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Setting the Standard: Two Generations of Wireless Telecom

Starting in the late 1980s, the global market for mobile communications embarked on a large-scale technological change as it transitioned from analog to digital data transfers. The new technology, popularly referred to as 2G (second generation), provided consumers with a range of add-on services including text messaging (SMS) and basic email functionality; and marked the first of several milestones which would alter the industry landscape.

The transition to 2G posed a special challenge to governments worldwide as they struggled with the issue of formulating a standardization policy. The dilemma: should governments dictate a common industry standard, thus facilitating cooperation among market participants but at the risk of choosing the wrong standard? Or should they allow the standards to emerge from market competition? And how would standardization policy affect the national industry's competitive position on the global market?

De jure vs. de facto: Europe and the US[1]

When it came to public policy towards 2G standards, Europe and USA followed two very different paths. In Europe, policymakers decided to create a common European standard. This approach, which from the start allowed consumers to roam across Europe using a single phone, was aligned with the EU (previously EEC) single European market goal.[2] 2 It was further informed by Europe's experience with first generation (1G) networks: the unregulated spread of 1G had led to a fragmented and inefficient set of networks and significant barriers to industry growth.[2]

In 1987, thirteen EU countries signed a memorandum of understanding to develop a common 2G standard to be selected by a pre-existing body named GSM (Groupe Spéciale Mobile). Hearings were held to determine which standard should prevail. Out of nine different prototypes, the choice fell on NMT (Nordic Mobile Telephone), which thus became the core of the European GSM standard.

In 1990, the European Telecommunications Standards Institute (ETSI) published the first set of standard specifications for GSM, an acronym that was eventually renamed "Global System for Mobile communication."[3] As a result of the early decision to adopt a de jure standard across Europe (meaning, a mandatory standard), GSM achieved widespread adoption and quickly became the dominant technology.[4]

In the US the story was different. The Federal Communications Commission (FCC), the regulatory body governing the usage of the airwaves, decided not to dictate a standard, leaving it to industry players to develop their own standards.[5]

Exhibit 1
Number of subscribers by 2G standard (millions). Sources: see Endnotes 8, 9, 10, 11

	1993	1996	2000	2002
GSM	1	25	213	750
CDMA	N/A	1	72	120
TDMA	N/A	N/A	N/A	100

Filling the FCC regulatory vacuum, the major telecom companies formed a voluntary consortium, the Cellular Telecommunications Industry Association (CTIA). The CTIA consortium eventually settled on a technology called TDMA — short for "Time Driven Multiple Access" — which was very similar to the European GSM standard. This private sector attempt at de facto standardization could potentially have recreated the European success in the US — though without regulatory oversight. However, in 1991 Californian startup Qualcomm introduced a competing, proprietary, standard called CDMA, short for "Code Driven Multiple Access." Several industry players judged Qualcomm's standard as superior to CTIA's TDMA. In fact, several operators began adopting CDMA instead of TDMA, and before long the US market was evenly divided between these two standards.[6] Later, more standards were added, bringing the total of major standards in the US market to four.

The FCC's laissez faire approach thus had important consequences. The impact on US consumers is reflected in a 1998 article on the intricacies of choosing the right mobile phone:

> Where you will use the phone is a critical consideration. Every cellular phone company has a complex map showing a home area, areas where roaming fees apply, and in some cases, areas where service is not available ... Different companies use different transmission systems, so a phone bought for one company may not work with service from another provider.[7]

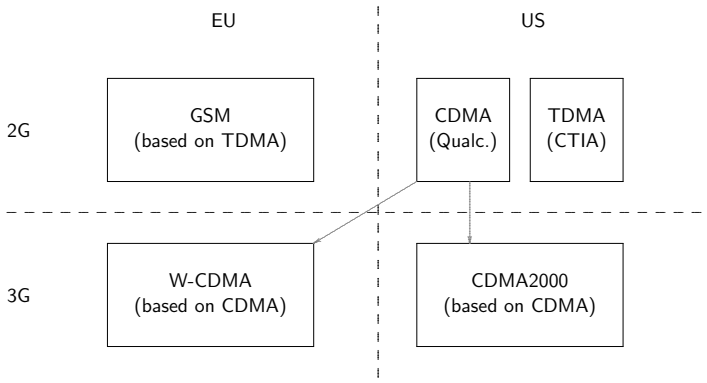
The fragmented system of incompatible regional networks partially mirrored Europe's 1G experience. Moreover, lacking a unified, sizeable market, suppliers found it difficult to take advantage of scale economies and produce affordable equipment. All in all, the US mobile industry fell behind Europe's.

Exhibit 1 presents subscriber-base estimates by standard for selected years. Some additional data help complete the picture: In 1998, US sales of digital phones (of all technologies) first surpassed analog phone sales (10.1 vs 7.9 million units);[12] in Europe, by contrast, the tipping point occurred in 1995 — three years earlier.[13] In June 2002, US mobile penetration rates had reached 40%; in Europe and Asia, most countries had by then surpassed the 70% threshold.

Some commentators were quick to declare Europe's victory:

> This decisive, early action generated significant network externalities for European firms and consumers. In the United States, regulators in the FCC ... left network standardization to the nascent wireless industry. Where the 2G experience is regarded as one of the greatest technological triumphs of recent European history, it marks the lowest point in a century that was otherwise dominated by American leadership in telecommunications.[2]

Exhibit 2
Overview of technology standards



But the FCC stuck to its guns:

> A single, government-mandated standard ... would hamper the industry's ability to respond quickly to new challenges and opportunities and remove incentives to improve upon existing technology. Multiple standards, on the other hand, avoid "locking in on an obsolete technology." They provide companies with the incentive to meet varying consumer needs and adapt to new ones, and to constantly search for technological innovations in the race to outdo their competitors.[14]

Third generation standards: W-CDMA vs. CDMA2000

2G technology was a marked improvement over the analog 1G technology. However, it was still primarily designed for basic phone service, which can be offered with relatively slow data transmission. As the mobile market kept growing and as phones became increasingly multifunctional, the industry moved toward a third generation (3G), which offered vastly improved data transfer capacity, better security, and the support of more advanced data services like multimedia messaging, improved internet browsing, video calling and GPS navigation. It would also start a new round in the standards battle between Europe and the US.

The battle for 3G standards revolved around two competing designs: W-CDMA, favored by Europe, and CDMA2000, largely supported by US operators. CDMA2000 was an evolutionary development of Qualcomm's original CDMA standard and worked with the existing technological infrastructure (cell towers, etc.). W-CDMA, by contrast, was marketed as an extension of the GSM network under the names UMTS and 3GSM. The W-CDMA standard was developed by Finnish telecom company Nokia. Its first commercial application took place in Japan in 2001, led by Nokia's collaborator NTT DoCoMo.[15] Unlike CDMA2000, Nokia's W-CDMA standard could not work with the existing cell towers, thus requiring network operators to build an entirely new technical infrastructure to support it.[16]

Both CDMA2000 and W-CDMA built directly on Qualcomm's proprietary 2G standard, CDMA. The core technological advantage of the CDMA standard, as compared to TDMA

and GSM, revolved around the concept of packet switching. A CDMA-based call works by breaking up the signal into many different pieces (called packages) and routing these to their destination via different pathways — similarly to how the Internet works. For cellphones, the technology allows not just for greater and more reliable call quality, but also for better utilization of the expensive data channels — a considerable economic boon to network operators. In comparison, the competing TDMA and GSM standards relied on a less effective underlying technological principle known as circuit switching, which established one fixed link for the duration of a call, thus requiring more bandwidth than packet switching and reducing cost effectiveness.[17] While it is generally agreed that the CDMA standard dominates the GSM standard, the comparison of CDMA2000 and W-CDMA is not as clear — other than the abovementioned costs of upgrading from 2G.

Nokia and Qualcomm go to court

Seeing the potential of Qualcomm's technology, in 1992 Nokia entered a 15-year licensing deal that allowed it to utilize and build on the CDMA standard. By 2007, Nokia was the biggest mobile company in the world, with a 35 percent share of the handset market. Nokia paid about $450 million in annual royalties to Qualcomm, less than 1 percent of Nokia's total 2007 sales of $53.4 billion (and about 4.5 percent of the cost of a W-CDMA handset).[18] For Qualcomm, royalty revenues represented a third of its 2007 sales, which it charged to more than 150 equipment and cell phone manufacturers. (In 2008 Qualcomm reported a net income of $3,160 million.)[19]

The Nokia-Qualcomm licensing deal was due to expire in April 2007. In the years leading to the deadline, Nokia and W-CDMA enjoyed considerable success. But the relation between Nokia and Qualcomm became increasingly strained, in fact, it culminated in a series of legal disputes. In October 2005, Nokia and five other companies filed an anti-trust complaint with the European Commission, alleging that Qualcomm was unfairly exploiting its patents. A regulatory probe into Qualcomm's licensing practices was initiated.[20] A month later, Qualcomm filed a suit against Nokia for infringement of eleven patents which Qualcomm claimed were not covered by the existing licensing deal. More suits followed — some initiated by Nokia, some by Qualcomm — in US, European and Asian courts.[21]

Twelve days before the licensing deal expiration date, neither of the firms was willing to give in.

> Qualcomm Inc. and Nokia Corp. are engaging in a high-stakes game of chicken, and Nokia's chief financial officer says his company isn't about to blink ... Rick Simonson, Nokia's chief financial officer, vowed that his company "will hold our ground" in pushing for lower royalty rates. "We won't pay more," Mr. Simonson said in an interview Monday. "We expect to pay less."[22]

Qualcomm also held its ground, and further threatened to initiate a series of new suits after April 2007, preventing Nokia from using patents required by the W-CDMA handsets.

On April 6th, as it became clear that no agreement was forthcoming, Nokia declared that while the case was running, Nokia would continue to make a quarterly payment to Qualcomm of $20 million, or about 82 percent less than the old licensing fee. Nokia explained the $20 million value was reached through an internal "good faith" evaluation.[23]

Louis Lupin, Qualcomm's general counsel and executive vice president, didn't mince his words:

> The offer is pretty much a joke. What Nokia is trying to do here now is simple. They are trying to reduce their costs of doing business. But our patents are still just as valuable today as they were under the old agreement ... What they have done is they have simply made up a number.[23]

Nokia presented the case differently, claiming that while Qualcomm's technology made up 80 percent of the old CDMA standard, those same patents made up only 20 percent of the W-CDMA standard — whereas new patents developed by Nokia since then comprised about 30 percent of the standard. According to Nokia spokeswoman Ulla James:

> We actually believe we have contributed more intellectual property to Wideband CDMA than Qualcomm has. That's why we want a new agreement. We are talking about different technology here.[18]

In 2008, after three years of legal battles, the case was finally settled. Nokia and Qualcomm signed a new fifteen-year cross-licensing deal which gave Nokia rights to a wide portfolio of Qualcomm's patents, while also transferring some of Nokia's patents to Qualcomm.[6] As part of the deal, both companies agreed to put an end to all other patent infringement litigation, including the European anti-trust complaint initiated in 2005.[20] Financially, the terms of the new licensing deal were not disclosed, but Nokia later stated that it included a lump-sum payment from Nokia to Qualcomm of $2.29 billion, to be made in 2008. The size of any on-going licensing payments in addition to this, if any, is not known, but industry experts consider it likely that such payments continue to be collected by Qualcomm.

China: the third way

China provides an interesting illustration of a country that tried a different approach to the process of standard setting. As the 2G battles raged, in order to avoid paying licensing fees to Qualcomm, the Chinese government controversially chose to develop its own proprietary standard, TD-SCDMA, to be used by their three main (government-owned) telecom operators.[24]

TD-SCDMA was partially incompatible with the standards used in the US and Europe, and was considered by experts to be less stable than either CDMA and GSM.[25] International manufacturers were hesitant to redesign equipment especially for the Chinese market. And Chinese manufacturers were slow to develop new equipment, partly due to the slow process of Chinese commitment to a specific standard. In 2009, only 959,000 of China Mobile's 493 million customers were using homegrown TD-SCDMA-based services, well short of the 10 million target set by authorities.[25] By contrast, when a CDMA2000-based service was finally introduced by China Telecom in March 2009, it took only four months to reach 1 million subscribers.

The present and the future

Partially because of the costs associated with installing W-CDMA, CDMA2000 initially gained the lead in the 3G market, which it still holds (see Exhibit 3). In 2006 W-CDMA had

Exhibit 3
Number of subscribers by 3G standard (millions). Sources: see Endnote 26

	2004	2006	2007
CDMA2000	115	323	390
W-CDMA	19	110	210

been deployed in over 55 countries, especially in Japan, Europe and Asia.[15] Qualcomm's CDMA2000 networks saw a similar wide deployment, especially in the Americas, with coverage in 58 countries.[15] W-CDMA is currently growing faster than CDMA2000, and some industry experts expect it to eventually overtake CDMA2000.

The International Telecommunication Union estimates there were 4.1 billion cellphone users in 2008, 85% of which using 2G technology.[27] The industry forecast is that, by 2010, 3G technology (CDMA2000 and WCDMA) will account for 43% of users.[28] Judging by the fate of 1G technologies, 2G standards will exist for many years to come: in the US, for example, it was not until February 2008 that the 1G analog services were finally discontinued.[29]

Endnotes

1. Much of this section draws on the source indicated in Endnote 2.
2. Andrew L. Russell, "Standardization in Digital Networks: The Case of 2G Mobile Phones," Progress on Point, November 2004.
3. The world of telecoms can be hard to understand for outsiders because of the many technical abbreviations. In the interest of clarity, we have simplified the use of abbreviations in this case and omitted several non-essential technical details.
4. Thomas J. Duesterberg, "A Bad Start to a New Year," Wall Street Journal (Europe), Dec 31, 1998.
5. For an analysis of the underlying motivation for FCC's pursuit of a deregulated approach, see Russell (2004).
6. Hoover's Company Information, 2009. Available via ProQuest.
7. James Cummings, "Untangling cellular options," Dayton Daily News, Ohio, Nov 21, 1998.
8. Vanessa Pegueros, Eric David, Tod Hirsch, Jonathan Hobson: "W-CDMA and cdma2000 Technology Standards for 3rd Generation Wireless Systems: Current Issues and Analysis," 2002 (est.).
9. Mary J. Cronin: 'Mobile commerce', in Hossein Bidgoli: "The Internet encyclopedia, Volume 2," 2004, John Wiley & Sons.
10. Chris Chapel, "GSM group predicts tighter stranglehold on wireless market," South China Morning Post, Oct 1, 1996.
11. ITU Internet Report: "The Internet of Things," 2005.
12. "Qualcomm Responds to Dataquest Market Study," PR Newswire, New York, Dec 10, 1998.
13. Robert Bailey, "Europe Sets the Standard for Mobile Phones," International Herald Tribune, Nov 29, 1994.
14. "Consumers of New Wireless Technology Better Served by Market Competition Than Government-mandated Standard, Economic White Paper Concludes," PR Newswire, New York, Nov 24, 1998.
15. Wikipedia, http://en.wikipedia.org/wiki/W-CDMA_(UMTS), retrieved August 17, 2009.
16. Wikipedia, http://en.wikipedia.org/wiki/UMTS, retrieved August 17, 2009.
17. Wikipedia, http://en.wikipedia.org/wiki/Code_division_multiple_access, retrieved August 17, 2009.
18. J. O'Brien, "The Nokia-Qualcomm disconnect," International Herald Tribune, Apr 9, 2007.
19. Hoover's Company Information, 2009.
20. "Nokia, Qualcomm End," *The Washington Post*, Jul 24, 2008.
21. "Qualcomm Says Nokia Infringed Six Patents," *Los Angeles Times*, Jun 13, 2006.
22. Don Clark, "Nokia, Qualcomm remain at odds over patent royalties," Wall Street Journal, Mar 28, 2007.
23. Don Clark and Roger Cheng, "Nokia, Qualcomm Joust in Patent Dispute; Arbitration Is Requested As Pact Deadline Nears," *The Wall Street Journal (Eastern edition)*, April 6, 2007.
24. http://en.wikipedia.org/wiki/TD-SCDMA, retrieved August 17, 2009.
25. Frederick Yeung, "3G players struggle as customers shy from homegrown technology," *South China Morning Post,* July 23, 2009.
26. "WCDMA to Get the Upper Hand," *Market Avenue,* March, 14 2008.
27. Wikipedia, http://en.wikipedia.org/wiki/Mobile_phone, retrieved August 17, 2009.
28. Research & Markets: "3G Market Forecast to 2010," RNCOS, July 2008.
29. http://wireless.fcc.gov/services/index.htm?job=about_cellular_reports&id=cellular, retrieved August 17, 2009.