

THE CONTINUED EVOLUTION OF TELECOMMUNICATIONS NETWORKS

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ABSTRACT

An earlier paper described the ways in which recent advances in technology have impacted the way that telecommunications services can be offered [1]. This was shown to radically alter how the defense and intelligence communities must deal with telecommunications systems, as both a target and as an enabling force. This paper revisits those observations in light of financial meltdown which occurred in the capital marketplace in 2000 and 2001, examining which players remain and how they are likely to act. Their approach will define the telecommunications “playing field” for the next ten years.

1. INTRODUCTION

The divestiture of the Bell System in 1984 was the result of the belief within the US government that even though telephone service was very good in the US, customers were paying more than they needed to and that technology was not being advanced as fast as it could be. The divestiture was considered successful within political circles since it led to lower prices for long distance service and the emergence of many new competitors in the field. This encouraged the government to take the next step, permitting competition with the remaining portions of the monopoly, the Bell operating companies. The method by which this change was to be brought about was the Telecommunications Act of 1996. The passage of this act brought forth an avalanche of financial investment in companies meant to compete with the Bell companies and the technology believed to be necessary to do it. This investment was a key part of the stock market boom in 1998 and 1999. Conversely, the successful resistance of the Bell companies to this onslaught of new competition was a principal cause of the market’s precipitous decline in 2000.

In this paper we examine the implications of these events to the expected design and implementation of telecommunications networks over the next ten years. We

begin by reviewing the technological situation as seen in 1999 and then we examine the first-order effects of the failure of the Telecom Act of 1996 [1]. From this we can identify the key issues going forward into the next decade and, from them, the implications to our defense and intelligence communities.

2. REVIEW OF THE WORLD IN 1999

An earlier paper identified a series of technical developments and business trends that evolved through the 1990s and significantly changed the way that telecommunications networks are now designed and operated [1]. Before proceeding we will first review some of the most important ones.

- The “Death of Distance” – An optical fiber can carry more than 1000 times as much data per second today than it could in 1990. This rapid improvement in fiber optic transmission systems led to the demise of long-haul microwave radio relay systems and has permitted the use of highly effective schemes for increasing network reliability (e.g., redundant rings) and for routing calls as if distance doesn’t matter. As the improvement continues it will radically change how networks are designed, leading to the use of more transmission and less switching and routing.
- Fractionation of the monolithic telephone companies – Until 1984 it was standard practice that a telephone company (or, in other countries, the governmental telephone authority) built, owned, and operated all of the physical facilities comprising the network and its terminals. The original divestiture in the US permitted competition in the long distance telephone market. The projected expense of building complete networks proved daunting to the new competitors and they looked for ways to avoid as many of the required capital outlays as possible. This market opportunity, plus the appearance on the market of high-quality fiber optic transmission equipment, brought the creation of companies who were willing to operate as wholesalers (in this case, of bandwidth) instead of providing the full spectrum of tele-

communications equipment or services. These wholesalers (e.g., Williams Telecommunications) provided specific services to the “retailers,” the new long distance companies such as Sprint and MCI. The realization that a “retail” telephone system could be assembled out of services provided by a variety of behind-the-scenes wholesalers brought many new retailers into the marketplace, forcing the older companies to cut costs any way they could. In many cases the wholesalers could offer services (such as fiber optic transmission) cheaper than the incumbent could, since the wholesaler’s system was newer and used more modern equipment. Thus both the newer and older companies quickly embraced the use of cheaper “wholesale” services in order to effectively compete.

- Decline of the PTTs/Rise of the RPOAs – Until 1984, virtually all of the telephone systems in the world were operated by business monopolies. In most countries this monopoly was the government’s “post, telephone, and telegraph” (PTT). Where the monopoly was private, as in the case of the Bell System in the US, it was known internationally as a “recognized (by the international telephone community) private operating authority (RPOA).”

Since 1990 more and more countries are privatizing their PTTs and permitting competition between companies within their countries. The motivation for this is the sequential realizations that (1) modern telecommunications systems are required to achieve economic growth within a country and (2) that the capital expenditures required to modernize those systems exceed the ability and/or willingness of those governments. As a result, there is a clear trend toward the privatization of telecommunications services both within countries and in the international services that connect them.

In 1999 it was concluded in that these technical and policy trends would conspire to radically change how telecommunications networks would be designed and operated [1]. While there will still be exceptions (in countries where the royal family owns the PTT, for example) the trend is clearly toward the existence of many separate networks within each country and several privately-owned international networks available to connect each national network to any other. Upon deeper examination, however, it will be found that the networks themselves are not monolithic, but are often comprised of portions leased from “wholesalers.” The tendency for transmission technology to improve faster than switching and routing technology will continue to force changes in the technical design of the networks themselves.

Independent of whether the defense community wants to use telecommunications services or exploit them, it is clear that the trends of the 1990s are changing the nature of the business. Companies, not countries, will be operating national and international communications systems,

and those systems will be built differently than they were in the twentieth century.

3. SINCE THEN – THE WIND LEAVES THE SAILS

The precipitous decline in the US equity market during the last half of 2000 can be traced to two related issues – the collapse of the “dot-coms” and the somewhat slower, but more important, withering of the “competitive service providers,” those companies built to compete with the Bell operating companies. The collapse of the dot-coms was predictable. It was only a matter of time until investors’ fascination with the Internet wore off and the more classical examination for a valid business model and a search for profits would begin. Failing to find either (in most cases), venture capital investment stopped and the dot-coms died when their remaining funds were exhausted.

The second cause was harder to see coming, however (except to the true cynics). The US’s policy was to encourage the creation of alternatives to the Bell operating companies and to protect them until they flourished and could defend themselves against the monopolies. With this offer of protection, a large number of competitive providers were funded by venture capitalists (and the large equipment vendors). The various companies spanned the space of voice and data services, providing local, long-distance, DSL, and wireless connectivity to businesses and homes.

In fact, the Telecom Act of 1996 was not enforced and failed to produce real competition. The Bell operating companies used the courts and regulatory organizations to resist providing the access that the competitive providers needed to reach their customers. The carrot that the Bell operating companies were offered to “play ball,” entry into the interstate long distance business, was given before they had provided the local access that they were required under law to give. In this environment the competitive companies could not meet their sales objectives and ultimately were unable to continue to attract the capital that they needed to maintain and extend their networks.

This victory by the Bell operating companies has a variety of immediate business implications which are listed below. The technical implications are discussed in the next section.

- One of the most surprising effects of the failure of this national effort to bring local competition was the financial impact it had on the companies that provided equipment to the new providers. It was clear that the failure of the new companies to flourish would lead to a reduction in future sales by the equipment providers, but what wasn’t clear was the degree to which the equipment providers had bet on the success of competition by extending very favorable credit terms to the new companies. By agreeing in effect to become their bankers, the equipment providers were hurt badly when the companies began to fail. The corporate valuations of Nortel

and Cisco are currently 30% of what they were in mid-2000, and the very continued existence of Lucent is currently in question.

- More than a dozen new national fiber optic networks were built in the US in the past three years and an equal number of transoceanic fiber systems are in construction. As a result there is a significant oversupply of transport. By some estimates only 3% of the fiber bandwidth in the US is in use, the rest being “dark” or simply not fully “built out.” This oversupply will clearly reduce the price of bandwidth, both nationally and internationally. It can be expected to (1) help the retailers, (2) hurt the fiber “wholesalers,” and (3) continue the encouragement of network architectures which trade bandwidth and distance for the cost of switching and routing.
- There has been a distinct pause in the drive to deploy third-generation (3G) cellular services. This pause (of uncertain duration) has at least three root causes. Cellular operators throughout the world are still in debt because of the massive investments they made to move to or create second-generation systems such as GSM and CDMA. They are not eager to continue their investment into the third generation until they see a clear market for the data services that it would provide. They currently don’t see the “killer app” that will cause sufficient customer demand to justify the expenditures. Secondly, the distressed financial condition of the telecommunications equipment providers, as mentioned above, has made them less willing to act as the banker for 3G systems. The third factor is the behavior of many governments who have seen the auction of bandwidth for the 3G systems as a delightful alternative to public taxation. The spectrum prices exacted at some of the European auctions will place the companies that “won” them in financial distress for years.

4. KEY ISSUES GOING FORWARD

In short we see that the wind has come out of the sails of the telecommunications business since 1999. In the US the Empire has struck back, leaving the Bell operating companies in control of the local voice and data delivery business. The long distance market will become even more competitive as the Bell operating companies enter that business as well. Privatization will continue in other countries, but without the massive financial backing that would have been expected several years ago. The average investor is leery of telecommunications ventures, the big equipment vendors are less able to finance their customers, and the surviving service providers are eager to slow down a bit so that they can make a profit.

How then can we expect the business to evolve over the next decade?

- Commoditization of voice as a business – The incredible advances in the data-carrying capabilities of optic fiber transmission systems, coupled with the oversupply pro-

duced by the recent network construction binge, will drive down the cost of bandwidth, and with it the price of fixed-bandwidth services. An important example of this is the impact on the delivery of 64-kb/s voice services. The cost of a voice call is falling with every year. It is already below the level where it is cost-effective to bill for each long-distance call within the US. The foreseeable impact of this trend is that long distance voice service will be billed as a subscription rather than toll service and will commonly be bundled “at no charge” with other telecommunications services such as local wired or wireless access. The access vendor (e.g., AT&T Wireless or Southwestern Bell) will come to “own” the long-distance user, and will become the retailer for that service. This trend will put even more pressure on the national long-distance suppliers, forcing them into the wholesale business and reducing their retail opportunities.

- Use of voice recognition – Three facts will combine to make voice recognition grow in importance over the next decade – (1) the dramatic improvement in the quality of speaker-independent, limited-vocabulary speech recognition, (2) the growing complexity and variety of the services that wired and wireless operators would like to provide, and (3) the ability to make terminal devices ever smaller, making pushbuttons an ever more problematic way of controlling the voice or data session.

The general use of voice recognition for session control will again change the topology of the networks that use it, either forcing the computational resources needed for it out to the terminal devices themselves, or by creating voice pathways to the servers which provide the required recognition services. Either will have a significant effect on the signaling by which the various parts of the network are controlled.

- Fiber to the edge – The core of the US network(s) is currently rich in bandwidth (with most of it unused) while the “last/first mile” of the network is limited for most people to 50 kb/s or less. This will create the demand to open up this constriction and the usual approach can be expected to be the extension of fiber to as close to the terminal devices as is economically feasible. There are three ways in which this will be done. (Some are already in use for a very few users.)

Depending on the density of users and the broadband services they desire, fiber will extend from the central office to (1) a radio distribution hub (e.g., MMDS), (2) to a coaxial cable hub (e.g., CATV), or (3) to the premises itself. Once to the premises, the digital signals carried by the transmission systems will almost certainly be accepted by a router and then distributed to the various entertainment and communications devices over a very-short-range wireless system.

- The killer app and its implications – The rate at which fiber moves toward actual contact with the premises will depend on which telecommunications service emerges

as “the killer app.” This service is very unlikely to be voice transmission, simple teleconferencing, or distribution of music services simply because the bandwidth that they require isn’t enough to justify the investments needed. The killer app will most likely be some form of entertainment, and in particular will probably be 3-dimensional, high-definition movies and sports events. Providing these types of service “on-demand” will require the ability to provide roughly 100 Mb/s to each and every user at the same time. Depending on how this is implemented, it could require all of the existing unused bandwidth and then the construction of 100 times more. And that’s just for the US!

The killer app will drive how the networks of the future are designed. Voice service was the killer app from 1880 until recently, and “leased line” services for data networks will be that application for the network for the next few years. After that – if depends on the next big application.

- Packetization – Yes, for everything.
- Who can survive financially? – The growth of networks will continue, both in the US and in the rest of the world, but not at the pace seen over the past five years. Financing will be available, but provided more carefully, and vendors will be there to provide equipment, but with less exuberance. New technology will be slower in coming forward owing to reduced R&D by the established vendors and less financial incentive seen by entrepreneurs. Once developed, the service providers will not apply the new technology unless they see a clear market advantage in doing so. To the degree that they can establish or re-establish monopoly positions, they will see this advantage in fewer and fewer cases.

The traditional suppliers of long-distance service will be driven from the marketplace as their margins

erode and the access providers gain control of their customers.

- What role will wireless have? – The marketplace for “go-anywhere” medium bandwidth digital cellular service (a.k.a. 3G service) is still unclear. The bandwidth available with these services will prove to be inadequate to satisfy the desires that mobile users have for either web-based or entertainment services. Wireless services can be expected to evolve into three important marketplaces – (1) distribution of high-bandwidth signals over distances of up to a mile in locations where direct fiber access is not economically feasible, (2) short-range (< 100 feet) distribution of multi-user high-bandwidth services within a premises, and (3) very-short range, very-high-bandwidth “fourth-generation” (4G) services.

5.0 IMPLICATIONS TO THE COMMUNITY

We conclude by summarizing the trends discussed above.

- There will be more telecommunications services available – each less secure and less reliable.
- There will be more equipment vendors in the marketplace – each more shaky financially and less inclined to do R&D.
- There will be less barrier to entry – but it will be harder to make money.
- There will be less investment in fiber (or wireless) technology – for fear that no one will buy it.

6.0 REFERENCES

1. John Treichler, “The Future of Telephone Networks,” Proceedings of the 2nd Biannual Conference of Defense and Science Applications, 23-25 August, 1999, Starved Rock, Illinois, USA.