Economic History* 49 (December 1989) 803–832; Kal Raustiala and David Victor, "The regime complex for plant genetic resources," *International Organization* 58 (spring 2004): 277–309.

## Chapter 7

1. On why the introduction of trade in telecom services was transformative for the traditional trade regime, see Jonathan D. Aronson, and Peter F. Cowhey, *When Countries Talk* (Ballinger, 1988). But that is not the primary focus here.

2. See Peter Cowhey and John Richards, "Building global service markets: Economic structure and state capacity," in *The State after Statism*, ed. J. Levy (Harvard University Press, 2006); Frances Cairncross, *The Death of Distance* (Harvard Business School Press, 1997). On the different perspectives of the US and Japan, see Sylvia Ostry, "Convergence and sovereignty: Policy scope for compromise," in *Coping with Globalization?* ed. A. Prakash and J. Hart (Routledge, 2000).

3. This is generally true when negotiating partners have divergent national regulatory and legal traditions. See Ostry, "Convergence and sovereignty."

4. Many trade economists disdain unilateral action. See Jagdish Bhagwati and Anne O. Krueger, *The Dangerous Drift to Preferential Trade Agreements* (AEI Press, 1995).

5. Some argue that domestic liberalization meant that the WTO deal was only a token ratification of de facto international liberalization. We believe that domestic competition inevitably leads to some form of greater international competition. What was unclear was how much competition would occur, when, and with what limitations. The WTO deal meant much more liberalization now and with fewer limits. See William J. Drake and Eli M. Noam, "Assessing the WTO agreement

on basic telecommunications," in *Unfinished Business*, ed. G. Hufbauer and E. Wada (Institute for International Economics, 1997).

6. On the breakdown of the traditional cartel, see Aronson and Cowhey, *When Countries Talk*; Cowhey, "The International Telecommunications Regime."

7. Everything is relative. Customers of local phone services might have paid less if competition and cost-based services existed than if they had subsidized monopoly services. Developing countries argued that international competition undermined development objectives because it made domestic network build-out more difficult. Their arguments resemble AT&T's assertions about the US domestic network in the 1970s. On AT&T positions, see Peter Termin with Louis Galambos, *The Fall of the Bell System* (Cambridge University Press, 1988). For a critique of this position, see Peter Cowhey, "FCC benchmarks and the reform of the international telecommunications Market," *Telecommunications Policy* 22 (1998), no. 11: 899–911.

8. Cowhey, "The International Telecommunications Regime."

9. Screen time quotas for films are exempted in GATT Article III. No other services were touched upon in the founding documents. The GATT focused exclusively on trade on goods until the Tokyo round when services required to facilitate trade in goods were touched upon for the first time. Trade in services first made it on to the negotiating agenda in the Uruguay Round during the late 1980s.

10. Leonard J. Schoppa, *Bargaining with Japan* (Columbia University Press, 1997); Bruce Stokes, "Divergent paths: US-Japan relations towards the twenty-first century," *International Affairs* 72 (1996), no. 2: 281–291.

11. Government-owned PTTs traditionally operated and regulated the monopoly telecom service provider. On monopolists' plans to offer an Integrated Service Digital Network (ISDN), see Aronson and Cowhey, *When Countries Talk*, pp. 186–204.

12. On the Uruguay Round, see Jeffrey J. Schott, *The Uruguay Round* (Institute for International Economics, 1994); John Whalley and Colleen Hamilton, *The Trading System After the Uruguay Round* (Institute for International Economics, 1996); Barry Eichengreen and Peter Kenen, "Managing the world economy under the Bretton Woods system: An overview," in *Managing the World Economy*, ed. P. Kenen (Institute for International Economics, 1994). For a history of trade in services, see William J. Drake and Kalypso Nicolaides, "Ideas, Interests, and Institutionalization: 'Trade in Services,'" *International Organization* 46 (1992), winter: 37–100. On NAFTA, see Frederick M. Abbot, "The North American integration regime and its implications for the world trading system," in *The EU, the WTO and the NAFTA*, ed. J. Weiler (Oxford University Press, 2000); Richard Feinberg, *Summitry in the Americas* (Institute for International Economics, 1997), pp. 42–48.

13. Asian countries sought binding dispute regulation to temper US use of anti-dumping and countervailing subsidies. For different reasons, the US wanted binding

dispute settlement. By placing agriculture and textiles prominently on the agenda developing countries were induced to cooperate on services, intellectual property, and investment.

14. The US telecom industry initially needed substantial coaching on the GATT. They thought that they could advance their purposes better in bilateral trade negotiations by using unfettered threats of sanctions by the US government against those not opening their market sufficiently. The shift to the GATT reflected the larger political agenda for multilateral trade.

15. The leading US bureaucratic proponent and strategist of including trade in services on the Uruguay GATT/WTO agenda was Geza Feketekuty, at the time the Senior Assistant Trade Representative at USTR. His strategy relied on international fact finding to demonstrate the relevance and logic of applying trade disciplines to services. See Jonathan D. Aronson, "Negotiating to launch negotiations: Getting trade in services onto the GATT agenda," Pew Case Study 125-92-R, 1988 (revised 1992).

16. Mexico also wanted to demonstrate its commitment to free trade at a time when the Salinas Administration was negotiating Mexican membership in the OECD.

17. Mexico's 1990 reforms allowed the privatization of Telmex, the dominant carrier, with minority foreign ownership. Mexico decided to end Telmex's monopoly on long-distance services after 1996. The growth of heterogeneous demand in Mexico had generated marketplace conditions that favored entry by focused firms to fill specific demand niches. This situation provided domestic support for reform in Mexico and incentives for US specialized players to back regional liberalization. On why heterogeneous demand matters in developing countries, see Roger Noll, "Telecommunications reform in developing countries," in *Economic Policy Reform*, ed. A. Krueger (University of Chicago Press, 2000).

18. The important distinction made in NAFTA, and reconfirmed in the 1994 and 1997 WTO agreements, was between services made widely available to the public and those that satisfied specific needs of telecommunications (private networks or value-added networks). See A. Acedo, "Opportunities in Mexico," presented at International Telecom Competition Seminar, Seattle, 1997. The NAFTA deal ensured the provision of private leased circuits on a flat-rate basis, the key to allowing a computer network to get a cheap, fixed rate for transmission capacity and then use advanced engineering to carry more data than the typical telecom circuit. Unlike NAFTA, the 1997 WTO offer included public networks; see Peter Cowhey and John Richards, "Deregulating and liberalising the North American telecommunications market: Explaining the US approach," in *Trade, Investment and Competition Policies in the Global Economy*, ed. P. Guerrieri and H.-E. Scharer (Momos, 2002).

19. Except for narrow exceptions, US rules forbade the regional Bell operating companies from owning equipment suppliers. Lucent was, until it was spun off in the

1990s, part of AT&T. The US had unilaterally liberalized the competitive supply of customer premises equipment.

20. Before NAFTA, the US equipment market was relatively open. US suppliers pushed for telecom equipment liberalization in NAFTA. On NAFTA equipment agreement, see Ronald A. Cass and John R. Haring, *International Trade in Telecommunications: Monopoly, Competition, and Trade Strategy* (MIT Press, 1998), p. 123.

21. The new criterion for network interconnection for equipment was a guarantee of “no harm to the network.” Previously equipment had to conform to idiosyncratic, national design standards. This fundamental reform was implemented by a rule that allowed countries to recognize one another’s certification of the safety of equipment (mutual recognition agreements). Mutual recognition promised to relieve equipment suppliers from slow and expensive procedures to get technical certification for their products in each individual country. Implementation of these agreements was often contentious, as was the case with Mexico.

22. World Trade Organization, Information Technology Agreement—Introduction, at [www.wto.org](http://www.wto.org).

23. NAFTA also created a complex dispute settlement mechanism that elicited divergent reviews. (Abbot, “The North American integration regime and its implications for the world trading system.”) US companies later criticized Mexico’s performance under its WTO telecom obligations. They preferred the WTO dispute-resolution system.

24. Settlement rates apply to switched international traffic offered on the public telephone network. Services like traditional phone calls require the use of telephone network switches. (Here the adaptation to VoIP and similar technological innovations is omitted.) If settlement rates sound arcane, the system was more complicated in all its bureaucratic glory. As a matter of economic analysis it is simpler and more accurate to focus on the settlement rate. For the full complexities, see Peter Cowhey, “FCC benchmarks and the reform of the international telecommunications market,” *Telecommunications Policy* 22 (1998), no. 11: 899–911.

25. The FCC created “proportionate return” rules to block the “whipsawing” of competitive US carriers negotiating with a foreign monopolist. The rule mandated that each US carrier be entitled to the same share of incoming switched international traffic from a country as it sent to the country. See Peter Cowhey, “Building the global information highway: Toll booths, construction contracts, and rules of the road,” in *The New Information Structure*, ed. W. Drake (Twentieth Century Fund, 1995).

26. The FCC’s International Bureau staff based this estimate on settlement rate data published by the FCC. See Jim Lande and Linda Blake, “Trends in the US interna-

tional telecommunications industry. Industry Analysis Division," Common Carrier Bureau, FCC, 1997.

27. The FCC acquiesced to balance-of-payments deficits that occurred in efficiently priced markets.

28. In 1995 the FCC formalized its rules governing foreign entry into the US market for basic telecommunications services in the form of the Effective Competitive Opportunities (ECO) test. It believed this test was fairer than past practices and could permit substantial opening. It still considered this route to be inferior to a multilateral trade agreement. Foreign governments disliked the test. They saw it as an intrusive examination of their domestic regulatory practices. However, the ECO tests foreshadowed the regulatory principles adopted in the subsequent WTO agreement on telecommunications services. The Commission intentionally cast ECO in a manner designed to signal the rules it would consider necessary for a satisfactory WTO agreement. See Federal Communications Commission, "In the matter of market entry and regulation of foreign-affiliated entities, report and order," IB docket 95-22, November 28, 1995.

29. Federal Communications Commission, "Regulation of international accounting rates, phase ii, fourth report and order," 11 FCC Rcd 20063, 1996 (the "Flexibility Order").

30. At that time less than a half dozen countries (including Canada, the UK, and Sweden) qualified for flexibility without special waivers from the FCC.

31. Put differently, settlement rates that far exceeded costs created the possibility of anti-competitive behavior in the provision of US international services. This would harm consumers and erode market efficiency over time. The FCC provided an operational definition of two forms of anti-competitive behavior. On the problems and the remedies, see Federal Communications Commission, "In the matter of international settlement rates, report and order," IB docket 96-261, 1997, paragraphs 211–259. Also see Thomas Krattenmaker, Richard Lande, and Steven Salop, "Monopoly power and market power in antitrust law," *Georgetown Law Journal* 76 (1987): 241–253.

32. Many worrisome tactics were variations on the strategy of "one-way bypass." This occurred if the home market of a foreign carrier licensed to provide services in the US required US carriers to terminate at the settlement rate while the foreign carrier terminated traffic into the US at the rates prevailing under "flexibility." Thus, country X might charge 39 cents as the settlement rate to terminate US traffic while its carrier could terminate traffic into the US at 6 cents using leased transmission lines without paying a settlement rate. This would drive up US net settlement payments and escalate the price of international services for US consumers. A WTO agreement made this scenario probable if the US agreed to liberalize licensing of

international leased circuits, but most WTO countries had not. For details, see Cowhey, "FCC benchmarks."

33. By contrast, carriers from less competitive markets worried that trade reforms would cut into their large profit margins from international services. Therefore, these carriers also lobbied their home governments to resist liberalization of competition in international telephone services.

34. The WTO negotiation had some parallel issues involving the specialized market for satellite communications services. Discussion is omitted because it is a logical subset of the problem discussed here. See Laura B. Sherman, "'Wildly enthusiastic' about the first multilateral agreement on trade in telecommunications services," *Federal Communications Law Journal* 51 (1998), no. 1: 62–100.

35. The U.S. unilateral and multilateral initiatives had many critics. For a representative critique, offered by an ardent admirer of traditional market governance, see Jill Hills, *Telecommunications and Empire* (University of Illinois Press, 2007).

36. This is based on Peter Cowhey's notes from negotiating sessions between the US and the EU. Japan supported the WTO negotiations but waited to see what the two main players could agree on before making its best offer.

37. The US understanding reflected its difficulties in using bilateral negotiations to liberalize global telecom markets in the early 1990s.

38. On the division of powers and credibility, see Peter Cowhey, "Domestic institutions and the credibility of international commitments: The cases of Japan and the United States," *International Organization* 47 (1993): 299–326; Charles Lipson, *Reliable Partners* (Princeton University Press, 2003).

39. The EU, based on experience, believed the US promise that compliance by its state regulatory commissions would be forthcoming after the passage of the 1996 Telecommunications Act mandated competition in local telephone services.

40. Similarly, divided powers increased the required scope for liberalization of international aviation markets. See John Richards, "The domestic politics of international regulatory policy: The regulatory institutions for trade in aviation services," Ph.D. dissertation, University of California, San Diego, 1997.

41. Peter Cowhey and Mathew McCubbins, eds., *Structure and Policy in Japan and the United States* (Cambridge University Press, 1995). The EU may face this problem in the future. The French Fifth Republic and many of the Eastern European members admitted to the EU after this period are better described as semi-presidential systems that draw on both presidential systems and parliamentary systems.

42. On the relationship between the division of powers and judicial action on environmental rules, see Kal Raustiala, "The sources of state interests: British and

American policy towards international environmental cooperation, 1983–1993,” Ph.D. dissertation, University of California, San Diego, 1996.

43. On how the structure and process of regulatory agencies matters for policy outcomes, see Mathew McCubbins, Roger Noll, and Barry Weingast, “Administrative Procedures as Instruments of Political Control,” *Journal of Law, Economics, and Organization* 3 (1987): 243–276.

44. EU member states ratify a tentative trade pact each time they authorize a new offer in a WTO negotiation. The Congress ratifies the US trade offer only at the conclusion of a negotiation. The Executive branch tries to anticipate congressional preferences.

45. This contrasted strongly with the impasse on WTO negotiations on aviation services, in which nobody believed in the end that Washington or Brussels would make credible commitments to make essential facilities (e.g., more landing gates at local airports) available.

46. See Maria Behrens and Raymund Werle, “Lobbying for global telecommunication markets? The political activities of dominant providers in the EU and the US during the basic telecommunication negotiations of the WTO,” paper presented at ECPR Conference, Marburg, 2003.

47. Peter Cowhey and Laura Sherman, “The FCC and the reform of the international telecommunications services market,” *Euromoney*, winter 1998; Laura Sherman, “Introductory note on reference paper to the telecommunications annex to GATS,” *International Legal Materials* 36 (1997): 354; Peter Cowhey and Mikhail M. Klimenko, “The WTO agreement and telecommunications policy reform,” World Bank policy research working paper 2601, 2001. Some scholars who opposed US telecommunications policy in the 1990s feared that the reference paper would force the rest of the world to replicate US errors. See Jeffrey H. Rohlfs and J. Gregory Sidak, “Exporting telecommunications regulation: The US-Japan negotiations on interconnection pricing,” *Harvard International Law Journal* 43 (2002), no. 2: 317–360.

48. The European Union left its market access commitments on the table when negotiations stalled. It argued that a deal could go forward without the US. But it is doubtful that this would have happened.

49. MFN treatment, a fundamental trade concept, requires that the same degree of market opening must be provided to all WTO members.

50. WTO members promise not to discriminate in favor of domestic firms over foreign-owned ones. The WTO rule on non-discrimination requires national policy measures to provide equal treatment of firms of WTO members and of local firms.

51. Even for developing countries (e.g. Mexico) that were committed to the timely introduction of competitive international services, the rents generated by settlement

rates were so high that the government designed measures to ensure their retention for several years.

52. The diplomatic dialogue is simplified to clearly emphasize the bottom line. Other issues are ignored that might have prevented agreement.

53. As hopes for a deal improved, the US government upgraded the level of political contacts used to press industrializing countries. Cabinet officers and senior White House officials began to call their foreign counterparts to request careful political attention by top officials to the WTO negotiation.

54. The benchmarks averaged cost data gathered by the FCC for each income tier of countries. The FCC used World Bank data on income tiers. The FCC allowed for a transition period to achieve the price cap, providing poorer countries more time. Industrial countries had one year to reach 15 cents per minute. The cap for middle-income countries was set at 19 cents with a two or three year transition period. Low-income countries needed to reach 23 cents in 4 or 5 years. See FCC, "In the matter of international settlement rates, report and order." Also see Cowhey, "FCC benchmarks and the reform of the international telecommunications market." The US was optimistic that benchmarks would work and not be overturned by trade challenges at the WTO. See Peter Cowhey and John Richards, "Dialing for dollars: The revolution in communications markets," in *Coping with Globalization*, ed. J. Hart and A. Prakash (Routledge, 2000).

55. For a summary, see Jonathan D. Aronson, "Telecom agreement tops expectations," in *Unfinished Business*, ed. G. Hufbauer and E. Wada (Institute for International Economics, 1997).

56. The waiver of the foreign ownership restriction applies only to companies from WTO members. The FCC rules adopted in fall 1997 to implement the WTO agreement created a presumption in favor of entry for foreign carriers into the US market. The FCC also used its discretion under the Communications Act of 1934 to eliminate discrimination against foreign ownership. The 1934 act restricts the FCC from waiving the limits on direct foreign ownership, but the differences between direct and indirect ownership are a matter of legal form. See Federal Communications Commission, "Rules and policies on foreign participation in the US telecommunications market, report and order," IB dockets 97-142 and 95-22. For an analysis that correctly attacks the original foreign investment limits but misses how the FCC reformed them effectively in 1997, see Gregory Sidak, *Foreign Investment in American Telecommunications* (University of Chicago Press, 1997).

57. See Ben Petrazzini, *Global Telecom Talks* (Institute for International Economics, 1996).

58. Laura B. Sherman, "Clarifying the Meaning of WTO Telecommunications Obligations: Mexico—Measures Affecting Telecommunications Services," *Info* 7 (2005), no. 6: 16–32.

59. James Hodge, "WTO negotiations in telecommunications: How should SADC countries respond?" *Spitjerm Africa Update* 18 (2003): 1–4.
60. International Telecoms Intelligence, "South Africa—Market intelligence report," 2007. Also see "South Africa: Let's talk," Economist Intelligence Unit, Global Technology Forum, 2007.
61. Robert Pepper, presentation at WTO Services Symposium on WTO Basic Telecommunications Negotiations, Geneva, 2008.
62. Even Japan ritualistically protested that Japanese carriers could not afford to terminate US traffic for less than 50 cents per minute. Nobody believed this claim, including the Japanese government. Today, US traffic terminates in Japan for a few cents per minute.
63. Cowhey, "FCC benchmarks and the reform of the international telecommunications market."
64. The ITU reports that in 2007 only 54% of international traffic gateways are fully liberalized (and 17% partly liberalized), a big jump from 1997 but an indication of how many countries try to protect these price margins by monopoly. See Susan Schorr, "Ten years of regulatory trends," WTO Services Symposium on WTO Basic Telecommunications Negotiations, 2008, available at <http://www.wto.org>.
65. Telegeography Research, "Map of Major Internet Routes, 2005"; Scott Wallsten, "An Econometric Analysis of Telecom Competition, Privatization, and Regulation in Africa and Latin America," *Journal of Industrial Economics* 49 (2001), no. 1: 1–19; Scott Wallsten et al., "New Tools for Studying Network Industry Reforms in Developing Countries: The Telecommunications and Electricity Regulation Database," *Review of Networked Economics* 3 (2004), no. 3: 248–259.
66. Schorr ("Ten years of regulatory trends") reports that approximately 18 countries had general telecom competition and 50 had some mobile competition in 1995. By 2006, 110 countries had general competition and 150 had mobile competition (usually with multiple competitors).
67. Vanessa Gray, "ICT market trends," presentation to WTO Services Symposium on WTO Basic Telecommunications Negotiations, 2008.
68. Tim Wu, "The world trade law of censorship and Internet filtering," 2007, available at <http://papers.ssrn.com>.
69. On trade and cultural issues at the WTO, see J. P. Singh, *Negotiation and the Global Information Economy* (Cambridge University Press, 2009); Mu Lin, "Changes and consistency: China's media market after WTO entry," *Journal of Media Studies* 17, no. 3 (2004): 177–192.
70. We thank Don Abelson for pointing out this distinction to us.

## Chapter 8

1. Neuchterlein and Weiser, *Digital Crossroads*, p. 230.
2. Social scientists cannot provide definitive assessments on the technical merits of competing technology proposals. Luckily, the debate is not central to this argument. See Johan Lembke, "Global Competition and Strategies in the Information and Communications Technology Industry: A Liberal Strategic Approach," *Business and Politics* 4 (2002), no. 1 (available at <http://www.bepress.com>). For insightful efforts to examine decision making in standards bodies, see Mark Lemley, "Intellectual property rights and standard-setting organizations," *California Law Review* 90 (2002): 1889; Joseph Farrell and Garth Saloner, "Economic issues in standardization," working paper 393, MIT Department of Economics, 1985.
3. The EU created a new telecommunications standards organization, ETSI, partly out of frustration with the ITU process. See Walter Mattli and Tim Buthe, "Setting international standards: Technological rationality or primacy of power?" *World Politics* 56 (2003), no. 1: 1–42.
4. The Euro-Japanese alliance was primarily coordinated by industries with similar business interests. Once these ties were forged, they had implications for the options of governments and regulatory bodies. See Lembke, "Global Competition."
5. Robert Iannucci, Chief Technology Officer, Nokia presentation at Supernova Conference, San Francisco, June 16, 2008.
6. Calculating total 3G subscribers is confusing because sometimes, as in this case, CDMA 2000 1× RTT customers are counted as if they were 3G customers. "Using CDMA2000 and WCDMA (UMTS) technologies, commercial 3G networks are providing service to more than 486 million paying subscribers. As of July 31, 2007, KDDI in Japan had recorded more than 27.8 million CDMA2000 subscribers after 5 years of service. NTT DoCoMo in Japan now has more than 38.7 million WCDMA subscribers. SoftBank Mobile surpassed 10 million 3G subscribers. Korea has accumulated more than 40 million CDMA2000 subscribers through July 2007, more than 17.5 million of which are EV-DO." Source: Wireless Intelligence, <http://www.3gtoday.com>.
7. Where network externalities exist, networks become more valuable to individual users as more people use or are connected to the network. See Bruce Owen and Gregory Rosston, "Spectrum allocation and the Internet," SIEPR discussion paper 01-09, 2001.
8. Once a carrier has installed a supplier's network equipment, it is locked in and the vendor is unlikely to be displaced. Because global carriers prefer suppliers with global support capabilities, this limits entry for a network and, to a lesser extent, to handset equipment. (Based on interviews with European and Asian suppliers, November and December 2002.)

9. Stanley M. Besen and Joseph Farrell, "The role of the ITU in standardization," *Telecommunications Policy* 15 (1991): 311–321; Carl Shapiro and Hal R. Varian, *Information Rules* (Harvard University Press, 1998).
10. Eli Noam, *Telecommunications in Europe* (Oxford University Press, 1993).
11. Helen Milner and Marc Austin, "Product standards and international and regional competition," *Journal of European Public Policy* 8 (2001), no. 3: 411–431; George Tsebelis, *Veto Players* (Princeton University Press, 2002).
12. Shane Greenstein, "Markets, standardization, and the information infrastructure," *IEEE Micro: Chips, Systems, and Application* 13 (1993), no. 6: 36–51.
13. Johan Hjelm, "Research applications in the mobile environment," in *Designing Wireless Information Services* (Wiley, 2000).
14. The absence of private property rights partly reflects the high transaction costs of assigning and monitoring individual property rights in the early days of radio technology. See Thomas Hazlett, "The wireless craze, the unlimited bandwidth myth, the spectrum auction faux pas, and the punch line to Ronald Coase's big joke," *Harvard Journal of Law & Technology* 14 (Spring 2001): 335–567. Philip J. Weiser and Dale Hatfield, "Spectrum Policy Reform and the Next Frontier of Property Rights," *George Mason Law Review* 15 (2008): 549–609.
15. The laws of physics make bands differ in their radio propagation characteristics, so spectrum is not equally tractable for all tasks. For example, spectrum bands over 100 MHz permit straight-line transmissions that can be power efficient.
16. In most industrial countries the military controls about 30% of the spectrum.
17. The political process is arcane and fiercely contested. Advocates debate what would constitute a threat of interference and the plans for reallocating different pieces of spectrum to different uses. These proceedings raise enormous informational problems for government decision makers. The glacial process indirectly favors incumbents.
18. Owen and Rosston, "Spectrum allocation and the Internet."
19. See Peter Cowhey, Jonathan D. Aronson, and John E. Richards, "Property rights and 3G wireless standards," in *How Revolutionary Was the Revolution?* ed. Zysman and Newman.
20. Shankar Jagannathan, Stanislav Kura, and Michael J. Wiltshire, "A help line for telcos," *McKinsey Quarterly*, no. 1 (2003): 87–98.
21. Ovum Data, as reported in "Wireless Briefing," *Red Herring* (March 2002): 68–69.
22. In the late 1990s, when the serious decisions about the transition to 3G were made, consistent regional and global roaming across national borders remained rare

except within Western Europe and parts of Asia. The temptation to create viable global footprints was huge, despite gigantic investment costs. Economies of scale in purchasing for a single technology would reduce costs.

23. The global ITU standards process is formally organized around and fed by, leadership out of the major regional standards bodies. (The ITU was created in 1865. In March 2008 it had 191 member states, 565 sector members, and 141 associates.)

24. Significant consensus on the outline of the standard was reached by 1987. Initially, the European Conference of Posts and Telecommunications (CEPT) was the principal player. It created the GSM MOU (Memorandum of Understanding). This evolved into a global organization for promoting GSM. Source: Zixiang Tan, "Comparison of wireless standards-setting—United States versus Europe," draft paper, 2001.

25. National and regional standard-setting processes varied. Effective participation required a significant commercial presence and the ability to fund staffers who could spend extensive time on the standard-setting process. Voting, if used, often was weighted according to market revenues and required super-majorities of 60% or more. In contrast to the one company-one vote principle used by the US Telecommunications Industry Association, the ETSI used weighted voting. Market revenues mattered significantly in the weighting. Manufacturers dominated the voting. In 1997, 49.5% of the members were manufacturers, 15.8% were public network operators, 9.18% were national government authorities, and 12.4% were research bodies. See Heather Hudson, *Global Connections* (Van Nostrand, 1997).

26. It took the Japanese suppliers several years to acquire the IPR licensing agreements. The delay gave the major European firms a significant lead. See Rudi Bekkers, Bart Verspagen, and Jan Smits, "Intellectual property rights and standardization. The case of GSM," *Telecommunications Policy* 26 (2002), no. 3–4: 171–188.

27. The EU used a combination of spectrum and standards policy to ensure a common approach to 2G. For an excellent discussion of government intervention to make standards setting credible, see Jacques Pelkmans, *European Integration* (Prentice-Hall, 2001).

28. Japan eventually opened its procurement policy to international scrutiny by agreeing to extend the GATT procurement code to the NTT.

29. Michael Mastanduno, "Do relative gains matter? America's response to Japanese industry policy," *International Security* 16 (1991), summer: 73–113; Leonard J. Schoppa, *Bargaining with Japan* (Columbia University Press, 1997).

30. The economic reasoning involved in the FCC policy of technology neutrality is discussed in Farrell and Saloner, "Economic issues in standardization." Also see chapter 8 of Neuchterlein and Weiser, *Digital Crossroads*.

31. Johan Lembke, "Harmonization and globalization: UMTS and the single market," *Info* 3 (2001), no. 1: 15–26.

32. The most important dispute involved Qualcomm and Ericsson in litigation that began in 1995. This was resolved in an agreement announced on March 25, 1999, that included cross-licensing of patents and Ericsson's purchase of Qualcomm's terrestrial infrastructure business. Vitality, from the viewpoint of Qualcomm, the agreement included a stipulation that licensing would be done for all three proposed versions of 3G. This settlement allowed commercialization to proceed but other patent battles continued through 2008 that pitted Qualcomm against Broadcom and Nokia on control of patents and licensing terms. See Hjelm, "Research applications in the mobile environment."

33. Traditionally, some standard-setting organizations, including the ITU, demanded "royalty-free licensing." Many others now require "reasonable and nondiscriminatory" licensing. This discussion relies on Patterson 2002. In 2000 the ITU Telecommunication Standardization Bureau stated: "The patent holder is not prepared to waive his rights but would be willing to negotiate licenses with parties on a nondiscriminatory basis on reasonable terms and conditions." The bureau does not set precise criteria for these conditions and leaves it to negotiations among the parties. The relevant factors for setting royalties include development and manufacturing costs plus profits. See Mark R. Patterson, "Invention, Industry Standards, and Intellectual Property," *Berkeley Technology Law Journal* 17 (2002), no. 3: 1053–1054 and n. 40.

34. In 2002 another group of European vendors announced that it would set an absolute cap, at a relatively low level, on royalties charged for W-CDMA technology use. Qualcomm quietly rejected the cap and observed that it held about 50% of the IP on W-CDMA, thus making any royalty offer that it did not agree to meaningless. Other companies rejected Qualcomm's estimate of its holdings. This set the stage for royalty disputes extending through 2008.

35. For data on the large role still played by 2G in 2003 and the estimate for 2005 see table 14.2 of Cowhey, Aronson, and Richards, "Property rights and 3G wireless standards." Concern over 2G sales was why neither side followed the economic logic of compromise to grow the market size set out in Shapiro and Varian, *Information Rules*. In 2006 Japan became the first country in which 3G accounted for the majority of terminal sales. Source: "W-CDMA goes top in Japan five years after launch," [www.cellular-news.com](http://www.cellular-news.com), November 14, 2006.

36. The collective approach of numerous industrial actors sought to ensure compatibility across markets for preferred methods of technology. For more on how the objectives of both firms and national level actors were driven by regional interests, see Lembke, "Global Competition."

37. Neil Gandal, David Salant, and Leonard Waverman, "Standards in wireless telephone networks," *Telecommunications Policy* 27 (2003): 325–332.

38. The W-CDMA initiative emerged from a successful negotiation on common interests among the largest expected winners in Europe: DoCoMo, Nokia, and Ericsson. In *Brave New Unwired World* (Wiley, 2002), Alex Lightman notes that if the ITU had standardized only around W-CDMA specifications, the chip rate in the system would have been incompatible with seamless upgrading from 2G CDMA systems.

39. Irene Wu, *From Iron Fist to Invisible Hand: Telecommunications Reform in China* (Stanford University Press, 2008); Kenji Erik Kushida, "Wireless Bound and Unbound: The Politics Shaping Cellular Markets in Japan and South Korea," *Journal of Information Technology and Politics* 5 (2008).

40. Lembke, "Global Competition."

41. Qualcomm notified the standards bodies involved in 3G that it held essential patents on all proposed versions of 3G. It offered to license, on reasonable and nondiscriminatory terms, a single converged ITU standard for 3G or its own proposed standard. Qualcomm declared that it would not license other versions of 3G, such as the EU's W-CDMA standard. Sources: "Qualcomm supports converged standard for IMT-2000," press release, June 2, 1998, available at <http://www.cdg.org>.

42. There was no comparably dominant wireless incumbent in the US. AT&T was a TDMA carrier, as were the wireless groups of several regional Bell operating companies. Verizon and Sprint ran the flagship CDMA networks. So the carriers quarreled bitterly over the US position in the ITU on standardization.

43. For example, on October 13, 1999, US Commerce Secretary William Daley, US Trade Representative Charlene Barshefsky, and FCC Chairman William Kennard released a letter to EU Commissioner Erkki Liikanen protesting EU policy.

44. Most low-income developing markets rely more on European suppliers of network equipment than on North American suppliers. European companies, seeking larger markets, attempted to enter these markets before their American counterparts.

45. See figure 14-3 in Cowhey, Aronson, and Richards, "Property rights and 3G wireless standards."

46. Qualcomm collects IPR royalties on all versions of CDMA.

47. In November 2002, China appeared to tilt in this direction by setting aside spectrum reserved for this technology. The US and the EU raised issues about mandatory standards with China.

48. Hudson, *Global Connections*.

49. John Zysman and Wayne Sandholtz, "1992: Recasting the European bargain," *World Politics* 42 (1989), no. 1: 95–128; Peter Cowhey, "Telecommunications," in

*Europe 1992*, ed. G. Hufbauer (Brookings Institution Press, 1990); Pelkmans, *European Integration*.

50. Developing countries benefited enormously from 2G for reasons discussed in chapter 2 above. See Peter F. Cowhey and Mikhail M. Klimenko, "The WTO agreement and telecommunications policy reform," World Bank policy research working paper 2601, 2001.

51. Source: US Congress, Office of Technology Assessment, *The 1992 World Administrative Radio Conference: Technology and Policy Implications*, OTA-TCT-549, May 1993, pp. 108–115.

52. Commission of the European Communities, "Amended proposal for a European parliament and council decision on the coordinated introduction of mobile and wireless communications in the Community," 98/C 276/04; Council of the European Union, "Council decision on the coordinated introduction of third generation mobile and wireless communications system (UMTS) in the community," 128/1999/EEC.

53. Opponents included the politically powerful UHF television broadcasters.

54. Some dual-band and dual-mode phones could handle both 3G modes. This increases production costs in markets where consumers demand low prices.

55. CDMA carriers (Alltel, Sprint, Verizon) focused on the large North American market, while GSM and TDMA carriers (AT&T Wireless, Cingular) sought alliances with non-US carriers. Vodafone owned a minority share of Verizon. Deutsche Telekom (now called T-Mobile as a wireless provider) waited until 2000 before becoming the first foreign carrier to act, buying VoiceStream.

56. Gandal, Salant, and Waverman, "Standards in wireless telephone networks."

57. Based on 2004 an analysis done by Lehman Brothers that was provided to the authors.

58. The licensing system required large resources and usually was designed to produce one or two new entrants. See Paul Klemperer, "How (not) to run auctions: The European 3G telecom auctions," *European Economic Review* 46 (2002), no. 4–5: 829–845. Klemperer argues that the merits of auction designs of countries varied considerably. High price alone did not prove that an auction was poorly designed.

59. The Netherlands and France waived some auction fees or provided the winning bidders with financial aid. The UK and Germany granted relief by allowing carriers to share the build out of certain network infrastructure. This reduced the financial burden on all bidders by as much as 30% of capital costs. For evidence and details, see Cowhey, Aronson, and Richards, "Property rights and 3G wireless standards."

60. Most former British colonies in Asia (Hong Kong, Singapore, Australia, and New Zealand) tilted toward auctions with varying degrees of success. Hong Kong had four carriers. See John Ure, "Deconstructing 3G and reconstructing telecoms," *Telecommunications Policy* 27 (2003): 187–206.

61. Noll and Rosenbluth, "Telecommunications policy: Structure, process, and outcomes."

62. Japan did not consider increasing the number of competitors until mid-2005.

63. Michelle Donegan, "Tata unleashes WiMax in India," at [www.unstrung.com](http://www.unstrung.com).

64. Source of GSM data: 3G Americas, a trade group of GSM carriers and vendors. Source of data on spending and deployment of 3G and CDMA: CDG white paper.

65. "3G and 4G wireless blog," at <http://3g4g.blogspot.com>.

66. Global Mobile Suppliers Association, "3G/WCDMA launches worldwide," at <http://www.gsacom.com>.

67. See the discussion of EDGE in Morgan Stanley, "Telecom services and equipment: Cross-industry insights," February 1, 2005.

68. NTT DoCoMo dominates the wireless data revenues rankings with over \$3.4B in data services revenue in Q1 2008. In the first quarter of 2008 data services accounted for 35.7% of its revenues. Source: Chetan Sharma Consulting, "US wireless data market update, Q1 2008," May 18, 2008. [www.chetansharma.com/](http://www.chetansharma.com/).

69. Morgan Stanley Equity Research, *3G Economics a Cause for Concern*, February 1, 2005.

70. It is part of a generation of 802.16 that relies on one of two variants of orthogonal frequency division multiplexing. The 802.16-2004 standard relies extensively on "OFDM" to provide fixed wireless service, either to small businesses or as backhaul for cellular networks. This garnered considerable attention in 2004 but it is incompatible with 802.16e, the center of attention for Intel and Samsung, which relies on "OFDMA" to serve mobile users. The standard was not yet fully specified in 2007 and there was bitter fighting in the US standards group working on the 802.16e with Intel and Qualcomm exchanging complaints over the group's work.

71. At the end of 2006, WiBro only had about 1,000 subscribers on the Korean Telecom network. KT was looking for ways to invigorate growth while SK Telecom took a wait and see policy. Source: "In-Stat, WiBro in Korea: Ambitious launch—turbulent take off," May 17, 2007. [www.instat.com/](http://www.instat.com/).

72. Bill Ray, "WiMAX gets EU harmonization at 2.6 GHz," *The Register*, May 9, 2008. "European Commission decides to give 3.5 G.5-GHz WiMAX spectrum 'Mobility' status," *RFDESIGN*, June 10, 2008.

73. Some variants are fixed wireless systems that will compete against WiMAX.
74. George Gilder, "The wireless wars," *Wall Street Journal Online*, April 13, 2007.
75. Jeff Orr, "Mobile broadband: 4G 4Play," at [www.lightreading.com](http://www.lightreading.com).
76. Based on the authors' interviews with equipment vendors, network carriers, and government officials in the US and Japan in June 2007.
77. Some features of the contract in places like China may provide limited advantages for massive volume.
78. Qualcomm is also one of the largest producers of all forms of 3G chipsets. Qualcomm has faced legal complaints that it manipulated its IPR to favor its chip-making operation over its rivals. Complaints by Nokia, Ericsson, Broadcom, Texas Instruments, NEC, and Panasonic were filed with European, Korean, and the US competition and trade authorities that Qualcomm is trying to vertically leverage its IPR, much as Microsoft did. Qualcomm denies this. They have also filed suits claiming Qualcomm violated their patents. In 2006 Nokia and Qualcomm deadlocked on cross-licensing GSM and CDMA technology patents. The stakes were large. Business analysts estimated that Nokia could end up paying \$1 billion per year in royalties if terms did not change. In 2007 Qualcomm had several setbacks in these legal battles although the severity of the losses remained unclear. See "Cellphone crusader to divide and conquer," *Financial Times*, June 12, 2006.
79. In August 2007, Nokia, the last end-system producer still trying to produce the bulk of its own chips, decided to rely predominantly on outside suppliers. See "Nokia to outsource chip development," *Financial Times*, August 8, 2007.
80. A further complication is the possibility that Qualcomm has tied up essential IPR in important technologies for alternative approaches to 3G. It purchased Flarion in 2006 to reinforce its IPR.
81. Martin Cave, "Review of radio spectrum management, report for the UK department of trade and industry," at <http://www.ofcom.org>. Also see "Ofcom's response to the Independent Spectrum Review of Radio Spectrum Management," at <http://www.ofcom.org>.
82. "EU telecom ministers agree state aid inappropriate," *Wall Street Journal Online*, December 5, 2002.
83. Many governments still try to micro-manage competing interests and particular technology plans. India, for example, decided to designate WiMAX as the technology to expand broadband rural connectivity. And, in late 2006 Colombia awarded 55 WiMAX licenses, favoring long-distance carriers that were struggling, but it did not issue 3G licenses to mobile carriers that were prospering. Sources: "Gartner: India to remain niche market for WiMAX," *Fierce Broadband Wireless*, May 27, 2008; "MinCom assigns 55 WiMax licenses," at <http://www.wimax-industry.com>; Alec

Barton, "Colombian ministry receives 161 WiMax license applications, allocates 55," at <http://www.developingtelecoms.com>.

84. In-Stat, "The road to 4G: Will LTE, UMB and WiMax just be stops along the way?" (Product Number IN0703689GW), August 2007, [www.instat.com](http://www.instat.com).

85. William Lehr and Lee W. McKnight, "Wireless Internet access: 3G vs. WiFi," *Telecommunications Policy* 27 (2003): 351–370.

## Chapter 9

1. This chapter draws substantially on Peter Cowhey and Milton Mueller, "Delegation, Networks and Internet Governance," in *Networked Politics: Agency Power and Governance*, ed. M. Kahler (Cornell University Press, 2009).

2. John Perry Barlow argued that the Internet is beyond governments. Chapters 2 and 4 spelled out the regulatory realities omitted by this claim.

3. Some see large swaths of international agreements on commerce and human rights as parts of Internet governance. We follow the more restrictive definition suggested by John Mathiason et al. in an Internet Governance Project research paper titled "Internet governance: The state of play" (available at <http://www.internetgovernance.org>).

4. One could add a fourth layer, referring to policies, laws, and regulations governing the *use* of the Internet by people. This would include rules about crime, fraud, security, privacy, intellectual property, and content that attempt to govern *conduct* rather than the way the Internet and its resources are structured. These problems are not unique to the Internet, and are too inchoate to analyze here.

5. This point is stressed in the literature. See Wolfgang Reinicke, *Global Public Policy* (Brookings Institution, 1998).

6. One sign of the entrenched status of these principles was their central role in the proposal of the European Union on modifying Internet governance (Proposal for addition to chair's paper Sub-Com A Internet Governance on paragraph 5 'Follow-up and Possible Arrangements,' document WSIS-II/PC-3/DT/21-E, 2005, available at <http://www.itu.int>). The access goal is embraced as an educational mission by the Internet Society in "The strategic operating plan of the Internet Society," 2005 (available at [www.isoc.org](http://www.isoc.org)).

7. Despite the tortuous and convoluted working of global resolutions, all but the second norm (which is subject to an ambiguous compromise throughout the text) are embraced in the World Summit on the Information Society's Declaration of Principles: Building the Information Society: a global challenge in the new Millennium, document WSIS-03/Geneva/Doc/4-E, available at <http://www.itu.int>.

8. Important goals of the Internet Society's strategic plan include the ability to innovate and to share.

9. Its name changes, but its mission remains pretty much the same. The Advanced Research Projects Agency (ARPA), created on February 7, 1958, was responsible "for the direction or performance of such advanced projects in the field of research and development as the Secretary of Defense shall, from time to time, designate by individual project or by category." On March 23, 1972, its name was changed to Defense Advanced Research Projects Agency (DARPA). On February 22, 1993, it was renamed Advanced Research Projects Agency (ARPA). On February 10, 1996, its name was changed again to Defense Advanced Research Projects Agency (DARPA). To avoid confusion, we use DARPA, the current name, throughout. The quotation is from the DARPA history available at <http://www.darpa.mil>.

10. Often the DoD paid a premium of close to 100% to get desired performance and weight margins. See Leslie Berlin, *The Man Behind the Microchip—Robert Noyce and the Invention of Silicon Valley* (Oxford University Press, 2005), p. 130.

11. Peter Cowhey, "The Politics of US and Japanese Security Commitments," in *Structure and Policy in Japan and the United States*, ed. Cowhey and McCubbins.

12. For a vivid account, see Reed Hundt, *You Say You Want a Revolution* (Yale University Press, 2000). Anthony M. Rutkowski ("Multilateral cooperation in telecommunications: implications for the great transformation," in *The New Information Infrastructure*, ed. W. Drake, Twentieth Century Fund, 1995) notes the increase in importance given to ICT technology during the Clinton administration.

13. The World Wide Web Consortium ("W3C") deals with certain applications software issues that are pertinent to the transport software. For simplicity's sake this is omitted from this discussion. The section that follows draws heavily on Milton Mueller, *Ruling the Root* (MIT Press, 2002). Also see Daniel Benoliel, "Cyberspace technological standardization: An institutional theory retrospective," *Berkeley Technology Law Journal* 18 (2003): 1259–1339; Mathiason et al., "Internet governance: The state of play"; Bernd Holznagel and Raymund Werle, "Sectors and strategies of global communications regulation," *Knowledge, Technology and Policy* 7 (2004), no. 2: 19–37.

14. See the discussion of standards in chapter 8.

15. It had several earlier names and structures, and by 1990 it had evolved into the Internet Society, but the continuity is substantial enough to justify referring to the IETF throughout this discussion.

16. Janet Abbate, *Inventing the Internet* (MIT Press, 1999), pp. 144–145.

17. Benoliel, "Cyberspace technological standardization," p. 28.

18. Internet standards may contain corporate intellectual property, but only if licensed on a reasonable and non-discriminatory basis. Many standards have no intellectual property protection.

19. This motif included an informal process emphasizing expert participation open to all (unlike most standards bodies) that relied on a “request for comment” and feedback system to design standards, applied field tests to validate them, and relatively quick decision making. Tinkering over the years tried to ensure that the process was opened to a broader range of participants in the computer community. See Abbate, *Inventing the Internet*, pp. 206–207.

20. The “constitution” of these communities is the architecture of the Internet. There is agreement that central design principles of the Internet will be upheld in the implementation of standards. Even as ISOC membership and administration has come to reflect greater influence of corporate executives they participate in their private capacity and adhere to the “constitutional rule.”

21. The ITU was an early participant in the effort to create data networking. Caught up in a system of slower inter-governmental decision making and largely driven by the interests of telephone companies, its approach failed commercially. See Abbate, *Inventing the Internet*, pp. 150–151.

22. The theory of delegation does not require a formal act of deliberative delegation by a principal. Rather, it is common that the principal can find itself newly interested in an arena (such as credentialing doctors or certifying the safety of consumer products) where there is a pre-existing “agent.” See Hawkins et al., *Delegation and Agency in International Organizations*, p. 7.

23. For communications networks governments retain the right to dictate technical standards, and so their forbearance is an important restraint on standards-setting bodies. This influenced the dynamic of Internet standard setting. The IETF is treated as a “virtual agent,” not created by governments but requiring a decision by governments not to displace it by more traditional institutions with overlapping jurisdiction. This potential for governments to change IETF’s effective jurisdiction had implications for its operations. In contrast, the arrangement for governing Internet address was a classic act of formal delegation.

24. Abbate, *Inventing the Internet*, pp. 167–177. The OSI model also failed because it relied on traditional face-to-face, bureaucratic mechanisms. By contrast the IETF relied on virtual collaboration and a fusion of users and developers. The IAB was created in part to solidify this advantage. See Rutkowski, “Multilateral cooperation in telecommunications.”

25. In 1992 the CCITT was renamed the ITU Telecommunication Standardization Sector (ITU-T), but since most activities cited here took place before 1992, we use CCITT throughout. The Open Systems Interconnection Basic Reference Model,

usually referred to as the OSI Model, describes communications and computer network protocol design. It is sometimes known as the OSI seven-layer model. From top to bottom, the OSI Model consists of the Application, Presentation, Session, Transport, Network, Data Link, and Physical layers. Each layer is a collection of related functions that provides services to the layer above it and receives service from the layer below it.

26. Abbate, *Inventing the Internet*, pp. 174–176.

27. Shane Greenstein, “Markets, Standardization, and the Information Infrastructure,” *IEEE Micro, Chips, Systems, and Applications*, Special Issue on Standards, 13 (December 2003), no. 6: 36–51.

28. As late as 1990 there were factions in the US government that supported OSI over the TCP/IP protocols. See Petri Mahonen, “The standardization process in IT—Too slow or too fast,” in *Information Technology Standards and Standardization*, ed. K. Jakobs (IGI Publications, 2000). On a major dispute that arose between the IAB and IETF when the IAB proposed to incorporate an OSI standard into Internet protocols, see Andrew L. Russell, “‘Rough consensus and running code’ and the Internet-OSI standards war,” *IEEE Annals of the History of Computing* 28 (2006), no. 3: 48–61.

29. Shane Greenstein (“The economic geography of Internet infrastructure in the United States,” in *Handbook of Telecommunications Economics*, volume 2, ed. S. Majumdar et al., North-Holland, 2005) suggests that in this case no one had a superior position on IPR and all would benefit from strong network externalities. In addition, the Internet architecture made it possible to co-exist with other proprietary architectures as long as was necessary, thus reducing the costs for “losers” to the Internet protocols.

30. Based on Cowhey’s notes as a participant in the US government team that planned for the G-8 meeting.

31. This logic became clearer when standard setting for the software enabling the World Wide Web was institutionalized. The World Wide Web Consortium develops standards recommendations for the Web. The Consortium was founded when commercial interest in the creation of the Web was strong, as was government attention. Tim Berners-Lee, the key architect of the Web, writes that the desire of all players to avoid capture of key tools and design guidelines by any one company (i.e., Microsoft) made it easier for the Consortium to operate as an open standards-setting body. (See T. Berners-Lee, *Weaving the Web*, Harper Business, 2000.) Unlike the IETF, the W3C has membership dues and does some centralized development work of design tools.

32. The three conditions for any delegation were proposed by Lake and McCubbins in “Delegation to international agencies.”

33. See Request For Comments 4071, documenting changes in administrative support relationship between the Internet Society and the IETF, at <http://tools.ietf.org>. The World Wide Web Consortium is another hybrid model that some advocate for the IETF.

34. Actually  $N(N - 1)/2$ , not quite the square but close. See Milton Mueller, "The switchboard problem: Scale, signaling and organization in the era of manual telephone switching, 1878–1898," *Technology and Culture* 30 (1989), no. 3: 534–560.

35. An illustrative case is the (so far) lagging transition from IPv4 to IPv6. We thank Pierre de Vries for this observation.

36. Increasing bandwidth in the age of copper required expanding the diameter and weight of the copper cables, while extending their geographic scope meant adding more physical electronics devices such as loading coils or repeaters to boost the signal. See Neil H. Wasserman, *From Invention to Innovation* (Johns Hopkins University Press, 1985). A hierarchical control system for routing and centralized, integrated network management procedures conserved these scarce resources and allowed redundant routing options to increase reliability.

37. A central principle of the Internet, "end-to-end" connectivity, stipulates that the "end devices" (terminals) on the network contain much of the network intelligence instead of centralizing intelligence in a central telephone switch.

38. François Bar, Stephen Cohen, Peter Cowhey, Brad DeLong, Michael Kleeman, and John Zysman, "The Next Generation Internet," in *Tracking a Transformation*, ed. S. Weber (Brookings Institution Press, 2001); Roger Noll, "Resolving policy chaos in high speed Internet access," policy paper 01–013, Stanford Institute for Economic Policy Research, 2002.

39. A classic paper by David Parnas on systems software ("On the criteria to be used in decomposing systems into modules," *Communications of the ACM* 15 (1972), no. 12: 1053–1058 identifies another variant of the question of scarcity and hierarchy by pointing out that the time and effort to change code correctly are themselves scarce resources. Network designs differ on how they handle this problem. Parnas observes that hierarchy is one solution for conserving time and effort (one module orders the others) and, if done properly, hierarchy may actually make the lower level functions in the network more resistant to disruption. Chopping off the head does not hurt the rest of the body, only the highest level reasoning. The Internet's domain name system (DNS) handles the problem of assigning unique names in precisely this way.

40. For a good description of what they do and why they are needed, see National Research Council, *Signposts in Cyberspace* (National Academy Press, 2005).

41. This corresponds with Parnas's discussion referenced earlier.

42. For an excellent description of the root server system, see chapter 3 of *Signposts in Cyberspace*.

43. The software, known as BIND, is open-source software developed and maintained by the Internet Systems Consortium (ISC) in Palo Alto, California.

44. See Mueller, *Ruling the Root*; Michael Froomkin, "Wrong turn in cyberspace: Using ICANN to route around the APA and the Constitution," *Duke Law Journal* 50 (2000): 17–184; Robert Shaw, "Internet domain names: Whose domain is this?" in *Coordinating the Internet*, ed. B. Kahin and J. Keller (MIT Press, 1997).

45. Using a carefully negotiated compatibility among co-equal, hierarchic organizations, can coordinate the domain name system, but this raises the same strategic bargaining issues associated with telecommunications interconnection noted before. See Milton Mueller, "Competing DNS roots: Creative destruction or just plain destruction?" *Journal of Network Industries* 3 (2002): 313–334; also see *Signposts in Cyberspace*.

46. For a comparable case involving the International Monetary Fund, see J. Lawrence Broz and Michael Brewster Hawes, "Congressional Politics of Financing the International Monetary Fund," *International Organization* 60 (2006), no. 2: 367–399.

47. As a non-profit corporation, ICANN is subject to US law and courts. This further roots it in US sensibilities, which raises some concerns for non-US interests. The delegation to ICANN also makes its deliberations exempt from the Administrative Procedures Act, a concern for some US critics. See Viktor Mayer-Schönberger and Malte Ziewitz, "Jefferson rebuffed: The United States and the future of Internet governance," *Columbia Science and Technology Law Review* 8 (2007): 188–228; Jonathan Weinberg, "ICANN and the problem of legitimacy," *Duke Law Journal* 50 (2000), no. 1: 187–260.

48. The first is a Memorandum of Understanding (MoU) between the US Department of Commerce and ICANN. The second is a contract between ICANN and the US government. The third is a Cooperative Agreement between the US Department of Commerce and VeriSign.

49. The root zone is the top level of the Domain Name System hierarchy for any DNS system.

50. Contrary to the original intentions of the US Department of Commerce, most of the root server operators still have no contractual relationship with ICANN or any government. The relationship between the US government and the nongovernmental root server operators is one of co-existence. Consistent with delegation theory, however, should one of these operators within the US take actions that go beyond certain political parameters—e.g., seriously undermining the ICANN regime or the stability of the Internet—it likely would trigger action by the government.

51. Mueller, *Ruling the Root; Signposts in Cyberspace*.
52. ICANN resembles “discretion-based” delegation where uncertainty concerning the task and expertise of the agent lead to a significant grant of discretion. In view of the enormous influence of the US and the task of getting enough consent from the rest of the world’s stakeholders to be viable, ICANN has the implicit mandate of setting the policy at a point that precludes being overturned. See Hawkins et al., *Delegation and Agency in International Organizations*, pp. 27–28.
53. ICANN soon promoted competition by facilitating entry into the market for registering .com names in competition with VeriSign. However, the US negotiated the initial contract with VeriSign as it set up ICANN. This contract set the framework for the initial bargaining options for the movement to competition.
54. The policy is available at <http://www.icann.org>. See also Jonathan Weinberg, “ICANN, ‘Internet stability,’ and the new top level domains,” in *Communications Policy and Information Technology*, ed. L. Cranor et al. (MIT Press, 2002).
55. “At-large” delegates elected on the basis of geographic representation system were replaced by candidates selected by the board who were geographically diverse in their nationalities. See Hans Klein, “Global Internet Democracy,” *Info* 3 (2000), no. 4: 255–257.
56. The US decision to keep control was partly reversed by a decision to phase it out over a three-year period. This won praise from the EU. See Associated Press, “EU praises ICANN on role in Internet,” November 2, 2006. For an excellent review of WSIS, see Mayer-Schönberger and Ziewitz, “Jefferson rebuffed.”
57. The report of the Working Group on Internet Governance states in paragraph 48 that “no single government should have a pre-eminent role in relation to international Internet governance.”
58. Hawkins et al., *Delegation and Agency in International Organizations*, pp. 21 and 27.
59. NTIA statement, June 30, 2005.
60. Mayer-Schönberger and Ziewitz, “Jefferson rebuffed.”
61. Principles for the Delegation and Administration of Country Code Top Level Domains, ICANN Governmental Advisory Committee (GAC), 2000, available at <http://gac.icann.org>.
62. The sovereignty principle with respect to ccTLDs was formally recognized in the June 30, 2005 principles issued by the US government. For technical and political reasons, the continuing growth of the Internet has led to more resource assignment functions occurring at specialized regional authorities, such as those for North America, Africa, and Latin America. For example, this discussion omits detailed discussion of the role of regional address registries and other functional elements of the Internet. However, these arrangements fit in with the concept of a chain of

delegation and with the general US policy of internationalization through privatization. The two most important non US-based address registries (for Europe and Asia-Pacific) were delegated to external nonprofits before the creation of ICANN. In both cases, delegations of address resources to non-US actors was a conscious part of an attempt to promote the spread of Internet protocol by reassuring foreign actors that the US was willing to share control.

63. National Science Foundation, *The National Research and Education Network Program*, "A Report to Congress in response to a requirement of The High Performance Computing Act of 1991," (P.L. 102–194) December 1992. The privatization of the backbone was nudged forward by the effort to boost the US computing industry whose various public policy organizations (among them the Computer Systems Policy Project) saw high-speed networking for computing as a major advantage in competing against Japan. The High Performance Computing Act of 1991, sponsored by Senator Al Gore (D-Tennessee), created the National Research and Education Network. For a candid and opinionated review of the players and their interests at the time, see "The National Research and Educational Network—Whom shall it serve?" (available at <http://thecookreport.org>).

64. Charles Ferguson, *High Stakes, No Prisoners* (Three Rivers Press, 1999), p. 48.

65. Greenstein, "The economic geography of Internet infrastructure in the United States."

66. Traditional telephone networks were hierarchical. The data transport market had two main layers. One provided local access and transport by an ISP in, for example, a city. The other layer was the backbone, long haul transport. On how regulation influenced strategies about local access, but long haul is most relevant for Internet governance, see Greenstein, "The economic geography of Internet infrastructure in the United States."

67. Because of this, there was no systematic ability to withhold capacity to raise prices on a sustained basis or limit the ability of others to enter the market (Greenstein, "The economic geography of Internet infrastructure in the United States; Economides, "The economics of the Internet backbone." For a summary of the views of those worried that a competitive problem was ignored, see Jay P. Kesan and Rajiv C. Shah, "Fool Us Once Shame on You—Fool Us Twice Shame on Us: What We can Learn from the Privatizations of the Internet Backbone Network and Domain Name System," *Washington University Law Quarterly* 79 (2001): 89–220; Benoliel, "Cyberspace technological standardization."

68. The US government prevented one merger and required the divestiture of backbone transport to a third company in another merger.

69. The system prevailing before 1998 drove up prices and discouraged technological efficiency.

70. The individual contracts differed, but one common practice in the late 1990s particularly angered foreign carriers. Worldcom and other US carriers asked, for example, an Australian carrier to transport all of the Web traffic for Worldcom to and from Australia for free in return for Worldcom providing free transport within the US for the Australian carrier accessing US websites. See Peter Cowhey, "Accounting Rates, Cross-Border Services, and the Next WTO Round on Basic Telecommunications Services," in *The WTO and Global Convergence in Telecommunications and Audio-Visual Services*, ed. D. Geradin and D. Luff (Cambridge University Press, 2004); *Telegeography 2001* (Telegeography, 2004), pp. 58–59.

71. International Charging for Access to Internet Services (ICAIS) was a major issue at the ITU's Study Group 3 that dealt with "tariffing" issues and then at the ITU's World Telecommunications Standardization Assembly in 2000.

72. Cowhey, "Accounting Rates."

73. For examples of the divided editorial comment on this outcome, see Kieren McCarthy, "Breaking America's grip on the net," *The Guardian*, October 6, 2005; Adam Thierer, and Wayne Crews, "The World Wide Web (of Bureaucrats?)," *OpinionJournal.com*, October 9, 2005.

74. International development institutions might fund special facilities to aggregate the regional traffic of, say, West Africa before peering with a global network. Larger traffic volumes should improve the terms for peering. Another idea would place renewed focus on the high prices charged for international transport by the poorest countries because the prices reduced the growth of their traffic. See Russell Southwood, "Africa: Local IXPs and Regional Carriers, Balancing Act," at <http://www.balancingact-africa.com>; Michael Jensen, "Open access—Lowering the cost of international bandwidth in Africa," Association for Progressive Communications issues paper, 2006, available at [www.apc.org](http://www.apc.org).

75. Jack Goldsmith and Timothy Wu, *Who Controls the Internet?* (Oxford University Press, 2006). David W. Drezner, *All Politics is Global: Explaining International Regulatory Regimes* (Princeton University Press, 2007).

### Summary and Conclusions

1. Although competition and universal service challenges remain, this era should emphasize minimizing the transaction costs for mixing and matching the diverse modular resources of the emerging infrastructure and production system.
2. Strong and clear property rights generally are desirable for market efficiency, but rights can be beneficial or perverse depending on their precise terms.
3. The Next Generation Network (NGN) is "a multi-service network based on IP technology [that] provides an open architecture by uncoupling services and net-

works and allowing them to be offered separately. In this context, the services can be developed independently regardless of the network platforms being used.” (Working Party on Telecommunication and Information Services Policies, Next Generation Network Development in OECD, Paris, 2004, paragraphs 13 and 14) ITU-T Study Group 13 leads this work at the ITU. The IETF works on protocols that allow intersection with NGN, such as ENUM for allowing telephone numbering to intersect with VoIP and multimedia in new ways.

4. Our goal is to suggest common approaches that promote global negotiations but also allow for significant variance in national policies.

5. Jonathan Zittrain, *The Future of the Internet* (Yale University Press, 2008); Gerald Faulhaber, “Net Neutrality: The Debate Evolves,” *International Journal of Communications* 1 (2007), February: 680–700.

6. This is true because major buyers and the major ICT vendors assume a heterogeneous network and IT stack.

7. Farrell and Weiser, “Modularity, vertical integration and open access policies.”

8. Japan, Korea, and other countries are engaged in similar exercises. We use some elements of the European search for principles to illustrate this wider range of thinking.

9. For a concise summary of the EU thinking, see J. Schwarz da Silva, “Converged networks and services,” paper presented at NSF/OECD Workshop on Social and Economic Factors Shaping the Future of the Internet, Washington, 2007.

10. A hybrid that can be effective under certain circumstances is a trans-governmental network of specialized national bureaucracies. See Mette Eilstrup-Sangiovanni, “Varieties of cooperation: Government networks in international security,” in *Networked Politics*, ed. M. Kahler (Cornell University Press, 2008).

11. Privacy exchanges that follow this model are described later in this chapter.

12. Del Bianco, “Voices past.”

13. On the Wireless Grid and other developments, see the following papers, presented at the NSF/OECD Workshop on Social and Economic Factors Shaping the Future of the Internet (Washington, 2007): Lee W. McKnight, “The future of the Internet is not the Internet: Open communications policy and the future wireless grid(s);” David Clark, “Defining a future network: A new research agenda”; J. Schwarz da Silva, “Converged networks and services.”

14. Brenden Kuerbis and Milton Mueller, “Securing the root: A proposal for distributing signing authority,” Internet Governance Project, Syracuse University, 2007.

15. Many fear market manipulation through mandatory standards in big national markets. However, China and others will usually fail to achieve major global wins if they set compulsory local standards. Modularity makes it harder to leverage vertical layers into broader successes. To the contrary, successful global standards rely more on ubiquity and speed of deployment. Nonetheless, government mandates could harm consumer welfare.

16. The focus here is more on the theory that these markets are prone to “tipping” and bundling of capabilities around platforms than on complaints aimed at specific forms of illegal competitive conduct.

17. For a sophisticated comparison, see Katarzyna A. Czapracka, “Where Antitrust Ends and IP Begins,” *Yale Journal of Law and Technology*, 9 (2007), Fall: 44–108; Nicholas Economides and Ioannis Lianos, “The Elusive Antitrust Standard on Bundling in Europe and in the United States at the Aftermath of the Microsoft Cases,” *Antitrust Law Journal* (2008).

18. Robert Hahn, ed., *Antitrust Policy and Vertical Restraints* (AEI-Brookings Joint Center for Regulatory Studies, 2006).

19. Remaining foreign direct investment restrictions are documented in *OECD Communications Outlook 2007* (Information and Communications Technologies, 2007). See p. 29 and table 2.6 on pp. 43–44.

20. For example, a global telecom carrier concluded in 2007 that China simply would not let it make a meaningful investment regardless of its telecom commitments at the WTO. Source: meetings with corporation’s executives, October 2007.

21. As we noted in chapter 8, strategic game playing over spectrum is routine. The same game is being played out between 3G and WiMAX advocates today. Spectrum should be flexible. See Eric Sylvers, “Wireless: Seeking a voice in future of WiMax,” *International Herald Tribune*, October 10, 2006.

22. Modularity also allows for efforts to relieve “scarcity” by pricing. Real-time bidding for spectrum bands if there is crowding (most of the time spectrum is idle) is possible with smart terminals. See Eli Noam, “What regulation for Internet TV? Telecommunications vs. television regulation,” at <http://www.london.edu>.

23. In some countries the license comes with many terms and conditions. Paring these conditions down is also optimal.

24. Private clearinghouses for spectrum, for example, can improve transactional efficiency by distributing the compensation needed to clear existing spectrum for new uses, subject to regulatory oversight. The FCC selected the CTIA Spectrum Clearinghouse to serve this purpose for the 2.1-GHz band. Source: “CTIA Spectrum Clearinghouse Announces Launch of New website,” at <http://www.ctia.org>.

25. Similar models exist in poor countries. Microfinance institutions, such as the Grameen Foundation's "Village Phone" program, have built a successful business model for the poor by lending them the capital to buy a cell phone, minutes on a phone card, an antenna booster, and a car battery with recharger to resell services to their villages.

26. "Editor's corner," Fierce Broadband Wireless, September 17, 2007; Natasha Lomas, "Urban wireless networks set to surge," Silicon.com, July 26, 2007; "Wireless Internet for all, without the towers," *New York Times*, February 4, 2007; Hernan Galperin and François Bar, "The Microtelco Opportunity: Evidence from Latin America," *Information Technologies and International Development* 3 (2006) no. 2: 73–86.

27. We thank Carlos Casaus for drawing our attention to the work of Bill St. Arnaud of CANARIE Inc., a Canadian Internet 2 firm. St. Arnaud points to Montreal as a model city for these policy initiatives. This paragraph draws heavily on his "New Media and Infrastructure Issues in Canada." Atkinson and Weiser suggest in "A 'third way' on network neutrality" that tax incentives for broadband build out may be more desirable than more rigid regulations to ensure network neutrality.

28. Private communication.

29. One backbone carrier has a pricing option that is a variant on the club model. It has a lead user pay a premium price to get initial fiber service. As others sign up for the fiber, the lead user's price declines. In effect, the user most valuing the fiber bears the upfront risk but benefits as others join the "club."

30. We agree with Michael L. Katz and Howard A. Shelanski, "Schumpeterian competition and antitrust policy in high-tech markets," *Competition* 14 (2005): 47p. that there is still a need for antitrust policy, but think that the inflection point narrows the focus and changes the mix of tools used for the policy.

31. The EU member states have agreed on a limited number of subsectors in the electronic communications sector that are subject to "ex ante" procedures. They must notify the European Commission of these procedures.

32. The US mix might include simpler ex ante rules built around a stronger presumption that competitive harm is difficult. Properly designed, such rules might pair with somewhat quicker enforcement mechanisms to provide a rough equivalent to "light touch" regulation.

33. Howard Shelanski, "Adjusting regulation to competition," *Yale Journal on Regulation* 24 (2007): 56–105.

34. The USC Annenberg Center Principles were developed during an off-the-record seminar among representatives of stakeholders in February 2006. The goal was to

provide a simple, clear set of guidelines addressing the public Internet markets for broadband access. We have slightly modified them by eliminating the call for competitive facilities (see our earlier discussion) and adding the requirements on wholesale and terminal equipment and applications. Atkinson and Weiser suggest comparable guidelines based on their independent analysis of the challenges.

35. Network operators providing basic access should not insert themselves in the traffic stream by blocking or degrading traffic. Traffic should be carried regardless of content or destination, and operators should not give preferential treatment to their own content in the basic access service.

36. The specific parameters (speed and latency) of this service could be reviewed on a quadrennial basis. In 2006 speeds exceeding 1 megabit per second downstream and less upstream were deemed acceptable. In time the idea is to move increasingly symmetric bandwidth at higher speeds in the future.

37. There are issues that are central to broadband competition in developing country markets that this package does not address. For example, many developing markets have competition but carriers with significant market power dominate the wholesale market and often refuse to deal with newcomers. Such situations may require additional measures.

38. Michael Kleeman, "Point of disconnect: Internet traffic and US communications infrastructure," *International Journal of Communication* 1 (2007): 177–183.

39. The economic negotiation over peering based on roughly reciprocal volumes of traffic is purely a commercial decision. This discussion applies only to "technical" issues influencing peering.

40. In April 1996 WTO members agreed in the Fourth protocol to specific commitments and exceptions to the WTO's agreement concerning basic telecommunications.

41. Assem Prakash and Matthew Potoski, "Racing to the bottom? Trade, environmental governance and ISO 14001," *American Journal of Political Science* 50 (2006), no. 2: 350–364.

42. For one view, see <http://www.wired.com/wired/archive/12.01/mpaa.html>.

43. "Draft non-paper on the WIPO Treaty on the Protection of Broadcasting Organizations," Draft 1.0, March 8, 2007, available at <http://www.wipo.int>.

44. The non-linear category still is subject to more restrictions that we would prefer, as explained in this passage in an analysis funded by Ofcom, the UK regulator: "Where the viewer actively requests the individual video file on demand. . . . [It] would be regulated according to minimal standards, lighter than linear 'broadcasting' regulation, but still encompassing a wide range of prohibitions against particu-

lar types and durations of advertising, other commercial communications, different types of expression, and so on. The definitions do not exclude video blogs, interactive computer games or delivery of video over mobile telephone networks." (*Assessing Indirect Impacts of the EC Proposals for Video Regulation*, Rand Europe, 2006, p. v).

45. In "What Regulation for Internet TV?" Eli Noam lists eight factors that lead to infrastructure regulation as the nexus for Internet television regulation: least mobile, fewest participants, market power, existing sophisticated regulatory tools, enforcer of content restrictions, effective revenue source, source of in-kind contributions, and customization of regulation.

46. Clay Shirky, *Here Comes Everybody* (Penguin, 2008).

47. For a smart outline of why draconian reinforcement of the status quo will not sell, see Gigi B. Sohn, "Don't mess with success: Government technology mandates and the marketplace for online content," *Journal of Telecommunications and High Tech Law* 5 (2006), fall: 73–86.

48. Abramson, *Digital Phoenix*, pp. 29–44.

49. *Ibid.*, pp. 29–35. Lawrence Lessig is one of the many critics of this position; see his 2001 book *The Future of Ideas* (Random House).

50. Cass R. Sunstein and Richard H. Thaler, "Liberal paternalism is not an oxymoron," *University of Chicago Law Review* 70 (2003), no. 4: 1159–1202.

51. All that is necessary for this is for copyright holders to use an equivalent of Google Alerts to monitor their IPR and for the copyright office to post notices of obsolete contact information on their websites. This approach differs in spirit from the WIPO privacy convention that the US recently signed, although the agent system could provide for privacy. One obstacle for this system is making sure that a synthesis of DRM and a trading system does not lead to an unwarranted expansion of copyright claims; see Pamela Samuelson, "Digital rights management {and, or, vs.} the law," *Communications of the ACM* 46 (2003), no. 4: 41–45.

52. The options on Creative Commons licenses allow up to eleven different combinations for licenses. As of October 2008, licenses were available in 46 countries and under development in 18 more. Source: <http://creativecommons.org>.

53. Suzanne Scotchmer has shown that private mechanisms for implementing market rights and capabilities, like ASCAP's system of collecting royalties for broadcasts of copyrighted music, require monitoring.

54. Set forth in the Health Insurance Portability and Accountability Act of 1996.

55. See Douglas MacMillan and Paula Lehman, "Social Networking with the Elite," at <http://www.businessweek.com>.

56. Furthermore, some personal rights may be treated as impossible to waive. Distinguishing these fundamental rights from other layers of protection is one task for policy making.

57. For Microsoft's policy, see <http://privacy.microsoft.com/en-us/fullnotice.aspx>. On Ask.com, see <http://www.informationweek.com/news/showArticle.jhtml?articleID=201200282>.

58. The report can be found at <http://www.privacyinternational.org>. On recent calls for international regulation, see "Google calls for international standards on internet privacy," *Washington Post*, September 15, 2007.