Adoption of New Telecommunication Technologies and Services: Historical Patterns and Lessons

by John Carey

Columbia Institute for Tele-Information
Graduate School of Business
809 Uris Hall
New York, NY 10027
(212)854-4222

ADOPTION OF NEW TELECOMMUNICATION TECHNOLOGIES AND SERVICES: HISTORICAL PATTERNS AND LESSONS

John Carey
Greystone Communications

An important question in the debate about the information superhighway is: if we build it, will people buy and use it? In trying to answer this question, there is a tendency to believe that new telecommunication technologies will succeed or fail based upon a marketplace context that is unique and different from all previous settings for earlier technologies. However, a review of the history of technology introductions reveals many common factors that affected the outcomes for those technologies. An understanding of these factors can inform our assessment about how the public will respond to new technologies and services on the information superhighway such as interactive television, multi-media computer software and advanced telephone services. Further, many historical lessons can be extracted from earlier marketplace experiences and applied usefully to future technologies. In this paper, several common patterns associated with earlier technologies are reviewed. These can be applied usefully to the new technology environment. Further, a few key lessons are drawn that can help to guide decisions about the implementation of new services.

(This paper is adapted from a report prepared by the author and Bortz & Associates for the Corporation for Public Broadcasting.)

Standards

Is it important that a single standard be adopted, de jure or de facto, in order for a technology or service to be adopted in the marketplace?

Technologies often fail when several competing standards confuse consumers or discourage manufacturers from bringing the technology to the marketplace. Teletext provides a useful example. Teletext utilizes the vertical blanking interval (VBI) of a broadcast television signal to transmit text and, in some systems, simple graphics. It may be perceived as a small "extra" channel that rides along with a television transmission without interfering with the main video signal. Broadcast teletext has a very limited capacity. It can transmit approximately 100 screens of information in 5-20 seconds, depending upon how many lines in the VBI are used for the service and how much data is contained in each screen of information. In order to view the service, users have to purchase a special decoder or buy a TV set that has the decoder built into it. Typical uses for teletext have included weather information, TV program schedules, news headlines and sports scores.

Teletext services were successfully implemented in Britain (where a single standard was adopted) during the mid 1970s. A short time later, teletext services were initiated in other European countries, Canada, Japan and the U.S. Research studies in the U.S. about teletext found that consumers generally liked the service but they were not willing to pay much for the extra

equipment necessary to receive it. Most research indicated that an acceptable price for decoders was $50 to $100. In the U.S., the teletext marketplace was complicated by a number of competing standards. The FCC decided that it would not select a single standard but rather would let the marketplace decide. However, service providers disagreed about which standard to adopt. In the absence of an FCC standard or a de facto standard, manufacturers were reluctant to mass produce a few different teletext decoders and place them inside television sets - an essential requirement if the price of decoders was to be kept low. From 1983 to 1985, CBS and NBC each carried a national teletext service. However, decoders were not generally available and those that were marketed cost several hundred dollars. At this price level, there was little or no consumer demand and teletext disappeared as a consumer service.

At the same time, it should be noted that other secondary television services using the VBI have been implemented successfully. These include closed captioning for the hearing impaired and second audio programs (SAP) such as descriptive audio services for the blind (this provides a verbal description of visual action on the screen). In both cases, implementation has been affected by the adoption of a single standard and the integration of the receiving equipment in television sets. In the case of SAP, manufacturers built the receiving equipment into high-end sets initially and later into most color receivers. Consumers purchased these in large numbers in order to receive

stereo audio - the SAP component was integrated within the standard and equipment for stereo reception. In this sense, SAP was implemented in millions of consumer homes at virtually no cost. In the case of closed captioning, manufacturers were reluctant to build the receiving equipment into television sets, since the potential market for the technology was limited. Those who wished to receive closed captioning had to purchase a separate receiver at a cost of a few hundred dollars. This placed a restraint on broad implementation. However, the FCC subsequently adopted a policy that required the technology in TV sets. This sharply increased the base of households that can receive closed captioning.

AM stereo experienced a similar fate as teletext. The FCC authorized the transmission of AM stereo in 1982 but failed to adopt a single standard for AM stereo. Six different systems competed for acceptance by manufacturers and broadcasters. Subsequently, the field narrowed to two standards. However, no clear winner emerged. As a consequence, stations were reluctant to adopt AM stereo, manufacturers were reluctant to build sets and consumers were confused. The synergy of these elements crippled AM stereo.

There are many counter examples of technologies with multiple standards that have flourished, e.g., personal computers. In trying to understand where standards are important to successful adoption of a technology, it is useful to distinguish mass market and niche technologies as well as open

and closed applications. Technologies and services that are marketed initially to a mass market often require standardization in order for economies of scale to quickly bring prices within an acceptable range. When the product or service can be introduced to a niche user group that can afford higher initial prices (e.g., businesses), standardization may not be as important.

Further, it is important to distinguish between open and closed applications. Open applications are available to the broad public and are more likely to require a single standard. Closed applications are limited to a user group that can control the technology and the applications for which the technology is used, e.g., a company that uses videodisc for training. A single standard is not as important in these cases.

There are many other factors that influence the need or lack of need for standardization. However, regulatory policy about standards is based upon a different set of criteria and has little to do with marketplace needs.

Pricing

The price of consumer electronic products has played an important role in the adoption of those products by the public. Historically, products are introduced at a high price in order to recover some of the costs associated with the research and development of the product. Also, early manufacturing of the product is generally expensive since it cannot realize the economies of scale that are possible when the product is mass

produced. Typically, however, the price drops sharply over time and this spurs adoption by the mass public. There are dozens of examples that reflect this pattern, including radios, black and white TVs, color TVs, VCRs and personal computers. In each case, the initial price of the technology was very expensive for an average U.S. household, but the price dropped sharply over time and this spurred wider adoption.

This raises an important question: who purchased these products when they were expensive? The answer varies somewhat by product. Typically, early purchasers are wealthy individuals, people with an insatiable desire for the product or service, individuals who are love "electronic gadgets" and are willing to pay a high price in order to be the first person on their block to own a new electronic device, and in some cases businesses and schools that need the product. While the mix of early users varies, the lesson is clear: a new technology has to find some early users who are able and willing to pay a high price for the product or service in order to achieve the economies of scale in manufacturing that can reduce the price for the general public.

It is also useful to note the cost of these technologies at the point when they entered half of US households. Radio achieved a 50 percent penetration of US homes in 1931, black and white TV in 1955, color TV in 1972 and VCRs at the end of 1987. Compact disc players have not yet entered half of US households - they achieved a 43 percent penetration of households in early 1994. For radio sets, black and white TV and color TV, the

technology cost approximately 1.8 or 1.9 weeks of household income at the point when it was entering half of US homes. For VCRs, however, the price dropped to approximately one week's household income at the point just before it entered half of US homes. It should also be noted that compact disc players entered the market at a much lower price compared to earlier technologies. Compact disc players cost approximately 1.8 weeks' household income when they were introduced compared to 5 or 6 weeks' income for TVs and VCRs when they entered the market. Further, although compact disc players have not yet entered 50 percent of US homes, the price has dropped well below half a week of income for an average household. This suggests that the price standard a new technology must meet is getting tougher. A new consumer electronic product may have to enter the market at a lower price relative to weekly household income and it may have to drop much lower than in the past in order to achieve a mass market penetration of 50 percent or greater.

Killer Applications Vs. A Confluence Of Factors

Among groups who develop and market new communication technologies it is common to hear discussions about "killer applications" or "magic bullets" that can lead to a decisive "home run" for a new technology or service. And indeed, there are examples of very popular applications that helped technologies to gain quick acceptance in millions of American homes, e.g., a few very popular video games that drove the sale

of videogame consoles.

However, it is more common for a new communication technology to require the coming together or confluence of several factors in order for the technology to "take off" and gain widespread acceptance. This confluence of elements can occur relatively quickly or it can take many years. Broadcast AM radio and black and white TV provide examples of the former - they grew very rapidly after their introduction. Cable television and FM radio provide examples of the latter - they were in the marketplace for many years before they experienced a period of rapid marketplace growth. Cable TV and FM radio are useful case examples to illustrate the confluence process.

From 1950 to 1972 cable television grew from zero penetration of US households to 10 percent penetration. In other words, it required more than 20 years to achieve a 10 percent penetration level. From 1972 to 1990, cable grew from 10 percent penetration to just under 60 percent penetration. Why did penetration jump so rapidly in the 1970s and 1980s? It was not a single factor or "killer application."

In the 1950s and 1960s cable TV represented a way to get better reception for over-the-air signals in communities that had poor reception. Generally, these were small towns and surburban areas 50 or more miles from a broadcast transmitter. Cable offered very few extra channels or services, so it had little appeal in areas where there was good over-the-air reception. In the 1970s, a confluence of several new elements acted as a

"starter motor" for a large growth engine to "kick-in." For the first time, it appeared that cable could be profitable in large cities and, at the same time, the FCC lifted a freeze on franchise awards in major markets. In addition, satellite transmission made national cable program distribution easier and less costly which gave rise to the launch of many basic and pay channels, notably HBO and WTBS. Then, in the late 1970s, an interest in interactive cable services encouraged much experimentation with program formats as well as investment in cable as the technology of the future. The experimentation led to the development of several new channels with specialized programming; the investment brought cable infrastructure to many communities that previously had no access to cable. This confluence of elements allowed an engine of growth to kick-in.

FM radio provides another example of a technology that experienced slow growth for many years before a period of rapid expansion kicked-in. FM radio was available to the public in the 1940s. For 30 years, audience share grew at a very slow pace, but in the 1970s a dramatic growth in audience share began. Over a 12 year period, from 1973 to 1985, FM's share of the radio audience climbed from 28 percent to 72 percent. In other words, the FM:AM share of audience changed from approximately 30:70 to 70:30. Why did this change occur at this time? The answer does not appear to be related to any single element but to a confluence of elements that triggered a growth spurt.

During the 1940s and 1950s, most FM stations were co-owned by an AM station operator who carried the same programming on both stations. In addition, FM receivers were expensive and there were relatively few FM stations compared to AM stations. For example, in 1960 there were four AM stations for every FM station. With relatively few stations on the air, little original programming and expensive receivers, consumers were reluctant to adopt FM even though it was technically superior to AM.

Nonetheless, FM gained a foothold that was due in large part to classical music fans who valued the superior sound quality of FM.

Begining in the late 1950s, a series of events helped FM gain marketplace strength. In 1958, AM frequency allocation reached a saturation level in major markets, thereby encouraging new groups who wanted to launch a station to apply for FM licenses in those markets. In 1961, FM stereo was developed and in 1965 the FCC ruled that co-owners of AM-FM stations in the same market could not transmit the same content on both stations. Stereo provided a qualitative enhancement to FM while the requirement to offer original programming led many FM stations to explore new formats. In addition, the price of FM receivers declined and many manufacturers began to offer combined AM-FM receivers. This encouraged many households to acquire an FM receiver. By 1970, the ratio of AM:FM stations was 3:2 and 74 percent of households had an FM receiver. This confluence of elements placed FM in a strong position to challenge AM.

The cable television and AM-FM case examples suggest that a technology or service can reach a threshold and then grow rapidly. This is often characterized as an s-curve pattern of growth. The elements required to reach the threshold will not be the same for all technologies and the timetable for reaching the threshold can be a few years or many decades. Indeed, the crucial question associated with s-curves is the time required to move from launch of a new technology to the threshold point where rapid growth begins. This can vary from a few years to a few decades. Further, many technologies never reach the point at which rapid growth becomes possible or they simply fail to gain marketplace acceptance.

It is also important to note a common pattern associated with unsuccessful technologies - a phantom s-curve. Frequently, these technologies languish with low consumer acceptance for a period of time. However, advocates for these technologies proclaim that they are about to "take off" and project rapid near-term growth based upon an s-curve pattern of adoption. Videotex, 8-track audio cartridges, and projection TVs are among the technologies that have followed this pattern.

Early Vs. Later Users And Uses

There is a broader generalization that applies to many technologies: the early uses and the early users for a technology may differ from later uses and later users. The process may be described in terms of a step progression. In order for a

technology to be adopted, several steps must be climbed. The first step consists of one group of users and uses but the group or mix of groups at the second and third steps may change. It follows that there must be a first step if the technology is to reach the second step. Those who are introducing the technology should try to anticipate the mix of users and uses at each step. Since this is very difficult, they must be prepared to shift strategies as they climb each new step. VCRs illustrate this process. When VCRs were first introduced in the U.S., they were quite expensive - approximately $1500. Early users included businesses and schools that used the technology for training and education as well as high income households, especially those with an interest in the latest electronic gadget. Household usage included time shift viewing of television programs and a considerable amount of pornography (a majority of videocassettes sold and rented in the late 1970s was pornography). Businesses, schools, people who were willing to pay a high price for time shift viewing of programs, and those who wanted to see pornography made up the first step of users and uses. They made it possible for a second step of adoption to occur, at a lower price and with a different mix of uses, including videocassette movie rentals and (later) videocassette sales. This example suggests that there may be some services which might appeal to a mass market at the second or third step in the adoption process but which never have the opportunity to test the mass market because there is no group prepared to pay the higher price at the

first step or because of some other early barrier. In the case of VCRs, there were also some important unanticipated events. The emergence of "mom and pop" video rental shops was unanticipated and unplanned. Yet, these shops were critical for the second and third steps of VCR adoption to occur. This suggests that the growth of a technology is often a fragile, changing process. Early use can be different from later use and the elements that are critical to success at various steps along the way can sometimes come from unplanned and unanticipated sources.

The Advantages And Pitfalls Of Being First

There has been a long-term debate about the advantages and disadvantages associated with early entry in the communication marketplace. Brian Arthur ("Positive Feedback In The Economy," Scientific American, February, 1990) makes the positive case for early entry. He notes that economists generally view competition in terms of equilibrium. For example, a hydro-electric power company that gains an advantage in the marketplace will likely run out of good locations to build new plants over time and this will provide an opportunity for other power companies to compete effectively and thus restore equilibrium. Brian Arthur argues that this classical model of economists does not adequately explain what happens in communication and information industries. In the communication and information industries, he argues, small competitive advantages gained early often escalate over time and lead to market dominance. Arthur describes this process in terms

of economic feedback and cites many examples. From this perspective, a technology with a small marketplace advantage receives positive economic feedback that strengthens the advantage. This in turn generates more positive feedback that can lead to market dominance. For example, when VHS and Beta formats were competing for the videocassette market, VHS gained a small early lead. This in turn attracted more retailers to market VHS and more film distributors to make their product available on VHS format. Over time, the positive economic feedback for VHS escalated and Beta was essentially eliminated from the consumer marketplace even though many argued that Beta was technically superior. Curiously, the small early advantage for a competing technology may be based on serendipity, a favorable geographic location, or a seemingly innocuous event such as positive coverage in a magazine story.

Arthur's model of positive economic feedback can be used to support the case for early market entry as a means to generate positive feedback. Indeed, there are many examples of early market entry that escalated into market dominance. AM radio preceded FM into the marketplace and dominated radio for fifty years; HBO was the first to develop a national pay cable service and quickly dominated the market; and, the three broadcast networks that entered television in the late 1940s achieved a lock on the market that was not challenged for 30 years; among other examples.

However, for each example of early entry that led to positive feedback and marketplace dominance there is an example of early entry that led to failure or weak market performance. A 45 rpm automobile record player developed in the 1950s failed to achieve any significant market; two-way video trials and services in the 1970s for business meetings and medical applications were largely unsuccessful; and an over-the-air pay TV service developed by Zenith in the 1950s failed; among other examples. And yet each of these cases was followed by similar technologies and services that succeeded. There are many reasons why early market entrants fail. In some cases the technology simply doesn't work, e.g., the 45 rpm automobile record player skipped whenever the car hit a bump. In other cases, the costs associated with marketing and launching a service overwhelm an early entrant, e.g., several groups that planned to launch direct broadcast satellite services in the early 1980s abandoned their plans as they faced the huge costs associated with launching the services. In still other cases, an inhospitable regulatory climate can cripple an early entrant or consumers' lack of skill in using the new technology can lead to failure. Groups that follow early entrants may, in some cases, find that the technology works better, costs are lower, consumers have improved their skills in using the technology, the regulatory climate is more hospitable, etc.

An historical review of new communication technologies suggests that early entry is an advantage in some cases and a

disadvantage in others. It is an advantage when all the pieces are in place to launch the technology successfully. It is a disadvantage when the technology must stand on one or more Achilles heels.

Replacement Cycles And Pace Of Change

The growth of some technologies is linked to the purchase of other media. For example, few people buy a TV set or VCR just to obtain a remote control device or stereo sound. However, when they purchase a new VCR or replace their old TV set many consumers select models with remote control and stereo. In this sense, replacement cycles for existing media can provide an important way to introduce new media. For example, in U.S. households, the average color TV is replaced after 8 years, the average telephone answering machine after 5 years and the average personal computer after 6 years. Associated with these replacement cycles, it is important to assess the reasons why people purchase a new model of an existing technology. There at least four reasons for purchasing a new model of an existing technology:

1. To replace an existing model that no longer works.
2. To obtain an additional unit of the technology.
3. To upgrade an existing model that works but which does not have a desired feature or is lower quality than the upgrade model.
4. As a byproduct of another purchase. For example, a person may purchase a new personal computer that comes with a modem. The modem may not have been a reason for the purchase but it is a consequence of the purchase.

Upgrade purchases have been very important for technologies such as television and personal computers where the pace of technological change has been rapid. The pace of technological change in some other technologies has been slower.

Failures, Fads And Marketplace Decline

There are also many lessons to be derived from technologies that failed in the marketplace or lost ground after achieving a significant penetration of US households. A few of these lessons will be noted here. First, many technologies have failed because they offered a superficial benefit. Quadraphonic sound provides one example. Quadraphonic or four-channel sound, for the consumer market, did not represent an advance in technology. Rather, it represented an application of existing industrial technology (multitrack recording and playback) with a genuine industrial benefit (control of editing) into a home market where no benefit could be demonstrated. In addition, little software was developed for the new system, thus further reducing its appeal to consumers. From a consumer's point of view, quadraphonic sound offered no advantage over existing stereophonic sound.

A second lesson relates not so much to outright failure in the marketplace but to a sharp decline in use of a service or technology after an initial period of success. Some technologies are fads. We are familiar with fads in leisure products such as hula-hoops, yo-yos and pet rocks. However, consumer electronic technologies can also be fads or have a fad component. CB radio

provides an example. In the early 1970s, CB radio had a steady population of approximately 200,000 users. As CB became a fad in the mid 1970s, the population of users grew to a peak of 10 million in 1976. It then declined almost as rapidly and leveled off to a population of approximately one million users by the early 1980s.

In addition to fads, some technologies experience cyclical patterns of strong adoption, decline in usage and subsequent renewed usage. 3-D movies and videogames provide examples of this pattern. 3-D movies were very popular during the mid 1950s then faded away only to experience renewed interest in the 1960s and for brief periods each decade thereafter. Videogames surged in the early 1980s, collapsed in the mid '80s and were resurrected in the late 80s. More recently, in the early 1990s, they experienced another dip though it was not as precipitous as the decline in the mid 1980s. In 1994, they appear to be enjoying another upswing. These patterns suggest that some technologies share characteristics with the toy market, where fads, cyclical sales patterns and high volatility are commonplace.

It is also important to note that failure in the marketplace may not be failure at all but an initial false start. For example, both television and VCRs experienced false starts. Television was launched in the late 1930s, but the high price of TV sets ($600) and disruption caused by World War II led to a false start. The technology was reintroduced after World War II

and grew rapidly. Similarly, two home video recording technologies were launched and then withdrawn in the early 1970s (the EVR system by CBS and Avco's Cartrivision system) before the modern VCR finally took hold in the mid 1970s.

Enhancements And New Services

It is useful to distinguish enhancements to existing services from the development of entirely new services and the patterns of adoption for each. Qualitative enhancements to existing services can provide a reasonable path for the development of many new services. Consumers have responded positively to enhancements such as color enhancement to black and white TV, higher fidelity for audio and stereo for audio as well as television. Consumers have also rejected pseudo enhancements such as quadraphonic sound. New services by contrast provide a more radical change from earlier services, including in many cases new content. Examples include new cable channels, FM radio (at the point where stations were required to provide new content), personal computer software and video games.

Enhanced services and new services both require, in most cases, that consumers buy new equipment or pay new fees for the service. New services also require a change in how people use media. For example, a person watching color television uses the same content as someone watching black and white TV even though there is a qualitative difference in their experience. However, someone watching basic cable channels for the first time in the 1970s or listening to a new FM station in the 1960s was altering

his or her behavior. This is a more significant change since it requires that people alter existing media habits. Associated with this, the change may require some time. Indeed, the growth in use of basic channels and the rise in audience share for FM spanned a number of years. There is also a significant difference in the cost of providing enhanced services versus new services - new services often require the creation of new content.

A related issue is the demand for new or enhanced services. When new services are launched is there generally a proven or unproven demand? Many analysts have noted correctly that new technologies are often created by engineers with little knowledge about whether there is a demand for the technology. In this sense, new services often result from "technology push" rather than "user demand" - a practice that many criticize, arguing that this is why so many technologies fail. However, it should be noted that most communication technologies in this century, e.g., motion pictures, radio, phonographs and television entered the marketplace in a context of uncertain demand. Technologies do not fail simply because they represent technology push. They fail because they cannot find or create applications that people want. Finding or creating these applications is a challenge.

The issue of creating new applications leads to a further question: who controls content creation for a new technology? In some instances a new group of entrepreneurs leads content development, as in the case of early personal computer software.

In other instances, existing players control content for the new technology, as in the case of CDs that were produced by the same record industry groups who created LPs and audiocassettes. Entrepreneurs are more likely to bring creativity to the process and generate new ideas. Existing players are more likely to bring financial resources and organizational relationships to the process and help ensure that the technology gets a reasonable opportunity in the marketplace.

Conclusion

An historical review of earlier communication technologies cannot be used to predict the future. Its purpose is to identify common patterns in the introduction of earlier technologies that may apply to some future technologies and to highlight key lessons that can guide planning for new technologies. This historical review has identified some patterns that may apply to new technologies on the information highway and a few lessons that can help in planning new services.

It may be noted first that experiments with new technology often come in phases, as technological developments lead to the introduction of new products into the marketplace and service providers seek to reach new audiences or change information and entertainment habits. The period from the mid 1970s through the early 1980s was marked by a great deal of experimentation, followed by a period of quieter activity.

It appears that the mid 1990s will again be a period of high experimentation as many new technologies are introduced. While

such experimentation is exciting, it can also create a significant drain on financial resources. For this reason, it is important to learn from past experimentation - to avoid repeating the same mistakes and to maximize the efficiency of new ventures. For example, in the past many research and development (R&D) efforts were under capitalized and dispersed among many organizations. The resulting R&D was often weak.

At the same time, it should be noted that there are many benefits to R&D experimentation. For example, it allows testing of a new technology at relatively low cost before greater costs are incurred through the broad implementation of the technology. Through this, organizations can learn how to efficiently deploy the technology and if it makes sense to implement the technology on a large scale. Experimentation also builds expertise within organizations that can yield direct and indirect benefits. Direct benefits include the ability to create excellent programming or services at an early stage in the deployment of the technology. Indirect benefits include developing skills that can be used in other areas and learning how to evaluate future technologies.

Second, it should be noted that commercial groups who are developing new technologies tend to paint the best possible picture for the technology. It is important to not get caught up in marketing hyperbole. In particular, marketing groups often exaggerate the likely growth patterns for a technology or service - adoption typically takes longer. What are the projected growth

patterns for a new technology or service? Are they realistic? If adoption rates are slower, how might this affect the business case for the technology or service?

A third useful question is - does new technology provide a real benefit that users want? In the case of early videotex services, an assumption was made that the public wanted access to vast databases of information. This presumed benefit proved to be illusory. On the other hand, communication services delivered through videotex have proven to be very popular. In this sense, the planned applications for videotex were way off the mark. Service developers discovered the applications people wanted after they had launched the services.

Fourth, production of high quality programming for interactive television and other multi-media content for personal computers will be expensive. This will require new talent(s) and significant financial resources. In the past, content developers have often underestimated the time and resources required to develop software. Software development will require a concentrated effort with new personnel and sufficient funding.

Fifth, when new information highway technologies and services are first introduced, they are likely to be expensive. What are the expected prices of early equipment and services? Who will be the target users? Are they able and willing to pay the expected high price?

In addition, groups who promote new technologies tend to extoll their virtues and overlook or hide flaws in the

technology. In the case of teletext, early promoters glossed over the slow response time of teletext, e.g., in some systems a user had to wait for 30 seconds or more before a requested frame of information appeared. In the case of videotex, the superior graphics that were promised for some systems never materialized. What are the weaknesses or flaws in the new information highway technologies? Might these hurt marketplace development of services? How can service providers work around limitations, if any, in the new technology environment?