Standardization Issues on Local Competition

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I. Introduction

State and federal policy makers have begun the process of removing the remaining barriers to entry into local telecommunications markets for the purposes of extending the benefits of competition to consumers. Although not typically associated with these efforts, technical standards requirements are emerging as a key regulatory tool and safeguard in this transition. These developments suggest the need to review how mandated standards requirements are being used in this regard, particularly given the rapid pace of innovation in telecommunications technologies and the uncertainties of the direction of marketplace evolution.

Speculation on how local competition might evolve is a current source of controversy in the policy arena. Figure 1 predicts one view of the direction this evolution might take. This view suggests a large number of suppliers may emerge over time to compete in the provision of local communications services. The current market structure for these services, consisting of several suppliers offering separate services with little competition, gives way in the near term (5 - 10 years) to more suppliers and joint ventures as wireless and interactive television technologies mature. In the long term, several suppliers offer a wide range of services on multimedia platforms in competition with one another.

While one may disagree with various aspects of the scenarios described in Figure 1, the important point is that new services and technologies have the potential to introduce more local competition. These developments will place a much greater dependence on interconnection and compatibility standards to govern the relationships among providers than exist today.

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Given the large stakes involved, the debate over standardization issues is sure to intensify as policy makers formulate regulatory frameworks that promote more competitive local telephone and cable television markets. Congress, for example, is considering a bill that would mandate standards for access in order to guarantee that any provider of telecommunications services would have access to and interconnection with the facilities of the local telephone companies.[2] This bill would also mandate interoperability standards to ensure competing networks can interconnect in an efficient and effective manner. Thus, policy makers are not necessarily interested in the notion of standards as commonly understood in the telecommunications community -- *e.g.*, the development of technical specifications of protocols and network interfaces -- but in the specification of interconnection and compatibility standards that govern how networks can be interconnected and premises equipment can be connected to the network.

With this more expansive view of standards, this paper examines some of the standardization requirements adopted or proposed by the Federal Communications Commission (FCC) as part of a general regulatory framework advanced to introduce more competition into local communications markets. The FCC has ordered interconnection requirements to stimulate facilities-based competition among local telephone carriers, as well as compatibility requirements to facilitate more competitive customer premises equipment (CPE) markets. These standards might generally influence the prospects for competition by: 1) lowering equipment costs based on the volume of manufacturing output, 2) facilitating new entry by ensuring interconnection and interoperability between network operators, and 3) ensuring compatibility between network operators, and between networks and CPE thereby lowering the costs to customers of CPE as well as switching service providers.

While it is clear that the impact of standards on equipment costs in the subscriber loop could be substantial, this paper does not focus on this aspect of standards. The markets for network switching and transmission equipment appear competitive with a number of prospective suppliers. Hence, manufacturers and service providers have strong incentives to develop transmission and switching standards that reduce their production or equipment costs. Under these circumstances, there is no obvious need for intervention by policy makers into the standards process of the physical layer network components.

Instead, this paper surveys the existing or proposed interconnection and compatibility standards requirements by the FCC, and examines salient issues raised by these requirements as the local marketplace evolves in a direction like that described in Figure 1. These standards specify the technical specifications for the network interfaces through which competing providers and users access

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[2]See H.R. 3636, "The National Communications Competition and Information Infrastructure Act of 1993," as introduced by Representatives Markey, Boucher, and Oxley to the U.S. House of Representatives Subcommittee on Telecommunications and Finance, November 22, 1993.

the network. This paper divides the discussion of these standards questions into two sections. One section covers interconnection requirements, the second section examines compatibility requirements.

II. Interconnection Standards for Equal Access

Policy makers generally apply interconnection standards to encourage the formation of new network transport and service providers. Interconnection standards address the concern that incumbent monopolists can suppress new entry by refusing to interconnect with new, competing network operators. Because of the strong network externality in telecommunications markets -- the value of the service to one subscriber increases with the number of other subscribers interconnected to the network -- refusal to interconnect represents a serious barrier to entry. As a consequence, some of the first steps taken be federal and state regulators to foster more alternative transport providers in local telephone markets has been to set rules, or standards, for interconnection.

This section examines two types of interconnection standards. The first type requires the dominant carriers to establish physical interfaces through which new entrants can interconnect their own transport services to form a source of facilities-based competition. The second type requires the dominant carriers to establish logical interfaces through which new entrants can interconnect their own unique information or software-based services in competition with the incumbents own information services.

This classification of interconnection requirements corresponds directly with the notion of physical and logical unbundling, which has been raised in the context of open network platforms or open network architecture (ONA).[3] Network unbundling refers to the process of breaking the network into separate functional elements, or building blocks. Independent service providers select only those unbundled components needed for their own service applications since the network operator cannot tie the availability of one element to subscription with another. In this context, a logical unbundled element could be a software-defined network feature; a physical element could be a physical resource employed in the transmission or switching of the service. The substitutability between unbundled physical and logical elements of private and public networks inherently implies a set of standardized interfaces to assure interoperability among unbundled elements.

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[3]For more discussion on the technical and economic aspects of unbundling physical and logical network components, see David P. Reed, "Taking It All Apart: Principles of Network Modularity," Presented at the Conference on Private Networks and Public Objectives, Columbia Institute for Tele-Information, New York, December 6, 1991.

Interconnection Standards For Physical Interfaces

Interconnection requirements designed to promote facilities-based competition consist of a set of specifications that define the physical interface through the new entrant can interconnect and interoperate with the existing network operator.

The expanded interconnection rules of the FCC provide an example of this type of interconnection standards.[4] These rules require large telephone companies (those with annual revenues in excess of $100-million) to permit outside parties to terminate their own transmission facilities in the central offices of the telephone companies to provide interstate special access and switched services. The decision includes detailed standards for physical collocation, which permits competitors to install, maintain, and repair their own equipment in central offices.[5] Thus, telephone companies must provide expanded interconnection for switched transport in central offices, serving wire centers, and tandem offices given a *bona fide* request for these services.

While the decisions defining the points of interconnection and the standards for these arrangements are relatively straightforward, determining the correct pricing of interconnection charges is a complex task. Interconnection charges not aligned with costs can send the wrong pricing signals to competitors, encouraging inefficient entry of the charges are too low or serving as an unnecessary barrier to entry if they are too high. Ideally, interconnection charges should be "cost-based," yet there is a lack of market experience to indicate competitive price levels. Regulatory concerns to maintain universal service further complicate these decisions. The expanded interconnection decisions set forth a rate structure for interconnection charges that includes a contribution for universal service paid by all parties interconnecting, and grants the telephone companies some pricing flexibility to respond to this new threat of competition. Not surprisingly given the complexity of these issues, there has been considerable debate about this rate structure, which has led the FCC to reconsider and investigate a number of pricing issues.[6]

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[4]See, Second Report and Order and Third Notice of Proposed Rulemaking, In the Matter of Expanded Interconnection with Local Telephone Company Facilities, CC Docket 91-141, FCC 93-379, released September 2, 1993.

[5]While not covered in depth in this paper, the expanded interconnection decision includes detailed standards for interconnection arrangements regarding central office space allocation and exhaustion, the points of interconnection and entry (*e.g.*, telephone companies do not have to provide expanded interconnection from remote switches because of the technical difficulties raised by this form of access), the equipment placed in central offices by or for interconnectors, and interconnection of non-fiber technology.

[6]See Order Designating Issues for Investigation, In the Matter of Local Exchange Carriers' Rates, Terms, and Conditions for Expanded Interconnection for Special Access, CC Docket No. 93-162, DA 93-951, released July 23, 1993. A few of the issues under investigation beyond the basic rate structure include dark fiber

Assuming a cost-based pricing structure can be achieved, the FCC expects the benefits of the expanded interconnection decision will be to foster more significant competition in the local transport of interstate special access and switched services. The potential costs of this decision arise if the interconnection interfaces eliminates economies of scale and scope across the interconnection interfaces -- an outcome that seems unlikely since the decision builds upon existing interconnection points in the network -- or precludes the deployment of new technologies.

Interconnection Standards For Logical Interfaces

The FCC has proposed to require standards that will facilitate logical interconnections through which the software or other information of third-party providers can access customers using the facilities of the local telephone networks. These interactions could vary from merely providing database information through intelligent network technology to programming the network switch as part of customized service application software. The objective of these standards is that, much the same way that the personal computer has served as a platform to spawn a new industry of application software developers, the public network could play a similar role as the public platform that stimulates a new application software industry for innovative network-based services. An essential characteristic of the public network platform, if it is indeed capable of assuming such a role, will be the extent to which the logical elements of network functionalities can be offered on an unbundled basis (*i.e.*, the extent to which interconnection standards can define logical interfaces which permit interoperability).

As noted above, the FCC proposed to consider whether logical interconnection requirements should be applied more broadly as a policy tool to open access to the network and foster more competition in the provision of intelligent network services.[7] These rules seek to ensure that the intelligent network develops in an open manner, and proposes a scheme of mediated access -- the means by which a new entrant could gain access to network functions without compromising network reliability -- to achieve an open network.[8]

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interconnection, channel assignment, space warehousing, termination notice and reasons, relocation, insurance, liability.

[7]See, Notice of Proposed Rulemaking, In the Matter of Intelligent Networks, CC Docket 91-346, FCC 93-380, released August 31, 1993.

[8]The proposals are quite technical in nature and based upon the current architecture of the intelligent network. In general, this item proposes to open access to the network in a phased approach from the service management center (SMS), to the service control point (SCP), to the switch. Specific actions recommended by the item include: 1) require large telephone companies to offer mediated access at the SMS within a year of adoption; 2) seek comment on the costs and benefits, technical feasibility, and impact on network reliability of

The FCC is also considering what logical interface requirements are necessary to insure open and equal access to the local exchange network through the Open Network Architecture (ONA) policy.[9] This framework of nonstructural safeguards governs how the Bell Operating Companies may participate in enhanced services as well as the unbundled services available to enhanced service providers. ONA requirements are conditions these companies must meet to offer their own enhanced services on an integrated basis.

The intended benefits of these interface requirements are the benefits of competition that arise from service providers who can deliver their services to customers using the facilities of the telephone company. Because of this reliance on the facilities of the dominant supplier, and the inherent view that no other transport providers will be available, these interconnection requirements could be inconsistent with the objectives of physical interconnection requirements which promote facilities-based competition. On the other hand, one can view logical interface requirements as a safeguard ensuring network access during the transition to more local competition or in the event such competition does not materialize.

These logical interconnection rulemakings raise some additional cost concerns beyond those raised by physical interconnection requirements. Like all interface standards, logical interconnection standards can impose costs by eliminating economies of scope across interfaces and influencing the technical design of the network to accommodate the interfaces. In addition, however, these standards can increases the risks of intrusions, system failures, and potential privacy breaches to the public switched networks. Because the network is a shared resource, the troubles of one application can send shock waves throughout the entire network operating system. These unique concerns for network security and reliability should not preclude the possibility of an open architecture -- advances in software technology are likely to offer opportunities for building layered architectures that will protect network integrity -- but they are likely to add some cost to the network.[10] Clearly, if the magnitude of these costs are large,

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requiring mediated access at the SCP and switch; 3) defer to industry to resolve technical issues associated with the implementation of mediated access, although it does require uniform interface standards across all large telephone companies.

[9]See, for example, *Memorandum Opinion and Order*, Filing and Review of Open Network Architecture Plans, CC-Docket No. 88-2; FCC 91-382 38309, Released December 19, 1991.

[10]An example of a layered architecture that separates physical and logical network elements is the Information Networking Architecture proposed by Bellcore. The INA call processing software consists of one or more service segment building blocks which are distinct from the technology dependent details of switching and transmission. The building blocks interact via standardized interfaces. See N. Natarajan, Gary Slawsky, "A Framework Architecture for

they would be a subject of concern in a competitive environment if they are to be born only by the dominant supplier.

III. CPE Compatibility Standards for Subscriber Loop Networks

The FCC has imposed compatibility standards on telephone networks for well over a decade, and are in the process of mandating compatibility standards for cable television networks for the first time. These standards define a network interface between the network and CPE with the objective that subscribers can obtain and use their own CPE from retail vendors as well as the network operators.

Compatibility Standards for Telephone Networks

In a culmination of a long series of decisions, the market for CPE attached to telephone networks was deregulated in 1983.[11] These rules define network channel terminating equipment (NCTE) as unregulated CPE which the telephone companies generally cannot offer as part of their regulated network.[12] NCTE is the interface equipment located on the customer premises between the network and CPE. NCTE can be separate from CPE, or also built in as part of the CPE. The rules stipulate that a petition must be filed to the FCC for new service offerings that require a new interface to CPE.[13] Full registration then constitutes authorization for the equipment to be directly connected to the switched telephone network without causing any harm.

Since deregulation, a large diversity of CPE products have been brought to market both as a result of market forces and technological advances. CPE now can perform sophisticated switching, messaging, and routing functions. The trend to more functional, or intelligent, CPE decreases the functional requirements of the network and the general direction of network evolution is to

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Information Networks," *IEEE Communications Magazine*, April, 1992, pp. 102-109.

[11]See Amendment of Part 68 of the Commission's Rules Concerning Connection of Telephone Equipment, Systems and Protective Apparatus to the Telephone Network. 94 FCC 2nd 5-31, (1983).

[12]For more, see Pepper, Robert M. "Through the Looking Glass: Integrated Broadband Networks, Regulatory Policy and Institutional Change." Office of Plans and Policy Working Paper #24, Federal Communications Commission, November, 1988, pp. 49-54.

[13]Thus, for example, the FCC just recently amended its rules to include terminal equipment connected to basic rate access services provided via integrated services digital network (ISDN) access technology. See Notice of Proposed Rulemaking, CC Docket No. 93-268, RM 7815, released November 22, 1993.

decentralize the placement of intelligent nodes throughout the network.[14] Thus, signal processing, network signaling, and monitoring functions, once the exclusive domain of the network, increasingly can be integrated economically into the CPE.

The migration of functionality into the CPE has its limits. Some functions such as switching, call set-up, or call breakdown require coordination with network components. Yet finding a boundary line defining where the network functions logically leave off and CPE functions begin is difficult in the presence of the swift technological advance. For example, the current rules presume the functions and physical design inherent to telephone network using twisted wire pairs. On a copper network electrical signals travel directly to the CPE which translates standard electrical currents into ringing, dial tone, or voice conversations. In most cases, no intermediary equipment is necessary.

The same may not be true of fiber networks. All-fiber networks place the optical network interface on the subscriber premises. The optical signal from the network must first be detected by a photodetector which translates the optical signal into an electrical signal, followed by multiplexing functions which select the correct channel for any particular device. Other codec and signal processing functions might also be necessary. The issue of whether this equipment should be properly treated as deregulated CPE will have to be addressed when all-fiber networks are deployed. In the near term, telephone companies are more likely to deploy hybrid fiber systems that will connect to houses using existing copper wire pairs or coaxial cable. Nevertheless, despite the familiarity with compatibility standards for these media, new interface specifications will be necessary because of the different configuration of services delivered by the new hybrid fiber networks.

Compatibility Standards for Cable Television Systems

Compatibility between CPE and cable television systems is another area of recent concern for policy makers. Historically, cable operators supplied their own set-top converters with no compatibility requirements with customer-owned set-top converters. The Cable Act of 1992 included provisions which require the FCC to place new compatibility requirements between cable systems, televisions, and video cassette recorders (VCRs).[15] This section examines these developments, and examines some issues raised by these requirements in the face of anticipated technological advances.

Past attempts to standardize the interface between cable systems and the cable-top converters have largely met with failure. Three standards efforts stand out in this area.

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[14]One aspect of asynchronous transfer mode (ATM) technology, for example, is that it shifts control functions "to the edges" of the network into CPE.

[15]See the Cable Television Consumer Protection and Competition Act of 1992, Pub. L. No. 102-385, 106 Stat. 1460, (1992).

Industries Association/Consumer Electronics Group (EIA/CEG) Interim S
S-6) defines a uniform channelization plan for cable systems.
National Standards Institute (ANSI) is now certifying IS-6
of a new version is also underway to cover the latest new
extended bandwidth cable systems.

the Desirable Characteristics of Reception Equipment to be
Cable: Interim Standard 23 (IS-23) by the Joint Engineering
Draft under active negotiation since 1985.[14]

band Interface Between NTSC Television Receiving Devices and
Devices: EIA/ANSI-563. This standard defines a decoder interface
which locates the signal descrambler after the tuner of the TV or
to market in 1989 with over 1 million TVs the cable industry
the use of the decoder interface and the electronics industry
ntinued its efforts to include these connectors except for high-

concerns, this situation led Congress to require that the FCC
possibility of mandating compatibility standards for cable television
1992 Cable Act ordered the FCC to examine the compatibility
sets, VCRs and cable systems consistent with the need to
able service.[16] This report found the following compatibility

nelization plans (both in the number of channels and the center
of each channel) between customer equipment and cable systems
boxes[17] that effectively disable TV and VCR features (e.g., set-on
prevent simultaneous viewing and recording of programs,
recording on different channels, or viewing picture-in-picture
features).

remote control units do not operate the set-top units.

compatibility problems, the FCC has proposed to require new
ds for cable systems. These rules would
ng of signals on the basic tier of cable service.

Electronics and Cable System Compatibility: Report to
mmunications Commission. October 1993.

unctions of today's set-top boxes include: 1) provide access to
nge of channels on the cable system exceeds that of the
er or VCR, 2) shielding to prevent leakage of cable signals
cable system from external radio signals, 3) remote control
mer equipment without its own remote control, 4) channel
ses of parental control of children's television viewing, 5) to
signal security. Only one channel output from the set-top

roposed Rulemaking, In the Matter of Implementation of
Television Consumer Protection and Competition Act of
Between Cable Systems and Consumer Electronics
No. 93-7, released December 1, 1993.

Draft Prior Part of the Without Permission of the Author

- allow subscribers the option of viewing all pay-per-view signals;
- require cable systems to notify the supplementary equipment needed to enable the operation of activated features of customer equipment;
- if cable operators like subscribers the option of renting a remote control unit, they must also permit operation of commercially available remote control units;
- require cable systems to use the EIA/IS-6 channel plan;
- adopt new standards for all equipment marketed as "cable ready" including the EIA/IS-6 (or better) interface connector (this will allow television signals to first pass through the television VCR tuner so as not to disable advanced features before descrambling by a standalone decoder), and the ability to tune to all channels specified in IS-6;
- require cable operators to provide component descramblers/decoders at the subscribers without a separate charge.

On the surface, it would appear that the cable compatibility rules are more stringent than similar rules for telephone networks. The different approaches arise because of the different nature of each service. The broadband nature of cable systems means that all signals, even those for services which a subscriber may not have be paying for, are transmitted to every household. Cable systems scramble video signals to ensure access to different channels on the subscriber bus. The proprietary nature of scrambling and the fact that some descrambling technologies require additional equipment in the customer premises, emphasize the formation of compatibility standards for cable systems.

Telephone networks, in contrast, are fully switched, and therefore do not require scrambling as a security measure since only those signals intended for the subscriber are available on the network. This switched network permits the definition of an interface that separates the CPE from the network. Policy makers would prefer a similar approach with cable systems. Accordingly, the FCC rulemaking encourages the use and development of cable signal delivery methods such as traps, interdiction, addressable filters and other clear channel delivery systems that eliminate the need for any additional equipment in the subscriber's premises.

Likewise, as with telephone networks, there is the question of how compatibility standards for cable systems can evolve with new technological developments. Cable systems also are beginning to upgrade their networks with fiber optic systems which, when coupled with digital video compression technology, could greatly expand channel capacity. These developments have fueled intense interest in broadband, general-purpose set-top devices, which many believe will evolve into multimedia home entertainment centers using current multimedia workstations as a guide. Yet, the current compatibility standards, for example, do not support two-way interactivity. Given the 10-month product lifetimes common to consumer equipment, how can the FCC ensure sufficient flexibility in the compatibility standards to accommodate such multimedia services, innovations and new service offerings.

IV. Discussion

Relying on a view of standards that goes beyond the common view, this paper demonstrates how standards are playing a key role in the transition to a more local competition. The interconnection and compatibility requirements are serving as the key regulatory tools for promoting both facilities-based competition and competition in information services. The standards requirements described above apply only to the telephone or cable television companies with dominant status in their respective markets, not to the new entrants. This asymmetry in regulation can be justified by the near monopoly position now held by telephone companies in telephony markets. So far, the overriding intent of using interconnection requirements has been to foster new entry and interoperability with the dominant carriers.

The rules for personal communications services (PCS) offer an example of the FCC deferring, at least for the time being, from establishing interconnection standards between wireless providers for the purposes of interoperability (the rules do include rules for interconnection to the public switched telephone network). A key element of these rules is the broad definition of PCS, which gives PCS licensees the flexibility to provide almost any set of wireless services.[19] Thus, for any given area, PCS providers may offer different services using different, incompatible, radio systems. In weighing the costs and benefits of standards for PCS, the FCC decided that the benefits of standards, namely roaming throughout large regions and the certainty of a standard, likely would be less than the benefits of flexible licenses, particularly given the significant uncertainties regarding the optimum PCS technologies.

Moreover, mandating PCS standards would inevitably favor particular applications, technologies or network infrastructure. PCS providers, in particular, are expected to be an important source of competition in local telephone markets and to draw upon a wide variety of existing infrastructure to deliver their services. Thus, a decision by the FCC to mandate standards at this early stage of industry development could inadvertently, and significantly, bias the structure and evolution of the market.

In addition to not requiring interoperability among wireless providers, the FCC also has loosened CPE compatibility requirements. Recently the FCC modified its cellular bundling policy to allow cellular CPE and cellular service to be offered on a bundled basis, provided that cellular service is also offered

[19]As stated in the *Report and Order*, the definition of PCS is given as "radio communications that encompass mobile and ancillary fixed communication services that provide services to individuals and businesses and can be integrated with a variety of competing networks." (FCC, 1992a, ¶24). PCS licensees cannot use the allocations for broadcasting or exclusively for fixed point-to-point services.

separately at a nondiscriminatory price.[20] This decision relied upon the finding that the market for CPE was sufficiently competitive to prevent a facilities-based provider from restricting competition through anticompetitive behavior.

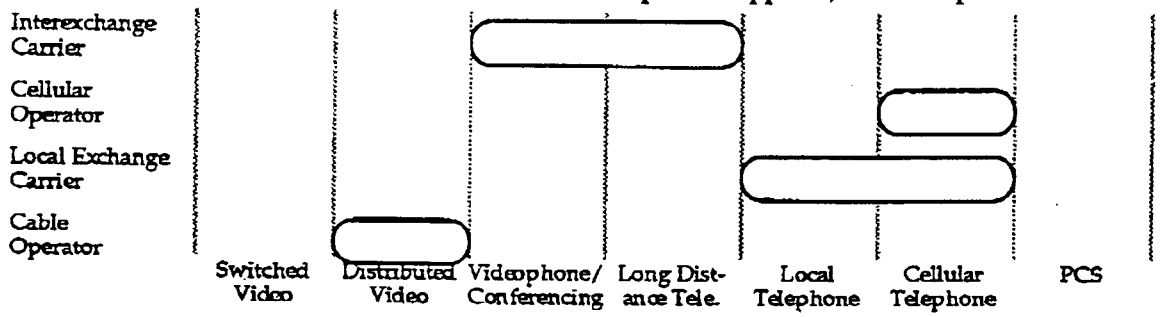
Thus, as demonstrated by the regulatory framework for PCS, potential competitors in the local telecommunications markets presently do have a different regulatory status. At this early point in the transition, this asymmetry is viewed as necessary to correct for the residual market power of the incumbent monpolists. But calls for regulatory parity are already being sounded, and equivalent interconnection and compatibility standards requirements likely will be an important component of these considerations.

As the transition to local competition progresses, some important standards-related issues likely will be:

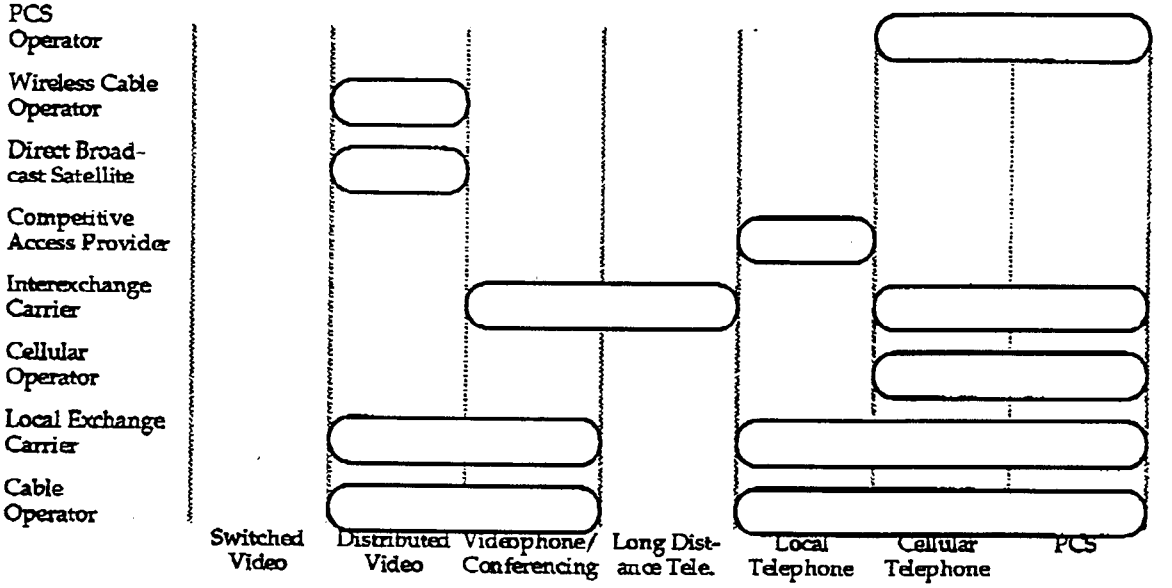
- Are their new potential bottlenecks in the subscriber loop infrastructure created by new technological developments (*e.g.*, video servers) that can be addressed through interconnection or compatibility requirements?
- Which competitors should have to meet standards requirements? Should telephone and cable television companies be subject to the same interconnection and compatibility requirements?
- Can interconnection standards be used as a regulatory tool to force the emergence of a cost-based pricing structure?
- What are the inherent technical limits to interconnection requirements?
- At what point do logical interconnection requirements become unnecessary if facilities-based competition emerges?

[20]In the Matter of Bundling of Cellular Customer Premises Equipment and Cellular Service, Report and Order, CC Docket No. 91-34, Released June 10, 1992. FCC 92-207 38396.

Current Market Structure: Separate Suppliers, Less Competition



Near Term Market Structure: More Suppliers, Joint Ventures, and Competition



Long Term Market Structure: Suppliers Build Multimedia Platforms, Competitive Markets