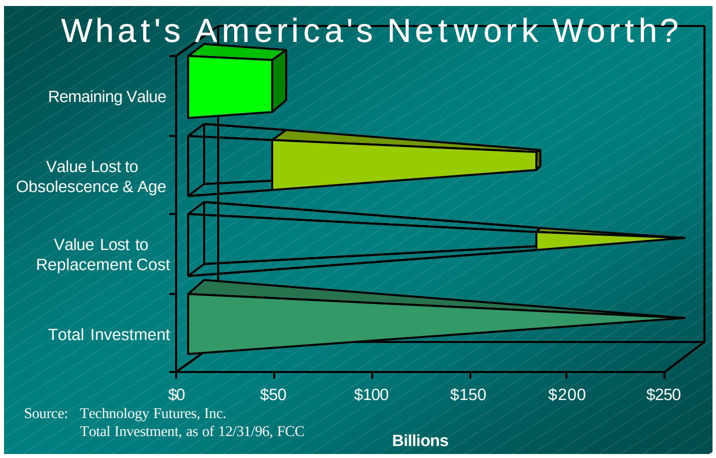
America'$ Network:

How Much Is It Worth?

Issued: 1998

Until recently, the modernization of the America's Public Switched Telecommunications Network (PSTN) was driven by the economics of providing plain old telephone service (POTS). Today, however, the public network is facing the most extensive transformation since voice telephony was introduced over 100 years ago. Rapid advances in technology, the global use of the Internet, deregulation, competition, and the integration of computers and communications into all facets of business and society are taxing its capabilities. Consequently, the public network is undergoing unprecedented technological obsolescence and a corresponding loss in economic value.



For nearly fifteen years, the author has been assessing the pace of technological changes in the telecommunications industry. The accumulation of his research along with input from other industry expert and in cooperation with several local-exchange and long-distance carriers in the U.S., the author assesses the effect that obsolescence is having on the economic lives and remaining economic value of network technologies; which is the focus of this report are the focus of this Report.

ASSESSING LOSS IN VALUE

The primary drivers affecting the value of the PSTN are *Technological Obsolescence, Traditional Mortality and Replacement Cost*. Technological obsolescence is the focus of this paper, however, a brief description of traditional mortality and replacement cost is needed.

Traditional Mortality refers to the loss in an assets value due to the forces of the elements. Wear and tear through usage, deterioration with age, and chance destruction are the principle drivers of traditional mortality.

Replacement Cost New (RCN) refers to the current cost to replace an asset. For example, if you purchased a typical PC 3 years ago; and a typical PC today costs half of what you originally paid, then obviously your PC would not be worth any more than half your original cost. The loss due to the RCN is said to be 50%.

Unless otherwise noted, the values cited in the remainder of this paper reflect loss in value due to technological obsolescence and traditional mortality; and do <u>not</u> include changes in value due to the RCN. While the RCN varies from technology to technology, on average, the loss in value due to RCN is about 30% for the PSTN infrastructure as a whole.

MARKET DEMAND AND CONSUMER EXPECTATIONS

Demand for higher-speed, reliable, and intelligent data communication services is growing exponentially. With the explosion of the Internet, demand for high-speed data services, once the exclusive domain of large-businesses, is rapidly spreading to the consumer market as well. A few short years ago, very few US households had access to the Internet (see figure). Today, approximately 25% of US households access the Internet, and by 2005 the percentage may grow to as high as 80%. In recent years, the Internet has doubled in size every 100 days.

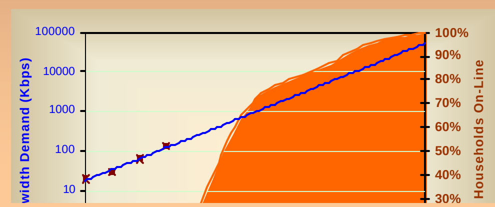
As Internet adoption grows, consumers demand faster and faster Internet access. In 1990, 12 Kbps modems were the latest technology. Today, 56 Kbps analog modems are standard; and high-end consumers are opting for higher-speed digital modems, such as ISDN, ADSL and Cable Modems. Current technology advancements suggest that the growth in consumer expectation for bandwidth, consistent for over 15 years, is poised to accelerate.

Quite simply, the old, analog copper-based PSTN can not keep pace with consumer demands. To meet ever-increasing consumer expectations, carriers must continuously add capacity and modernize their networks. This will fuel the already rapid pace of technological obsolescence.

Consumer Expectations

Bandwidth Demand & Market Size

Consumer expectations for bandwidth to the home has been growing steadily and exponentially for 15 years. If this trend continues, high-end residential consumers will expect 10 Mbps by 2010 and 50 to 100 Mbps by 2015.



Competition

Competition and deregulation within the telecommunications industry is also contributing to the rapid obsolescence of the PSTN. While many see the public network as dominated by local telephone companies, local competition is very strong and growing. Companies like AT&T, MCI, Sprint, Qwest, Teleport, WorldCom, and others are offering digital end-to-end fiber-based alternatives to the Local Exchange Carrier's (LEC) local loop.

WorldCom, soon to merge with MCI, provides a good illustration of growing local loop competition. Once this mega-merger is complete, WorldCom will be the second largest long-distance carrier in the U.S., the largest Internet service provider in the world, the second largest carrier of international voice traffic in the world, and the largest competitive LEC (CLEC) in the United

MCI and Worldcom on Local Competition

- *We have created the first company since the breakup of AT&T to bundle together **local** and long distance services…*, Bernard J. Ebbers, WorldCom CEO.
- *Worldcom's merger with MCI creates a new company for this new era of communications, one that is ideally*

States. Worldcom's stated strategy is to put together the most advanced end-to-end fiber-based network to compete in the local loop for those customers that generate the highest revenues and profit margins.

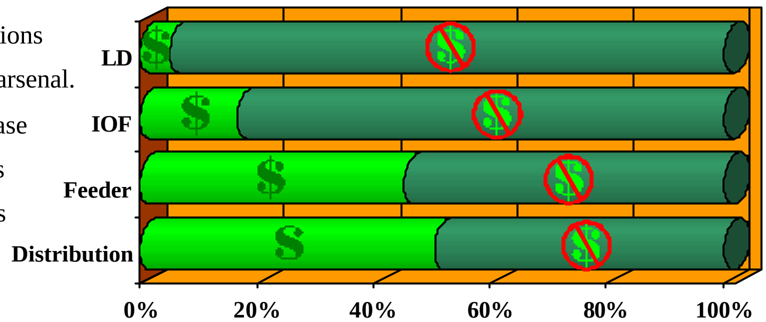
Like WorldCom, AT&T is also aggressively pursuing local services for medium and large customers. In January, AT&T purchased Teleport Communications Inc., adding significantly to its business market arsenal. This acquisition along with their pending purchase of Tele-Communications Inc. (TCI) acknowledges their strategy to go beyond the large business markets and enter the local consumer market in head-to-head competition with LECs for local high-speed data and telephony services.

WorldCom and AT&T's strategy is not unlike other world-class competitors. The major CLECs currently have extensive fiber networks. They are rapidly upgrading the capacity and versatility of these networks to provided integrated voice/data local loop services. In the past, they targeted medium to large size businesses for their high revenues and profit margins. As small businesses and residential consumers purchase more high-speed data services, CLECs are increasing their focus on these markets as well.

While this author firmly believes that competition will prove beneficial, it is a contributing factor to the rapid decline in value of today's PSTN. One need only look back to the Sprint *Pin-Drop* commercial to appreciate how competition can accelerate new technology adoption. This one simple ad, forced long-distance carriers to rapidly complete the migration to an all digital, fiber optic network.

In recent past, new technologies were deployed and old technologies displaced simply because the new technologies were more efficient at basic telephony. As competition increases, old technologies are increasingly replaced to maintain and grow market competitiveness, accelerating the pace of obsolescence.

Remaining Value of Metallic Cable

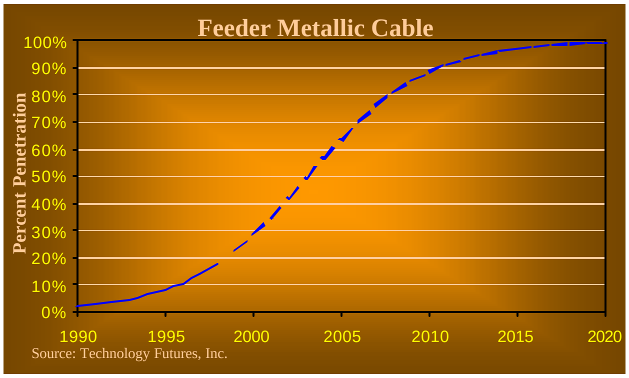


Source: Technology Futures, Inc.

The full extent that competition will have on the obsolescence of the PSTN is uncertain. The emergence of new services, that are outside the core strength of incumbent carriers, will certainly present a window of opportunity to new providers not encumbered with obsolete networks. High-speed Internet access, or perhaps a future service called Broadband Electronic Commerce Access (BECA) may be the *pin-drop* of the exchange network. Because of the uncertainty surrounding the extent and impact of ongoing local competition, its potential impact is not factored into the value assessments presented in this article. As existing markets evolve and future markets emerge, competition will further diminish the value of the PSTN.

VALUE OF NETWORK ELEMENTS

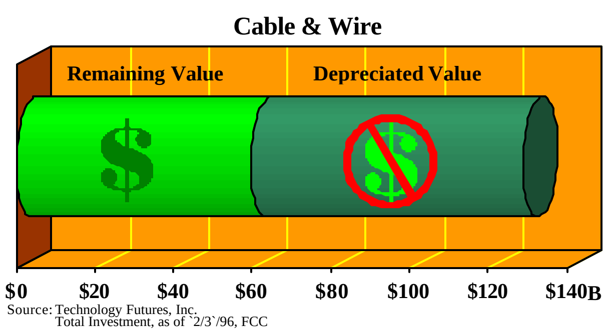
To keep pace with increasing market expectations, and to hold ground against competitive challenges, carriers are rapidly modernizing their networks. Within the narrow-band PSTN, they must replace their old copper cables with fiber, deploy integrated high-capacity digital electronics, and replace their remaining analog switches with modern digital switches. At the same time, they must expand their existing packet-data networks to meet demand for high-speed data services. Additionally, within the next five years, carriers must begin the replacement of the entire narrow-band PSTN with a single broadband network, capable of providing voice and data services simultaneously. If they don't build the network of the



future, someone else will. In either event, the rapid obsolescence of the PSTN is unavoidable. The essential question is not if it will happen, but how fast will it happen.

Outside Plant Cable

An important element in the evolution of the public switched network is the migration from copper to fiber cable. Fiber cable offers many economic advantages over copper. It is cheaper, less prone to electromagnetic



interference, reduces maintenance cost, and has immensely more capacity. As a result of its efficiencies, fiber cable adoption has been rapid and widespread. Consequently, the obsolescence of metallic cable has been equally rapid. Of the roughly $130B of investment in cable and wire facilities, over $70B of its original value has been lost to technological obsolescence and age.

Long-Distance (LD) and Interoffice (IOF) Metallic Cable

High traffic volumes and long cable routes characterize the Interoffice (IOF) network. Today, traffic volumes are growing drastically, associated in large part with the explosive growth of the Internet. These characteristics establish large economies of scale that greatly favor the deployment of fiber. Carriers first deployed fiber optic cable as a substitute for copper cable back in 1977 in the LD network, followed by fiber deployment in the IOF network in 1979.

Today, there is very little copper remaining and its remaining economic life and value are very low. Fiber cables now carry virtually all LD traffic and roughly 95% of all IOF traffic. Of the remaining LD and IOF copper still in service, TFI estimates that, on average, it will remain in service 2 more years, and its remaining value is only 16.7% of its original cost.

Feeder Metallic Cable

The Feeder network is part of what is commonly called the loop or local-loop network. Feeder cables extend from the LECs central offices to the edge of the residence and business communities where they interface with the distribution cables that blanket the neighborhoods. The transport capability of these arteries must accommodate the dynamic and diverse needs of the business and residential communities they serve. To economically meet these challenges, LECs began deployment of fiber cables in the Feeder network in the early 1980s.

The Feeder network has characteristics similar to that of the IOF, but to a lesser extent. As a result, fiber deployment in the feeder network started a few years later and its rate of adoption was slightly lower than that of the IOF. Today, fiber penetration is near 20% for the industry, and over 30% for some LECs. The pace of fiber adoption is increasing (see figure) as the price/performance improvements for fiber continues to outpace that of copper. This increase in adoption is typical of new technology deployment, and consistent with the historical fiber deployment patterns experienced in the LD and IOF networks.

Our forecast for the future adoption of fiber represents a continuation of the historical adoption trend. Potential increases from higher consumer expectations and increasing competition are not reflected in these forecast. The resulting average remaining life of copper Feeder cable is 7.5 years, and its value is just over 45% of its original cost, excluding losses in value due to the RCN.

Distribution Metallic Cable

The Distribution network refers to the cables that blanket the neighborhood or community. The Distribution network has characteristics quite different from the IOF and Feeder networks. Cable lengths are relatively short; concentration of multiple communications signals is almost nonexistent; and consumer demand has been overwhelmingly for basic telephony services. Nonetheless, copper cable in the Distribution network is doomed to eventual technological obsolescence.

Despite the past vitality of copper cable in the Distribution network, several fiber technologies (collectively referred to as FITL) are threatening copper's stronghold. As evidenced in the LD, IOF and Feeder networks, the relative economic advantages of fiber over copper cable, for voice telephony, have grown rapidly and steadily for over twenty years. While advances in copper technology have continued, and will continue in the future, the pace of these advances is negligible when compared to that of the various fiber technologies available.

FITL deployment, to date, has been for voice telephony only. In fact, the systems deployed today can not provide broadband services. While FITL is slightly more costly to install for most voice applications, FITL is significantly more economical than copper for installations requiring high-speed data communications. Thus, as demand for high-speed data continues to grow, FITL deployment and copper obsolescence will increase accordingly.

Our analysis of the potential for FITL systems to displace copper in the face of increasing demand for high-speed data services also considers the potential of new copper-based technologies to meet this demand. Specifically, TFI considered the application of the new copper-based technologies generally referred to as digital subscriber line or xDSL.

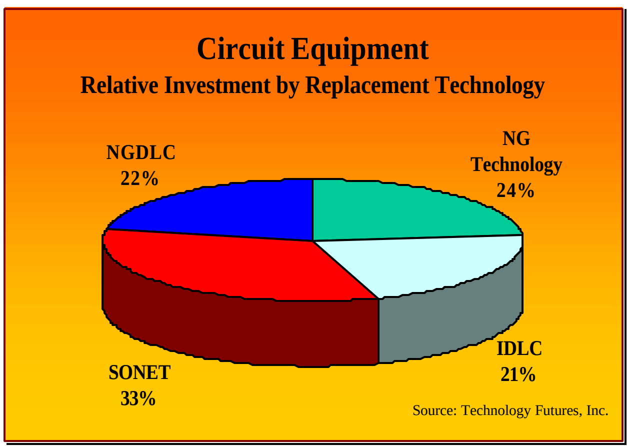
For new-build applications requiring high-speed services, FITL is more economical than copper-based xDSL solutions. In existing copper-fed areas, however, where cable lengths are not excessive and the cables are in relatively good working condition, deploying xDSL systems to serve sparse demand for high-speed services is often the more economical choice.

A LEC's choices regarding deploying FITL or xDSL involve the balancing of short-term and long-term considerations. In the short-term, they must meet growing demand for high-speed services with the facilities and technologies already deployed. Over the long-term, however, they need to transition to a network architecture optimized to consumer needs and expectations. FITL technologies offer the best long-term solution.

TFI estimates that the economic life of metallic Distribution cable is just over 9 years, and its resulting average value is 51% of the original cost.

The Potential Impact of Wireless Technology

If demand for high-speed data services stops growing and telephony remains predominately a voice-grade service, the obsolescence of copper Distribution cables will still occur. The pace of increases in the price/performance of wireless communication exceeds that of copper for voice grade services. If the nature of telephony remains static, wireless will ultimately prove more economical than copper. Again, one can see that the obsolescence of copper Distribution cable is inevitable.



Fiber Cable

While wireless technology could one day become competitive with fiber technology for basic telephony services resulting in the obsolescence of Fiber, growing consumer demand for high-speed services increases the viability of fiber cable throughout the PSTN. It is too early to say how wireless, or new fiber technologies, will influence the long-term viability of today's fiber cable. Consequently, traditional forces of mortality are assumed to drive the economic life and value of fiber cable. Based on industry mortality characteristics, the remaining life of embedded fiber cables is 15 years, and its remaining value is estimated at 74% of its original cost.

Circuit Equipment

Circuit equipment plays a vital role in the telecommunications network. With over $50B of investment, circuit equipment significantly contributes to the overall value of the PSTN. There are numerous circuit technologies all competing against one another for market share. To better understand the extent that technology obsolescence is influencing the value of circuit equipment, the various types of circuit equipment were segmented by the major technologies that are causing their obsolescence (see figure).

Obsolescence Due to NGDLC

NGDLC or next generation digital loop carrier, is a direct replacement for older, digital carrier equipment (DLC) located in the remote terminal (RT). In the context of our analysis, NGDLC also refers to newer generations of NGDLC, such as so called BigDLC and DSLAM equipment. Approximately 28% of a typical LECs investment in circuit equipment is located in the RT and is subject to replacement by NGDLC equipment.

NGDLC offers many advantages over the older technologies. For example, it provides direct SONET interfaces, is traffic engineerable, and newer vintages provide some integrated handling of high-speed data services. While NGDLC deployment began in 1994, TFI expects obsolescence of older DLC systems to begin slowly this year, and reach significant levels in about six years. As a result, older DLC equipment has a 7.5 year average remaining life and is currently worth about 62% of its original cost.

Obsolescence Due to SONET

Synchronous Optical Network (SONET) technology greatly enhances the robustness, capacity and costs of fiber optic systems. Developed to exploit the many advantages of fiber cables, SONET's performance met, and by most accounts exceeded, early expectations. Consequently, the pace of its adoption into the public network was unprecedented in history.

SONET technology is influencing the economic lives and value of essentially all circuit equipment. In many cases the influence is indirect, in that newer technology equipment, such as NGDLC, is SONET compliant. The obsolescence of DLC equipment resulting from SONET, for example, is captured in our assessment of the obsolescence due to NGDLC. Such equipment, therefore, is excluded from this equipment category.

SONET technology does directly influence some circuit equipment; most notably standalone multiplexers, digital cross-connect, some portions of the COT, and other equipment. This non-SONET equipment comprises roughly 42% of all circuit equipment.

While general deployment of SONET began in 1982, displacement of non-SONET equipment did not reach measurable levels until 1995. This technological obsolescence, coupled with the impacts of traditional mortality yields an average remaining life of just under 2 years, and a remaining value of 59% of its original cost.

Obsolescence Due to IDLC

Integrated DLC (IDLC) is a replacement technology for the universal carrier (UDLC) equipment inside the central office. Approximately 27% of a typical LEC's investment in circuit equipment falls into this category of equipment.

The obsolescence of the carrier equipment in the central office began around 1992; and becomes significant as the turn of the century approaches. By the year 2015, TFI expects that virtually all carrier systems will have integrated interfaces into the switch, with virtually all UDLC equipment taken out of service. These expectations yield a 4.7 year average remaining life, and an assessed value of 53% of its original cost.

Obsolescence Due to Next Generation Technology

All circuit equipment is subject to technological obsolescence, even the newest circuit technologies. Experience tells us that none of the latest technologies are the ultimate technology – newer improved technologies are always just around the horizon. Traditional motility gives us an expectation for the *potential* physical life of new technologies. That is, how long the technology would likely be useful if no new technologies were expected to emerge, and if customer expectations were to remain static. Both of these conditions are unrealistic. Newer technologies are expected, and market expectations are changing rapidly.

In the case of current SONET standalone multiplexers and NGDLC equipment, the next replacement technology is already known, and in fact, is commercially available. Thus, to establish a reasonable expectation for the remaining life and value of this property, its eventual technological obsolescence must be taken into account. TFI estimates that just over 3% of a typical LECs investment in circuit equipment consist of SONET standalone multiplexers and NGDLC equipment.

Obsolescence of this equipment is not expected to reach significant levels until near the year 2005. This outlook for obsolescence coupled with the influences of traditional mortality forces result in a remaining economic life of 6.5 years, and an assessed value is 59% of the original cost.

Circuit Equipment Composite Life and Value

Combining the effect of technological obsolescence and tradition mortality forces for the circuit study categories, described above, yields a composite average remaining life of 4.3 years, and a remaining value of 48% of its original cost.

Switching Equipment

Telephony switching has undergone rapid and exciting changes in the past and will continue to do so in the future. Numerous switching technologies have been rendered completely obsolete over the last 25 years. These include Manual, Panel, CrossBar, and Step-By-Step. Soon Digital switches will replace the remaining Analog switching; and within a few years, ATM-type switches will begin the replacement of Digital switches.

Analog Switching Obsolescence

Digital switches have been replacing Analog switches since 1984. Today, the percentage of access lines still served by Analog switches has fallen to nearly 10%. Technological obsolescence began slowly after 1990, nearly 15 years after they were introduced into the network, and became significant in 1995. TFI estimates that by the end of 2002, virtually all the remaining value of Analog switching equipment will be gone.

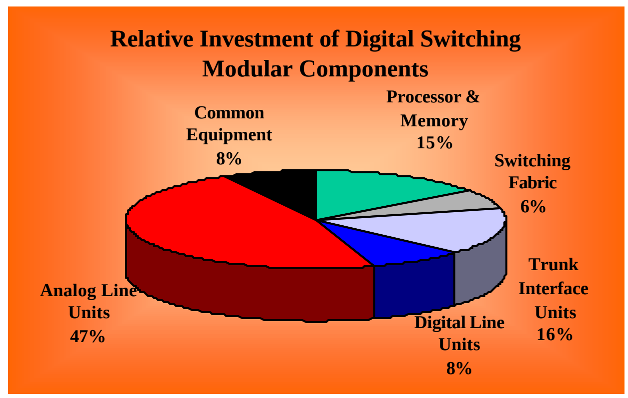
The remaining economic life resulting from the combined influences of technological obsolescence and traditional mortality forces is 1.4 years. The corresponding industry average remaining value of Analog switching investment is 15% of its original cost.

Digital Switching Obsolescence

The modular nature of modern Digital switches requires that the technological obsolescence of each modular component be separately assessed. The net obsolescence of all digital switching equipment is then computed as the investment weighted average of the individual modules (see figure).

Analog Line Units

Analog line units (ALU) directly interface analog voice channels to the switch. The obsolescence of ALU is driven by the technological displacement of analog voice channels with digital channels. This displacement is reflected in the



displacement of non-DLC and DLC telephone lines by IDLC technology, presented earlier. As a telephone line is upgraded to IDLC, the analog line card that connects the line to the digital switch must be replaced with integrated digital line cards (DLU).

Digital Line Units

Digital Line Units (DLU) connect IDLC circuits in the Feeder network directly to the Digital switch. Virtually all of the DLU equipment placed prior to 1996 is TR-008 technology and is not compatible with the new TR-303 technology. Today, TR-303 IDLC system deployments are initiated primarily for new growth applications, and system exhaust situations. Consequently, these applications contribute slightly to the obsolescence of DLU equipment today. The rate of obsolescence will gradually increase, becoming significant after the year 2004. By 2012, the total obsolescence of current DLU technology will be virtually complete.

Trunk Interface Units

Trunk Interface Units (TIU) connect the IOF network facilities to the Digital Switch. Today, virtually all TIU equipment operates at the DS1 (1.5 Mbps) rate. Deployment of new higher-speed SONET trunk interfaces will eventually lead to the demise of current generation TIU equipment. New SONET interfaces are currently available; however, several factors impede their rapid deployment.

The lowest SONET communication channel, the STS-1, operates at 57 Mbps and can carry over 1000 voice-grade (64 Kbps) signals. This large capacity makes SONET/TIUs uneconomic for most growth applications because it is rare that a single IOF growth application will involve this much growth in voice-grade communication. Additionally, a typical IOF trunk route will carry significant quantities of non-switched traffic along with the switched voice-grade traffic. These non-switched signals must be removed from the communications channel before the channel is connected to the switch. The cost of this re-grooming is prohibitive for most applications today.

Our projections reflect the slow migration of TIUs to SONET-TIUs described above. The obsolescence of TIU is almost nonexistent until after 2004, when it begins to increase slowly, becoming significant near the year 2006. At this time, TFI expects the rate of obsolescence to be rapid, with total obsolescence occurring near the year 2015.

Computer Process & Memory

In a modern digital switching system, those machine functions that are best performed from a central location are provided by an equipment category referred to as the processor & memory. Many factors contribute to processor and memory change outs. These include access line growth, Local Number Portability, growth of Class features (e.g., call waiting, caller ID, etc.), increasing call duration due to Internet access, and the fact that many of today's digital switches are operating at or near capacity. Consequently, new processor technologies are introduced about every three years.

At any given time, only two generations of processors technology will be in significant use. Typically, one would find a number of switches using the latest processor technology, a large number of switches using the prior generation of processor technology, and a very small number of switches, if any, using older processors. Thus, since new processor technologies are introduced every three years, the average life expectancy is approximately six years.

The public network switching environment is an extremely high-production environment. Like PCs in a business environments, the demands of the job and the software applications very quickly consume all of the processor and memory capacity available; and still yearn for more. Today, there are principally two processor technologies in use, with some residual of the older technologies still lingering.

Our assessment for the obsolescence of processors and memory models the successive generations of processor & memory technology introduced every three years.

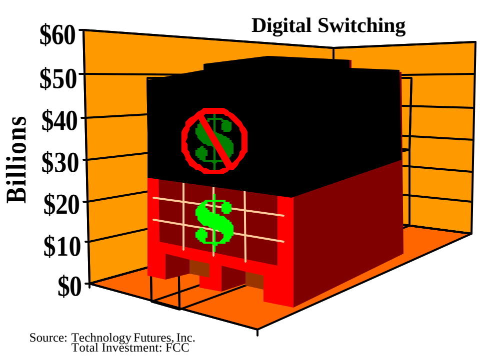
Switch Fabric

The switching fabric performs the actual switching function. It consists of computer equipment very similar to processor and memory equipment. Consequently, the obsolescence of switch fabrics is very similar to that of central processors and memory. Historically, upgrades to the Switching Fabric have become available about every four years, as opposed to three for the processor and memory. Like the processors, two generations of Switch Fabric technology typically dominate the market.

Common or Shell Equipment

The Common Equipment, also called Shell equipment, consists of power equipment, wiring, cross-connect frame and other hardware items that are expected to live the life of the entire switch entity. The obsolescence of this equipment is, therefore, driven by the next generation switching technology. TFI expects the replacement technology to current digital switches to be a form of ATM switch.

Based on the opinion of experts, vendor information, and our assessment of market demand and the timing between successive prior switching technologies, a new generation of ATM switch, capable of replacing today's DESS switches will be introduced near the year 2003. TFI expects the migration to ATM switches to complete shortly after the year 2012. The corresponding obsolescence of DESS switches is expected to begin around the year 2004, and become significant about 5 years later, 2009.



Digital Switching Remaining Life and Value

The investment weighted composite average remaining life for DESS equipment, middle scenario, is 5.8 years; and the corresponding average remaining value is 52% of the original cost.

SUMMARY

The Public Telecommunication Network is undergoing unprecedented technological obsolescence. In the past, the economic provisioning of basic telephone service was the principal driver for change and age was the primary determinant of the assets value. Today, technological obsolescence is rapidly eroding the economic value of America's Network. As technology advancement continues to accelerate, so too will the obsolescence of the PSTN.

Steve Barreca is President – BCRI, Inc., a research and consulting firm in Birmingham, AL. Steve has over 25 years exerience in the communications industry and over 18 years experience assessing technological obsolescence, economic lives, depreciation, and asset valuation. Information on BCRI can be found on www.BCRI.com or info@bcri.com. Steve Barreca can be contacted at SBarreca@bcri.com.

(Bio Updated June, 2002)