

**Ma Bell's Orphan:
US Cellular Telephony, 1947-1996**

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Abstract

The AT&T Bell System invented cellular telephony and deployed the world's first prototype cellular system. Strangely, neither AT&T nor its spin-off Regional Bell Operating Companies capitalized on that technological lead, and cellular telephony in the US slipped behind that in other countries. This turnaround is explained as a combination of a competency trap that blinded the AT&T Bell System leadership to the importance of the wireless telephony market and the lead their cellular system offered, coupled with a failure of institutional agency required to organize and direct the emerging industry resulting from the death of the AT&T Bell System.

Introduction

Two interesting but somewhat contradictory stories characterize the US position in global cellular telephony. In one, the US was a pioneer led by entrepreneurial players such as Craig McCaw who “invented the cellphone industry” (Young, 1998; Corr., 2000). In the other, the US cellular industry and the services it offers lag considerably behind those in Europe and Japan (DQWeek, 2001; Stone, 2000). Both stories provide valid accounts of the facts, but their implications are very different. The US lag in cellular telephony is inconsistent with previous technological development. The US record of innovation in telephony dates from the late 19th century, when the US led the world into the telephone age. The US was the wellspring of numerous telephony breakthroughs, from direct dialing to digital switching that transformed telephony on a global scale. Perhaps most interesting is the fact that cellular telephony was invented in the US. For all this, Craig McCaw did not invent the cellphone industry; the US was not the first country to deploy commercial cellular telephone service, and the US lag continues.

This paper contributes two new perspectives to the explanation of this unexpected US lag: a competency trap whereby the leadership of the AT&T Bell System lost its powerful lead in the cellular arena; and a failure of required institutional agency to recapture the US lead in the field following the breakup of the AT&T Bell System. Clearly, a story too complex to be comprehensively covered by a brief paper, and this paper makes no claims to such comprehensiveness. Instead, the primary objective is to help set the rhetorical stage for the detailed analyses that will emerge. The paper suggests that the US lag is a consequence of failures in organizational leadership, but also failures in the broader institutional conditions that were necessary to enable success.

The failure of organizational leadership is important, but it is subtle and subject to being overemphasized. The organizational leaders in US cellular telephony story at the time when the US lag began were no more blind to the potential of the technology than their counterparts in Europe and Japan. However, it can be argued that the huge US lead in the technology at that time suggests that the US leadership should have been more aware of potential. That they were not was less due to shortsightedness than to their being trapped by the tremendous success of the wireline infrastructure they had created. The question is not *whether* they missed the boat, but rather *how* they missed it given their advantage at the time. The paper suggests that a competency trap is the likeliest explanation for this failure.

Failures in institutional condition have been noted, but the mechanisms of those failures have not been explicated as they should be. This paper suggests that the problems in organizational leadership noted above had much more serious consequences at the institutional level. To a considerable degree, the organizational leadership behind US telephony was also the primary institutional agency governing its evolution. That is to say, for most of a century the production and deployment of telephonic innovation in the US were guided by a specific institution, the AT&T Bell System, acting as the agent on behalf of other interests and organizations. Through such institutional agency AT&T — while lacking a formal *de jure* institutional role — gave the US telecom industry the leadership that in other countries was typically provided by a post, telephone & telegraph (PTT) government department.

Had the Bell System’s institutional agency been undisturbed at the time cellular telephony became both technologically and economically viable, it is quite likely that the US would not have fallen behind. By historical coincidence, however, the break-out of cellular telephony occurred at approximately the same time as the break-up of the US telephone industry. This break-up essentially destroyed the institutional agency required to lead the US into the cellular era, and permitted the organizations and institutions in other countries to take the lead. The implications of this analysis are important in drawing lessons from the US lag in cellular telephony. Does the US lag in cellular telephony foreshadow continuing lags in the communications area, or is the US lag an anomaly, an historical

accident, on which little prescription for the future should be based? The paper takes the latter course, and recommends further investigation to examine the question.

In the section that follows a brief history of US cellular telephony is provided and the current status of US cellular use is presented in contrast to two important calibration countries, Finland and Japan. This analysis suggests that the US did have a significant advantage in the early development of cellular telephony, but has lost that advantage in recent years. Next, the organizational and institutional context for the US lag in cellular telephony is examined through the story of Ma Bell, the American Telephone and Telegraph Company and its Bell System. The story provides historical context for the rise of Ma Bell's virtual monopoly power in US telephony, and the competency trap that emerged to cause a failure of organizational leadership to see the potential of cellular telephony even though Ma Bell had a significant lead in that technology. The story concludes with the death of Ma Bell through the anti-trust actions of the US Justice Department, and the subsequent loss of institutional agency that would have been required for the US to exploit its lead in cellular telephony. The paper concludes with a discussion of the implications of the analysis.

Cellular Telephony in the US

The US telephone industry invented cellular telephony, and maintained a strong lead in the march to deployment through the late 1970's. As shown in Table 1, the first mobile telephones were deployed in 1946, and between invention and the first effort at deployment in 1978, Ma Bell made a number of attempts to expand on its new technology. However, as shown in Table 2, the US was not the first country to launch commercial cellular telephone service. Japan's Nippon Telephone and Telegraph launched service in 1979, but that service soon failed. More important was the launch in the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden) of the Nordic Mobile Telephone (NMT) service in 1981. The first US services were not launched until 1983.

More important than the launch of these early analog (first generation) services was the subsequent effort to build digital (second generation) services that allowed dramatic expansion of capacity and enabled the huge growth in use of cellular telephony shown in Figure 1. As Figure 1 shows, the use of cellular telephony began to take off aggressively in Finland in the early 1990's, due largely to the deployment of the digital successor to NMT, the Groupe Special Mobile (GSM, now called Global Standard for Mobile) service. While US use of cellular telephony did grow impressively through the 1990's, it was overtaken by Japan in late 1996 and has lagged behind both Finland and Japan since that time.

Ma Bell and Cellular Telephony

It is necessary to examine the historical context of Ma Bell and US telephony to understand how the US gave up its advantage in cellular telephony. Ma Bell grew out of Alexander Graham Bell's patent on the telephone and the AT&T company. AT&T came to dominate the US telephone industry and produced much of the telephone technology used in the rest of the world. The company grew to power through mergers of local operating companies and long distance operations. It became a vertically integrated firm providing research, design, manufacturing and telephone operations. This integrated service provider, the AT&T Bell System, began its evolution toward this unique status by way of an agreement struck in December of 1913. In exchange for AT&T's commitment to pursue the goal of universal US telephone service, the US government agreed to provide AT&T with immunity from anti-trust prosecution (Temin 1987). By 1972, the company was the world's largest private industrial organization as measured by assets and number of employees. It consisted of over 20 Bell Operating

Companies providing local telephone service to most US households. Its manufacturing subsidiary, Western Electric, was the world's largest maker of telephone equipment. The AT&T Long Lines company served as an inter-operator among the operating companies providing domestic and international long-distance telephone service. The renowned Bell Laboratories provided technological leadership.

The AT&T Bell System was virtually, though not technically, a monopoly. More than a thousand independent telephone companies provided modest competition at the local level. However, like the Bell Operating Companies, they were regulated monopolies in their service areas, and did not constitute the kind of competition normally associated with free markets. Moreover, these independent operating companies were for all practical purposes captive of the AT&T Bell system for long distance operations and for leadership in equipment. Other regulated public utilities in electric power and natural gas exerted local or regional monopolistic influence, but none came close to the AT&T Bell System's national monopolistic power. In time the AT&T Bell System had acquired a nickname that expressed love and fear, Ma Bell.

By 1972 Ma Bell was the scientific and engineering leader in the technocratic realm of common carrier communications. It was the undisputed market leader, as well, with products and strategies used throughout much of the Western Hemisphere. Through a combination of technological expertise and deft political behavior, it had come to govern the telephone industry in the United States. In pursuing the mandate of universal service, it had supported artificially low service charges for households by charging high rates for long-distance services used mainly by commercial customers; a market distortion it was permitted to follow for decades. In pursuit of universal service, it had deployed a huge number of public telephones in addition to its business and residential services.

AT&T's top stated priority was not to maximize returns on shareholder equity, but to improve the welfare of the United States through advanced communications technology (Fischer, 1992). To a remarkable degree, the company was allowed to pursue this mission without much interference from the government. The Federal Communications Commission had been given plenary jurisdiction over telephony by the 1934 Communications Act, but the FCC did not focus on telephony. The Bell System managed the technology, while state and local public utility commissions established rates and quality of service. The goal of universal service was a uniting factor among the disparate interests for a number of decades. As long as the telephone system seemed to be operating well, the FCC could concentrate on the complicated and highly political regulation of commercial radio and television.¹ This relative autonomy from routine oversight at the national level would come to play a major role in the story of US cellular telephony in the 1980's and 1990's.

It would be incorrect to credit AT&T with the invention of mobile telephony, *per se*. Mobile telephony emerged over time from the marriage of conventional wire-based telephony and two-way mobile radio. Wire-based telephony began in the late 19th century, and underwent a series of improvements in quality and reliability as well as switching automation. Mobile radio began with one-way (broadcast) police dispatch using amplitude modulation (AM), first deployed in Detroit in 1928. Two-way mobile quickly followed, and was deployed in most U.S. cities during the 1930s. A major breakthrough came in 1935 with the advent of practical frequency modulation (FM) that provided better signal quality in moving vehicles. By 1940, most U.S. police department had switched to the new FM technology (Calhoun 1988). In the process of this evolution, wireless communication came to be seen as a kind of parallel development to the wireline common carrier realm, and the FCC came to regulate these

¹ A high-ranking staff member in the Common Carrier Bureau of the FCC remarked during an interview with one of the authors in 1995, "For an expert organization, the FCC never did know much about telephones. AT&T ran the phone system, and the commissioners went to lunch with the broadcasters."

“radio common carriers.” Among the key radio common carriers was Motorola, which emerged eventually (and remains) a key force in cellular telephony. AT&T remained a powerful force in radio-only mobile communications until, in a 1956 consent decree, it agreed to give up the wireless capability it had developed.

In anticipation of World War II, the U.S. Army contracted with AT&T Bell Labs to evaluate the relative merits of AM and FM. AT&T recommended FM, and the Army adopted the recommendation. AT&T, along with other U.S. radio makers, made thousands of two-way radios during the war, and were ready to extend this experience to the civilian market when the war ended. In St. Louis in 1946, AT&T introduced the world's first commercial mobile telephone service using a single, centrally-located FM transceiver tower for the entire metropolitan area. This design became the prototype for thousands of mobile telephone systems operated in North American and Western European cities for the next 30 years (Young 1979; Calhoun 1988; Garrard 1998). The main problem with such systems was severely limited capacity from the sharing of a single set of radio frequencies across a large area. For example, AT&T's 23-channel service for metropolitan New York was limited to 543 paying customers with a waiting list of 3,700 potential users (Calhoun 1988: 31). In response to such limitations, AT&T Bell Labs scientist D.H. Ring invented the concept of cellular telephony, which used a large number of lower-power FM base stations in “cells” that would pick up and hand-off calls as subscribers passed through the cells. This strategy increased capacity by reusing all frequencies throughout a region. In 1962, AT&T engineers demonstrated a prototype cellular telephone system to FCC officials visiting Bell Labs in Murray Hill, NJ. However, it was nearly 30 years after its invention before the concept was made operational in AMPS (Young 1979).

The question arises as to why this powerful technology was delayed for so long. The answer in part was the tremendous success of Ma Bell's pursuit of the Communications Act of 1934's mandate for universal service — “making available, so far as possible, to all the people of the United States a rapid, efficient, nationwide and worldwide wire and radio communication service with adequate facilities at reasonable charges...” At the time of Cellular Telephony's invention in 1947, Ma Bell controlled 83% of US telephones, 91% of US telephone plant, and 98% of long distance lines (Farley, 2001). It remained steadfastly behind the philosophy of universal service, as well. When the US Congress amended the Rural Electrification Act in 1949 to include long-term, low interest loans to expand telephone service to rural areas, Ma Bell lent direct and indirect support to the many small, independent telephone utilities that served these areas (NTCA, 2001). It would seem logical that the promise of cellular telephony would have figured prominently in the universal service vision due to its ability to provide wide coverage without the capital requirements of wireline service. This was not the case, however. Ma Bell continued to provide non-cellular mobile communication services via manually switched links between radio carsets and the public switched wireline network. This service was intended for a small customer base of commercial clients, and was limited to urban areas where wireline service was already highly developed. Radio-based service was not seen as a solution to reaching rural subscribers, and growth in rural telephone service between 1950 and 1965 was due entirely to rapid expansion of the wireline infrastructure.

The invention of cellular telephony was, like many things in Ma Bell's vast empire, an idiosyncratic development not tied to the core missions of the company. It was seen as a promising means of increasing service to a narrowly defined customer base on the commercial side of the universal service scheme. The commercial side was deliberately charged high fees to provide revenues that would subsidize residential and rural services, and fees could simply be raised whenever demand exceeded supply. There was little thought that mobile telephony would be a special market for the simple reason that telephone service was generally not a market at all. In addition, there were important technical limitations in frequency management and political problems in frequency allocation that had to be overcome (West 2000). It is likely that Ma Bell could have addressed these limitations had it seen

cellular telephony as an important vector of development, but that did not happen. Wireline networks and conventional switching would remain superior until much more sophisticated solutions to problems of network control and high-speed switching were developed, and Ma Bell remained focused on wireline strategies. A foreshadowing of what was to come is seen in the 1956 Consent Decree wherein Ma Bell surrendered its mobile radio opportunities in exchange for continuing anti-trust immunity in wireline service.

In the early 1970's, major breakthroughs began to emerge in technologies that would prove essential to the rise of modern cellular telephony solid state electronics, microprocessors, digital switching, and frequency synthesis. Although Ma Bell's renowned research center, Bell Labs, was a leader in these areas, and the organization was dedicated to applying new technology to the telephone system, there was no sustained focus on cellular telephony as an application objective. Key cellular services began to be deployed between 1972 and 1987, but Ma Bell continued to focus on wireline strategies in pursuit of its core mission. It was during this period when the commercial viability of cellular telephony began to emerge that traditional US competitiveness in new telephone technologies began to wane. The cause was in part the sustained focus of Ma Bell's leadership on its genius in exploitation of wireline technology in pursuit of its universal service mandate. This became a competency trap in which the benefits of a vital innovative strategy are occluded from view by rigid focus on a course of action that has proven right for a long time.

This competency trap is only part of the explanation for the US lag in cellular telephony. The other key component was the coincidental institutional transformation of the entire structure of US telephony through market liberalization. The trend toward liberalization was long emerging, but the changes that affected the US role in cellular telephony directly were triggered by the anti-trust lawsuit brought by the US Justice Department in the late 1970's. That suit that culminated in a consent decree effective January 1, 1984 that brought about the breakup of the legendary AT&T Bell System and the death of Ma Bell that had dominated US telephony for seven decades(Temin 1987).

The Death of Ma Bell and the Fate of Her Orphan

Ma Bell did not abandon cellular telephony in the process of privileging wireline technology. In fact, it continued to develop the technology as a means for improving its specialized wireless telephone services that were always oversubscribed. The result of these efforts was the Advanced Mobile Phone Service, AMPS, which was tested in Chicago in 1978. AMPS was not only a workable system, it was subsequently deployed and operated very successfully. Oddly, however, it was not Ma Bell that deployed AMPS and benefited from its success. Rather, entrepreneurs with little previous background in common carrier communications, and virtually no connection to Ma Bell, were responsible for this. Entrepreneurs such as Craig McCaw were brilliant business innovators, but they did not have the technological or institutional power of Ma Bell, and they could not individually or collectively pursue US leadership in cellular technology or services. By 1987 the US had lost whatever dominance it had in mobile telephone communications. When Ma Bell died, cellular telephony in the United States became an orphan in terms of global leadership.

The death of Ma Bell was due to a profound shift in US social policy that came to a head between 1972 and 1987. This shift stripped the AT&T Bell System of its key defenses against the accusations of those who were disaffected by two long-standing practices. One was the subsidy of local service with high long-distance tariffs which, critics argued, unfairly penalized commercial customers. The cross-subsidy had been a bulwark in the pursuit of universal service, but the universal service mandate was only salient as long as there were major gaps in service. By the mid 1970's virtually anyone who wanted telephone service could get it, rendering the arguments for cross-subsidy weak. The other practice that

outraged competitors was the AT&T Bell System's refusal to allow competitor equipment on the telephone network. This practice was defended by the argument that "foreign attachments" would harm the network and result in service degradation. As technology improved, this argument became less defensible. In the 1968 AT&T lost a lawsuit brought by the Carter Electronics Corporation of Dallas, Texas, that manufactured equipment to allow interconnection of private two-way radios with the telephone system via a base station (Brooks, 1976). Independent companies began connecting their equipment to the AT&T network, and the predicted service degradation did not occur. Regulators began to see equipment competition as beneficial to the consumer – a key defeat in AT&T's efforts to preserve its privileged position (Coll, 1986).

A less widely recognized but very important shift in the Ma Bell's defense of its monopoly status was the weakening of its role in national security (Farley, 2001; c.f. L-Foster, 2001). The AT&T Bell System was a huge asset during WW II and the Cold War, but its role weakened as the rising resistance movement in Eastern Europe signaled a waning of the Cold War and new technologies such as the Defense Advanced Research Projects Agency ARPANet demonstrated that packet-switched communications was a viable alternative to the circuit-switched infrastructure of the Bell System. Although the Reagan Defense Department mounted a spirited objection to the breakup of AT&T in 1981 on grounds of national security, Reagan's Justice Department pursued the anti-trust suit to its end (Temin, 1987; Coy, 1999)..

The ingenuity that went into constructing the AT&T Bell System prepared it for the breakup. US telephony was separated into the regulated local exchange carrier (LEC) structure that included more than 20 companies, and the inter-exchange carrier (IXC) structure that provided long distance service connecting the LECs. The AT&T Bell System LECS were collapsed into seven new Regional Bell Operating Companies (RBOCs), plus the existing independent companies. AT&T Long Lines became just one of the competitive IXCs along with competitors such as MCI and SPRINT. The technical details of the breakup were at times chaotic, with AT&T and RBOC personnel literally drawing lines down the middle of machine rooms to separate the assets of the new companies, but this was accomplished with surprisingly little disruption to telephone service (Tunstall, 1985). When the separation was complete, the RBOCs continued to pursue their long-standing wireline local service business, and the new AT&T entered the competitive arena of long-distance service, computers, information services, and new ventures such as credit card services. AT&T's long-distance services remained grounded in the wireline focus of the old Bell System, augmented by microwave and fiber-optic improvements. The breakup happened so quickly and provided so many daunting challenges that there was little time or energy for speculation about future technologies and markets that might materialize.

The new AT&T did not recognize the potential of the asset it held in AMPS. It fought to keep Bell Labs, which had invented cellular telephony, but it made little effort to keep the cellular business. It allocated the cellular business to the RBOCs in what appears to have been a rather *ad hoc* action rather than a carefully researched decision (Murray 2001: 27; Beckman 2001). This is strange, in retrospect, because the cellular business was exactly the sort of unregulated business the new AT&T had sought in the division of responsibilities with the state-regulated RBOCs. Yet, the leadership of the new AT&T was not alone in failing to recognize the potential of cellular telephony. The major telecom operators in both Europe and Japan at this time assumed that cellular service would serve a small niche of high-income or highly mobile professionals, such as executives or commissioned field sales representatives (Noda, 1996; West, 2000). Moreover, the new AT&T leadership had the long experience of the Bell System in which nearly all households and workplaces were equipped with telephones. By the mid-1980's new services such as calling-cards were rapidly doing away with the inconvenience of placing expensive collect calls or using coins. The critical capacity for "roaming" enabled by cellular telephones, and which has been counted as one of the most important aspects of the success of cellular telephony, was

already provided by the ubiquitous US telephone infrastructure. The leadership of the new AT&T organization simply never saw cellular telephony as a competence they owned and could exploit.

The RBOCs were the inheritors of the opportunity of cellular telephony, but they did not see the potential of AMPS any more clearly than the leadership of the new AT&T did. The individual RBOCs, together with the largest independent operator, General Telephone and Electronics (GTE), split the cellular licenses allocated for the top 30 markets. None of the RBOCs controlled more than four of these metropolitan areas (West 2000). The RBOCs at this point were also becoming fragmented and increasingly competitive with one another. Of all the RBOCs, only Pacific Telesis pursued cellular technology aggressively. Yet, as soon as Pacific Telesis began to see the value in its AMPS operation, it spun wireless off into the new AirTouch company, thereby depriving the parent RBOC of leadership in this field. By the late 1980's the US was the only major industrial country where the incumbent wireline telephone operators did not offer a national wireless network. Ironically, the closest thing to a national cellular telephone network in the U.S. during the late 1980s was provided by a cable TV company.

In 1987, McCaw Communications, a cable TV company, began leveraging \$5 billion in low-grade high-interest corporate debt to acquire licenses and to build cellular networks in the licensed territories (Young, 1998 Corr 2000). This culminated in McCaw's 1990 purchase of control of LIN Broadcasting, making it the largest cellular service provider in the US. In August 1993 McCaw announced its intention to sell its cellular telephone assets to the new AT&T, and thirteen months later did so for \$11.5 billion. AT&T re-entered the cellular telephone industry with considerably less coverage of the US population than it could have had if had embarked on an aggressive cellular telephone business in 1987. AT&T was not alone in missing this opportunity. Among the McCaw licenses were those for six major markets that McCaw purchased in 1985 from MCI, marking MCI's exit from the cellular telephone industry. Similarly, Sprint, the third largest IXC, sold its cellular licenses to Centel in 1988. Sprint merged with Centel 1992 and in 1996 spun off its old licenses to bid for new PCS licenses.

The US cellular industry did not fail after the death of Ma Bell. Cellular service was provided, and eventually US penetration rates in use of cellular phones approached those of the rest of the developed world. Nevertheless, cellular development in the US was a helter-skelter affair compared to the logical and deliberate innovation roll-outs that had characterized most of Ma Bell's history. Whatever criticism one might level against Ma Bell's slow response to innovation, Ma Bell was very competent in bringing innovations to high levels of use and substitution. Indeed, at the time of the break up, the pro-cellular community within Ma Bell was preparing for roll-out of a nation-wide AMPS service based in Chicago. It is impossible to know now what would have happened if the breakup had not occurred and the AMPS roll-out had proceeded according to plan. As it happened, the US at least suffered a serious lag in this area of innovation compared to other industrialized countries, and especially in comparison to those of Northern Europe.

The lag continues and is likely to continue for some time. US companies have not been aggressive in promoting US technology in the emerging third generation standards.² Britain's Vodaphone bought AirTouch in 1999, abandoned AirTouch's second generation technology, and is building the new AirTouch's third generation standard around the Vodaphone GSM standard. Japan's NTT DoCoMo bought a stake of AT&T Wireless in January of 2001, and is using it to promote DoCoMo's i-mode and W-CDMA standards in the U.S. Motorola and Lucent (the old Bell Labs), two firms that helped create the U.S. cellular industry, no longer lead in network equipment sales, even in their home market. There is open speculation over whether Lucent can survive as a company, and Motorola has seen its once

² The conflict between W-CDMA and cdma2000, including the economic incentives of the partisans of both sides, is beyond the scope of this paper.

dominant global position in cellular handset sales disappear as its market share dropped threefold in only four years.

Explaining the US Lag in Cellular Telephony

In the mid-1970s, the United States had all the technological prerequisites for leading the cellular telephone industry. This lead evaporated, and technological leadership was abdicated to Japan and European countries where cellular diffusion and service innovation became far more successful. One possible explanation for this turnaround is superior technological prowess in Europe and Japan. This is not convincing because the technology required to bring cellular telephony to market was widely available and understood in the period between 1972 and 1987. Indeed, the US held the advantage in many key technologies, and under this explanation, was most likely to prevail. The US advantage was to a significant degree “locked up” in the AT&T Bell System, however, and thus was constrained by the strategic decisions of the AT&T leadership. Similarly, it can be suggested that important elements of the national systems of innovation in Europe and Japan, such as the Nordic traditions of cooperation and the “Japan, Incorporated” strategy of technological development, provided special advantage. This explanation is weak, though, because the long history of AT&T Bell System leadership in telephony is evidence that the US national system of innovation was working well. It seems likely that the instance of the US lag in cellular telephony is an anomaly, explained by factors that were critical during an unusual period of rapid technological and institutional change.

The turnaround in US fortunes in cellular telephony are best explained as the result of a competency trap that made it difficult for the leadership of the AT&T Bell System to recognize the significance of its own cellular telephone invention, followed by a failure of necessary institutional agency resulting from the fragmentation of essential authority to guide US cellular development after Ma Bell died.

A Competency Trap

Under the leadership of Ma Bell the US had achieved its goal of universal telephone service. It had created a ubiquitous infrastructure of wireline telephone service throughout the U.S., and had contributed greatly to expansion of service in North America and much of the Western Hemisphere. Ma Bell had evolved into a skilled provider of a particular kind of telephone service, in response to a particular mandate. The annals of AT&T’s history are replete with accounts of the strong, self-perpetuating “Bell System” culture that governed the organization and its thinking (Feldman 1986; Kraus and Duerig 1988;).

Strangely, this culture created a competency trap that made it almost impossible for Ma Bell to change course quickly toward a new form of telephone service. A competency trap occurs when outstanding performance with a no longer superior strategy or process creates a vicious cycle of adherence to proven ways and denial of evidence to support a change in the viability of those ways (Fiol and Lyles, 1985; Levitt and March 1988; Levinthal and March, 1993). This leads to complacency on a number of fronts. In the case of Ma Bell, it resulted in a late awakening to the growing weakness of its traditionally successful defenses of its special status as a powerful monopoly. The result was drastic change in the form of the anti-trust lawsuit and the eventual breakup of Ma Bell. The issue was less that Ma Bell’s game-winning strategies were less effective than that the game itself was changing and old strategies were no longer salient. In addition to problems generated by the competency trap regarding business strategy, Ma Bell also suffered from the tendency of companies caught in competency traps to fail to respond to transforming technological innovations (Foster 1986). This is particularly ironic, given that the transforming technology was within Ma Bell’s own family from the start.

It should be emphasized that Ma Bell did not fail altogether to recognize the potential of wireless communications. It did recognize cellular technology as a promising solution to meeting the needs of a narrowly defined community of mobile telephone users, and it acted on that recognition in a slow, deliberate Ma Bell manner (Noda, 1996). The competency trap was in the failure of Ma Bell's leadership to recognize early the gravity of the impending breakup and the possibility that an entirely new future under the new AT&T, the RBOCs, or both, might be found in cellular telephony.

A Failure of Institutional Agency

Competency traps caused Ma Bell's failure to see the potential in cellular telephony, but this alone did not cause the US lag. Rather, Ma Bell's death brought about a failure in the institutional agency required to mobilize and deploy cellular telephony at the scale required to incentivize ongoing investment in technological and service leadership. The concept of institutional agency is an extension of agency theory from the realm of individual actors and firms to the broader social level of constituent and formal organizations whose purpose is to transcend and guide the trajectories of other social interests and organizations (King, *et al.*, 1994). The deliberate and sustained intervention of one or more institutions is usually required to guide standard setting and other tasks that provide an overarching framework for future innovation. Without sufficient agency power at the institutional level to channel the disparate interests of a pluralistic group of self-interested competitors it can be difficult or even impossible to secure the cooperation required to prove the value of an innovation in technology or services.

Many different factors had to come into alignment to enable the success of analog 1st generation cellular telephony, which in turn would stimulate investment in the digital 2nd generation technology that eventually unleashed the potential of the cellular market. Telephony had always required powerful institutional agency to establish signaling standards, consistent addressing, vesting of legal authority for rights of way for transmission lines, the structuring of local service monopolies, and so on (Andeen and King, 1998). In addition, special needs accompanied cellular telephony's evolution, especially related to allocation of radio spectrum and alignment of the new, comparatively unregulated cellular services with the older, regulated wireline services with which they must interoperate (West 2000).

Ma Bell provided extraordinarily effective institutional agency for decades as the wireline telephone system moved from manual operations to electromechanical switching, number plan area creation for direct dialing, the creation of world zones for international direct dialing, variable payment schemes for calling such as toll-free long distance, and a host of other innovations. It had even provided sufficient institutional agency to organize and gain permission for a test of its cellular telephony technology in Chicago, and was planning to take the steps necessary to roll out cellular service nationally. This institutional agency even persisted for a time after the breakup as both AT&T and the RBOCs kept the existing system going and implemented the new digital switching system, Signaling System 7, that is now the backbone of US telephony (Andeen and King, 1998).

It is conceivable that either the AT&T or the RBOCs (or both) could have shepherded the new cellular telephony after the breakup. In fact, this would have been a prerequisite for the scenario presented earlier, wherein AT&T and/or the RBOCs seized on wireless as a post-breakup redeemer. Both had the necessary technological capability, institutional expertise, and political influence to succeed in this. But, blinded by Ma Bell's competency trap, they did not see the opportunity or the need to do so. AT&T ceded cellular to the RBOCs, and the RBOCs ceded it to entrepreneurs like McCaw. As prescient and bold as those entrepreneurs were, they did not have the institutional agency of Ma Bell or her residual parts. The entrepreneurs inherited the entitlement of cellular telephony, but they did not inherit the means to realize its promise in the required move from first generation analog technology to second generation digital technology. That critical move was made first by the Nordic countries in partnership with the larger European community, and the US has lagged ever since.

Conclusion

The arguments made above are not intended to provide a complete assessment of the mechanisms by which the US lost its lead in cellular telephony. Rather, the intent is to provide a plausible starting point for such an assessment that breaks away from explanations grounded solely in tales of entrepreneurial initiative and failures in strategic thinking. The leadership of Ma Bell failed to see the potential of cellular telephony, but so did everyone else at the time the break-up of the AT&T Bell System began. Had Ma Bell remained intact, it is possible that the US lead would not have been surrendered. However, Ma Bell did not survive, and that is the fact on which the larger story of the US lag in cellular telephony turns.

Ma Bell grew to power as the result of a fundamental social contract that granted an immensely successful private monopoly in exchange for unwavering dedication to the goal of universal service and technical excellence in telephony. Ma Bell's quest for universal service pursued wireline telephony, and that strategy worked. Cellular technology never played a part in that vital mandate, and thus never made it to the center of Ma Bell's sense of institutional identity. Quite by accident, this long-standing social contract was rewritten at a vital moment in the technical evolution modern cellular telephony. A competency trap made it difficult for the leadership of Ma Bell to see the importance of a technology it had invented and was preparing to roll out in a nationwide service network. After the break-up, neither the new AT&T or the Regional Bell Operating Companies recognized the promise of cellular technology.

In the mean time, equipment manufacturers and telecom operators in the Nordic countries began to grasp the potential of cellular telephony through the success of the NMT analog standards. This stimulated the drive to create the digital GSM standard. Like Ma Bell, they were initially hampered by a wireline competency trap, but they did not suffer the wrenching dislocations the US industry suffered during the breakup of Ma Bell. As the new competitors gained experience with wireless services, they were able to leverage their institutional agency to capitalize on their positions. They became global leaders in a vital new industry, while the US lagged behind.

It can be tempting to conclude that the US lag in cellular telephony signals a general weakness in US ability to lead in global telecommunications. This conclusion seems unwarranted for several reasons. The first and most obvious is the fact that the US is far from lagging in consumption of cellular service. Although the lead in production of cellular equipment and development of cellular services now rests elsewhere, the enthusiasm of the US market for wireless communication (indeed, all kinds of communication) is strong. The US market provides real incentives for US-based firms to compete aggressively with competitors from abroad. In addition, the US has been aggressive in pursuit of alternative technologies for wireless communication that might prove in time to be important or even dominant. The TDMA-based GSM standard is being challenged in some international markets by the US-created CDMA standard, and other areas of technological competition are emerging. The US might be lagging now, but the race is far from done.

It is also important to recognize that the US has been a leader in other areas of communications innovation. One of these is in satellite telephony, with the creation of both Iridium and Globalstar low-earth orbit satellite systems. These have not fared as well as hoped, and their problems could be taken as a sign of US miscalculation, but at least they demonstrate that the US communications industry is far from risk-averse when it comes to bold new technological strategies. It is also likely that the US lead in space-based communications capabilities will eventually bear fruit in ways not foreseen now, just as cellular communications did. The US Navstar system of military satellites opened the realm of pinpoint geographic positioning, and GPS technology is now being embedded in all kinds of technologies, including cellular telephones. The commercial potential for this system was only vaguely recognized

when the Navstar satellites were developed and deployed, but in the past few years a whole new industry has emerged based on this infrastructure.

Beyond space-based communications, the US is leading in internet infrastructure. This is important because of the widespread expectation that voice communications will eventually move toward use of the internet protocol. The US will not hold a monopoly on voice-over-IP, but it will be an aggressive player. More broadly, the US is among the leaders in the area of “convergence” of information processing and communications. It is far too early to see the full implications of this notion, but the surprising advances of the past twenty years caution against assuming the resilience of the *status quo*.

The last reason to avoid writing off the US communications industry is the fact that the major factor behind the US lag in cellular telephony – the death of Ma Bell – was itself an important innovation. The innovation was not technical, but rather institutional. The United States was an early leader in deregulating telephony, and this trend has been followed in some measure by nearly all industrial nations. This was uncharted territory when the US entered it, and not surprisingly, the consequences of deregulation were impossible to foresee accurately. The results are promising, and the willingness of the US to innovate institutionally is likely to be a major asset in the future.

<u>Date</u>	<u>Action</u>
1946	AT&T introduces first mobile telephone system in St. Louis
1947	Bell Labs scientist D.H Ring invents concept of cellular system
1962	AT&T demonstrates for FCC a test UHF cellular system in Murray Hill, NJ
1964	AT&T introduces non-cellular Improved Mobile Telephone Service (IMTS)
1971	AT&T, RCA and Motorola file proposals to use 800 MHz band for cellular mobile telephone systems
1975	Illinois Bell applies for permission to build Chicago cellular AMPS development system
1977	FCC authorizes Illinois Bell’s Chicago AMPS development system
1978	Illinois Bell begins equipment test phase of prototype AMPS system
1982	AT&T and Justice Department sign consent decree leading to AT&T divestiture
1983	FCC grants first commercial cellular licenses; Ameritech Mobile Communications (an AT&T subsidiary) launches the nation’s first commercial cellular system in Chicago
1984	Seven “Baby Bell” operating companies divested from AT&T

Table 1: Key dates in U.S. mobile telephone industry

Country	System	Field Test	Market Trial	Launch
U.S. (AT&T)	AMPS	mid-70s (unlicensed) 1978 (licensed)	1980-83	10/83
U.S. (Motorola)	DynaTAC	1973 (unlicensed) 1979 (licensed)	1981-83	12/83
Northern Europe	NMT	1977-78	1981	10/81
Japan	NTT	1975-78		12/79

Table 2: Launch of first-generation cellular systems

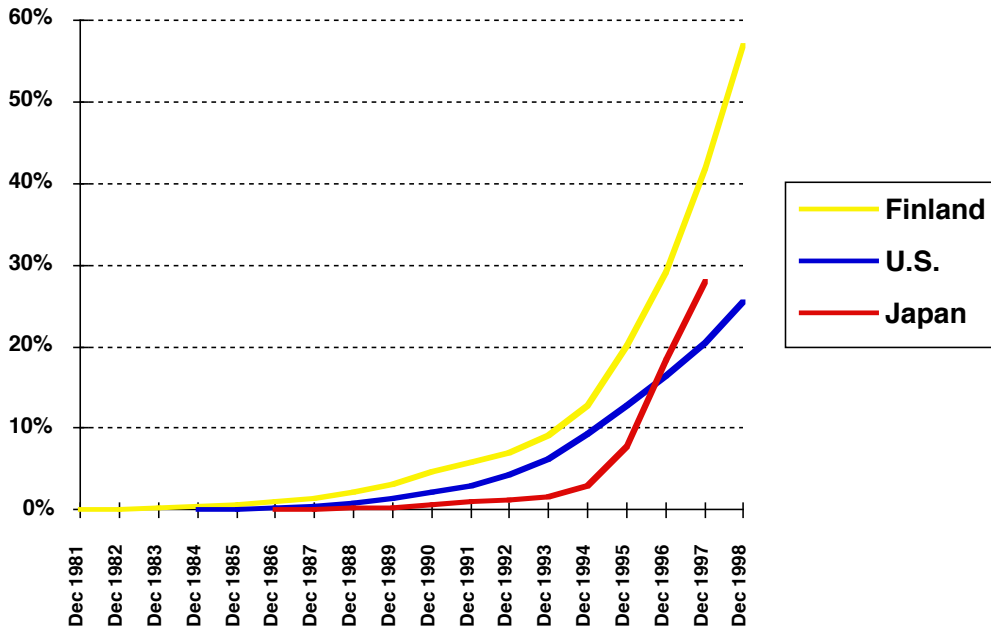


Figure 1: Cellular telephone penetration rates, selected countries

References

- Andeen, Ashley and King, John L. "Addressing and the Future of Communications Competition." *Information Infrastructure and Policy* 6, 1 (1998): 17-46
- Beckman, Kristen, "Breaking Ma Bell," *RCR Wireless News*, February 12, 2001, <http://www.rcrnews.com/news.php3?id=14201>
- Brooks, John. *Telephone: The First Hundred Years*. New York: Harper & Row, 1976.
- Calhoun, George. *Digital cellular radio*. Norwood, Mass: Artech House, 1988.
- Coll, Steve. *The Deal of the Century: The Breakup of AT&T*. New York: Atheneum, 1986
- Corr, O. Casey, *Money from Thin Air: The Story of Craig McCaw*, New York: Crown Business, 2000.
- Coy, Peter, "Commentary: The Lessons of the AT&T Breakup," *Business Week*, (Nov. 22, 1999): 50, http://businessweek.com/1999/99_47/b3656010.htm
- DQWeek, "The US Wireless Lag," January 5, 2001, <http://www.dqweek.com/content/Columns/101010502.asp>
- Farley, Tom, "Telephone History Series," 2001, <http://www.privateline.com/TelephoneHistory/History1.htm>
- FCC Official. Interview with John L. King and Ashley Andeen, May 1995, name withheld on request.

- Feldman, Steven P., *The Culture of Monopoly Management: An Interpretive Study in an American Utility*, New York: Garland Publishing, 1986.
- Fiol, C. Marlene and Marjorie A. Lyles, "Organizational Learning," *Academy of Management Review* 10, 4 (Oct. 1985): 803-813.
- Fischer, Claude S., *America Calling: A Social History of the Telephone to 1940*, Berkeley, CA: University of California Press, 1992.
- Foster, Mark, "L C XR," undated (accessed August 2001), <http://www1.shore.net/~mfoster/LCXR.htm>
- Foster, Richard N., *Innovation: The Attacker's Advantage*. New York: Summit, 1986.
- Funk, Jeffrey L., "Competition between regional standards and the success and failure of firms in the world-wide mobile communication market," *Telecommunications Policy* 22, 4-5 (May/June 1998): 419-441.
- Garrard, Garry A.. *Cellular communications: Worldwide market developments*. Norwood, MA: Artech Hous, 1998.
- King, John L., Vijay Gurbaxani, Kenneth L. Kraemer, F. Warren McFarlan, K.S. Raman, and Chee-Sing Yap, "Institutional Factors in Information Technology Innovation," *Information Systems Research* 5, 2 (June 1994): 139-169.
- Kraus, Constantine Raymond and Alfred W. Duerig, *The rape of Ma Bell: the criminal wrecking of the best telephone system in the world*. Secaucus, N.J.: Lyle Stuart, 1988.
- Levinthal, Daniel A. and James G. March, "The myopia of learning," *Strategic Management Journal* 14 (Winter 1993): 95-112.
- Levitt, Barbara, and James G. March "Organizational learning," *Annual Review of Sociology*. 14 (1988): 319-340.
- Murray, James B., Jr., *Wireless Nation: The Frenzied Launch of the Cellular Revolution*, New York: Perseus, 2001.
- Noda, Tomoyoshi, *Intraorganizational strategy process and the evolution of intra -industry firm diversity: a comparative study of wireless communications business development in the seven Bell regional holding companies*, unpublished D.B.A. dissertation, Harvard University, Graduate School of Business Administration, 1996.
- NTCA, "History of Rural Telecommunications," National Telephone Cooperative Association, 2001, <http://www.ntca.org/about/history/index.html>
- Stone, Martha L. "U.S. Cell Phone Technology Lags Japan, Europe: Advanced Wireless Applications Several Years Away," *E&P Online*, June 7, 2000, <http://www.mediainfo.com/ephone/news/newshtm/stories/060700n2.htm>
- Temin, Peter, *The Fall of the Bell System*, Cambridge, Cambridge University Press, 1987.
- Tunstall, W. Brooke, *Disconnecting Parties: Managing the Bell System Break-Up: An Inside View*, New York: McGraw-Hill, 1985.
- West, Joel , "Institutional Constraints in the Initial Deployment of Cellular Telephone Service on Three Continents." In Kai Jakobs (Ed.), *Information Technology Standards and Standardization: A Global Perspective*. Philadelphia: Idea Group Publishing (2000).
- Young, Jeffrey S., "Craig McCaw — The Wireless Wizard of Oz." *Forbes.com*, June 22, 1998, <http://www.forbes.com/1998/06/22/feat.html>.
- Young, W.R. "Advanced Mobile Phone Service: Introduction, background, and objectives," *Bell System Technical Journal*, 58, 1 (Jan. 1979): 1-14.