

Implications of Local Loop Technology for Future Industry Structure

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Abstract

This paper explores the impact of the Internet on the deployment of technology for advanced residential network access. While the shape of the future is certainly not clear, certain considerations provide a basis for conjecture, such as the high cost of new wireline facilities, the emerging ability to provide higher quality Internet service over the existing wireline facilities of the incumbent LEC and cable providers, the rapidly changing nature of the Internet and its service requirements, and the open nature of the Internet's interfaces, which tends to inhibit vertical integration of the Internet and the higher-level services provided over it.

Considering these factors, many outcomes are possible, but it is possible to construct a future in which there is only a limited degree of competition in the provision of residential Internet service, and the degree of actual consumer choice changes rapidly due to the changing nature of the Internet, as well as the investment decisions of the facilities operators. Over the next decade, choice in residential Internet access could become as much of an issue as choice in local telephone service is today. Research and innovation in alternative modes of residential Internet access might improve the future options for competition.

Introduction

The industry structure surrounding the local loop is changing fast. The continuing process of deregulation combines with the advent of new service offerings such as the Internet to provide a powerful push for evolution. In attempting to examine this market, the factors that are easier to assess are those that surround the more mature telephone and television service, and attention is naturally directed there, because of the level of current and past

investment, and the size and influence of the industry players. None the less, it is important to look at the possible shape of the industry that might emerge around new services, particularly the Internet, as they relate to the deployment of advanced local loop facilities. While such a look must be very speculative, it can provide a common framework for discussion, and perhaps a common understanding of the range of options within which the future will evolve. It is possible that within a decade, society will be as concerned with the industry structure behind the Internet—the nature of competition, the range of consumer choice, the rate and level of investment in support of innovation—as we are today with the telecommunications industry.

It is difficult to predict the future course of the Internet. The Internet is a creature of the computer industry, and it evolves rapidly, as do all parts of that industry. It evolves in response to the emergence of new computer-based services, and the services and the Internet drive each other. The rapid rate of innovation interacts with the need for new investment to sustain the advances, and this interaction creates a future that is difficult to predict¹. But there are specific factors that seem to constrain the future, especially when looking at the local loop.

The key issues facing the potential provider of advanced access to the residence are as follows. To install a new generation of access technology that reaches the residence and small business is expensive. This level of investment is not likely to happen many times in any technology cycle, especially for wireline services that imply a large, up-front investment. In justifying this investment, one must predict the uncertain nature of the higher level services to be delivered over the Internet, because these determine the importance and utility of advanced access facilities. One must ask whether in the life of any current or new access facility, the Internet will evolve to deliver new services such as television and telephone service, or just continue to provide the “traditional” Web and e-mail? There is thus a tension between the apparent drive for the Internet to evolve, and the difficulty of justifying the necessary investment.

¹ For a general discussion of the uncertain but inevitable evolution of the nation’s communications infrastructure, see the report by the Computer Science and Telecommunications Board (1996).

The goal of the paper is to focus on possible shapes of the industry surrounding the local loop that provides network access to the residence and small business, looking at the Internet as a shaping factor. The intention is to provide a framework for debate and identify certain constraints on the future, while acknowledging that this sort of discussion is very speculative.

Baseline: the “old” structure

To provide a baseline for discussion, figure one presents a simplified and abstracted illustration of the past, showing the three major communication services that reached the home, and the technologies that carried them. Telephone was carried over copper pairs, radio over metropolitan broadcast, and television over broadcast or co-axial cable.

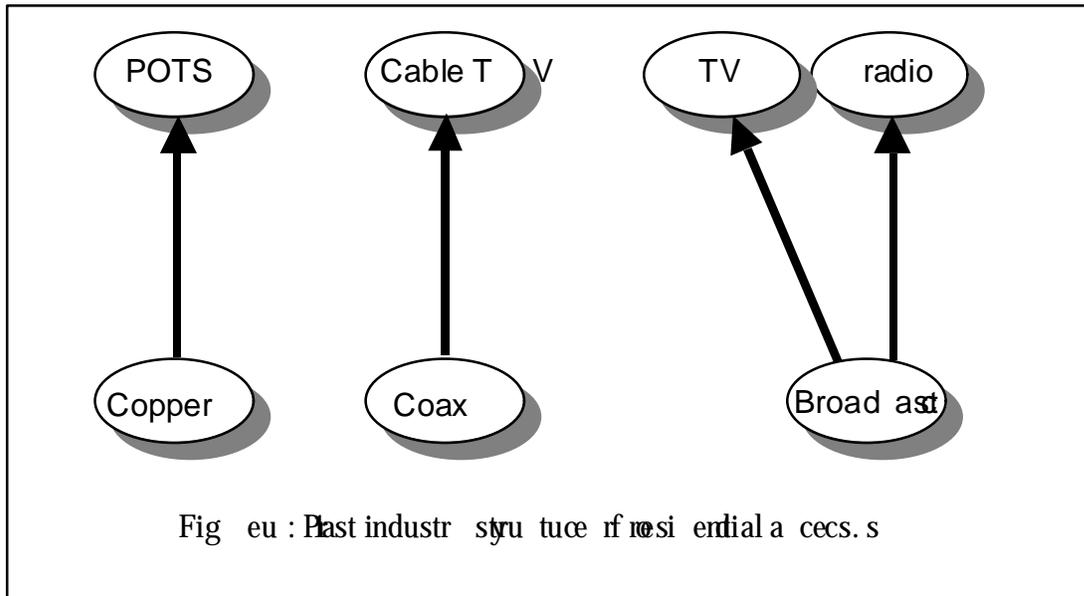
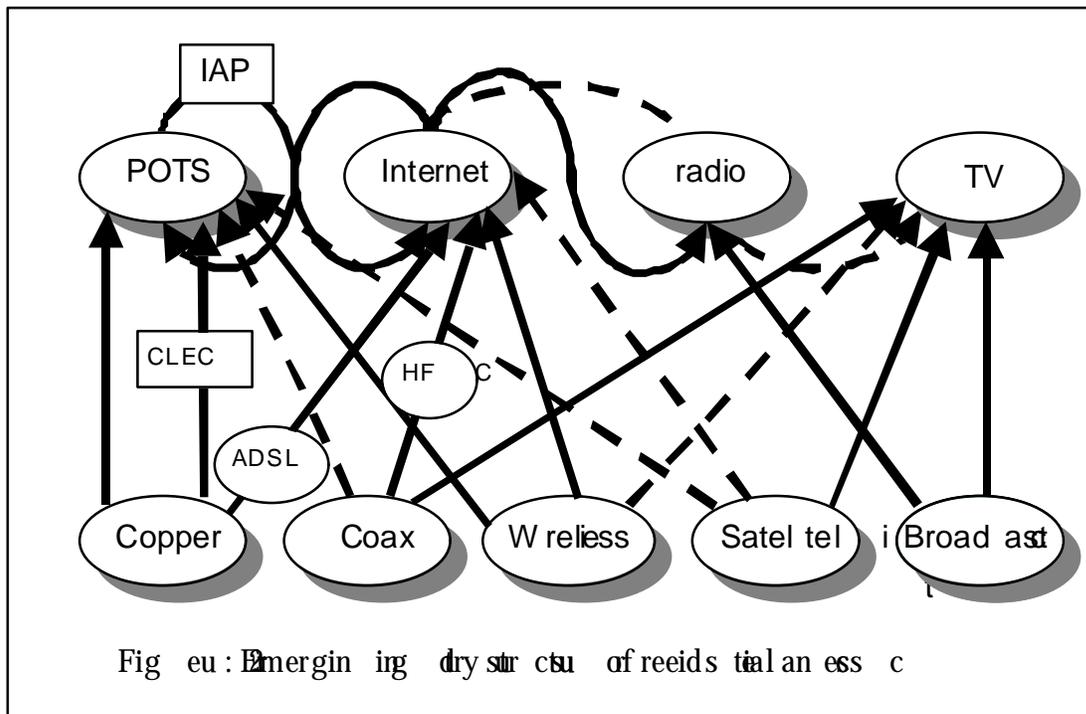


Figure 1: Past industry structure of residential access

There are two important points about this structure. First, there is a direct linkage between the delivery technology and the service. The provider who installed and operated copper pairs knew that the service being provided was telephone. This clarity in defining the line of business allowed the provider to design his system to optimize the known service, and made it somewhat straightforward to construct a business plan for investment in infrastructure. Second, and related, the service and the technology were provided by the same company. The facilities provider and the service provider were vertically integrated.

The emerging structure

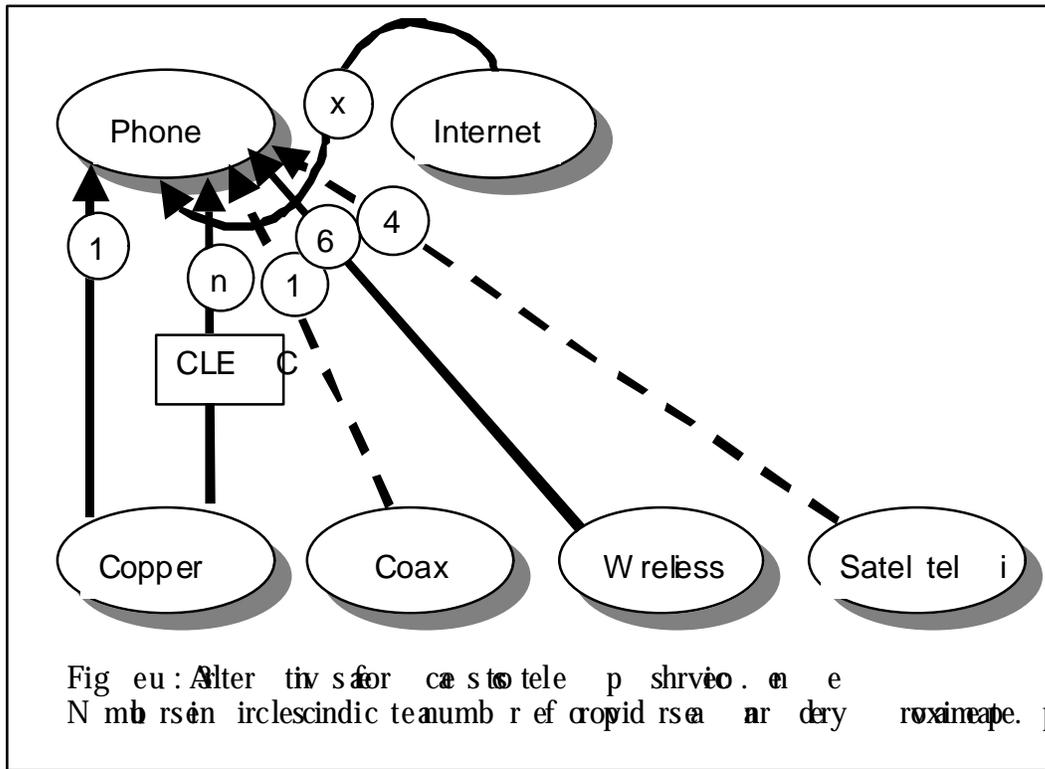
Starting some time ago, this picture began to change. Divestiture, and the resulting recognition that it was potentially beneficial to be in multiple lines of business, caused the simple picture to evolve toward a more complex structure. Figure two represents a view of what we might expect in the near future, where solid lines represent what is actually available today, and dotted lines represent reasonable possibilities in the not too distant future. The services represented are the same, with the addition of the Internet, and two new delivery technology modes have been added, satellite and cellular (in contrast to single-tower metropolitan broadcast).



There are several points about this picture. The first is that the strong vertical pairing of the first figure is replaced by a matrix structure. Many services are coming over several delivery technologies. Second, the Internet is in an interesting intermediate position. It is delivered over lots of technologies, and lots of services are (or can be) delivered over it.

The telephone industry as an example

Figure three extracts from figure two the subset of links that relate to telephone service. The way the copper pair is being used has expanded, in that (at least in the U.S.) unbundling has been mandated as a way to increase competition. But telephone service is also available using cellular communication, will soon be available from satellite, has been provided in certain areas over co-axial cable, and is emerging as a service over the Internet. While some of these modes are not yet technically mature (such as certain forms of Internet-based telephony²) and some like telephone over cable are not being pushed (for reasons that may have to do with economics and regulation as much as technology), this picture illustrates the complexity of the situation that the consumer, the industrial players, and the regulator must come to deal with.



The regulatory situation is certainly more complex, in that it is now much less clear what (if anything) is to be regulated. In the old structure, the vertically integrated industries

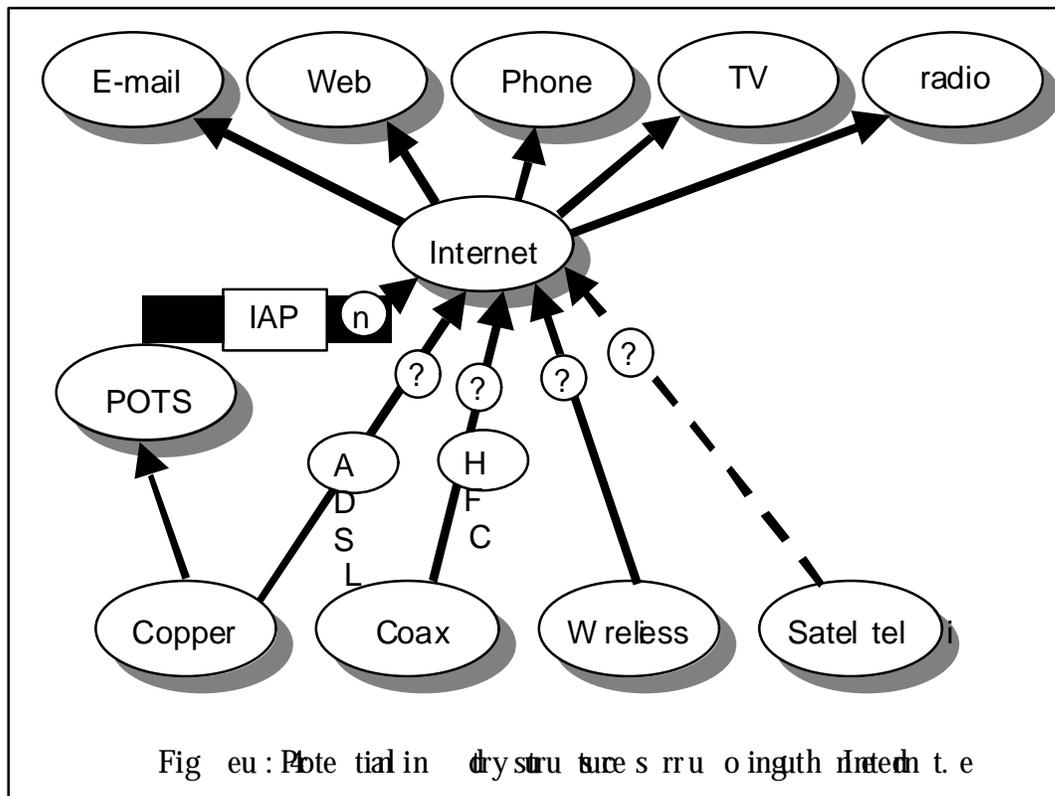
² Clark (1997) provides an analysis of different sorts of Internet telephony and the factors that limit the deployment of each.

were easy to identify. But in this picture, should one look at diversity in facilities, in higher level services, or some other criteria to assess the potential need for regulation?

The unique nature of the Internet

In figure two, the Internet occupies a unique position. It can be provided over almost the full range of current and emerging local access technologies, and it can (or will in the future) be able to provide all of the enumerated services. It thus has the potential to be a universal means of facilitating the delivery of high level services to the consumer. Figure four extracts from figure two the relationships relevant to the Internet.

This way of looking at the Internet is not new. A report from the Computer Science and Telecommunications Board (1994) illustrated the Internet as an hourglass, providing a single common means (by way of its standardized interfaces) to make a wide variety of technologies available to a wide variety of services. As figure four makes clear, this role as a cross-connect between technology and service is a very significant one for the Internet in the context of the local loop.



Services over the Internet

Looking first at the upper half of figure four, how will higher-level services over the Internet evolve, and what will be the implications? More specifically, what will inhibit or enhance the introduction and offering of each sort of service over the Internet? Second, are there forces that would favor or inhibit the integration of the higher-level service with the provision of the basic Internet service itself?

This second question of who provides the higher level services and applications over the Internet is critical in predicting the future of the Internet and the industries that drive and shape it. The services that are illustrated in figure two do not include the “old” services that we traditionally associate with the Internet—e-mail, the World Wide Web, file transfer and so on. For completeness, some of these are added to figure four. To an experienced user of the Internet, these services are what the Internet is “for” today. I did not include them for a simple reason. These are not services that are today provided by a “service provider”. They do not represent services that somebody sells, and consumers purchase. They come into existence through the combined efforts of all the producers and consumers of content and information exchange. People may make money by selling a particular file, but no service provider makes money by selling the “file transfer service”.

The new services that I illustrate have more direct analogs in the pre-existing world of consumer communication—telephone, radio and music delivery, and television. The cable television industry, if not the broadcast industry, sells access to television as a subscription service, which they present as a bundle with options, all of which they package and select for marketing.

An important speculation about the Internet is whether this more integrated model will emerge for some higher level Internet services, in which these services are bundled with the lower level delivery service for the Internet itself.

Past experience would suggest that the answer is no. As noted above, current high-level services are not sold by Internet Service Providers as bundled products. As Internet telephony emerges, it is a collection of stand-alone software packages and network-based products being sold by independent third parties. It is not a service being provided by the

Internet Service Providers. And other high-level services that are now evolving seem to have a similar structure.

Internet radio/music

Internet radio, which is now emerging as a significant offering on the Internet, provides a chance to observe the development of an industry in its early stages. There are content packagers such as AudioNet that are assembling a large amount of material and provisioning their own wide area infrastructure to better deliver it. At the same time, individual performers, radio stations and other “small” sources of audio material are making their content available in piecemeal fashion. Whether the large or the small providers of audio content succeed in the market, the Internet Service Providers do not seem to be a significant provider of any of this service. Their only role is to upgrade the Internet to better carry this sort of content, and perhaps thus justify a higher fee for their Internet service.

Technology base

Turning from the upper part of figure four, which concerns higher-level services, to the lower part, which concerns the delivery technology, there are again two questions to ask. First, to what extent are all of these technology options the same from the perspective of the user? Second, how rich will the competition be in providing them?

There is a wide range of delivery modes for Internet illustrated in figure four. They differ in a number of respects. Some, like ADSL and IP over cable, are capable of rather high-speed delivery, perhaps several Mb/s. Internet over dialup modem, in contrast, is limited to no more than 56 Kb/s today, and dialup is not likely to get faster. Some forms of wireless service will be even slower than this. Different delivery modes differ not just in speed. For example, Internet over dialup modem is only connected when the consumer makes a phone call for the purpose. Internet over cable is a service designed to be available at all times. It is not yet clear how ADSL (Internet over copper) will be designed.

Do these differences matter? The answer is that it depends on the higher level service being used by the consumer. For e-mail, there is not a compelling difference between a

56 Kb/s modem and a faster link. For cruising the Web, the increased speed seems to be valuable, and for Internet television, when and if that becomes significant, the 56 Kb/s modem may simply not be enough. Some forms of Internet telephony, in which calls are placed to the recipient directly over the Internet, are difficult to bring to market if the recipient is not connected to the Internet at all times. If the user must dial up in advance to receive a call, this prevents receiving a call without pre-arrangement. This limited service is hardly a replacement for traditional telephone service. On the other hand, using an “always on” Internet service such as is provided by Internet over cable, it is possible to receive an unanticipated call, the way the telephone system works today. So the features that the Internet customer will demand will depend on the higher level services that are currently popular. And if a majority of the users do not have a suitable Internet service, this can cause certain high level services to stall in the market.

Competition in providing Internet access service

Just as we are concerned today with competition in the provision of telephone service, it is important to inquire now as to what degree of competition might finally emerge in the provision of Internet service. There is no certain answer today, of course. But we can see the relationship between decisions now being made and the eventual outcome.

One fact that seems quite certain is that installing a whole new wireline facility is very expensive. It is not likely that there will be many new wires (or fibers) installed to the residence in any technology cycle. And there is anecdotal evidence that the higher-speed Internet options such as Internet over cable (or more specifically over Hybrid Fiber-Coax or HFC) are proving sufficiently popular that they may come to represent a distinct variant of Internet access for which the slower options like dialup do not provide a direct substitute. Today, there is typically one provider offering copper pairs (the incumbent LEC) and one provider of cable. These are the only two high speed Internet options currently in the picture. So one extreme for future Internet service is that high speed Internet service is provided by a duopoly, consisting of the current LEC and the current cable provider. Unless there is some business or regulatory pressure to move away from this outcome, it is a likely one.

There are other outcomes that are not so extreme. The LEC might sell a “ADSL” service, and permit the consumer to select from a number of competing Internet services over that ADSL link. Or the LEC might be forced to unbundle the copper loop for ADLS service, by analogy with the current approach to service competition for telephone service³.

While it is not possible to predict with certainty how these options might evolve, one can look at the current approach of the cable industry for a first hint. Currently, those cable providers who choose to sell Internet service over their cable do so by offering the consumer a bundled Internet service option, which they provide and sell as a part of their overall service product. There has been no tendency to give the consumer a choice of Internet Service Providers over their cable infrastructure. Were the LECs to follow this model, a duopoly in high speed Internet service would be the outcome.

The technical innovation most likely to alter this picture would be the emergence of some wireless service with enough bandwidth to compete with the performance of the wireline solutions. But this sort of service raises serious technical challenges, including the difficulty of achieving the basic bandwidth, the need to provide the “always on” form of the service, and so on. It may be that if the duopoly as the final outcome is not considered an adequate range of choices for the consumer, some intervention in the market may be required.

If high-bandwidth applications of the Internet become popular, so that the dialup service becomes a second-tier service for customers interested in low price rather than service quality, the current very competitive market for consumer Internet access over modem will become squeezed into one low value corner of the market, with the high end concentrated in the facilities-based providers, of which there might only be two. This sequence of events would signal a major transformation of the consumer Internet Service industry.

³ The recent filing by NTIA (1998) to the FCC advances both these options as desirable outcomes, and supports regulatory unbundling of DSL facilities. This suggests that they believe that regulation is necessary, even at this early stage of the emerging market for advanced services, to mitigate the power of the facilities owner.

Hybrid technology

One interesting issue that is only now emerging is that it may be possible to construct a superior Internet service by using more than one sort of residential access technology at a time. For example, Internet access is provided today using satellite or cable in one direction and telephone links in the other. In the future, we may see more novel hybrids, for example involving low and high orbit satellites. Since, traditionally, one industrial player has installed one sort of technology, these hybrid options will force some sort of relationship between multiple players to provide the overall service that the consumer purchases.

Internet television

This application of the Internet does not really exist yet. But it is informative to speculate on the different forms it might take. A simple option is that television over the Internet works exactly the same way television does today—very high bandwidth access links are installed, and a number of channels are broadcast to the consumer over these links.

However, an alternative model might be that the consumer subscribes to a number of “channels”, or content bundles, and these are downloaded in advance on to a local disk at the site of the consumer, where they can be watched at will. Some sorts of content, like the news and weather channels, which provide highly repetitive material, might achieve a tremendous reduction in required bandwidth to deliver this material by downloading the various pieces just once in the background, and then letting the viewer watch them at will. This model of video distribution would contribute to much greater diversity of programming, because channels with only limited content (insufficient to fill a cable slot full time) could still develop a market.

This model of Internet television cannot instantly come into existence, because it requires simultaneous evolution of the local loop, the consumer equipment (the successor to the set-top box) and the mode of content formulation and organization by the producer. This interaction illustrates the point that the Internet and the applications that run over it co-evolve, which makes predicting the future (and especially its timing) very difficult. But depending on which model emerges, there could be very different application for satellite and wireless services as a part of the overall access technology infrastructure.

A “next generation” local loop technology?

There is continued speculation that some form of advanced access technology might be installed to the residence, for example fiber to the curb or fiber to the home. At present, there does not seem to be any significant planning or investment in these next generation technologies. However, there are still some considerations that seem reasonable. One is that the expense is such that the typical consumer will not see a high level of competition in this offering. It is quite possible that there would be only one version of this service for most consumers. Second, any such investment would almost certainly be motivated by the desire to get into as many high-level businesses as possible—telephone, television, Internet, and so on. So were this to happen, it would represent a rather complicated business situation. On the one hand, it might serve to increase the competition in all of these higher level services. On the other hand, it might represent a non-competitive presence in the access market that might drive the less capable technologies from the market and leave the consumer with insufficient choice in the basic access service. Into this speculative picture comes the Internet, with its potential to deliver all of these higher-level services in a competitive and unbundled way. Is it possible that the future picture is one in which the access technology is a recognized monopoly or a non-profit or government sponsored facility, but there is open competition for all the services that run on top of it, including telephone, television and the Internet?

Conclusions

Wholesale installation of wireline access technology to the residence is expensive enough that we cannot expect a rush to enter this market. At the present time, there are two incumbents, the LEC and the cable provider. Both are moving to enter new service markets, in particular the Internet market. A number of factors will shape the future of the local loop. In the short run, there does not seem to be any serious plans to install additional wires (or fibers) to the home.

One possible outcome is that there are two providers of high-bandwidth Internet service, the incumbent LEC and cable provider. While there will be other forms of Internet access (wireless, satellite, and so on) these may be sufficiently different in features such as

bandwidth and continuous availability that they do not directly substitute for the high-bandwidth wireline solutions. The result is a duopoly in the provision of residential Internet access.

If this outcome is considered undesirable, one way to mitigate it (other than regulatory intervention) would be to encourage research in alternative delivery technologies, including high bandwidth wireless, and hybrid models that use more than one technology to build a single, high-performance Internet service. However, exactly which forms of Internet service are in practice substitutable will depend on which higher level applications become popular, which can and will change over time. It is thus plausible to anticipate that the competitive breadth of the residential access to the Internet may change with the pace of the evolution of higher level services, which can happen much faster than the pace of infrastructure investment.

The implication of the Internet for consumer access to higher level services is that there may be increased competition in the provision of these services, including those such as telephone and television that are limited in competitive breadth today. This derives from the open character of the Internet design that militates against vertical integration of the Internet service provider and the higher-level service provider.

Citations

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