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WHITE PAPER

Past as a Guidepost to the Future: Reflections on the Continued Growth of the Mobile Communications Industry

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IN THIS WHITE PAPER

In barely more than 25 years, mobile telephony has undergone three generations of technological change and stands on the threshold of a fourth. Anchored in cellular technologies and architecture, the mobile industry today boasts almost 3 billion subscribers worldwide, supported by cellular operators espousing principally code division multiple access (CDMA) and Global System for Mobile Communications (GSM) standards and their next-generation derivatives. Perhaps one of the more salient indicators of the robust health of the industry and its bright future is the fact that more than 1 billion cellular devices were shipped worldwide in 2006 and that these shipments are likely to grow every year. IDC predicts more than 1.4 billion mobile phones will be shipped in 2011; the prediction reflects the broad industry consensus that nearly 4 billion people worldwide will be tied to the cellular networks by the end of this decade. Further, after a period of conflicting industry expectations and a steep learning curve, third-generation (3G) mobile systems are now beginning to proliferate at an accelerating pace. By IDC's count, more than 250 third-generation mobile networks have been deployed in various countries of the world; another 130-plus 3G networks are in the process of deployment.

However, as 3G networks are finally beginning to gain a sizable foothold, the mobile industry has already started looking to the future with other wireless broadband technologies. There is broad consensus in the industry that 3G networks based principally on CDMA technologies will evolve to or be replaced by orthogonal frequency division multiple access (OFDMA) technologies. However, the specific design and business justification of such standards are still being worked out, and the broad contours of the migration path from 3G to the fourth generation (4G) are still undefined.

The migration from 3G to OFDMA-based systems represents a major disjuncture for the wireless and mobile industry. The concurrent changes wrought by convergence, a rise in mobile data usage, and the proliferation of new access technologies provide an occasion for reflection and review and for considering the question: What should the wireless and mobile industry do to sustain its remarkable growth?

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This IDC white paper seeks to address this question. It briefly reviews the past to tease out some of the key attributes that have shaped the mobile industry to date, helping it grow to a critical global infrastructure. Looking forward, the white paper also considers current and emerging market realities, and developments in technology, to identify some of the more contemporary attributes that the mobile industry might embrace for sustained growth. It concludes with recommendations that the industry might consider for continued growth in the new and emerging competitive environment, beyond merely building high-bandwidth networks.

The white paper concludes that while the mobile industry ought to consider the promise of newer access technologies, it might do well to retain its focus on the revenue-generating technological trajectory that it has painstakingly, and deliberatively, built for itself. Many of the key attributes that have helped the industry grow to its present state of preeminence — evolutionary change, economies of scale and scope, standardized radio environment, path dependency, predictability, interoperability, availability of cross-technology and cross-generational devices, and a well-managed ecosystem, among others — remain critical for its continued growth. The mobile industry is anchored in a complex web of political, economic, and technological interdependencies that are growing more salient and entrenched as convergence brings the mobile industry closer to the world of entertainment, consumerism, education, health, public safety, enterprise, and the Internet. To sustain its exponential growth, the global mobile industry would do well to continue strengthening and expanding its existing ecosystem, even as it embraces and assimilates newer technologies and players within its fold.

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SITUATION OVERVIEW

The wireless and mobile industry has come a long way since its inception in the early 1980s, when a leading consulting firm had famously predicted that there might be, at best, about 1 million mobile phones worldwide by the turn of the century. In roughly 25 years, the wireless and mobile industry has undergone three generations of technological change and stands on the threshold of a fourth. More importantly, it boasts nearly 3 billion subscribers today and has made it possible for policymakers to imagine a truly connected world with "communication for all." Besides generating billions of dollars in revenue, as well as employment for millions, the wireless and mobile industry has created the conditions for overcoming the digital divide and improving the economies of developing markets. In that sense — and quite separate from the fact that it today comprises a critical infrastructure for other industries and constitutes a necessary element of our social fabric — the mobile industry has *directly* generated untold economic wealth for millions and created political parity between individuals and groups.

Looking Backward: The Past and Its Lessons

Several factors have contributed to the growth of the wireless and mobile industry from somewhat shaky foundations — of competing national standards and fragmented protocols — to a critical global infrastructure industry informed by international cooperation on spectrum and standards. In light of George Santayana's admonition that those who cannot remember the past are condemned to repeat it, this paper reviews the past in an attempt to tease out key lessons that might serve as guideposts to the future.

First-Generation Mobile Networks

The first commercial mobile systems — the "first generation" — were deployed in the early to mid-1980s in the developed countries of Western Europe and in the United States and Japan. Based on analog technology and FDMA protocols, these early systems relied on expensive and bulky handsets and offered relatively poor-quality voice service over limited coverage areas. The early mobile systems developed in national isolation; one consequence of such isolation was the development of multiple, and often incompatible, standards across national boundaries.

For first-generation (1G) mobile telephony, some countries in Europe deployed Nordic Mobile Telephone (NMT) and Total Access Communications System (TACS) standards, while mobile network operators in the United States used variants of the Advanced Mobile Phone System (AMPS) standard. There were also other proprietary standards that were mostly confined to domestic national markets, for instance, in Germany and Japan. Incompatibility between regional standards hampered global roaming and expansion.

Second-Generation Mobile Networks

The second-generation (2G) networks, for the most part, sought to rectify the challenges of their first-generation counterparts. These mobile systems, initially deployed in the early 1990s, introduced digital transmission protocols. This had several advantages, including more efficient use of the radio spectrum, transmission of data in addition to voice, and improved security of voice and data transmissions. Also, because digital networks operated at lower power, handsets could be smaller and lighter, with longer battery life.

The 2G standards include Global System for Mobile Communications (GSM); Time Division Multiple Access Interim Standard 36 (TDMA IS-136); Personal Digital Cellular (PDC), used exclusively in Japan; and Code Division Multiple Access Interim Standard 95 (CDMA IS-95).

GSM was developed by the European Telecommunications Standards Institute (ETSI). European policymakers wanted a single technological standard for the whole of Europe to create a single market that would not only permit roaming but also allow manufacturers to capitalize on economies of scale. The effort was backed by European vendors that wanted to reduce their R&D expenditures and build economies of scale by supporting fewer standards. As designed, GSM was not backward compatible with any of the analog standards. Nevertheless, given low mobile penetration at the time, the forced switching cost was deemed affordable.

The 2G trajectory in the United States was different. The Federal Communications Commission (FCC) avoided mandating any technological standard when issuing spectrum licenses. In other words, unlike the European Union, which needed a standard to create a sizable market, the United States allowed the market to choose the technology standard. The regulators, however, pushed for one goal: backward compatibility.

The U.S. market largely opted for TDMA IS-136 — a digital enhancement of AMPS technology that was introduced in the early 1990s. Even though TDMA was eventually deployed in more than 65 countries worldwide, it found salience mostly in the United States and the Americas.

Meanwhile, Japan, then dominated by a single player, NTT, decided on PDC. Japan's great hope at the time was that it could "export" its standard to the rest of the world, or at least to the rest of Asia. This did not happen. Given the nature of the standardization process and for reasons of international competitiveness, national standards do not usually succeed abroad.

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The mid-1990s also saw the deployment of the CDMA IS-95 standard, known as cdmaOne™, in the United States and several Asian countries. The CDMA standard was based on spread spectrum technology. While the industry recognized CDMA as a superior air-interface technology compared with GSM or TDMA, GSM continued to grow in popularity, owing, among other reasons, to its cohesive ecosystem and international roaming feature.

The 2G systems, anchored in digital technologies, were demonstrably superior to 1G analog systems. Yet, it took 2G technologies the better part of a decade to find widespread adoption. Not until 1998 — roughly 15 years after the industry's inception — did the number of subscribers on digital networks first exceed the number of subscribers on analog networks.

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Third-Generation Mobile Networks

The 3G mobile systems, based primarily on CDMA technology, are obviously superior to 2G systems, among other things, because of their increased spectral efficiency that, in turn, supports higher network capacity, higher speeds, and reduced capital and operating costs. However, like 2G systems, 3G systems have faced teething troubles. The principal reason we have not seen widespread adoption of 3G WCDMA solutions is that social acceptance of a new technology is often faced with a "chicken and egg" problem, in which inadequate and poorly understood end-user demand and limited, spotty service availability (and high prices) inhibit each other's growth. Migration to a full-blown 3G WCDMA system represents a very high-stakes process, challenged by confusing technical and economic claims. Further, the fact that the process is framed within the dimension of international competitiveness creates an additional level of complexity, which has further slowed the process. Overoptimism and growing pains are often intrinsic to the process that informs the introduction of any new technology.

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Operators running CDMA2000 1X systems have found it easier to migrate to the third generation, in part because they were able to capitalize on the evolutionary nature of migrating to the new technology in the same frequency band while preserving backward compatibility, the ecosystem, and economies of scale.

Operators running GSM and TDMA networks were forced to acquire fresh spectrum to deploy WCDMA, often at high cost. European operators cumulatively spent roughly $120 billion to acquire spectrum for these networks.

The migration to 3G for GSM operators was also initially delayed owing to the lack of cross-generational (2G/3G) handsets critical to their business.

KEY LESSONS LEARNED

Several lessons can be drawn from this brief recap of the history of the mobile industry. Some of these lessons, anchored in several interrelated but conceptually distinct economic principles, are critical for the continued success of the mobile industry. Key among these are the following:

1. Evolutionary Change

Deployment of a network, even one employing a much improved technology, is always informed by considerations of cost and backward compatibility of networks and services. Mobile network operators, like others engaged in network-based enterprises, prefer a graceful evolutionary change to a disruptive revolutionary change. They like to gradually evolve to higher levels of functionality in a manner that allows them to preserve (and leverage) their substantial investments in earlier systems. The preference for evolutionary change also finds resonance with policymakers charged with the mandate of safeguarding the public interest. As noted earlier, policymakers in the United States, even though they did not impose any technology choice on industry players, did demand backward compatibility of 2G systems to protect consumers from being unnecessarily burdened with switching costs.

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It may be argued that the deployment of GSM in the European Union constituted a revolutionary — not evolutionary — change in that national analog systems were "scrapped" in favor of a new digital system. Although true, it should be noted that such change required *political* intervention, manifest in the European Council's 1987 Directive 87/372; and further, Europe's GSM decision too was anchored in economic considerations — of achieving future economies of scale through the creation of a single technological standard and a single cohesive market in Europe.

2. Network Effects and Critical Mass

The decision of GSM mobile operators to choose a standards-based evolution to WCDMA over a hurried 3G deployment points us simultaneously to the power of network effects and critical mass. Related to evolutionary change, network effect refers to the fact that a service becomes more valuable as more people use it, thereby encouraging ever-increasing numbers of adopters. Several GSM operators have suggested they chose delayed launches over nonstandard migration paths because they believed that a standards-based evolution would create a broader subscriber base with a greater network effect and that the broader subscriber base would enable the early emergence of a critical mass of high-end data users.

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Building next-generation networks to nonstandardized parameters would have introduced unnecessary complexity and fragmented the potential subscriber base, raising the eventual cost of mobile devices as well as the cost of rolling out services. Further, it would have forced operators to sacrifice roaming revenues and delayed — if not jeopardized — the emergence of a critical mass of users.

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3. Economies of Scale and Scope

The telecommunications business is necessarily anchored in economies of scale because unit cost decreases as a function of process and R&D efficiencies, lower input prices, and distribution of expensive expertise across a broader product base. Economies of scale allow a firm or region to become more competitive.

Scale also provides an operator increased leverage when negotiating with handset and infrastructure manufacturers. Further, it also helps network operators spread marketing and operational costs over a bigger base.

Economies of scope occur when a player is able to leverage its existing assets to support more than one product or service less expensively. Device vendors, for instance, seek to achieve economies of scope by leveraging their platforms across multiple types of devices and by building brand recognition that allows them to leverage the brand value across a series of products. Mobile operators also seek economies of scope through bundled services. Given the high costs of R&D required for designing networks, devices, and services, industry players — both operators and their vendors — must seek and realize economies of scale and scope to become or remain competitive.

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4. Coverage Is King: Footprint Matters

Coverage is king in telecommunications. Footprint matters, whether one runs a fixed-line or mobile network, because subscribers expect and demand excellent coverage — or network connectivity — most anywhere they go. Satisfying this elementary user expectation of providing seamless uninterrupted coverage is essential for attracting and retaining subscribers.

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Because the network's reach often defines the limits of the number of customers that an operator can serve and, hence, the revenues that the operator can earn, greater ubiquitous coverage provides network operators a significant advantage in terms of subscriber-based income and charges for roaming — both outbound and inbound. The greater the footprint of the mobile operator, the greater the likelihood that the mobile operator will be able to complete calls on its own network and, as a result, will not have to pay outbound roaming charges. Further, inbound roaming — resulting from serving a user from another network — can also be a lucrative source of revenue for mobile operators. The greater the coverage area of a mobile operator, the greater the chances of limiting outbound roaming expenses and capturing inbound roaming revenues.

5. Island Rollout, Cross-Generational Devices

Technology generations interpenetrate and coexist. Most operators prefer to see transition to a new generation take place gradually. This is because, in addition to considerations of cost, operators prefer to reduce their risks by rolling out new technologies and network architectures incrementally to gain a better understanding of the technology and the market response.

As a result, new network technologies are often deployed in an "island" manner, whereby operators improve and augment their existing networks with the new technology in certain "hotspots" such as major metropolitan cities, with deployments tempered by strategic considerations of available spectrum, existing infrastructure, and competition.

The island rollout speaks to the need for cross-generational or multimode and multiband devices that can operate within and outside the "island" covered by the new technological system. The cross-generational or multimode devices help socialize and bridge the new system with the existing subscriber base and network. The success of any new technology depends on its ability to attract a critical mass of users; achieving this critical mass of users becomes very challenging when a new technology is deployed in a standalone, isolated fashion.

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Limited availability of multimode, cross-generational (2G/3G), or cross-technology devices in sufficient volumes and at competitive, affordable prices delayed WCDMA network rollouts. European operators argued that the poor availability of multimode devices hampered their plans to roll out new and innovative services and build an early critical mass of profitable subscribers. The Koreans are relearning this lesson with the painstakingly slow adoption of WiMAX, known as WiBRO in their home turf.

6. Path Dependency

History matters. Path dependency is the idea that the initial choice of a technological standard can have important and sometimes irreversible influences on future market allocation of resources. This is because changing course, what economists call switching costs, can be prohibitively expensive for all parties involved if there is a large installed base of technology or users.

The mobile industry today supports almost 3 billion subscribers. Several hundreds of billions of dollars have already been invested in network infrastructure by operators and in mobile devices and services by enterprises and individual consumers. Equally important is the knowledge investment that the industry — the operators and their principal vendors, as well as the smaller vendors supplying components, platforms, and applications — has made in the system. Given that technological innovation depends on an infrastructure of knowledge, competence, and skills, arbitrarily changing technological paths always carries the potential to undermine innovation and negatively impact the industry. The cost of switching away from the current mobile system and its future trajectory is incalculable, especially when one considers the social practices and behaviors that have become institutionalized within the system.

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In short, a technological trajectory is an institutionalized form of technological change in which individuals and companies have invested monies, careers, and credibility. Like all institutionalized practices, it lends itself to change only at a cost — often a very high cost.

7. Predictability

Every firm, as well as every industry, seeks a stable and predictable environment for effective allocation of resources critical for efficient planning. One of the principal benefits of implementing predictability is that it allows companies in an industry to continuously improve while reducing cost and risk, and thus become more efficient and productive.

The mobile industry is no different: Predictability has been one of the key factors contributing to its success to date. One of the principal ways that the mobile industry sought to achieve predictability was through the creation of a standardized radio service environment that drove investor confidence, allowed systematic allocation of R&D resources, and resulted in innovation in services and devices.

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In fact, the uncertainty caused by the wrangling over the migration path to 3G networks had devastating effects on the industry. In an effort to conserve R&D dollars, some industry players made conscious, if unfortunate, decisions not to pursue certain technological paths. Others bet that the transition from 2G to 3G would occur earlier than it did. Missteps caused by the uncertainty that exists in a fast-changing technological environment have resulted in consolidation among mobile operators and, especially, vendors.

8. Compatibility and Interoperability

Given that multiple actors are involved in building, operating, and using the complex technical system called the mobile network, the pursuit of compatibility is a serious undertaking. With autonomous but interdependent actors designing, building, and operating these systems, there is a great need for coordination — usually achieved through the setting of standards — to ensure compatibility and interoperability of various system elements.

The coordination endeavor requires an appropriate discursive arena — usually a standard-setting body — in which industry players can meet to discuss and resolve their concerns and build consensus in a productive and expeditious manner. Building these discursive spaces is often difficult even in national or regional contexts, and the challenges are only exacerbated in the larger international context, where players' economic goals are often intermixed with geopolitical considerations of national competitiveness and national pride.

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The rising salience of mobile data services is creating its own level of complexity. Mobile data is making it necessary to ensure compatibility and interoperability not only between mobile networks and devices but also between enterprise platforms, operating systems, and the myriad forms of multimedia content available from the entertainment world. Building meaningful data services and solutions that might attract subscribers requires players from different industries to coordinate their efforts.

The mobile industry has recently begun to build structures of collaboration with IT players and application developers in different content industries, from gaming and music to messaging and broadcasting. Some players have been more successful than others in building stable business models that facilitate interindustry cooperation and ensure compatibility and interoperability between hardware and services. The process of ensuring compatibility and interoperability across multiple industries requires efficient standard-setting bodies, network maturity, and business predictability.

9. Complexity and Ecosystems

From the perspective of service providers, the network environment and the business environment are becoming more complex. On the network side, the operators must increasingly accommodate new network elements and technologies as they migrate their networks across technology generations. This is because new network elements must be backward compatible and work with (or "talk to") existing network elements. This opens up new niches for network equipment vendors, particularly in developing gateways.

Increased complexity on the business side is creating the need for leading industry players — sometimes leading infrastructure vendors, but often leading network operators — to cultivate and manage the ecosystems necessary for the provisioning of emerging mobile data services. Evolving an existing ecosystem is becoming increasingly necessary because the expertise that resides within the various elements that constitute an attractive and useful mobile data service is often distributed across players from different industries.

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Looking Forward: The Future and Its Promise

Following the somewhat slow take-up of WCDMA in the GSM world, especially in Western Europe where 3G coverage is limited and device costs are high, and in part because the business model justifying an investment in OFDMA-based technologies is still being decided, some leading operators, such as Vodafone, Orascom, and SK Telecom, have expressed their concern about the future trajectory of their broadband networks beyond 3G. Several CEOs of leading mobile operators in Europe and Asia publicly stated at the 3GSM conference in Barcelona in February 2007 that if the cellular world does not get its act together on network trajectory, it might find itself upstaged by alternative technologies.

CHALLENGES

One of the technologies being positioned as a potential competitor to the future trajectory of cellular networks is mobile WiMAX. This OFDMA-based access technology has recently gained credibility since Sprint Nextel announced its decision to deploy it on a nationwide basis. Since Sprint Nextel's decision, WiMAX has garnered the support of several major infrastructure vendors, including Motorola, Samsung, and Nortel. In July 2007, Sprint Nextel announced that it would collaborate with Clearwire to build out and share a nationwide mobile WiMAX network.

Mobile WiMAX, which is being positioned as the alternative (to 3G) broadband wireless access technology, comes in three variants: 802.16-2004 (fixed), 802.16e (mobile), and 802.16m (enhanced mobile).

In response, the cellular industry has introduced Long Term Evolution (LTE) and Ultra Mobile Broadband™ (UMB™) as the OFDMA-based standards that will evolve networks from WCDMA and CDMA2000 communities, respectively.

The WiMAX technology offers an IP-based solution that is not burdened with legacy issues associated with circuit-switched telephony networks. The use of greater bandwidths (20MHz), a flat IP architecture, and Multiple Input and Multiple Output (MIMO) antenna technology should enable WiMAX service providers to witness lower capital and operational expenses, plus more rapid deployment of services.

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However, IDC believes WiMAX is somewhat tenuously situated between a variety of potentially competing or complementary networking technologies, such as WiFi, 3G broadband, DSL, cable, and fiber to the curb. On the positive side, given its point-to-multipoint transmission capability, WiMAX in its 802.16-2004 incarnation could be, theoretically, a cost-effective *fixed* wireless broadband access in certain specific circumstances. WiMAX, in its fixed wireless access manifestation, could also find reasonable traction as a backhaul technology for cellular networks and WiFi hotspots.

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With respect to mobile or portable wireless broadband access, the case for WiMAX is somewhat unclear, in part because the business models in which it might be embedded are yet to be fully fleshed and articulated.

Further, the incumbency of the cellular 3G networks — and the associated economies of scale and scope inherent in both networks and devices — ought not to be overlooked or minimized. As the experience of 3G deployments has taught us, especially in the GSM universe, the previously mentioned "Key Lessons Learned," such as the lack of coverage, are likely to pose a serious challenge. Operators deploying WiMAX as an overlay may find it necessary to carry the cost of their network deployment for some time before reaching a critical mass of users or return on investment.

Further, the incumbency of the cellular 3G networks — and the associated economies of scale and scope inherent in both networks and devices — ought not to be overlooked or minimized.

Further, 3G networks, even in the GSM trajectory, are likely to best WiMAX networks on service ubiquity, at least in the foreseeable future. The other salient advantage that cellular networks enjoy is that their high-speed broadband data networks (e.g., EV-DO, HSPA), unlike those that might be built on the WiMAX standard, are fully subsidized by ongoing voice revenues.

CONCLUSION

New technologies are never born in a vacuum; rather, they are brought forward in existing structures of power represented by legacy systems. These legacy systems represent not merely old and/or obsolete technology or, in the case of mobile networks, antiquated network gear but also relationships — among industry players, between industry players and capital markets, and between technologies and developers. In other words, they represent working ecosystems or ecologies of support that remain in place for long periods of time and continuously evolve with newer technologies. It is very difficult for any new technology to supplant a legacy system unless it is orders of magnitude more valuable to the industry and, more importantly, the end customer.

Surely it is possible for a new technology or technological system to be disruptive, to cause what the economist Schumpeter called "creative gales of destruction." However, one must consider the ease with which a technology may succeed at being disruptive when the industry it is attempting to penetrate constitutes a critical global infrastructure anchored in well-entrenched ecosystems that currently support real-time and highly reliable communications and connectivity among nearly 3 billion people across six continents.

We believe that the mobile industry, like any open system seeking to continue to grow, should be open to new ideas, new technologies, and new methodologies. And, given the vast financial and intellectual capital vested in it, we believe it should address the adoption of these new technologies judiciously, assimilating them in a prudent fashion within the larger complex of relationships.