CIRF

Converging Industries Research Foundation

Practical Solutions for Communications Policy

A Snapshot in Time: LEC Switch Investment and Price Structures for Connections to the Switch Just before the Telecommunications Act of 1996

May 10, 1996

Presentation at the July 1996 NARUC Meeting, Los Angeles, CA

www.ConvergingIndustries.org

A Snapshot in Time: LEC Switch Investment and Price Structures for Connections to the Switch Just before the Telecommunications Act of 1996

May 10, 1996

Presentation at the July 1996 NARUC Meeting, Los Angeles, CA

Telecommunications Industries Analysis Project

Carol Weinhaus
Telecommunications Industries Analysis Project

Bob Lock
Illinois Commerce Commission

John Bosley and Dennis Wax
NYNEX

Pat Constable, Mike Shelton, and Glen Sims
SBC Communications

Dan Harris
Bell Atlantic

Terry Monroe
New York Public Service Commission

Jeff Dupree
NECA

Bill Brown
BellSouth Cellular

Mark Jamison
Sprint

Peter Copeland
U S WEST

Charlene Lagerwerff
Federal Communications Commission

Rich Go
360E Communications

Charlie Rizzo
Bellcore

Paul Vasington
Massachusetts Department of Public Utilities

David Charlton
Corning Inc.

Hitoshi Imafuku
NTT America

Takashi Nakayama
InfoCom

Sanford Berg
University of Florida

Sally Simmons
Florida Public Service Commission

Ray Marner
Kalona Cooperative Telephone

Pete Martin
BellSouth

Douglas Rice
Telecommunications Industries Analysis Project

Copyright and Project Address

Telecommunications Industries Analysis Project:

A Snapshot in Time: LEC Switch Investment and Price Structures for Connections to the Switch Just before the Telecommunications Act of 1996

Carol Weinhaus, Bob Lock, John Bosley et al.
May 10, 1996

Presentation at the July 1996 NARUC Meeting, Los Angeles, CA

The Telecommunications Industries Analysis Project is associated with the Public Utility Research Center at the University of Florida College of Business Administration.

In addition to the work of project participants, the project appreciates the reviews of this paper by Jim McConnaughey of the National Telecommunications and Information Administration (NTIA); Doug Weiss of the Corporation for Public Broadcasting; David Berman of Bay Networks, Inc.; Brian Kahin of the Harvard Information Infrastructure Project, Harvard University; Linda Garbanati and Jim Deak of Bellcore; and Bartlett Thomas of Continental Cablevision.

The views expressed in this paper are those of the Telecommunications Industries Analysis Project. The information in this paper is intended to provide general public information and does not constitute or foretell the official position of any of the parties who contributed to this paper. The opinions expressed in this paper do not necessarily reflect the views of the FCC or of any other agency or institution.

Graphics were produced by Erika Jobson, Cedar Designs.

For information on this research, contact Carol Weinhaus at:
www.ConvergingIndustries.org

Table of Contents

Table of Contents, cont.

Project Information

List of Participants in the Telecommunications Industries Analysis Project

State Regulators	NARUC Representatives from: Florida Public Service Commission Illinois Commerce Commission Iowa Utilities Board Massachusetts Department of Public Utilities New York Pubic Service Commission Ohio Public Utilities Commission Washington Utilities and Transportation Commission
Regional Holding Companies	Bell Atlantic BellSouth NYNEX SBC Communications Inc. U S WEST
Independents	GTE Kalona Cooperative Telephone Sprint Local Telecom Division
Interexchange Carriers	AT&T Sprint
Cellular and Wireless Carriers	360º Communications
Foreign Domestics	InfoCom Research, Inc. NTT America
Local, National, and International Services	BT France Telecom North America
Materials Manufacturers	Corning
Academic	University of Florida

Sponsors:

Corporation for Public Broadcasting

Assisting with *public* data:

Bellcore
Federal Communications Commission
National Exchange Carrier Association
National Telecommunications and Information Administration

Project Information, cont.

Background on the Telecommunications Industries Analysis Project

The goal of the Telecommunications Industries Analysis Project is to provide information to support the development of alternative communications policies to meet the needs of stakeholders in an environment that includes competitive and non-competitive markets, federal and state regulatory jurisdictions, and a proliferation of new services made possible by technological advances. The purpose of the project is to produce research and analysis which will assist policy makers in making informed decisions.

The project is a neutral forum of communications industry stakeholders exploring multiple viewpoints of selected issues. This forum incorporates the following elements:

- **Broad representation:** The current forum includes foreign and domestic local exchange carriers (LECs), interexchange carriers (IXCs), materials and equipment manufacturers, and federal and state regulators. The project actively seeks expansion of this forum to include other communications industry representatives such as competitive access providers, cable television companies, computer companies, electric power utilities, or publishers.

- **Multiple viewpoints**: Participants are required to play an active role in the research and analysis, to represent their own interests, to understand and to assist in developing others' perspectives, and to work toward the common goal of representing multiple views. Since papers reflect multiple viewpoints and ideas, authors and reviewers may not agree with particular views or approaches expressed in the papers. The objective is to lay out ideas and options to assist policy makers in their decisions.

- **Analysis and results of alternative policies**: Research tools, including a jointly produced data base and computer software models, and data analysis developed by this forum create a common language for examining issues. The common language allows the participants to focus on underlying issues. Appropriate computer software tools, including modifications to existing tools, are developed.

- **All data, analysis methods, and results are public**: Data used by this project must be publicly available on a nationwide basis. Research products become public domain information.

- **Neutral setting**: The project resides in a neutral setting, free of partiality, thereby ensuring objective and independent research.

List of Figures and Diagrams

List of Figures

List of Figures, cont.

List of Acronyms

List of Acronyms

2B + D	Two bearer (voice/data) channels and one data signaling channel
AIN	Advanced Intelligent Network
ALT	Alternative Local Telecommunications (service provider)
ALTS	Association for Local Telecommunications Services (trade association)
BOC	Bell Operating Company
BRI	Basic Rate Interface
Cable TV	Cable Television
Caller ID	Caller Identification
CAP	Competitive Access Provider
CCLC	Carrier Common Line Charge
CCS	Common Channel Signaling
CLEC	Competitive (or Certified) Local Exchange Carrier
CMRS	Commercial Mobile Radio Service
CMS	Commercial Mobile Service
CP	Central Processor
DS-1	Digital Service 1
DS-30	Digital Service 30; also referred to as DS-3
DS-512	Digital Service 512
E911	Enhanced 911 Services
ENET	Enhanced Network
ESP	Enhanced Service Provider
EUCLC	End User Common Line Charge
FCC	Federal Communications Commission
FX	Foreign Exchange
HH	Households
ICC	Interstate Commerce Commission
ICCF	Industry Carriers Compatibility Forum (ICCF)
ILEC	Incumbent Local Exchange Carrier
IP	Intelligent Peripheral
ISDN	Integrated Services Digital Network
IXC	Interexchange Carrier
LATA	Local Access and Transport Area
LEC	Local Exchange Carrier
Mbps	Megabits per second
MF	Multi-Frequency
MFJ	Modification of Final Judgment
NANP	North American Numbering Plan
NECA	National Exchange Carrier Association
NPA	Numbering Plan Area
NTIA	National Telecommunications and Information Administration
NY PSC	New York Public Service Commission
NXX	Central Office Code or Area Code (in a Telephone Number)
OCC	Other Common Carrier
PBX	Private Branch Exchange
PCS	Personal Communications Services
POP	Point of Presence

List of Acronyms, cont.

PRI	Primary Rate Interface
PSN	Public Switched Network
RBOC	Regional Bell Operating Company
RIC	Residual Interconnection Charge
SCP	Service Control Point
SLC	Subscriber Line Charge
SS7	Signaling System 7
SSP	Service Switching Point
STP	Signal Transfer Point
TIC	Transport Interconnection Charge
TV	Television

II. LEC Switch, Transport, and Local Loop

Introduction

This paper describes how interconnection issues have been addressed in the U.S., including the current status of interconnection with traditional local telephone company networks. The objective of this paper is to provide a snapshot in time of investments and interconnection pricing structures associated with local telephone company switches. In the past, interconnections by different types of companies and customers were treated differently according to technical differences and to the politics of the day. This paper reveals four important points that policy makers should consider:

- Today's digital technologies are removing the technical differences between some types of connections, but not all.
- Today's political environment has removed many of the differences between various companies.
- Changes in how customers use networks (specifically, the increased use of faxes, Internet, point of sale, and other data services) are causing dramatic changes in the underlying assumptions about how networks need to be engineered.
- Even though the types of companies, the customer usage patterns, and technologies have changed, the old pricing structures have remained.

The *Telecommunications Act of 1996* requires sweeping changes in interconnection price structures. This Act not only requires telephone companies to interconnect with one another, the Act also provides rules and lays out new definitions for what constitutes a telecommunications carrier.[1]

> Each telecommunications carrier has the duty... to interconnect directly or indirectly with the facilities and equipment of other telecommunications carriers - *Telecommunications Act of 1996*, Sec. 251(a)(1).

In accordance with the Act, the **Federal Communications Commission (FCC)** initiated a proceeding to revise the rules or interconnection between companies.[2]

This paper sets the stage for discussion by describing a snapshot of connections to traditional local telephone company switches just before legislation passed. This paper does not attempt to define terms, such as "access" or "interconnect," since interpretation of the *1996 Act* is a matter of ongoing debate.

The legislation provides a blueprint for opening markets to competition and for removing traditional boundaries between telephone, ***Cable TV***, and broadcast industries. This paper lays the groundwork for revising the labyrinth of rules for setting prices for interconnection with local telephone companies. The term for these companies is ***Local Exchange Carriers (LECs)***. However, the Act also distinguishes between new entrants (also called LECs) and the traditional local companies, called ***Incumbent Local Exchange Carriers (ILECs)***. Therefore, in this paper, the term "LEC" refers to both the ILECs and the new market entrants.

II. LEC Switch, Transport, and Local Loop

In order to allow quick identification of key concepts, these terms are in both boldface and italics when they first appear. These terms include names of different types of companies and customers that connect to the ILEC switch and names of major network elements.

It is important to note that current practices, which have evolved over time, are the starting point for implementing new interconnection policies and making sweeping changes. **Figure 1** provides an overview of the history of connection to the ***Public Switched Network (PSN)*** through the local exchange carrier. In the past, the rules for connecting companies and customers depended on the market philosophy (monopoly, competition, and regulation) in place at the time. The current move to competition can be seen as a pendulum swinging between the philosophies of monopoly and competition.[3] As **Figure 1** indicates, the United States is currently moving toward competition for a third time, nearly a century after the first cycle. For background for this chart, see **Section VI, Appendix A**.

The sections in this paper cover the following items:

- **Section II, LEC Switch, Transport, and Local Loop:** Describes the general types of connections with the LEC switch made by the companies or customers described in **Figure 1**. **Section II** also provides simple definitions of the LEC network elements associated with hooking up to the LEC network and routing traffic through it. In addition, there is a discussion of switch duration and capacity measures.

- **Section III, Percent of Total Switch Investments by Company/Customer:** Indicates the percentage of switch investments for what is common to all companies and services, and what is specific. Percentages are for both large and small switches currently being installed by ILECs.

- **Section IV, Different Price Structures by Type of Company:** Shows the different pricing structures for connection to the LEC switch and for routing traffic through it.

- **Section V, Summary:** Provides an overview of the main points covered in this paper: variation in prices for connection to the LEC switch, comparisons of percentages of LEC switch investment, and traditional switch engineering for traffic routed through the PSN.

- **Section VI, Appendix A: Monopoly/Competition Time Line:** Uses a time line to illustrate that when various companies and services arrived on the scene, different philosophies toward monopoly, competition, and regulation were dominant.

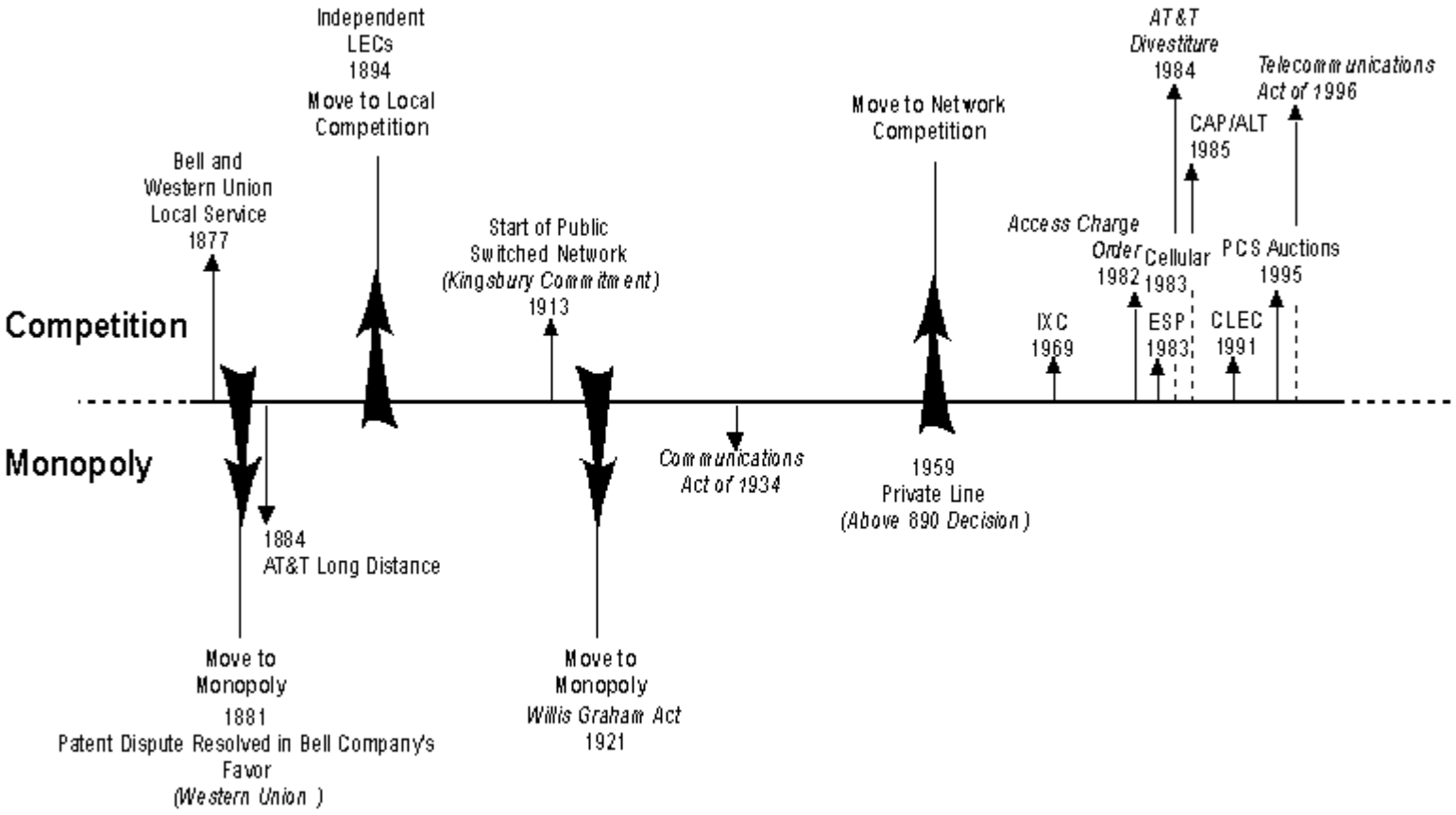
- **Section VII, Appendix B: Definitions:** Provides definitions for the names of key competitors and concepts.

- **Section VIII, Appendix C:** Competitive Checklist: Contains the language from the *Telecommunications Act of 1996* defining the competitive checklist that the Bell operating companies (BOCs) must meet before they may provide interLATA (Local Access and Transport Area) services.

- **Section IX, Appendix D: Switch Modeling Definitions and Assumptions:** Provides greater detail on the definitions and assumptions used to model the switch investment.

- **Section X, Notes**

Figure 1: Monopoly/Competition Time Line, 1877-1996



II. LEC Switch, Transport, and Local Loop

Major Network Elements

The types of connections for companies described in **Section II** depend on the technology, rules, and market philosophy existing at the time when the companies arrived on the scene. This paper focuses on the "local" switch since sooner or later traffic has to pass through this switch because it connects customers to the public switched network, or PSN. New entrants want to reach all customers on the PSN; and currently, the only way for everyone to reach everyone else is to route traffic through an ILEC switch at some point.

This paper is a snapshot of the PSN at the time of the *Telecommunications Act of 1996*. Points of connection other than the local switch, such as the line to the customer, may play a major role in the future. For a discussion about other points of connection that are closer to the customer, see *Section III, Location of Connection Points*.

In addition, this paper covers connections to the LEC switch because it is a major network element central to the interconnection requirements in the *Telecommunications Act of 1996*. The Act defines a checklist of minimum network/service requirements that the BOCs must provide in order to open local markets to competition. Completing this checklist allows a BOC to provide in-region interLATA long distance.[4] (For the complete checklist, see **Section VIII, Appendix C**.) Therefore, this section focuses on the following requirements from the Act's competitive checklist: loops, transport, and switching.[5] The definitions for these network elements are as follows:

- **Loop Transmission:**
  The communications path from the company's switch to and from the customer is commonly called the ***local loop***, commonly called the "***loop***". Loops are provided by a number of different technologies. For a **wireline** transmission, the path is made of copper wire, coaxial cable, or optical fiber. Wireline networks include the traditional telephone network. Loops are also called ***access lines***, or even shortened to just **"lines."**[6]

- **Transport:**
  A ***trunk*** is a transmission route between two switches. These routes are also referred to as ***transport facilities*** in LEC networks.

- **Switching:**
  A ***switch*** is a specialized computer that provides, among other functions, the ability to connect and disconnect one customer to any other customer connected to that switch, or to reach all other customers through trunks connected to the PSN. The LEC switches that connect loops with the PSN are also called ***central office switches***, or ***end office switches***, since the central office of the local telephone company was historically the building that housed these switches. For clarity in describing interconnection issues, this paper focuses on the central office connections.

It should be noted that LECs may have other types of switches to which other companies may connect. Switches that link only trunks are called ***tandem*** switches. These switches simplify the routing of calls by avoiding the need to connect every switch to

every other switch. Instead, a tandem switch collects traffic from multiple switches, serving as a central traffic routing point. Tandem switches perform a function similar to that of an airline hub where passengers fly into a central point for routing to other destinations.[7] Often the tandem switch is the location of the connection point between two companies. In this case, the company that owns the tandem switch routes the call through trunks connected to the central office switch. These facilities are not covered in this paper since the focus is on the LEC local switch.

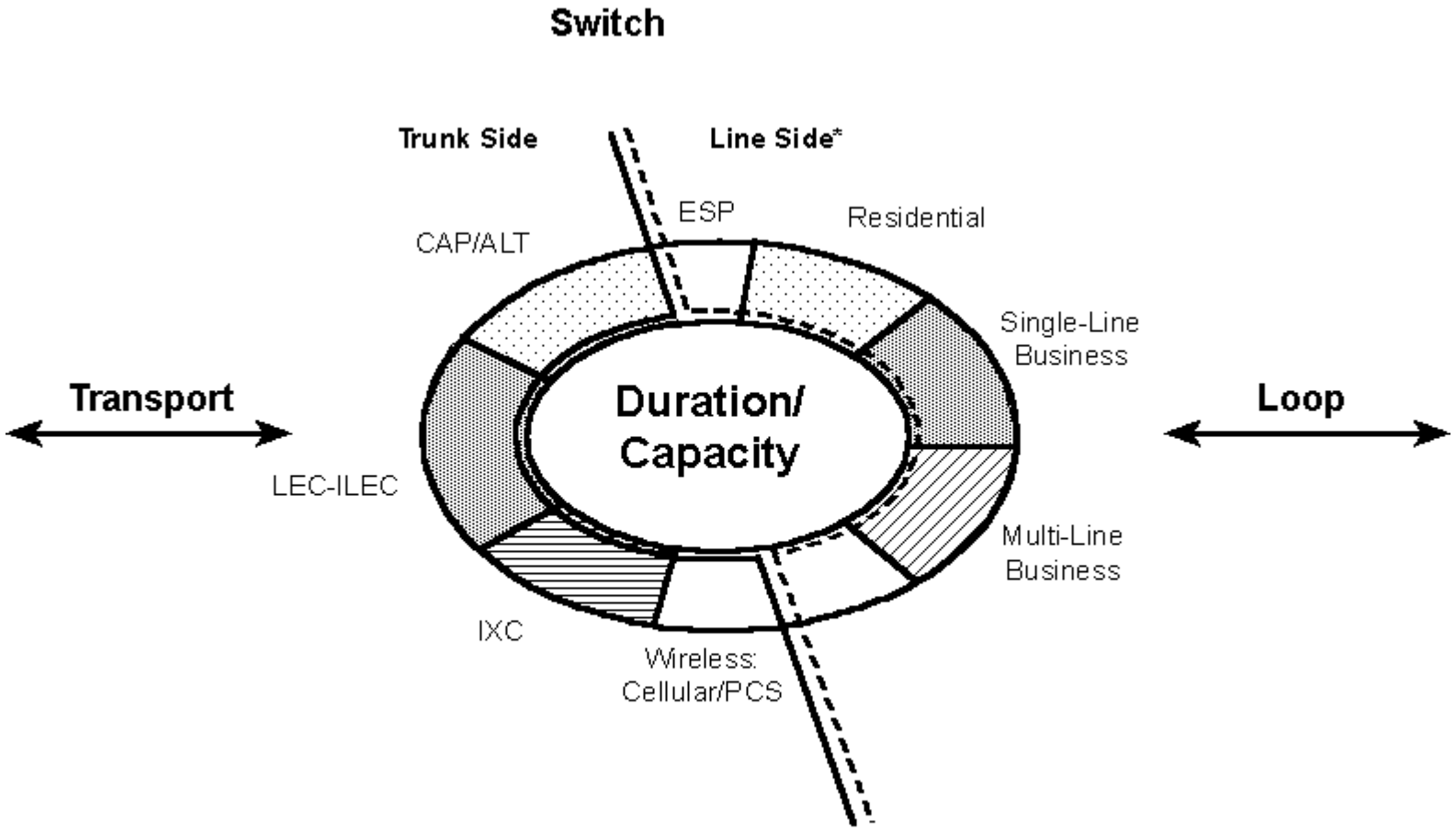
Figure 2 indicates three of the major network elements associated with interconnection with the LEC network: loop, transport, and switch. This figure provides a high-level, simplified view of complex relationships among connecting companies. There are two general categories of connection with the switch based on early technologies: loops and trunks. The earliest switches routed calls among only those loops attached to the switch. Later, trunks routed calls between switches. Today, the term ***trunk side*** refers to the ***port***, or location, on a switch where a trunk connects. The term ***line side*** refers to the port on a switch where the loop connects.[8] See **Section IX, Appendix D, Requirements for Ports: Trunk Side and Line Side**, for a comparison of the technical differences between trunk side and line side connections.

Connections by Type of Company or Customer

The focus of **Figure 2** is on the different types of companies and customers that connect to the ILEC switch. The following descriptions are part of the snapshot in time presented in this paper. However, as technologies continue to evolve and services continue to change, the traditional methods for defining services, measuring traffic, and designing networks become increasingly meaningless. For example, as more people work at home,[9] the distinctions between small business use and residential use become increasingly hazy. It should also be noted that cellular mobile telephone services, defined by the FCC as a local exchange service, have never made a distinction between business and residential customers. The types of connections illustrated in **Figure 2** can also be linked to the time line in **Figure 1**.

The following switched services have line side connections to the ILEC switch: ***Residential*** (service to homes), ***Single-Line Business*** (one-line service), ***Multi-Line Business*** (two or more lines in service), and ***Enhanced Service Providers (ESPs)*** . The following companies generally have trunk side connections (between the ILEC switch and another company providing services): ILEC-to-LEC, ***Interexchange Carrier (IXC)***, and ***Competitive Access Provider (CAP)/Alternative Local Telecommunications (ALT) Provider.***[10] In some cases, the company connecting to the ILEC switch may use both line side and trunk side connections. These may be ***wireless companies***, also called ***Commercial Mobile Service (CMS) Providers*** - which include ***Cellular*** and ***Personal Communications Services (PCS).*** **Figure 2** refers to connections between companies and not to connections between the ILEC and the ESP/wireless company's customers. From the ESP customer's viewpoint, the connection to the ILEC switch is through residential or business services. From the wireless

Figure 2: Interconnection to ILEC Switch by Type of Company or Customer



*In some cases, IXCs, new entrants, and others may also use line side connections.

Customer's viewpoint, the connection to the ILEC switch is through the wireless carrier's switch.

Providing services, such as ***E911 (Enhanced 911)*** or operator services, to residential and business customers requires additional functions in a LEC switch. See **Section IX, Appendix D,** for a definition of these service specific features.

Basic Network Configurations for Connections between Companies

Before there can be a discussion on variations in price structures for connections between companies, it is important to understand the basic network configurations for these connections. The various diagrams in **Figure 3** illustrate the major types of network configurations for connections by various companies to the LEC (ILEC or new market entrant) switch. It is important to note that in **Figure 3** the emphasis is on the LEC switch and how other companies and local customers connect to it. For some connecting companies, the point of entry into the LEC network, is a tandem switch and not the local LEC switch. In this case, the call will travel through additional facilities (more trunks and switches). Therefore, the picture for some connections is more complicated than those covered in this paper.

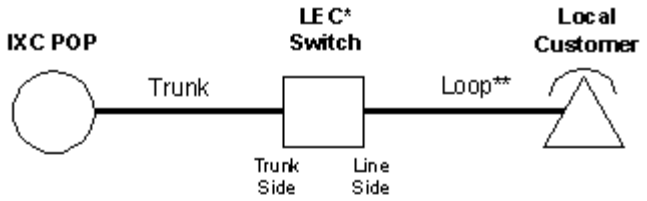
Figure 3A illustrates the traditional network configuration for "access" connections between a long distance company and the LEC switch. This diagram reflects the long history of local and toll calls - from the start of the Bell-Independent partnership (formed to connect independent company local switches with the Bell long distance network) up through the breakup of AT&T.

In the case of an IXC, the local customer's traffic goes into a line side port on the LEC switch and out a trunk side port. A trunk (transport facility) carries the traffic to a specific location, called a ***Point of Presence (POP)***,[11] where an IXC connects to the LEC network. This location in a LEC service territory is where all such connections are made.[12] The IXC can either route traffic received from the LEC switch through its own network or pass the traffic to another company's network connected to the IXC. Other companies that may connect to the IXC POP (in order to use the access configuration to reach LEC local customers) include wireless companies and other LECs.

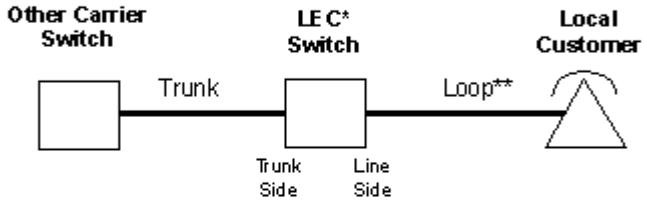
Figure 3B shows a network configuration in which a company, referred to as the "Other Carrier," connects one of its switches with the LEC switch using a LEC trunk. This configuration is similar to that in **Figure 3A**. In this configuration, the Other Carrier may be another LEC, a CAP/ALT, a wireless company, or a cable TV company.

The diagram in **Figure 3C** shows the network configuration for a variant of switch-to-switch connections - ***collocation*** arrangements. With collocation, a carrier pays for space in the LEC's building (called a ***central office***, or ***wire center***) and obtains trunk side ports or line side ports on the LEC switch. This location may be a physical presence or may be a

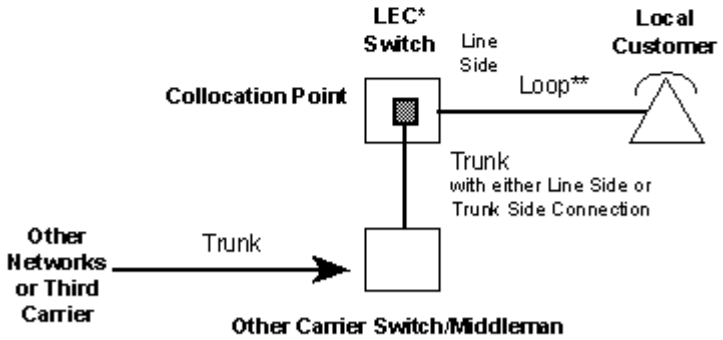
Figure 3: Network Configurations for Connection to the LEC Switch



A. Long Distance Company Access



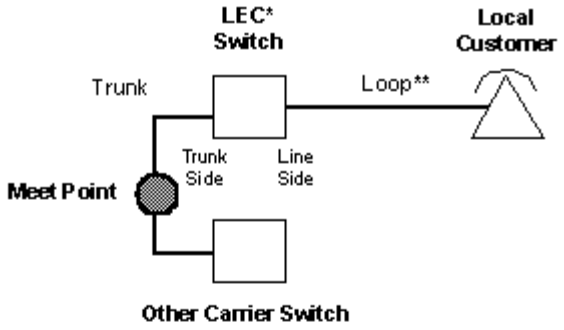
B. Trunk Side Port



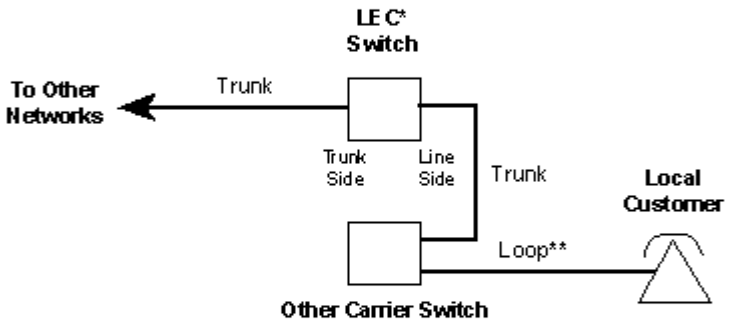
C. Collocation: Trunk Side Port or LIne Side Port

*Either an ILEC or a newmarket entrant.
**Also referred to as access line.

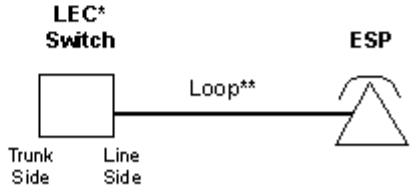
Figure 3: Network Configurations for Connection to the LEC Switch, cont.



D. Meet Point on Trunk



E. Line Side Port



F. ESP by Line Side Port

*Either an ILEC or a new market entrant.
**Also referred to as access line.

virtual arrangement - the connection is outside, but near to, the building housing the switch.

In **Figure 3C**, the Other Carrier collocates in the LEC central office and connects to either a trunk side port or a line side port. In this configuration, the Other Carrier may be another LEC, a CAP/ALT, a wireless company, an IXC, or a cable TV company. Often, a CAP/ALT will serve as a middleman connecting traffic from an IXC POP to the LEC switch. Also, a third party may connect to the Other Carrier's switch. This third party may be another LEC, an IXC, a wireless company, a cable TV company, or a large business customer.

In ***meet point*** billing arrangements, the LEC and the Other Carrier connect at a mutually agreed upon point on the trunk between their two switches (**Figure 3D**). The same types of companies that use collocation connections may, as an alternative, use meet point connections. Typically these arrangements are used by small telephone companies, and more recently, by new entrants who lack direct connections to IXCs. It should be noted that at the time of the *Act*, collocation and meet point arrangements were optional for the Other Carrier, but not for the LEC.

Figure 3E shows another network configuration used by wireless companies and CAPs/ALTs. Here the Other Carrier connects to the LEC switch through a line side port in order to route traffic to other networks, including the PSN. There are technically different types of wireless connections to the LEC switch (see **Section IX, Appendix D**, for details.) In the early days of IXC competition, the IXCs used line side connections.[13] Some IXCs still use these types of connections.

The last diagram shows an ESP connection (**Figure 3F**). This configuration shows how customers reach ESPs. In most cases, the ESP's own customers make the calls and the ESP receives them. (While these figures focus on how customers reach an ESP through the telephone network, ESP companies also need communications services to operate their business - purchasing, sales, etc. These business connections are the same as any other business and, therefore, are not covered in these diagrams.)

In **Figure 3F**, the ESP company is the customer and generally connects to the LEC switch through a loop with a line side port. In this diagram, the ESP's connection is similar to any local business customer connecting to the LEC switch. The ESP may take incoming traffic from its customers and directly provide services through a data base, may send the call to another database across the country, or may connect the customer to the Internet. This connection provides the ESP with a convenient way for its customers to call into the ESP service.[14]

Switch Traffic Considerations: Duration/Capacity

The PSN is currently engineered for traditional telephone voice and data traffic. The major properties of traffic passing through a switch are how many calls (capacity) and how long (duration). The following is a list defining key concepts that are used to determine what's needed in a given switch:

- **Switch Capacity:** Theoretically a central office switch may be able to have all its loops and trunks in use simultaneously. But in reality, this number is improbable. If every customer were to dial a call into this switch at the same time, the switch would not be able to set up all these connections. The result is that calls are ***blocked*** (not completed). The average local switch is engineered to switch approximately 20% to 45% of its total loops at a given time. However, other usage measurements also determine switch capacity and components.

- **Trunk Capacity:** A central office switch may be able to connect all the line side customers with one another. However, if every customer tries to make a call at the same time to a destination reached by trunks, a percentage of these calls will not be completed, and the call will be blocked. The result is that the customer can't make the call.[15] Switch engineers look at traffic patterns to determine the ratio of trunks to lines. **Figure 4** shows the average trunk to loop ratio used for traditional LEC switches. The range is from 1:4 to 1:10 for the ratios of trunks to loops.[16] The actual ratio depends on various factors such as number of calls, calling patterns (intra-office v. inter-office), call duration, and demand for specific services - i.e., call forwarding, call waiting, ***Centrex***, or ***Integrated Services Digital Network (ISDN)***. With a low ratio (1:10), call blocking (the inability to switch a call) may occur.

- ***Line Concentration Capacity: A line concentration module*** connects traffic from several loops into the switching module of a digital switch. Essentially, the line concentration module is a place where the traffic is concentrated to fewer paths.[17] This allows more efficient use of facilities to the switch since high-use loops and low-use loops can be combined to share a common path into the switching module, thereby increasing the efficiency of the switching. An increase in traffic volume requires a decrease in the line concentration ratios, such as a decrease from a 8:1 to a 6:1 ratio of loops to paths. If too many loops are in use, calls never make it into the switching module and the customer making the call either hears a fast busy signal (an overflow tone) or hears no a dial tone.

- **Duration:** This is the length of time a call takes - from call setup to call termination. Duration is greater than conversation time. Traditional telephone voice traffic ranges from 2 to 5 minutes per call. The actual duration of voice or data transmissions may be much larger or much smaller. For example, the average Internet connection from a home is 1 hour and 8 minutes, while a credit card verification takes only seconds.[18] The model in this paper assumes average traffic of 5 minutes (300 seconds) for all types of traffic.[19]

Figure 4: Comparison of Traditional Switched Telephone Network Traffic, Switched Internet Use, and Non-Switched Cable TV Use

Description of Switch Parameter:	*Traditional Telephone, Switched:*	*Internet, Switched:*	*Cable TV, Not Switched:*
Percent of U.S. Households with Service	**94%**	**4%**	**63%**
Holding Time per Connection: The average length of time per individual connection.	Assumption for model: 5 minutes per call (300 seconds per call).	1 hour 8 minutes per average session length.	Not Switched.
Capacity Measurements: ▪ *Trunk to Line Ratio:* The largest percent of loops (lines) that can be routed to a destination beyond the switch at any given time. This is one measure of peak capacity. ▪ *Percent of Loops in Use:* The largest percent of loops (lines) in use. This is a second measure of peak capacity. ▪ *Line Concentration Ratio:* This is the number of loops whose traffic is channeled into a single path by one line concentration module. This is a third measure of peak capacity.	Various methods to Measure capacity: Range is 1:4 to 1:10. Assumptions for model: Small Switch has 1:6 Ratio, or 16.7%; Large Switch has 1:5 Ratio, or 20%. Not an engineering criterion. Assumption for model: 6:1 Ratio	If the traditional telephone network is used for Internet access, then the engineering criteria are the same. Otherwise, depends on engineering of individual networks (nodes and transmission routes) owned by multiple parties. Also depends on how individuals connect to the Internet.	Not Switched, 100% Connected.
Busy Hour Call Volume per Hour: The number of calls a switch must be able to handle during its busiest hour, called the "peak load time."	Assumptions for model: Small Switch has 3,600 calls; Large Switch has 100,000 calls.		Not Applicable.
Call Completion: Percent of calls completed (destination point answers the call).	Assumption for model: 80-85%.		

This figure excludes information on lines not in service or needing maintenance. The average weekly viewing is for total TV (broadcast and cable TV) in households that have cable TV service is 59 hours and 12 minutes. **Section IX, Appendix D**, for sources and background on the data for this figure.

Changes in How Customers Use Networks

The current switches have been engineered for traditional parameters (**Figure 4**) while new technologies and new services are creating the need for different parameters. The cause is the widespread use of the traditional telephone voice network for data transmission. From the customer's view, these are faxes, e-mail messages, telecommuting from home, Internet use, point of sale transactions, and online information services.

Adding to the impact of increased data transmissions is the increased ability to tailor services to individual customers, such as offering personal 800 numbers. Another indicator is that if new 3-digit area codes (called ***Number Plan Area***, or ***NPA***, codes) continue to be assigned at the current rate of approximately one a month, the supply of 10-digit phone numbers will be used up around the year 2040.20 Yet another example is the increase in home-based Internet users. While current Internet use is an extremely small fraction of the switched local traffic, there have been instances where customers have been unable to get a dial tone due to a large number of ESP users feeding into a given telephone line concentration module.[21] In these cases, calls are blocked and some customers are unable to get even a dial tone. While these cases are rare, they indicate that if Internet usage increases, switches may need reengineering.

In addition to the increases in calls of a longer duration (online services, Internet) than that of an average voice call, there have also been increases in calls of shorter duration, such as faxes, credit card justification, and point of sale debit cards.[22]

The column with telephone statistics in **Figure 4** focuses on what happens when a call is sent through the switch. The quality of service issue contains more elements than those presented in **Figure 4**, and this issue is not covered in this paper.

Figure 4 compares some usage and capacity measurements for traditional telephone network traffic with Internet use and with cable TV use. Cable TV has been added to this list to indicate that there are other alternatives to the traditional telephone industry for Internet connections. It should be noted that traditional cable systems have been engineered for one-way traffic (from the company's head end to the customer), but this may not be necessarily true in the future. Also, a few cable companies already connect their head end to a LEC switch to gain entry to the PSN.

It is the sum of all these changes in technologies and in markets, rather than any one specific trend, that is driving the need to change network parameters. As time goes by, modems get faster, more data can be sent through the same channel (better data compression), and more time is spent on line. This pattern accelerates the need for even more changes. When images took forever to download, customers abstained from downloading. As download speeds and software improved, more customers downloaded more information. This cycle of ever expanded, "bandwidth hungry" information creates the need to reengineer or upgrade existing networks and to build new ones.

Location of Connection Points

The 1996 *Act's* competitive checklist presents three major network elements loop, local switch, and local transport. Inherent in these three elements are two points of interconnection with the switch: trunk side and line side. The diagrams in **Figures 2 and 3** are simplified to illustrate this.

There are, however, other ways to connect not only to the switch, but also to other points in the LEC network. Part of the debate associated with the implementation of the Act is about the future locations for interconnection. The *Telecommunications Act of 1996* states that the ILEC has the:

> duty to provide, for the facilities and equipment of any requesting telecommunications carrier, interconnection with the local exchange carrier's network....at any *technically feasible point* within the carrier's network [emphasis added].[23]

In addition to technically feasible, the *Act* requires that the interconnection "rates, terms, and conditions...are just, reasonable, and nondiscriminatory,"[24] and that interconnection "is at least equal in quality to that provided by the local exchange carrier to itself or to any subsidiary..."[25]

Even before this legislation passed there were debates over where companies and customers can connect to the LEC network.[26] For example, one area of debate is whether one of these points is on the path of the loop between the LEC switch and the customer.[27] Along this path, multiple loops may join together at a single connection point. Various companies have expressed an interest in gaining connections to their customers at these points as well.

III. Percent of Total Switch Investment by Company/Customer

Definitions of Large and Small Switches

Figure 5 shows the results of modeling based on assumptions, as well as averages and samples applied to the engineering standards for a current digital switch. This figure gives the percentages of total investment for major features of both large and small switches. This investment is for hardware and for associated software. This paper focuses on the initial investment (what a company pays when it purchases a specific switch) and not on the cost of upgrading technology or adding additional customers or services. Investment reflects purchase price, which is different from "common costs" and "incremental costs," as defined by economists."[28] For simplicity, the investments modeled exclude overheads for engineering, installation startup, and taxes. Generally, small switches serve primarily rural areas (**Figure 5A**) and large switches serve metropolitan areas (**Figure 5B**).

Since the objective of this paper is to indicate patterns and percentages, the assumptions were based on averages from large companies for both large and small switches, and from reports to the National Exchange Carrier Association (NECA) for small switches. The type of switch modeled is a digital switch representing current LEC purchases. For definitions of the services and for the assumptions used to model switch investments, see **Section II, Figure 4** and **Section IX, Appendix D**. The intent is to provide a snapshot of the PSN *before* implementation of the *Telecommunications Act of 1996*.

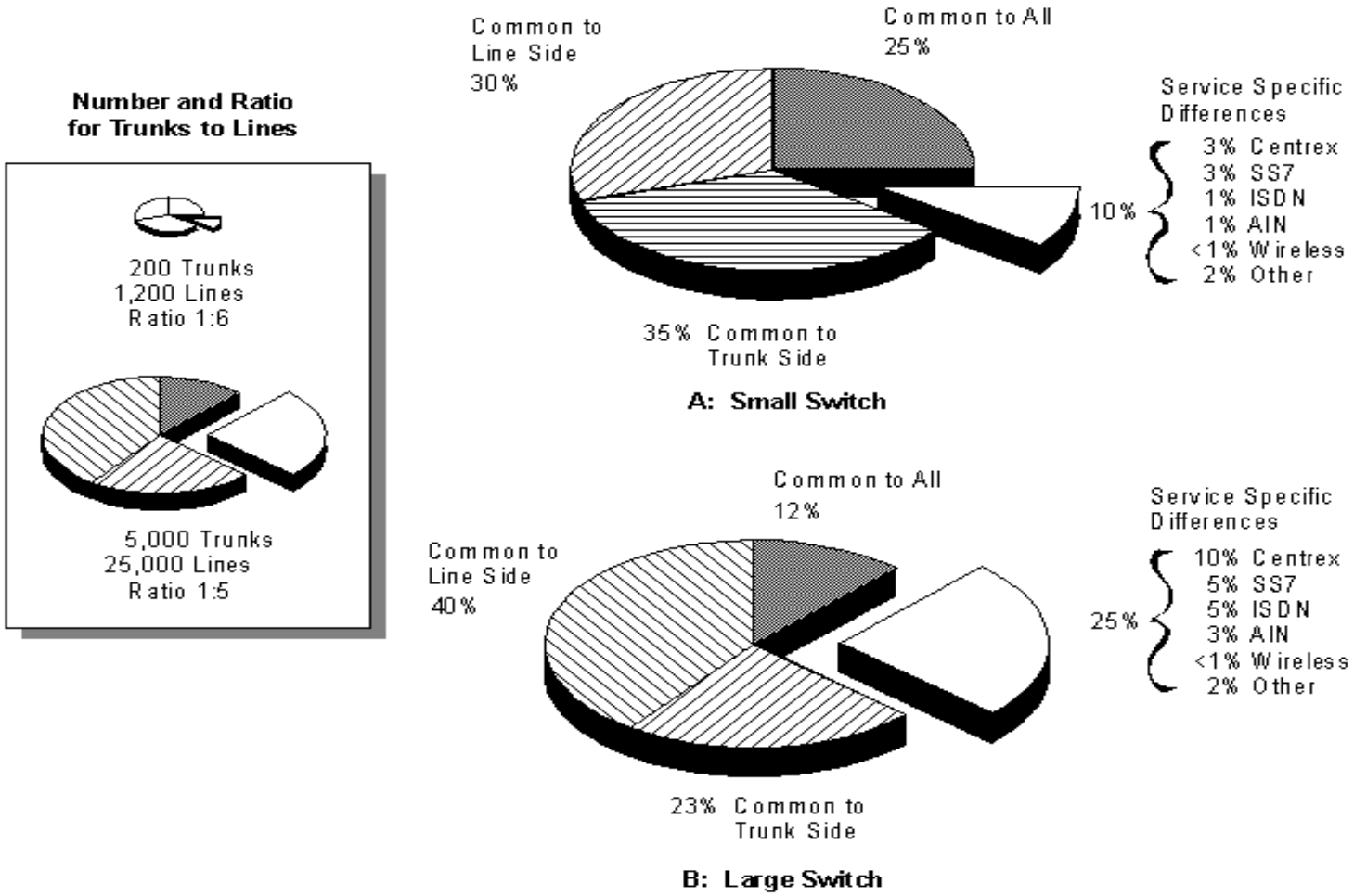
Percent of Total Switch Investment: Modeling Categories

The illustrations in **Figure 5** show the percentage of switch investment for the following categories: percent common to all, percent common to line side, percent common to trunk side, and the percent for service-specific or company-specific. These are defined as follows (see **Section IX, Appendix D**, for details):

- *Common to All:*
  These investments are needed for switching any type of service. This category includes cable and framework costs, power systems, operations support systems (maintenance and testing), call recording for billing, and other call services (i.e., announcements and tones). Common equipment generally does not vary with switch size (number of lines and trunks), with the exception of the central processor unit (whose capacity may be expanded).

- *Common to Line Side:*
  These investments are associated with any connections to the line side of the switch. This category includes line cards, line group frames and shelves, line test equipment, line concentrating equipment, and circuit packs. Some of this equipment forms the line side port.

Figure 5: Percent Total ILEC Switch Investment by Type of Connection



Note: Percentages are based on modeling assumptions. (See Section IX, Appendix D)

- *Common to Trunk Side:*
  These investments are associated with any connections to the trunk side of the switch. This category includes trunk cards, shelves, frames, trunk test equipment, circuit packs, and links to the central processor in the switch. Some of this equipment forms the trunk side port.

- *Service Specific:*
  These investments are associated with specific services or functions - Centrex, ***Signaling System 7 (SS7)***, ISDN, ***Advanced Intelligent Network (AIN)***,[29] wireless, and other (various miscellaneous services, such as call waiting, voice mail, and E911). For definitions of these services, see **Section IX, Appendix D.**

Differences between Line Side and Trunk Side Connections

There are significant differences between the type of equipment and the investment for a trunk side connection verses a line side connection. On a per connection basis, the type of equipment used for trunks is inherently more expensive than the equipment used for loops. Not only is the total investment for the trunk equipment more expensive, but this total is also distributed over a smaller number of connections.

For example, fewer trunks than lines feed into the switch. The line side equipment generally has from 1,280 to 5,760 lines connected to a single line concentration module.[30] line concentration modules can be connected to a single line group controller that feeds traffic (voice/data) into the switch module. For trunk side equipment, 20 to 40 trunks can be connected to a single trunk group controller and on to the switch module.

Percent of Total Switch Investment: Modeling Results

The main points of **Figure 5** are as follows:

- *The major difference between types of interconnection depends on whether the connection is on the line side or on the trunk side.*
  In the model, the small switch has 30% of the investment common to all line side connections and 35% common to all trunk side connections. The large switch has 40% of the investment common to all line side connections and 23% common to all trunk side connections.

- *A significant portion of the investment is common to all connections.*
  In the model, the small switch has 25% of the investment common to all connections and the large switch has 12% of the investment common to all connections.

- *When taken in total, the sum of the service-specific investments is significant.* In the model, the total of the service-specific investments is 10% for the small switch and 25% for the large switch.

- *With the exception of Centrex services, the service-specific differences are relatively small.* The range of percent of investment is generally 5% or less for specific services. The only exception is Centrex services on a large switch (assumed in the model to have many large business customers). In the model, the percentage of investment specific to Centrex services is 3% for the small switch and is 10% for the large switch.

Note that **Figure 5** shows percentages, not dollars. Percentages may be different for different modeling assumptions (traffic patterns, type of companies connecting, mix of services, etc.).

Other General Patterns for Switch Investment

As additional lines are added to the switch, the utilization of the switch's common components increases. This may affect some or all of the switch components depending on which services are used. For example, increases in the number of lines or changes in traffic patterns affect the investments in the line side and trunk side categories. As additional lines are added, the utilization of the switch's capacity increases, and changes in the computing equipment and software may be required. In the model used for this paper, one element that produces a decrease in the percent of "common to all" investment for the larger switch (as compared to the smaller switch) is the increase in the number of lines and trunks.

Furthermore, the ratio of trunks to lines is based on the amount and type of calls. Changes in any of these patterns affect the switch investment. For example, more calls between customers attached to the same local switch require fewer trunks. More calls beyond the switch require more trunks.

The investment for services that are ordered on a per line basis - such as **Caller Identification (caller ID)**, call forwarding, ISDN, and Centrex is sensitive to the size of the switch (number of lines and trunks) and to the demand from customers.

The Centrex investment reflects demand patterns. In a mostly rural area, with predominately residential service, the investment in Centrex is small. In contrast, more urban areas, with a number of large business customers, this investment is large. The investment in Centrex software is currently high. However, once the initial investment in software and lines are made, the investment per new line decreases as more Centrex lines are added. Compared to other services that require service-specific software, Centrex also requires a relatively high percentage of investment in software compared to its other components.

III. Percent of Total Switch Investment by Company/Customer, cont.

The SS7 investment is less for a small switch since there are usually more calls between customers on the same local switch (intra-office) and this type of call does not use SS7 technology. ISDN, AIN, and wireless investment reflect demand. Currently large businesses and some Internet users purchase ISDN services. With AIN the majority of the investment resides outside of the switch and the switch portion is essentially software. Wireless investment, which covers line side and trunk side ports with the associated software is minimal at this time. The investment in the "other" services category is primarily for software.

IV. Different Price Structures by Type of Company

Different Price Structures

Historically, there have been various methods for setting interconnection prices. Some rules apply to some companies, but not to others; some rules apply to some industries, but not to others; and some rules apply to some technologies, but not to others. For instance, the price structures for IXC connections are different than those for new entrants.

This section shows not only that the rules and methods vary, but also that inconsistent pricing policies provide incentives for types of connections that otherwise might not be made.[31] This section indicates the different pricing structures for connection to the LEC switch and routing traffic through it. This section also sets the context for the sweeping changes in the way prices for interconnection will be set in the future.

The *Telecommunications Act of 1996* requires interconnection with the ILEC network at "any technically feasible point." It also adds that the prices must be "just, reasonable, and nondiscriminatory," and provides rules for price negotiations, for regulatory oversight,[32] and for pricing standards that are:

> based on the cost (determined without reference to a rate-of-return or other rate-based proceeding) of providing the interconnection or network element (whichever is applicable), and...non discriminatory, and...may include a reasonable profit.[33]

Figures 6 through 11 combine the various network configurations from **Figure 3** with the rules for how prices are set for connecting to the LEC switch and for routing traffic through it. While there are other pricing elements (tandem switching and others), the following discussion focuses on connections to the LEC local switch and on routing traffic through it. The charts below each diagram answer the following questions: Who pays for it? How is it paid for? and, How is the price set?

These charts indicate that there are large variations in pricing structures for network configurations that are essentially the same, or are only slightly different. (See **Section II** for a discussion of network configurations and technical differences. See **Section III, Figure 5** for differences in the percent of switch investments for the major types of connections.)

Methods for Setting Prices

A number of methods have been used to determine prices for connections with the switch:

- ***Federal and State Tariffs:*** Prices filed according to federal regulations by the FCC governing interstate calls and according to regulations by individual state regulatory commissions for calls within each state.

- **Negotiated Contracts:** Companies negotiate with one another and use contracts to set the price. Sometimes regulatory approval is required.

- **Bill and Keep:** Each company bills its own customers for local calls and keeps all the money it collects. There are no transfers of dollars between companies.

In the future, additional methods are also possible. For example, there is the broadcast TV model where advertisers pay for the network in the prices for advertisements, or the cable TV pay-per-view model in which customers pay for specific programs beyond the price of basic cable TV service.

Access Tariffs

The diagram in **Figure 6A** illustrates the network configuration for federal and state access prices[34] from **Figure 3A**. The chart **(Figure 6B)** below the diagram answers the three questions: Who pays for it, how is it paid for, and how is the price set?

The tariffed rates reflect the long history of local and toll calls - from the start of interconnection of local to long distance networks by the Bell-Independent partnership (formed for this purpose) up through the breakup of AT&T and the creation of access charges. Set by federal and state tariffs, these access prices are for origination and termination of calls through the LEC switch.

In order to clarify structures used for access charges, this section divides the discussion into two parts: one is the actual price elements that cover switch investment, and the other is price elements that are based on switch usage. This means some payments cover other network elements (not the switch) but these payments are based on measures of switch use. In **Figures 6 through 11**, these usage measurements are referred to as "routing through the switch." It is important to separate these two issues for the ongoing policy debates over revision of interconnection charges. This discussion only covers price structures for switched services (traffic routed through the local switch).

Long distance companies pay for the LEC switch investment through a per minute of use for local switching.[35]

In addition, the long distance companies pay for recovery of a portion of loop investment based on usage of the local switch (a per minute of use charge, called in ***the Carrier Common Line Charge***, or ***CCLC***). This is referred to as an "access charge" because it gives the long distance companies and their customers access to the PSN. The "access" allows for the origination and termination of a call. Long distance companies also pay a portion of other LEC investments (tandem switching, signaling, trunks between tandem switches and the local switch) and miscellaneous costs based on usage of the local switch (a per minute of use charge, called the ***Residual Interconnection Charge***, or ***RIC***).[36] The usage charges paid by the long distance carriers may include subsidies for companies in high-cost areas, and for keeping local service rates low.[37]

IV. Different Price Structures by Type of Company, cont.

It is important to note that long distance companies pay access charges on both sides of the call (originating and terminating).

The LEC's local customers generally pay a monthly flat rate (but sometimes a per minute per call or some other form of measured service) for local telephone service **(Figure 6C)**. This includes investment in the local switch. However, they also pay a monthly flat rate for access into and out of the long distance network through the LEC local switch. This "access" charge is called the ***Subscriber Line Charge (SLC)*** and recovers a portion of the loop investment.[38] The SLC is included in this discussion because the local loop is needed to route traffic though the switch to customers.

The local customers - residential, single-line business, and multi-line business - subscribe to local telephone service and generally pay their LEC for calls they make (originate).[39] These traditional switched local services have origins in the first telephone services offered in the late 1800s. Some services, such as 800 services or ***private line services***,[40] have not been considered part of local exchange services until recently.[41] For 800 services, the customer that receives the call (terminating calls) pays their LEC for incoming calls.[42]

Price Structures for Trunk Side Connections

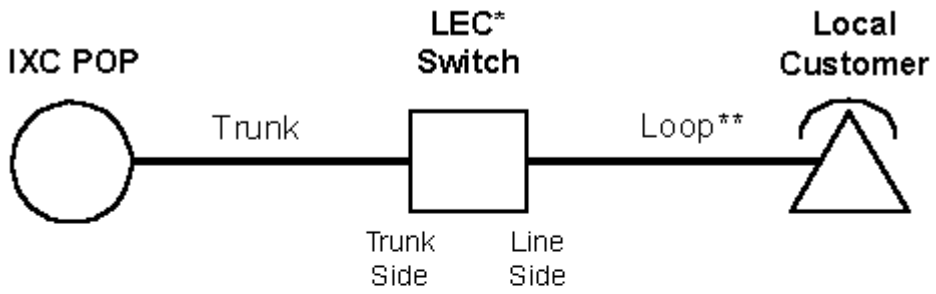
Figure 7A shows the network configuration where the Other Carrier connects one of its switches to the LEC switch using a LEC trunk. In this arrangement, the Other Carrier is another LEC, a CAP/ALT, a wireless company, or a cable TV company.

In addition to paying for the trunk, the Other Carrier pays for switch investment by paying a monthly flat rate for the trunk side port and by paying a per minute of use charge for switching. For wireless companies, this charge may be discounted below the standard rate for access.

These companies have the opportunity to negotiate with the LEC for interconnection prices. Once determined, these prices can be formalized by contract or by tariff.[43] However, for wireless carriers, the contract or tariff can only be changed through additional negotiations.

If the company is another LEC, their customers pay prices set by tariffs. The wireless, CAP/ALT, and cable TV customers pay prices set by their companies. In the case of cellular or wireless customers, these prices are effectively set by competitive forces in the marketplace. In the case of CAP/ALT customers, these same competitive forces impact pricing decisions. However, the starting point is based on the tariffed price of the incumbent LEC's competing service, which was established through regulation.

Figure 6: **Access: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It**



A. Long Distance Access Network Configuration

*Either an ILEC or a new market entrant.
**Also referred to as access line.

Figure 6A. Long Distance Access Network Configuration

Who pays for it?	*How is it paid for?*	*How is the price set?*
Long distance companies: IXCs, wireless companies, and new LECs.	Switch Investment: A per minute of use charge for the local switch.*	Federal and/or state tariffs. The usage charges may include subsidies for companies in high-cost areas, and for keeping local service rates low.
	Routing through the Switch: A per minute of use charge for a portion of loop investment based on usage of the local switch (called the CCLC).*	
	Routing through the Switch: A per minute of use charge for LEC investments (tandem switching, signaling, trunks between tandem switches and the local switch) and miscellaneous costs based on usage of the local switch (called the RIC).*	

*For both originating and terminating a call.

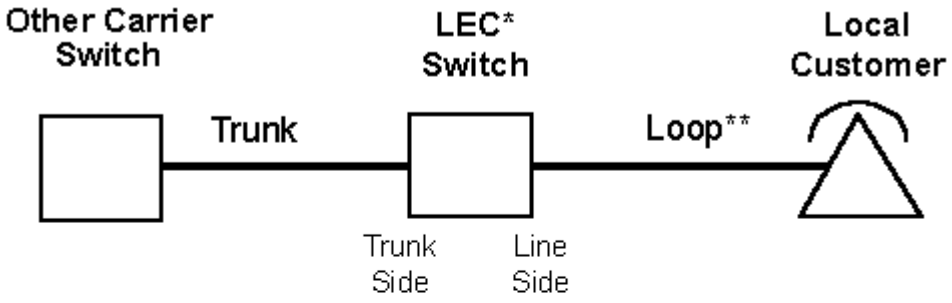
Figure 6B. Long Distance Access Price Structures

Figure 6: Access: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It, cont.

Who pays for it?	*How is it paid for?*	*How is the price set?*
Residential, single-line business, and multi-line business customers.	Switch Investment: Switching is included in a flat rate, in a per minute rate, or in a per call rate in the monthly bill for local telephone service.	State tariffs.
	Routing through the Switch: A monthly flat rate for access into and out of the long distance network through the LEC local switch. This "access" charge is called the SLC and recovers a portion of loop investment.	Federal tariffs.

Figure 6C. Loop Customer Price Structures

Figure 7: Trunk Side Port Connection: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It



7A. Trunk Side Port

*Either an ILEC or a new market entrant.
**Also referred to as access line.

Figure 7A. Trunk Side Port Network Configuration

Who pays for it?	*How is it paid for?*	*How is the price set?*
Other Carrier: CAP/ALT, other LEC, wireless company, and cable TV company.	Switch Investment: Monthly flat rate per port for a trunk side port.	Federal and/or state tariffs or contracts.
	Switch Investment: Per minute of use charge for switching to terminate a local call. For a wireless company, this charge may be discounted below the standard rate for access.	One or more of the following methods: 1. Fee based on a negotiated contract. 2. State tariffs. 3. Bill and keep. 4. In some cases, the tariffed rates include subsidies.

Figure 7B. Trunk Side Port Price Structures

The wireless companies pay the LEC for terminating calls from mobile customers. However, the LECs generally do not pay the wireless companies for terminating calls made by wireline customers (traditional landline telephone company customers).[44] Cellular carriers and LECs were allowed to establish interconnection arrangements through negotiations.[45] The LECs were also required to provide nondiscriminatory treatment and other interconnection related requirements to cellular companies. Unlike traditional wireline telephone customers, cellular customers pay not only for the calls they make (originate) but also for the calls they receive (terminate).

The requirements for treatment of cellular companies were subsequently extended to all **Commercial Mobile Radio Service (CMRS)** carriers.[46] They apply to all types of interconnection arrangements including, but not limited to Type I, Type IIA, and Type IIB.[47] (For a description of these types of wireless connections, see **Section IX, Appendix D, Description of Types of Wireless Connection with a LEC Network.**)

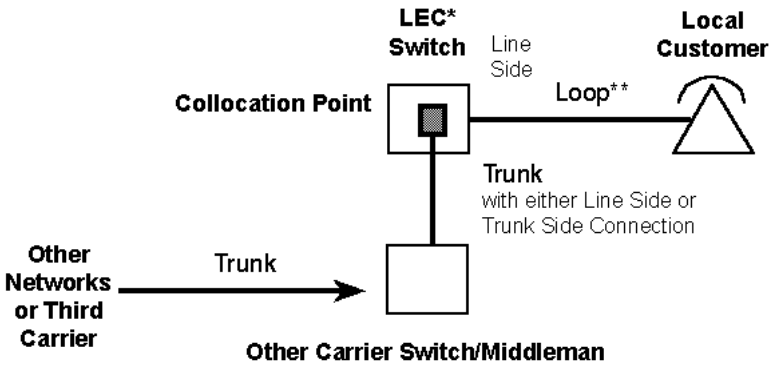
CAPs/ALTs are generally wireline carriers and want interconnection facilities and arrangements that provide the same service and functionality as existing CMRS to LEC arrangments. However, the guidelines for interconnection arrangements between CAPs/ALTs and LECs are not yet clearly estabilshed. The "bill and keep" issue arose in the context of LEC to CMRS connections. Here also, the guidelines for competition are not clearly established.[48]

Collocation Price Structures

The diagram in **Figure 8A** shows the configuration for collocation arrangements; the Other Carrier provides the trunk and pays for a location in the LEC's central office or wire center. This collocation configuration is included because it is one way to interconnect to the switch even though it does not pay for any of the switch investment. The *Telecommunications Act of 1996* requires that ILECs:

> provide, on rates, terms, and conditions that are just, reasonable, and nondiscriminatory, for *physical collocation* of equipment necessary for interconnection or access to unbundled network elements at the premises of the local exchange carrier, except that the carrier may provide for *virtual collocation* if the local exchange carrier demonstrates to the State commission that physical collocation is not practical for technical reasons or because of space limitations [emphasis added] - *Telecommunications Act of 1996*, Sec. 251(c)(6), Interconnection, Additional Obligations of Incumbent Local Exchange Carriers.

Figure 8: **Collocation: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It**



8A. Collocation: Trunk Side Port or LIne Side Port Network Configuration

*Either an ILEC or a new market entrant.
**Also referred to as access line.

Figure 8A. **Collocation: Trunk Side Port or Line Side Port Network Configuration**

Who pays for it?	*How is it paid for?*	*How is the price set?*
Other Carrier: CAP/ALT, other LEC, wireless company, and cable TV company.	Routing through the Switch: Monthly flat rate for renting space in the LEC's central office building or for a connection into this building.	Rental fee that is based either on a negotiated contract or on federal and/or state tariffs.
	Switch Investment: Monthly flat rate per line side port.	Federal and/or state tariffs or contracts.
	Switch Investment: Per minute of use charge for switching to terminate a local call.	One or more of the following methods: 1. Fee based on a negotiated contract. 2. State tariffs. 3. Bill and keep. 4. In some cases the tariffed rates include subsidies.

Figure 8B. **Other Carrier (CAP/ALT, Other LEC, Wireless Company, or Cable TV company) Pays LEC Directly for Collocation**

Figure 8: Collocation: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It, cont.

Who pays for it?	*How is it paid for?*	*How is the price set?*
Other Carrier: IXC	Routing through the Switch: Monthly flat rate for renting space in the LEC's central office building or for a connection into this building.	Rental fee that is based either on a negotiated contract or on federal and/or state tariffs.
	Switch Investment: Monthly flat rate per line side port.	Federal and/or state tariffs.
	Switch Investment: A per minute of use charge for the local switch.*	Federal and/or state tariffs. The usage charges may include subsidies for companies in high-cost areas, and for keeping local service rates low.
	Routing through the Switch: A per minute of use charge for a portion of loop investment based on usage of the local switch (called the CCLC).*	
	Routing through the Switch: A per minute of use charge for LEC investments (tandem switching, signaling, trunks between tandem switches and the local switch) and miscellaneous costs based on usage of the local switch (called the RIC).*	

*For both originating and terminating a call.

Figure 8C. IXC Pays LEC Directly for Collocation

Figure 8: Collocation: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It, cont.

Who pays for it?	*How is it paid for?*	*How is the price set?*
A Third Carrier pays the Other Carrier/ Middleman. Third Carrier may be an IXC, wireless company, other LEC, cable TV company, or large business customer.	Routing through the Switch (but Not Paid to the LEC): Fee for connecting to the Other Carrier's central office.	One of the following methods: 1. Based on negotiated contracts. 2. Federal and/or state tariffs.
A Third Carrier (wireless company, other LEC, cable TV company, or large business customer) pays the LEC directly.	Switch Investment: Per minute of use charge for switching to terminate a local call.	One or more of the following methods: 1. Fee based on a negotiated contract. 2. State tariffs. 3. Bill and keep. 4. In some cases the tariffed rates include subsidies.
The Third Carrier (IXC) pays the LEC directly.	Switch Investment: A per minute of use charge for the local switch.*	Federal and/or state tariffs. The usage charges include subsidies for companies in high-cost areas, and for keeping local service rates low.
	Routing through the Switch: A per minute of use charge for a portion of loop investment based on usage of the local switch (called the CCLC).*	
	Routing through the Switch: A per minute of use charge for LEC Investments (tandem switching, signaling, trunks between tandem switches and the local switch) and miscellaneous costs based on usage of the local switch (called the RIC).*	

*For both originating and terminating a call.

Figure 8D. Third Carrier Pays LEC Directly and Also Pays Middleman for Collocation

IV. Different Price Structures by Type of Company, cont.

There is wide array of collocation connections and how they are paid for. **Figure 8B** shows collocation price structures when the Other Carrier is a CAP/ALT, another LEC, a wireless company, or a cable TV company. In this case, the Other Carrier pays the LEC directly. The Other Carrier pays for switch investment by paying a per minute of use charge for switching to terminate a local call and by paying a monthly flat rate per line side port. The Other Carrier also pays for routing traffic through the switch by paying a monthly flat rate for rental space.

One example of this price structure is when a LEC connects to an ILEC **(Figure 2)**. The companies may use contracts to set the per minute prices for carrying each other's local and/or toll traffic. These contracts may use the different pricing methods listed in **Figure 8B**, depending on what the companies agree to and, in some cases, on regulatory approval. The negotiated options include compensation for actual traffic passing through the switch, bill and keep, and other methods.

Figure 8C shows collocation price structures when the Other Carrier is an IXC. Here the IXC directly pays the LEC two of the same charges paid in **Figure 8B:** a monthly flat rate for rental space for routing traffic through the switch and a monthly flat rate per line side port for switch investment. Instead of the per minute of use charge in **Figure 8B**, the IXC also pays for originating and terminating a call by paying three additional price elements listed in **Figure 6B** (long distance company access tariffs): a per minute of use charge for the local switch, the CCLC, and the RIC. Set by federal and state tariffs, these prices are for the routing of calls through the LEC.

Figure 8D shows the collocation price structures when a middleman is involved. The "Third Carrier," typically a new entrant, connects to the middleman's central office building and pays a fee for this. When the Third Carrier is a wireless company, another LEC, or a cable TV company, this carrier also pays the LEC directly a per minute of use charge for switching to terminate a local call. Some of these Third Carriers also pay when they receive a call. When the Third Carrier is an IXC, the IXC directly pays the LEC the three additional price elements from **Figure 6B:** a per minute of use charge for the local switch, the CCLC, and the RIC.

There are more pricing flexibilities for collocation arrangements **(Figure 8)** than for access arrangements **(Figure 6)**. Also note that at the time of the 1996 *Act*, collocation connections themselves were optional.

Meet Point Price Structures

Figure 9A shows the network configuration and price structures for meet point billing between two companies. Here, the LEC and the Other Carrier connect at a mutually agreed upon location on the trunk between their two switches. In this case, there is generally a per minute of use charge for switching to terminate a local call, or in some cases, a flat rate. Typically, small telephone companies use meet point connections. More recently, the CAPs/ALTs have used meet point connections.

Sometimes an IXC will use meet point connections to gain access to customers served by a small telephone company by using a large LEC's tandem switch and transport network. Since this paper covers only the LEC local switch, **Figure 9B** excludes these price structures. However, the IXCs pay both the small telephone company and the larger LEC in these cases.

As with collocation pricing, meet point pricing arrangements have more flexibility than those for access **(Figure 6)**. At the time of the *1996 Act*, meet point connections were optional.

Price Structures for Line Side Connections

Figure 10A indicates the network configuration and price structures used by wireless companies and CAPs/ALTs to connect to the LEC switch.

The wireless and CAP/ALT customers pay a monthly flat rate for a line side port on the LEC switch and pay a per minute of use switching charge with a discount below the standard rate for access. The prices are set by federal and/or state tariffs. There are different rates for technically different types of wireless connections **(see Section IX, Appendix D)**.

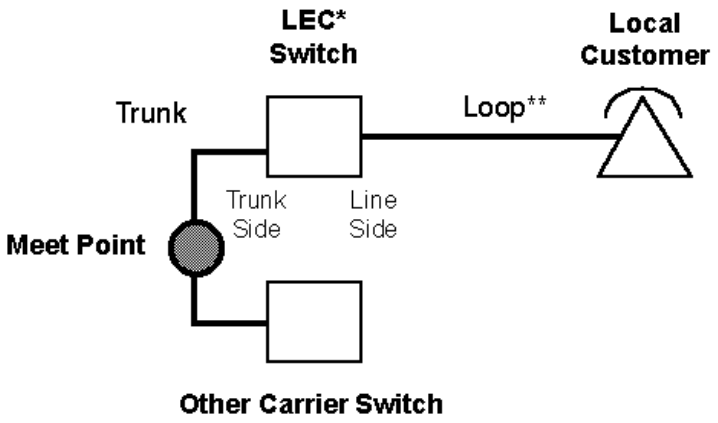
Enhanced Service Provider (ESP) Connection Price Structures

Figure 11A shows the primary way that ESPs connect to the LEC switch and the associated price structures. In the diagram in **Figure 11A**, the ESP looks like any other business customer. In this case **(Figure 11B)**, the ESP pays a monthly business line flat rate for a line side connection, a monthly flat rate or measured rate for local telephone service that includes switching, and the SLC, which includes access to the PSN through the switch.

For the provision of enhanced services, ESPs are exempt from paying the access charges that are paid by the IXCs for routing similar traffic through the switch.[49] In addition, ESPs are not allowed to collocate in the LEC central office building.[50]

Keep in mind that the focus is on prices for connections between companies. ESP customers do not pay for what would normally be a long distance call. Instead, ESP customers only pay for local telephone service (generally a flat rate, sometimes a per minute of use rate), while the call to the ESP is paid for like any other local call.

Figure 9: Meet Point: Network Configuration and Price Structures for LEC Switch Investment



9A. Meet Point on Trunk Network Configuration

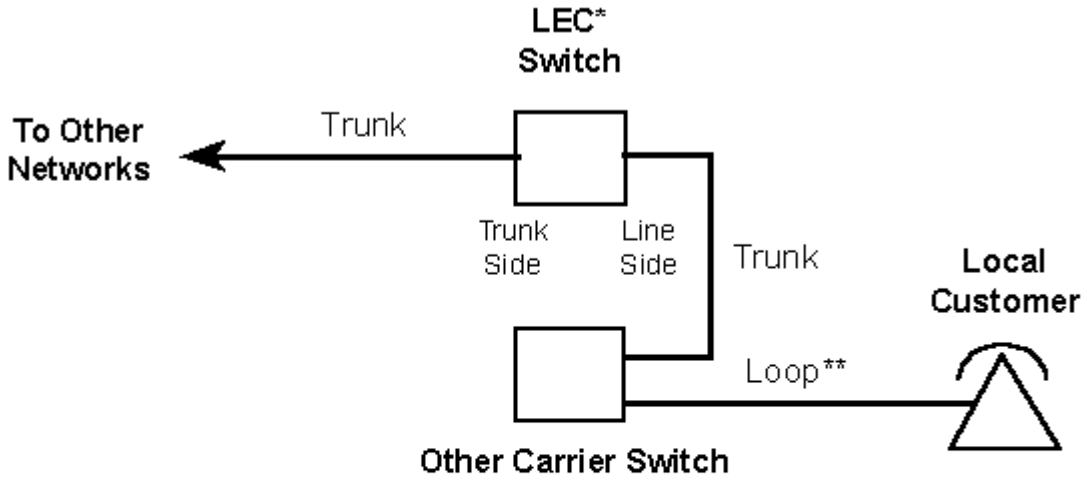
*Either an ILEC or a new market entrant.
**Also referred to as access line.

Figure 9A. Meet Point on Trunk Network Configuration

Who pays for it?	*How is it paid for?*	*How is the price set?*
Other Carrier: CAP/ALT, other LEC, wireless company, and cable TV company.	Switch Investment: Per minute of use charge and/or a flat rate for switching to terminate a local call. One or more of the following methods:	1. Fee based on a negotiated contract. 2. State tariffs. 3. Bill and keep. 4. In some cases the tariffed rates include subsidies.

Figure 9B. Meet Point Price Structures

Figure 10: Line Side Port Connection: Network Configuration and Price Structures for LEC Switch Investment



10A. Line Side Port Network Configuration

*Either an ILEC or a new market entrant.
**Also referred to as access line.

Figure 10A. Line Side Port Network Configuration

Who pays for it?	*How is it paid for?*	*How is the price set?*
Other Carrier: Wireless companies and CAPs/ALTs.	Switch Investment: Monthly flat rate for line side port on LEC switch.	Federal and/or state tariffs or contracts.
	Switch Investment: Per minute per use switching charge with a discount below the standard rate for access.	Federal and/or state tariffs or contracts.

Figure 10B. Line Side Port Price Structures

Figure 11: ESP Line Side Connection: Network Configuration and Price Structures for LEC Switch Investment and for Routing Traffic through It

Figure 11A. ESP by Line Side Port Network Configuration

Who pays for it?	*How is it paid for?*	*How is the price set?*
ESP (similar to what a business customer pays)	Switch Investment and Routing through the Switch: Monthly business line flat rate for a line side port and loop.	State tariffs.
	Switch Investment: Switching is included in a flat rate, in a per minute rate, or in a per call rate in the monthly bill for local telephone service.	State tariffs.
	Routing through the Switch: Included in an end user charge, called the SLC, for access to the PSN through the switch.	Federal tariff.

Figure 11B. ESP by Line Side Port Price Structures

V. Summary

Summary

As broadband and wideband services (media, data, Internet, etc.) merge with traditional switched voice, many of the old pricing rules for connecting networks need to be revised. For example, movies priced on the per minute phone call basis would be prohibitively expensive. Conversely, phone calls priced by the fraction they represent of a TV program transmission wouldn't cover the cost of sending the call.[51] There is a tension between what might be best for the long term and what might be best for the short term. For example, while there may be a policy to treat new market entrants differently, at what point should they be treated like everyone else? What happens if differences in regulatory rules result in rate disparities between services that look essentially the same to the customer? Are there incentives for customers to rate shop due to different regulatory rules for essentially similar services?

This paper is only a snapshot in time, just before the passing of legislation that requires sweeping changes in interconnection pricing structures. However, technology is not standing still. In the future, it is likely that the percent of investment tied to specific services may increase as the ability to tailor services to individual customer needs evolves along with changes in the price structures. This paper indicates the following points:

- Service definitions and methods for setting prices for connections to the LEC switch have depended on the prevailing market philosophy - monopoly, competition, and regulation - at the time that the service first appeared.

- The major difference between the investment for types of interconnection to the ILEC switch depends on whether the connection is on the line side or on the trunk side.

- A significant portion of ILEC switch investment is common to all types of connections. Currently, the percent of investment for specific services is relatively small (with the exception of Centrex services).

- The variation in price structures for different companies connecting to a given side of the ILEC switch (line side or trunk side) is far greater than the variation in the investment for connections to that side.

- The PSN has been traditionally engineered for voice calls. The explosion of data transmission services (faxes, e-mail messages, telecommuting from home, Internet use, point of sale transactions, and online services) requires dramatic changes in the underlying assumptions about how networks need to be designed and engineered. Capacity and duration of connections vary: credit card verifications take only seconds, average voice calls take less than five minutes, and average Internet connections take approximately one hour.

- Even though customer usage patterns and technology have changed, the old price structures have remained. The 1996 legislation requires sweeping changes in these old structures.

VI. Appendix A: Monopoly/Competition Time Line

Monopoly Competition Time Line

This section provides descriptions of the events and the introduction of companies listed in the monopoly/competition time line in **Section I, Figure 1**. It is important to note that service definitions that arose in the late 1800s still influence industry and market structures today. Service distinctions for business and residential customers and for local (exchange) and long distance (toll or interexchange) markets arose in the very earliest days of telephone service.

Local and Long Distance Services

After the invention of the telephone in 1876, there was competition between the telegraph company (Western Union) and the first telephone company, the Bell Telephone Company. The formal organization of the telephone business started in 1877 when patents were issued. These patents provided the Bell Telephone Company monopoly protection from Western Union's telegraph business.[52] Initially telephone service was local and was provided by the Bell Telephone Company, eventually giving rise to the name ***Bell Operating Company, or BOC***. While a few companies, later called ***Independents***, existed prior to the expiration of the monopoly patents, competition on a large scale arose only with the expiration of Bell Telephone's monopoly over manufacturing in 1894. This marked the beginning of first business, and then residential, service.

Long distance service arose as a technical innovation by Bell Telephone. In 1884, the first toll line was placed in service between Boston and New York City.[53] In 1885, AT&T was incorporated to provide interconnection among the Bell exchanges in various cities. This marked the beginning of toll service, both state and interstate. These service concepts are still in place today.

Starting in the 1910s there was a shift in market philosophy and the pendulum swung back toward monopoly. This shift accompanied an increase in both federal and state regulation of the telephone industry. The independent companies were concerned with AT&T's acquisition of independent companies and consolidations within AT&T once these companies were acquired. The independents also wanted to connect with AT&T's long distance network, which gave AT&T a competitive advantage. The Kingsbury Commitment of 1913 is a letter that heralded the start of the PSN. In the PSN, all customers could reach all other customers regardless of who owned the facilities in the interconnecting networks. In the Kingsbury letter, AT&T promised to provide the independents with interconnection to its toll network. In return for this commitment, AT&T could purchase independent companies, if the newly created federal regulatory agency (first the ***Interstate Commerce Commission,*** or ***ICC***, and later the FCC) approved.

The trend toward monopoly, already seen in the temporary nationalization of the telephone industry during World War I, took root in the *Willis-Graham Act* in 1921. This *Act* allowed AT&T to continue its consolidation, and methods were also established for resolving conflicts over acquisitions and mergers and for division of operating territories

among companies. In return, the independents were promised connection with the AT&T network, leading to the ***Bell-Independent Partnership***. The *Communications Act of 1934* firmly established a monopoly philosophy for the next two and a half decades.[54]

Connection of Competing Companies

Starting in 1959, there was a move back toward network competition. The Above *890 Decision*[55] opened the door for large, high-volume customers to build their own networks, eventually leading to private line services and the resale of facilities and services.[56]

In 1969, the FCC opened the door to competition in the long distance (interexchange) market by granting MCI a license to construct facilities. Eventually MCI won the right to compete with the AT&T Long Lines Division. Initially called ***Other Common Carriers (OCCs)***, these companies are now called IXCs. After a series of FCC and court decisions in the 1970s,[57] AT&T had to provide the other IXCs with interconnection to its network.[58] In this time frame, the concept of "access" into and out of the PSN arose. In 1982, the FCC issued its *Access Charge Order*.[59]

The Flurry of New Competitors

It could be argued that the institution of access charges not only made the breakup of AT&T possible, but opened the flood gates to new competitors. The IXCs and all the new types of companies wanted some form of interconnection with the LEC network. Ultimately, just as all politics, national and international, are eventually local because that's where the voters are, the same is true for communications: all communications involve local interconnection because that's where the customers connect.

Technological innovation continues to produce new opportunities for products and services. These, in turn, pressure existing markets to change and create opportunities for new markets.

In 1983, ESPs, which include on-line computer service providers, were given special exemptions for the price of connecting to LEC switches.[60] Most commonly known by the names of the largest ESP companies, such as America OnLine, CompuServe, or Prodigy, this group also includes companies and institutions providing connections to the Internet and other communications services.

The year 1983 also saw the introduction of cellular services, part of an ongoing evolution of mobile services, now called CMS[61] or wireless services (communications services where the customer is not tethered by a wire to the communications network).[62] Over a decade later, in 1995, the FCC created a new class of wireless services, called PCS.[63]

VI. Appendix A: Monopoly/Competition Time Line, cont.

1984 not only marked the breakup of AT&T into one IXC and seven large LECs (also called ***Regional Bell Operating Companies, or RBOCs***),[64] but also spurred on the entry of a number of new competitors in both local and long distance markets.

The 1980s also saw the FCC and individual states promote the introduction of competitors to the local market. For example, in 1985 the New York Public Service Commission (NY PSC) authorized Teleport Communications Group (TCG) - one of the first CAPs - to provide large business customers with private lines services that bypassed the traditional LEC networks and connected customers directly to the long distance carriers (the IXCs).[65] Over time the type of connections afforded to the CAPs, also known as ALTs, expanded, with increasingly fewer limits on the type of service provided. The new CAPs/ALTs are sometimes referred to as ***Competitive (or Certified) Local Exchange Carriers (CLECs).***[66]

As competition and technologies evolve, the group of new LEC entrants is expanding to include cable TV companies, and may in the future include more ***Electric Utilities*** and others.[67]

Telecommunications Act of 1996

The *Telecommunications Act of 1996* has accelerated the drive toward competition. It mandates development of competitive markets (including rules for interconnection), the elimination of market entry barriers, and infrastructure sharing. This Act redefines many terms used to describe the various telecommunications carriers and information service providers. For the specific language in these definitions, see **Section VII, Appendix B.**

VII. Appendix B: Definitions

Advanced Telecommunications Capability
Telecommunications Act of 1996, Sec. 706(c)(1)
"is defined, without regard to any transmission media or technology, as high-speed, switched, broadband telecommunications capability that enables users to originate and receives high-quality voice, data, graphics, and video telecommunications using any technology."

Basic Telephone Service
Telecommunications Act of 1996, Sec. 274(i)(2)
"any wireline telephone exchange service, or wireline telephone exchange service facility, provided by a Bell operating company in a telephone exchange area, except that such term does not include -

"(A) a competitive wireline telephone exchange service provided in a telephone exchange area where another entity provides a wireline telephone exchange service that was provided on January 1, 1984, or

(B) a commercial mobile service."

Basic Telephone Service Information
Telecommunications Act of 1996, Sec 274(i)(3)
"network and customer information of a Bell operating company and other information acquired by a Bell operating company as a result of its engaging in the provision of basic telephone service."

Bell Operating Company (BOC)
Telecommunications Act of 1996, Sec. 3(a)(35)

"(A) means any of the following companies: Bell Telephone Company of Nevada, Illinois Bell Telephone Company, Indiana Bell Telephone Company, Incorporated, Michigan Bell Telephone Company, New England Telephone and Telegraph Company, New Jersey Bell Telephone Company, New York Telephone Company, U S West Communications Company, South Central Bell Telephone Company, Southern Bell Telephone and Telegraph Company, Southwestern Bell Telephone Company, The Bell Telephone Company of Pennsylvania, The Chesapeake and Potomac Telephone Company, The Chesapeake and Potomac Telephone Company of Maryland, The Chesapeake and Potomac Telephone Company of Virginia, The Chesapeake and Potomac Telephone Company of West Virginia, The Diamond State Telephone Company, The Ohio Bell Telephone Company, The Pacific Telephone and Telegraph Company, or Wisconsin Telephone Company; and

"(B) includes any successor or assign of any such company that provides wireline telephone exchange service; but

"(C) does not include an affiliate of any such company, other than an affiliate described in subparagraph (A) or (B)."

Cable Service
Telecommunications Act of 1996, Sec. 301(a)(1)
"Section 602(6)(B) (47 U.S.C. 522(6)(B)) is amended by inserting 'or use' after 'the selection'."

47 U.S.C. 522(6)(B) Definitions, cable service, with revision from the Act added.
"Subscriber interaction, if any, which is required for the selection or use of such video programming or other programming service; [emphasis added]."

Cable System
Telecommunications Act of 1996, Sec. 301(a)(2)
"Section 602(7) (47 U.S.C. 522(7)) is amended by striking '(B) a facility that serves only subscribers in 1 or more multiple unit dwellings under common ownership, control, or management, unless such facility or facilities uses any public right-of-way;' and inserting '(B) a facility that serves subscribers without using any public right-of-way;'."

47 U.S.C. 522(7) Definitions, cable system, with revision from the Act added.
"a facility, consisting of a set of closed transmission paths and associated signal generation, reception, and control equipment that is designed to provide cable service which includes video programming and which is provided to multiple subscribers within a community, but such term does not include (A) a facility that serves only to retransmit the television signals of 1 or more television broadcast stations; (B) a facility that serves subscribers without using any public right-of-way; (C) a facility of a common carrier which is subject, in whole or in part, to the provisions of subchapter II of this chapter, except that such facility shall be considered a cable system (other than for purposes of section 541(c) of this title) to the extent such facility is used in the transmission of video programming directly to subscribers; or (D) any facilities of any electric utility used solely for operating its electric utility system; [emphasis added]."

Cellular Service
47 C.F.R. 22.99 Definitions
"Radio telecommunication services provided using a cellular system."

Cellular System
47 C.F.R. 22.99 Definitions
"An automated high-capacity system of one or more multi-channel base stations designed to provide radio telecommunication services to mobile stations over a wide area in spectrally efficient manner. Cellular systems employ techniques such as low transmitting power and automatic hand-off between base stations of communications in progress to enable channels to be reused at relatively short distances. Cellular systems may also employ digital techniques such as voice encoding and decoding, data compression, error correction, and time or code division multiple access in order to increase system capacity."

Collocation
Telecommunications Act of 1996, Sec. 251(c)(6)
"The duty to provide, on rates, terms, and conditions that are just, reasonable, and nondiscriminatory, for physical collocation of equipment necessary for interconnection or access to unbundled network elements at the premises of the local exchange carrier, except that the carrier may provide for virtual collocation if the local exchange carrier demonstrates to the State commission that physical collocation is not practical for technical reasons or because of space limitations."

Commercial Mobile Service Provider (CMS)
Telecommunications Act of 1996, Sec. 3(a)(44)
"[local exchange carrier] does not include a person insofar as such person is engaged in the provision of a commercial mobile service under section 332(c), except to the extent that the Commission finds that such service should be included in the definition of such term."

The United States Code defines the regulatory treatment of commercial mobile services, 47 U.S.C. 332(c). This includes the common carrier treatment of commercial mobile services, Sec. 332(c)(1); non-common carrier treatment of private mobile services, Sec. 332(c)(2); state preemption, Sec. 332(c)(3); regulatory treatment of communications satellite corporation, Sec. 332(c)(4); space segment capacity, Sec. 332(c)(5); and foreign ownership, Sec. 332(c)(6).

Comparable Carriers as Incumbents
Telecommunications Act of 1996, Sec. 251(h)(2)
"(A) such carrier occupies a position in the market for telephone exchange service within an area that is comparable to the position occupied by a carrier described in paragraph (1);
"(B) such carrier has substantially replaced an incumbent carrier described in paragraph (1); and
"(C) such treatment is consistent with the public interest, convenience, and necessity and the purposes of this section.

Enhanced Services
47 C.F.R. §64.702(a) Furnishing of Enhanced Services and Customer-Premises Equipment by Communications Common Carriers
"services, offered over common carrier transmission facilities used in interstate communications, which employ computer processing applications that act on the format, content, code, protocol or similar aspects of the subscriber's transmitted information; provide the subscriber additional, different, or restructured information; or involve subscriber interaction with stored information. Enhanced services are not regulated under title II of the Act."

Electronic Publishing Definition

Telecommunications Act of 1996, Sec. 274(h)

"(1) the dissemination, provision, publication, or sale to an unaffiliated entity or person, of any one or more of the following: news (including sports); entertainment (other than interactive games); business, financial, legal, consumer, or credit materials; editorials, columns, or features; advertising; photos or images; archival or research material; legal notices or public records; scientific, educational, instructional, technical, professional, trade, or other literary materials; or other like or similar information.

"(2) EXCEPTIONS.-The term 'electronic publishing' shall not include the following services:

"(A) Information access, as that term is defined by the AT&T Consent Decree.

"(B) The transmission of information as a common carrier.

"(C) The transmission of information as part of a gateway to an information service that does not involve the generation or alteration of the content of information, including data transmission, address translation, protocol conversion, billing management, introductory information content, and navigational systems that enable users to access electronic publishing services, which do not affect the presentation of such electronic publishing services to users.

"(D) Voice storage and retrieval services, including voice messaging and electronic mail services.

"(E) Data processing or transaction processing services that do not involve the generation or alteration of the content of information.

"(F) Electronic billing or advertising of a Bell operating company's regulated telecommunications services.

"(G) Language translation or data format conversion.

"(H) The provision of information necessary for the management, control, or operation of a telephone company telecommunications system.

"(I) The provision of directory assistance that provides names, addresses, and telephone numbers and does not include advertising.

"(J) Caller identification services.

"(K) Repair and provisioning databases and credit card and billing validation for telephone company operations.

"(L) 911-E and other emergency assistance databases.

"(M) Any other network service of a type that is like or similar to these network services and that does not involve the generation or alteration of the content of information.

"(N) Any upgrades to these network services that do not involve the generation or alteration of the content of information.

"(O) Video programming or full motion video entertainment on demand.

Exchange Access

Telecommunications Act of 1996, Sec. 3(a)(40)

"the offering of access to telephone exchange services or facilities for the purpose of the origination or termination of telephone toll services."

Exchange Access and Interconnection Requirements
Telecommunications Act of 1996, Sec. 251(g)
"each local exchange carrier, to the extent that it provides wireline services, shall provide exchange access, information access, and exchange services for such access to interexchange carriers and information service providers...until such restrictions and obligations are explicitly superseded by regulations prescribed by the Commission [emphasis added]."

Facilities-Based Competitors
Conference Report to Accompany S. 652, pages 147-148,
Clarification of the Act, Sec. 271(c)(1)(A), Bell Operating Companies Entry into InterLATA Services
"With respect to the facilities-based competitor requirement, the presence of a competitor offering the following services specifically does not suffice to meet the requirement: (1) exchange access; (2) telephone exchange service offered exclusively through the resale of the BOC's telephone exchange service; and (3) cellular service. The competitor must offer telephone exchange service either exclusively over its own facilities or predominantly over its own facilities in combination with the resale of another carrier's service.
"This conference agreement recognizes that it is unlikely that competitors will have a fully redundant network in place when they initially offer local service, because the investment necessary is so significant. Some facilities and capabilities (e.g., central office switching) will likely need to be obtained from the incumbent local exchange carrier as network elements pursuant to the new section 251. Nonetheless, the conference agreement includes the 'predominantly over their own telephone exchange service facilities' requirement to ensure a competitor offering service exclusively through the resale of the BOC's telephone exchange service does not qualify, and that an unaffiliated competing provider is present in the market."

Incumbent Local Exchange Carrier (ILEC)
Telecommunications Act of 1996, Sec. 251(h)(1)
"with respect to an area, the local exchange carrier that
"(A) on the date of enactment of the Telecommunications Act of 1996, provided telephone exchange service in such area; and
"(B)(i) on such date of enactment, was deemed to be a member of the exchange carrier association pursuant to section (47 C.F.R. 69.601(b)); or
"(ii) is a person or entity that, on or after such date of enactment, became a successor or assign of a member described in clause (i)."

Infrastructure Sharing
Telecommunications Act of 1996, Sec. 259(a)
"The Commission shall prescribe...regulations that require incumbent local exchange carriers...to make available to any qualifying carrier such public switched network infrastructure, technology, information, and telecommunications facilities and functions as may be requested by such qualifying carrier for the purpose of enabling such qualifying carrier to provide telecommunications services, or to provide access to information services, in the service area in which such qualifying carrier has requested and obtained designation as an eligible telecommunications carrier section 214(e)."

Information Service
Telecommunications Act of 1996, Sec. 3(a)(41)
"the offering of a capability for generating, acquiring, storing, transforming, processing, retrieving, utilizing, or making available information via telecommunications, and includes electronic publishing, but does not include any use of any such capability for the management, control, or operation of a telecommunications system or the management of a telecommunications service."

Interconnection Duty of the ILEC
Telecommunications Act of 1996, Sec. 251(c)(2)
"the duty to provide, for the facilities and equipment of any requesting telecommunications carrier, interconnection with the local exchange carrier's network -

"(A) for the transmission and routing of telephone exchange service and exchange access;

"(B) at any technically feasible point within the carrier's network;

"(C) that is at least equal in quality to that provided by the local exchange carrier to itself or to any subsidiary, affiliate, or any other party to which the carrier provides interconnection; and

"(D) on rates, terms, and conditions that are just, reasonable, and nondiscriminatory, in accordance with the terms and conditions of the agreement and the requirements of this section and section 252.

Local Access and Transport Area
"The *Modification of Final Judgment*, provided guidelines for setting up LATAs in Section IV(G), page 229. However, the federal court overseeing the breakup of AT&T spelled out the definition: "The purpose of the establishment of the LATAs is only ...to delineate the areas in which the various telecommunications companies will operate; it is not to distinguish the area in which a telephone call will be 'local' from that in which it becomes a 'toll' or long-distance call." *U.S. v. Western Electric*, Civil Action No. 82-0192 (following MFJ), 569 F. Supp. 990, Section I(A), pages 994-995.

Local Exchange Carrier (LEC)
Telecommunications Act of 1996, Sec. 3(a)(44)
"any person that is engaged in the provision of telephone exchange service or exchange access. Such term does not include a person insofar as such person is engaged in the provision of a commercial mobile service under section 332(c), except to the extent that the Commission finds that such service should be included in the definition of such term."

Conference Report to Accompany S. 652, page115,
Clarification of the Act, Sec. 3(a)(44), Additional Definitions, Local Exchange Carrier
Conf. Report, p. 115: this term "does not include a person insofar as such person is engaged in the provision of CMS under section 332(c) of the Communications Act, except to the extent that the Commission finds that such service as provided by such person in a State is a replacement for a substantial portion of the wireless telephone exchange service within such State."
Page 116, "The Senate definition of 'local exchange carrier' was included to ensure that the Commission could, if circumstances warrant, include CMS providers which provide telephone exchange service or exchange access in the definition of 'local exchange carrier.'"

Local Loop Transmission
Telecommunications Act of 1996, Sec. 271(c)(2)(B)(iv), from the Competitive Checklist
"from the central office to the customer's premises, unbundled from local switching or other services."

Local Transport
Telecommunications Act of 1996, Sec. 271(c)(2)(B)(v), from the Competitive Checklist
"from the trunk side of a wireline local exchange carrier switch unbundled from switching or other services."

Local Switching
Telecommunications Act of 1996, Sec. 271(c)(2)(B)(vi), from the Competitive Checklist
"unbundled from transport, local loop transmission, or other services."

Network Element
Telecommunications Act of 1996, Sec. 3(a)(45)
"a facility or equipment used in the provision of a telecommunications service. Such term also includes features, functions, and capabilities that are provided by means of such facility or equipment, including subscriber numbers, databases, signaling systems, and information sufficient for billing and collection or used in the transmission, routing, or other provision of a telecommunications service."

Personal Communications Services (PCS)
47 C.F.R. 24.5 Terms and Definitions,
"Radio communication that encompass mobile and ancillary fixed communication that provide services to individuals and businesses and can be integrated with a variety of competing networks.

Point of Presence
AT&T Plan of Reorganization, page 12, note 11.
"a physical location where there is a point of interface between the BOC facilities providing a LATA access functions and an interLATA carrier's facilities providing an interLATA function. A POP must be located within the boundary of the LATA being served, and it may contain an interLATA carrier's system or some other designated facility."

Pricing Standards - Interconnection and Network Elements
Telecommunications Act of 1996, Sec. 252 (d)(1)
"Determinations by a State commission of the just and reasonable rate for the interconnection of facilities and equipment for purposes of subsection (c)(2) of section 251, and the just and reasonable rate for network elements for purposes of subsection (c)(3) of such section -

"(A) shall be -

"(i) based on the cost (determined without reference to a rate-of-return or other rate-based proceeding) of providing the interconnection or network element (whichever is applicable), and

"(ii) nondiscriminatory, and

"(B) may include a reasonable profit.

Public Telecommunications Network Interconnectivity
Telecommunications Act of 1996, Sec. 256 (d)
"the ability of two or more public telecommunications networks used to provide telecommunications service to communicate and exchange information without degeneration, and to interact in concert with one another."

Qualifying Carrier
Telecommunications Act of 1996, Sec. 259(d)
For the purposes of Infrastructure Sharing, Sec. 259(a), this "means a telecommunications carrier that--

"(1) lacks economies of scale or scope, as determined in accordance with regulations prescribed by the Commission pursuant to this section; and

"(2) offers telephone exchange service, exchange access, and any other service that is included in universal service, to all consumers without preference throughout the service area for which such carrier has been designated as an eligible telecommunications carrier under section 214(e)."

Rural Telephone Company

Telecommunications Act of 1996, Sec. 3(a)(47)

"a local exchange carrier operating entity to the extent that such entity -

"(A) provides common carrier service to any local exchange carrier study area that does not include either -

"(i) any incorporated place of 10,000 inhabitants or more, or any part thereof, based on the most recently available population statistics of the Bureau of the Census; or

"(ii) any territory, incorporated or unincorporated, included in an urbanized area, as defined by the Bureau of the Census as of August 10, 1993;

"(B) provides telephone exchange service, including exchange access, to fewer than 50,000 access lines;

"(C) provides telephone exchange service to any local exchange carrier study area with fewer than 100,000 access lines; or

"(D) has less than 15 percent of its access lines in communities of more than 50,000 on the date of enactment of the Telecommunications Act of 1996."

Rural Competitor

Conference Report to Accompany S. 652, pages 127-128,
Clarification of the Act, Sec. 253(b), Barriers to Entry,

"a State may require the competitor seeking to provide service in a rural market to meet the requirements or designation as an eligible telecommunications carrier. That is, the State may require the competitor to offer services and advertise throughout the service area served by a rural telephone company. The provision would not apply if the rural telephone company has obtained an exemption, suspension, or modification under new section 251(f) [Interconnection - Exemptions, Suspensions, and Modifications] that effectively prevents a competitor from needing the eligible telecommunications carrier requirements. In addition, the provision would not apply to providers of CMS."

Telecommunications

Telecommunications Act of 1996, Sec. 3(a)(48)

"the transmission, between or among points specified by the user, of information of the user's choosing, without change in the form or content of the information as sent and received."

Telecommunications Carrier

Telecommunications Act of 1996, Sec. 3(a)(49)

"any provider of telecommunications services, except that such term does not include aggregators of telecommunications services (as defined in section 226). A telecommunications carrier shall be treated as a common carrier under this Act only to the extent that it is engaged in providing telecommunications services, except that the Commission shall determine whether the provision of fixed and mobile satellite service shall be treated as common carriage."

Telecommunications Equipment
Telecommunications Act of 1996, Sec. 3(a)(50)
"equipment, other than customer premises equipment, used by a carrier to provide telecommunications services, and includes software integral to such equipment (including upgrades)."

Telecommunications Service
Telecommunications Act of 1996, Sec. 3(a)(51)
"means the offering of telecommunications for a fee directly to the public, or to such classes of users as to be effectively available directly to the public, regardless of the facilities used."

Conference Report to Accompany S. 652, page114,
Clarification of the Act, Sec. 3(a)(51)
"'telecommunications service'...means the offering of telecommunications for a fee directly to the public or to such classes of users as to be effectively available to the public, regardless of the facilities used to transmit the telecommunications service. This definition is intended to include commercial mobile service ('CMS'), competitive access service, and alternative local telecommunications services to the extent they are offered to the public or to such classes of users as to be effectively available to the public."

Telephone Exchange Service
Telecommunications Act of 1996, Sec. 3(a)
amends 47 U.S.C. 153
"(1) in subsection (r) -
"(A) by inserting '(A)' after 'means'; and
"(B) by inserting before the period at the end the following: ', or (B) comparable service provided through a system of switches, transmission equipment, or other facilities (or combination thereof) by which a subscriber can originate and terminate a telecommunications service';"

47 U.S.C. 153(r), Definitions, Telephone Exchange Service, with additions from the Act.
"'Telephone exchange service' means (A) service within a telephone exchange, or within a connected system of telephone exchanges within the same exchange area operated to furnish to subscribers intercommunicating service of the character ordinarily furnished by a single exchange, and which is covered by the exchange service charge, or (B) *comparable service provided through a system of switches, transmission equipment, or other facilities (or combination thereof) by which a subscriber can originate and terminate a telecommunications service."*

Unbundled Access Duty of the ILEC

Telecommunications Act of 1996, Section 251(c)(3)

"The duty to provide, to any requesting telecommunications carrier for the provision of a telecommunications service, nondiscriminatory access to network elements on an unbundled basis at any technically feasible point on rates, terms, and conditions that are just, reasonable, and nondiscriminatory in accordance with the terms and conditions of the agreement and the requirements of this section and section 252. An incumbent local exchange carrier shall provide such unbundled network elements in a manner that allows requesting carriers to combine such elements in order to provide such telecommunications service."

Universal Service, Advanced Services Access

Telecommunications Act of 1996, Sec. 254(h)(2)

"The Commission shall establish competitively neutral rules --

"(A) to enhance, to the extent technically feasible and economically reasonable, access to advanced telecommunications and information services for all public and nonprofit elementary and secondary school classrooms, health care providers, and libraries; and

"(B) to define the circumstances under which a telecommunications carrier may be required to connect its network to such public institutional telecommunications users."

VIII. Appendix C: Competitive Checklist

Telecommunications Act of 1996,
Competitive Checklist Requirements
Telecommunications Act of 1996, Sec. 271(c)(2)(B)

"Access or interconnection provided or generally offered by a Bell operating company to other telecommunications carriers meets the requirements of this subparagraph if such access and interconnection includes each of the following:

"(i) Interconnection in accordance with the requirements of sections 251(c)(2) and 252(d)(1).

"(ii) Nondiscriminatory access to network elements in accordance with the requirements of sections 251(c)(3) and 252(d)(1).

"(iii) Nondiscriminatory access to the poles, ducts, conduits, and rights-of-way owned or controlled by the Bell operating company at just and reasonable rates in accordance with the requirements of section 224.

"(iv) Local loop transmission from the central office to the customer's premises, unbundled from local switching or other services.

"(v) Local transport from the trunk side of a wireline local exchange carrier switch unbundled from switching or other services.

"(vi) Local switching unbundled from transport, local loop transmission, or other services.

"(vii) Nondiscriminatory access to

"(I) 911 and E911 services;

"(II) directory assistance services to allow the other carrier's customers to obtain telephone numbers; and

"(III) operator call completion services.

"(viii) White pages directory listings for customers of the other carrier's telephone exchange service.

"(ix) Until the date by which telecommunications numbering administration guidelines, plan, or rules are established, nondiscriminatory access to telephone numbers for assignment to the other carrier's telephone exchange service customers. After that date, compliance with such guidelines, plan, or rules.

"(x) Nondiscriminatory access to databases and associated signaling necessary for call routing and completion.

"(xi) Until the date by which the Commission issues regulations pursuant to section 251 to require number portability, interim telecommunications number portability through remote call forwarding, direct inward dialing trunks, or other comparable arrangements, with as little impairment of functioning, quality, reliability, and convenience as possible. After that date, full compliance with such regulations.

"(xii) Nondiscriminatory access to such services or information as are necessary to allow the requesting carrier to implement local dialing parity in accordance with the requirements of section 251(b)(3).

"(xiii) Reciprocal compensation arrangements in accordance with the requirements of section 252(d)(2).

"(xiv) Telecommunications services are available for resale in accordance with the requirements of sections 251(c)(4) and 252(d)(3)."

IX. Appendix D: Switch Modeling Definitions and Assumptions

Definitions of Large and Small Switches

It should the noted that no single definition exists for what elements constitute a switch since companies purchase switches based on market needs and projections, and switch manufacturers offer products with different designs, features, and functions. The definitions for modeling switch investment in this paper are based on the sources and assumptions listed below.

General Description of Switch:

The basis for modeling switch investment percentages was Nortel DMS 100/200 switch engineering standards. The model assumed that the switch used a supernode (enhanced) processor and ENET (enhanced network) to allow for the engineering **of vertical services -** i.e., Centrex, ISDN, and enhanced customer service options. This allows for compatible mixing of various equipment combinations on the switch. The ENET is fully duplicated, with two mounting cabinets, serves both copper (DS-30) and fiber (DS-512) links and allows for modular growth.[68]

Where there were multiple choices for type of equipment, the investment percentage was derived from combined types.

Small Switch:

The average size of a small switch used in the model is approximately 1,200 lines. This estimate is based on switch size data from several sources:

- Data provided to the FCC in response to its Universal Service Fund Data Collection.
- Data published in a National Exchange Carrier Association (NECA) study entitled Telecommunications: America's Vital Link, 1995.
- Averages from large LECs rural service areas.

The first two sources listed above use NECA traffic-sensitive pool members, which are typically small telephone companies and serve predominantly rural markets. In rural areas, there is a larger percentage of residential customers compared to business customers. The range for small switches for rural telephone companies is 1,000 lines up to 7,500 lines.

Large Switch:

The average size of a large switch used in the model is 25,000 lines. However, in some large urban areas, a switch may have over 100,000 lines and a central office building may have more than one switch.

IX. Appendix D: Switch Modeling Definitions and Assumptions, cont.

Essentially everything that is not a small switch is a large switch. However, since there is no official definition of a large switch, the size for the model was determined by individual samples and company-wide averages from several large companies with different regional and network characteristics. Large switches generally service urban areas, with a larger percentage of business customers compared to residential customers. Traffic is mix of patterns: between customers attached to the same local switch (intra-office), between switches in the same local calling area (intra-exchange), and between local switches and tandem switches.

Basic Switch Investment Modeling Assumptions

The following assumptions formed the basis for the investment in **Figure 5:**

1. This model does not attempt to indicate actual dollars because these numbers are based on averages across a number of companies. Investment for specific switches are based on a number of different characteristics, such as type of customers and companies interconnecting, type of services, and traffic patterns. Since companies purchase switches based on actual markets, there is no standard definition for switch sizes. Other types of companies, such as IXCs and new entrants, may have switches with other investment characteristics.

2. For simplicity, the investments modeled exclude overheads for engineering, installation startup, and taxes.

3. All interconnection arrangements are for switched message (voice) services. This ignores the connections for fixed connections such as private line services. Generally, private lines don't use the switch, but there are some exceptions, such as virtual private lines.

4. Only connections to the ILEC switch are modeled: line side and trunk side. Connections that are made through an adjunct to the switch (i.e., special ISDN arrangements) are excluded.

5. All switched minutes are treated the same regardless of jurisdictional classification: local/toll/access or state/interstate.

6. The duration of all connections are the same. For details on call duration and other traffic-based statistics, see **Figure 4** and the discussion of these numbers later on in this section under "Sources for Figure 4 and Switch Modeling."

IX. Appendix D: Switch Modeling Definitions and Assumptions, cont.

Technical Definitions: Common to All Investments

Common equipment generally does not vary with switch size, lines, or trunks (with the exception of the processor. The "Common to All" category includes cable and framework costs, power systems, operations support systems (maintenance and testing), and any other vendor equipment. Equipment for this category includes the following: S/DMS CORE cabinet, message switch processor, computing module, central processor, program and data storage, input/output equipment, maintenance and test equipment, breakage, spares, initial office engineering and installation, main distributing frame, protector frame, DS-1, DS-30, and DS-512 interface central processor, and integrated services module.

Technical Definitions: Common to Line Side Investments

The "Common to Line Side" category includes line cards (types A through E) for basic loop service, multi-line services, data services, and message waiting; shelves and drawers; line test equipment; tone and ring generators; line concentration modules with frame; interface cards and circuits; line group controllers with circuits; universal tone receivers; and other miscellaneous circuits. Lines cards were a combination of speech and data types.

Technical Definitions: Common to Trunk Side Investments

The "Common to Trunk Side" category includes trunks cards
, tone circuit cards, shelves, frames, trunk test equipment, circuits pads, and the links to the social processor in the switch. This category also includes trunk modules (analog), maintenance trunk modules, digital recorded announcement modules, and activity trunk controllers. Trunk cards were set up for a combination of DS-1, DS-30, and DS-512 trunks.

Technical Definitions: Specific Services

- Centrex: Used by large businesses and institutions, a portion of the switch is dedicated to a specific customer, allowing the customer to have an on-site network for speech and data. A dedicated trunk routes traffic between the switch and this on-site network, making it look like the customer has an on-site switch.

- Signaling System 7 (SS7):Equipment used to determine the availability of a call route (voice or data) using a separate path before the call is switched. SS7 equipment sends the signal to a **Signal Tranfer Point (STP)** to check the trunks needed to complete the call. This frees up trunks or short periods of time between dialing and completion of the call. The STP is a fast packet switch that also routes information between the central office switch, the **Service Control Point (SCP)** - a database with information on customers and their service requirements, other STPs, and other switches.

- **Multi-Frequency (MF) Signaling** : Used for analog signaling, MF determines call routing, but unlike SS7, MF does not use a separate path. Therefore, SS7 is referred to as "out-of-band" signaling and MF is referred to as "in-band" signaling. SS7 is replacing MF as technology moves from analog to digital.

- ISDN/Wideband Video: There are two ISDN transmission rates:

  -**Basic Rate Interface (BRI)**, called "basic" for short: two 64 kilobit bearer (voice/data) channels and one 16 kilobit data signaling channel. Also referred to as "2B +D." The total is 1.5 mbps or the equivalent of a T1 line. BRI ISDN "is a phone line that is divided into two large paths and a smaller one, making it possible to be on the phone and the Internet at the same time." *The New York Times*, Business Day Section, "Quick Look at a Faster Interconnection," March 25, 1996, page D1.

  -**Primary Rate Interface (PRI),** called "primary" for short: 23 channels of 64 kilobits and one 64 kilobit channel for signaling.

ISDN uses packet handlers for link peripheral processors. ISDN services include ISDN signal processor, lines group controller for BRI, digital trunk controller for PRI, and line trunk controller for both BRI and PRI. The BRI lines terminate in an enhanced line concentration module.

- AIN: This service employs SS7 and intelligent peripherals (IPs) an off-network computer with LEC-Pacific software applications that provide off-network advance customer services that use the SS7 network for routing calls. For example, the ***Intelligent Network (IN)*** allows the IP to determine the shortest call routes based on the customer's location.

- Wireless: Model assumes Type I, II, and IIA connections. See description of types of wireless connections discussed later in this section. The majority of the investment is outside of the switch. This category includes line side or trunk side ports along with associated software.

- CLASS: These services include call forwarding, call waiting, caller identification (caller ID), and three-way calling. These services are primarily software-based.

- Voice Mail: A software based message storage system that allows the switch to act like an answering machine.

- E911/911: Allows a customer to dial three digits (911) to reach a centralized local emergency services site for connections to police departments, fire departments, ambulance services, and others. E911 uses SS7 data bases and software in the switch to provide additional information, such as the location of the closest emergency service provider, the customer's telephone number, the customer's locations, and other caller information.

- Coin Service: This is equipment and software used for public and semi-public pay phone services (coin and credit card) for connection with the PSN and with operator service.

Switch Capabilities Assumed in Model

SS7 and MF signaling
SSP capable
Call recording for billing
Announcements and tones for call processing
Basic testing and maintenance functions
Access to:
- Operator services: includes directory assistance
- Tandem switches: includes tandem signaling
- IXCs (equal access)
- Wireless carriers: cellular (Type I, II, and IIA) and PCS

Residential, single-line business, and multi-line business services
Centrex
CLASS services
ISDN/wideband video
Voice mail
E 911/911
Coin service

Description of Types of Wireless Connection with a LEC Network

The following are definitions for the various types of cellular interconnection facilities or arrangements adapted from Bellcore, *Interconnection of WSP/LEC Network* "Interconnection Types," TR-NPL-000145, Issue 2, December 1993, page 2-1.

Type I:
The cellular switch connects to the LEC local switch (end office or Class 5). The LEC provides more functions and the cellular switch functions like a **Private Branch eXchange (PBX)**. The LEC switch provides directory numbers (the database of telephone numbers, or NXX codes).

Type IIA:
The cellular switch connects to a LEC tandem switch. In this case the NXX data base can reside in the cellular switch. The cellular switch provides the equivalent of LEC Class 5 switching. Result is that the Type IIA cellular company pays the LEC a lower price than Type I cellular companies.

Type IIB:
The cellular switch connects to a specific LEC end office but in conjunction with a cellular Type IIA interconnection facility. Any overflow traffic in excess of the capacity of the Type IIB is handled by the Type IIA facility.

Type IIC:
The cellular switch connects to a LEC tandem office that provides E911 calls.

Type IID:
The cellular switch connects to a LEC tandem that provides LEC operator assisted calls or directory service using SS7 or MF.

Type S:
The cellular switch connects to a LEC for STP for access to the Common Channel Signaling (CCS) network.

Requirements for Ports: Trunk Side and Line Side

The following chart compares the technical differences between trunk side and line side connections to the LEC switch.

Trunk Side Port Requirements:	*Line Side Port Requirements:*
Signaling: Seizure Digit transmission:[a] Start End Idle	Signaling: Off-hook On-hook Ringing Busy Digit Collection (using tones or pulses)
Usually Digital Transmission	Usually Analog Transmission
Many Trunks per Wire/Fiber	Loop Requires at Least 2 Wires
1 Port for Many Trunks	1 Port per Loop

[a]With SS7, the trunk may not have to recognize the transmission of digits (the telephone number). With MF signaling, the trunk must be able to recognize the transmission of digits.

Sources for Figure 4 and Switch Modeling
Switch Traffic and Usage Statistics: Telephone Network

Percent of U.S. Households with Service
93.9% annual average for 1995. FCC, Telephone Subscribership in the United States, Washington, DC, February 27, 1996, page 17.

IX. Appendix D: Switch Modeling Definitions and Assumptions, cont.

Holding Time per Connection (Call Duration):
Traditionally, the average length of time per individual connection was 2.45 minutes per call (147 seconds per call). Information derived from Bellcore, *LATA Switching Systems Generic Requirements*, 1989, Section 17, Issue 3. The model assumes 5 minutes per call (300 seconds per call) for 1995 based on 1995 and 1996 samples from data used to determine average switch size described earlier in **Appendix D**.

Capacity - Trunk to Line Ratio:
The largest percent of loops (lines) that can be routed to a destination beyond the switch at any given time. This is one measure of peak capacity. The assumptions used in the model were a 1:6 ratio of trunks to lines (16.7%) for a small switch and a 1:5 ratio (20%) for a large switch. The actual range for this ratio may be as high as 1:4 or as low as 1:10. In the case of the lower ratio, the majority of originating and terminating calls are made among customers whose lines attach to the same switch (intra-office). The ratios are based on based on 1995 and 1996 samples from data used to determine average switch size described earlier in **Appendix D**.

Capacity - Percent of Loops in Use:
The largest percent of loops (lines) in use. This is a second measure of peak capacity but this is not an engineering criteria and, therefore, not used in the model.

Capacity - Line Concentration Ratio:
This is the number of loops whose traffic is channeled into a single path by a line concentration module. As traffic volumes increase, line concentration ratios need to decrease. Therefore, more line concentration modules are needed. If there are not enough modules, the customer may not even hear a dial tone and is unable to make the call. This ratio is a third measure of peak capacity. Historically, line concentration ratios have decreased. The ratios are based on based on 1995 and 1996 samples from data used to determine average switch size described earlier in **Appendix D**. The assumption for the model is a 6.1 ratio of loops to a path.

Busy Hour Call Volume per Hour:
The number of calls a switch must be able to handle during its busiest hour, called the peak load time. The call volume is based on three times the line capacity for a small switch and four times the line capacity for a large switch. However, these multipliers can be as high as six times the capacity depending on the demographics of the customers connected to the switch (urban/rural, business center/residential, government/private sector, number of switches in the extended calling area, etc.). Using the above assumptions, the busy hour call volume per hour was 3,600 calls for a small switch and 100,000 calls for a large switch.

Call Completion:
Percent of calls completed (destination point answers the call). Switches are engineered for 99% call connection. However, these actual percentage of completed calls is lower due to various factors, such as customers hanging up before the call is answered, customers receiving a busy signal because the party called is already on the line, or the person on the

other end never picks up the phone. The range used in the modeling was 80-85% based on 1995 data from sample LECs.

Sources for Figure 4 -
Internet Network Statistics

Percent of U.S. Households with Service
Data for 1996, 4.1 million U.S. households have at least one Internet user who connects to the Internet from home. This number is divided by a total number of U.S. households of 98.2 million to give result of 4%. Find/SVP, *The American Internet User Survey*, page iv. Also total number of U.S. households from Find/SVP, *The American Internet User Survey: New Survey Highlights*, at http://etrg.findsvp.com/features/newinet.html, April 5, 1996.

Holding Time per Connection:
American Internet User Survey, page 38. The average session length is 68 minutes.

There is a controversy over the estimated number of Internet users. A number of factors alter the results: age (what constitutes an adult), location, use (if there is an Internet user in the household but the home itself does not have a computer, how is this counted?), survey size and sampling method, and other assumptions. This paper uses the lower estimate from Find/SVP, since some studies included Canadian or e-mail users. See also http://www.cyberatlas.com/market.html, April 5, 1996, which gives a range from 6.4% to 8.4% for households with access to Internet's Worldwide Web. See also, Peter H. Lewis, "In a Recount, Cyber Census Still Confounds," *The New York Times*, April 17, 1996, pages D1 and D5, for a discussion of this debate. The Internet usage in **Figure 4** does not cover which on

The following are some statistics from various studies for the purposes of comparison:

- Find/SVP, The *American Internet User Survey*," The Emerging Technologies Research Group, Find/SVP, New York, NY, February 1996. All numbers are for mid-November to mid-December 1995. From personal communication on March 21, 1996.

  6.4% of U.S. households have an Internet user within the household but might use it elsewhere and 9.5 million people use it in general, page iv. The average use per week is 6.6 hours for overall usage from anywhere, 7.2 hours in a household if only an adult (18 years and older) uses it, and 9.4 hours in a household if both adults and children use it.

- Nielsen Interactive Services - Press Release, *The CommerceNet/Nielsen Internet Demographics Survey, Executive Summary,* from http://www.nielsenmedia.com/ whatsnew/execsum2.html, on March 21, 1996.

The Nielsen study has 24 million, or 11%, of the total population of U.S. and Canada (16 years or older, with a weighting to adjust for gender bias) used any aspect of the Internet within past 3 months. In addition, 6.7% had access to the Internet at home. The average Internet use within the past three months for all persons in the study was 5 hours and 28 minutes per week. The average use for on-line services was 2 hours and 29 minutes per week.

Sources for Figure 4 -
Cable TV Network Statistics

Percent of U.S. Households with Service
In 1994, 64.4% of U.S. households with televisions subscribed to basic cable service. National Cable Television Association, *Cable Television Developments*, Washington, DC, Fall 1995. To develop the percent of households with cable TV service, the 64.4% was multiplied by number of households with televisions in 1994 (98.3%). Data for 1994, U.S. Department of Commerce, Economics and Statistics Administration, Bureau of the Census, *Statistical Abstract of the United States*, 1995, 115th Edition, U.S. Government Printing Office, Washington, DC, 1995, Table 897, page 571. The calculated result is 63.3% of households with basic cable service.

Holding Time per Connection
For cable TV households, the total hours of TV viewing (both broadcast and cable) per week is 59.2 hours (59 hours and 12 minutes). The average weekly viewing time for households with cable TV basic service is 22 hours and 22 minutes for the 1994/1995 broadcast year. Cablevision Ad Bureau, 1996 *Cable TV Facts*, New York, NY, 1966, "Total Hours of Viewing per Week", page 30, and "Average Weekly Viewing in All Cable HHs (Hours: Minutes)"; page 15.

Capacity
A cable TV company continuously broadcasts its signal and therefore all its customers (100%) are connected. However, the specific measures for capacity, busy hour call volume, and call completion in **Figure 4** apply only to traditional LEC local switch architectures. These do not translate to the current cable TV network which typically has a bus architecture, uses an Ethernet protocol (with cable modems), is a shared facility, and has no switch to manage contention for capacity. Industry wide standards do not exist for the newer broadband networks being constructed by cable TV companies.

X. Notes

Notes: Section I, Introduction

1. *Telecommunications Act of 1996*, Pub. L. No. 104-104, February 8, 1996. For more details, see U.S. Congress, House of Representatives, 104th Congress, 2d Session, Report 104-458, *Telecommunications Act of 1996, Conference Report to Accompany S*. 652.

2. FCC, *In the Matter of Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, CC Docket No. 96-98, *Notice of Proposed Rulemaking*, FCC No. 96-182, April 19, 1996 [hereinafter referred to as *Interconnection Proceeding*].

3. For a discussion of these cycles, see, Carol Weinhaus and Anthony Oettinger, *Behind the Telephone Debates* [hereinafter referred to as *Behind the Telephone Debates*], Ablex Publishing Company, Norwood, NJ, 1988, Chapter 2, pages 5-14.

Notes: Section II, LEC Switch, Transport, and Local Loop

4. The court decision breaking up AT&T also created new boundaries for LEC service territories, called ***Local Access and Transport Areas (LATAs).***

5. *Telecommunications Act of 1996*, Sec. 271(c)(2)(B).

6. For a wireless transmission, the path may be entirely wireless or may have both wire and over-the-air components. Wireless networks provide services such as cellular, PCS, paging, and mobile radio. The Act refers to wireless companies as "Commercial Mobile Service (CMS)" providers, *Telecommunications Act of 1996*, Sec. 253(e).

   Also, in the context of federal and state tariffs, the term "access lines" implies connection to the PSN.

7. For a discussion of the role of tandem switches and transport, see Weinhaus, Carol and Seaver, Rob, et al., *Interim Report of the Alternative Costing Methods Project: An Example of Modeling an Issue – Transport: Equal Charge for Equal Unit of Traffic.* Program on Information Resources Policy, Harvard University, April 19, 1991, pages 8-17.

8. There are always exceptions to the rules and, in some cases, these exceptions are significant. Sometimes two switches are connected through line side ports and sometimes loops are connected through trunk side ports. For example, large business customers may use their own switches, called PBXs, to connect to the trunk side ports. Similarly an IXC may have a line side connection.

9. "In 39 million U.S. households, at least one person has a home office - up from 36 million in 1994." Also, 6 million people telecommuted to their job from home in 1995. From *USA Today*, "USA Snapshots®: Working More at Home," April 12, 1996, Section B, page 1. Original source for article is IDC/Link 1995 Home-Office Market Update.

10. In this paper, the term "ALT" refers to a service provider. It should be noted that the term "ALTS" refers to a trade association called the Association for Local Telecommunications Services.

11. The court decision breaking up AT&T also created LATAs, and the POPs.

X. Notes, cont.

12. The diagram is a simple configuration. Often the POP connects to a LEC tandem switch. Therefore, other access configurations might include additional switches and trunks. Also, a small rural company often connects to a larger LEC's tandem switch to reach the POP to connect to the PSN. The *AT&T Plan of Reorganization* defined the POP in order to implement the **Modification of Final Judgment (MFJ)** which set the rules for the AT&T divestiture. *U.S. v. AT&T, Modification of Final Judgment*, 552 F. Supp. 131 (D.D.C. 1982), *aff'd mem.*, 103 S.Ct.1240 (1983). *U.S. v. Western Electric, Civil Action* No. 82-0192, *AT&T Plan of Reorganization* (December 16, 1982), at page 10, n. 9; for definition of a POP, see page 12, n. 11. Submitted by AT&T pursuant to *MFJ*, at Section I (A), page 226; Section VIII(J), page 232. For a discussion, see *Behind the Telephone Debates*, pages 127-131.

13. *AT&T and the Bell System Operating Companies Tariff No. 8 (BSOC 8), Transmittal No. 53, Exchange Network Facilities for Interstate Access (ENFIA)*, CC Docket No. 78-371, *Memorandum Opinion and Order,* 71 FCC 2d 440 (1979); *Memorandum Opinion and Order,* 90 FCC 2d 6 (April 14, 1982); *Memorandum Opinion and Order,* 90 FCC 2d 202 (April 30, 1982); *Memorandum Opinion and Order,* 91 FCC 2d 1079 (September 1982); *Order on Reconsideration*, 93 FCC 2d 739 (1983).

14. In some cases, an ESP company may use a trunk side port to connect to the LEC switch. Here, the connection is similar to a business with a private line connection. Also, ESPs, like any other customer or company, may purchase **Foreign Exchange (FX)** service, which gives line side connections to a switch beyond the first switch (the central office switch).

15. Another way to look at blocking is to envision a highway with the trunks as lanes. If all the lanes are full, the call coming from the loop is blocked and can't go through.

16. Based on data used to develop the large and small switch definitions described in **Section IX, Appendix D.**

17. More than one loop will connect to a line concentration module. This module groups originating calls through the line group controller onto the switching module. A line concentrator is different from a multiplexer.

18. Find/SVP, *The American Internet User Survey,* The Emerging Technologies Research Group, New York, NY, February 1996. All numbers are for mid-November to mid-December 1995. From personal communication on March 21, 1996, page iv. There is also controversy over the actual number of Internet users and other related Internet statistics. **Figure 4** uses a conservative estimate. See **Section IX, Appendix D** for additional statistics and background.

19. This average is based on *all* switched voice calls, including access to the Internet over telephone modems, and ignores fixed connections, such as those for private line services.

20. "In North America, a geographic division within which telephone directory numbers are subgrouped. A 3-digit, N0/1X or NXX code is assigned to each NPA, where
    N = any digit 2 through 9
    0/1 = 0 or 1
    X = any digit 0 through 9."

The NXX format "embodies the concept of interchangeable codes, wherein central office codes and area codes [are] no longer...characterized by mutually exclusive formats." Bell Telephone Laboratories, Inc., *Engineering and Operations in the Bell System*, Prepared by Members of the Technical Staff and the Technical Publication Department, New Jersey, 1977, pages 112 and 673.

This projection is on a study about when the North American Numbering Plan (NANP) will exhaust the supply of 10-digit telephone numbers. Jim Deak, NANP Administration, Industry Numbering Committee (a standing committee under the Industry Carriers Compatibility Forum, or ICCF), NANP Expansion Workshop, "NANP Exhaust Projections," November 2, 1995, pages 1 and 2. This projection is based on the current rate of new area code assignments. Changes in this pattern will alter the exhaust date.

21. From isolated engineering reports.

22. For example, often calls from fax machines are short-burst, one-page transmissions. Credit card verifications, where the merchant swipes a card through a terminal to validate a transaction, may take only ten to twenty seconds. Another example is the use of point sale debit cards in lieu of checks. An instantaneous electronic transfer of funds moves money from the customer's bank account to the store's bank account. Pacific Bell, *Petition for Rulemaking to the FCC, In the Matter of Pacific Bell Petition for Rulemaking to Amend Section 69.106 of the Commission's Rules*, RM8496, June 30, 1994, Section III, "Proliferation of Short Calls," pages 3-6.

23. *Telecommunications Act of 1996*, Sec. 251(c)(2)(B).

24. *Ibid.*, Sec. 251(c)(2)(D). The universal service description for access to advanced services for specified schools, hospitals, etc., includes the terms "technically feasible and economically reasonable." Sec. 254(h)(2).

25. *Ibid.*, Sec. 251(c)(2)(C).

26. Hatfield Associates, Inc., *Open Network Architecture: A Promise Not Realized*, prepared for ADAPSO, Computer and Business Equipment Manufacturers Association, CompuServe Incorporated, Dun & Bradstreet, Independent Data Communications Manufacturers Association, Inc., and Telenet Communications Corporation; Boulder, CO, April 4, 1988.

27. FCC, *Interconnection Proceeding*, ¶97, "The Commission *could require* incumbent LECs to provide access to feeder and to distribution plant on an unbundled basis at remote switching or concentration sites, in addition to access to the switching or concentration equipment itself" [emphasis added].

Notes: Section III, Percent of Total Switch Investment by Company/Customer

28. When several services share a piece of equipment, economists do not simply consider the equipment's costs to be common costs. Instead, economists examine how the services affect the equipment's costs. If adding a service or increasing the use of a service increases the equipment's costs, this cost increase is an incremental cost to the service, even if the equipment is shared by multiple services.

29. The AIN employs off-network computers and databases for services. For example, a large business with stores in many locations may have a single telephone number. The AIN routes incoming calls from customers to the nearest store.

30. There are some exceptions where up to 8,000 lines can be connected to one line concentration module.

Notes: Section IV, Different Price Structures by Type of Company

31. For example, large business customers can shop for tariffs with the best price. The customer decides whether the state or interstate price is cheaper. Since the state/interstate information is not recorded, it's the customer's decision to report the actual traffic or to report the one that's cheaper, regardless of reality. As part of implementing the *Act*, there will be a debate as to which of these methods, if any, will continue to apply.

32. *Telecommunications Act of 1996*, Sec. 251(c)(B) and (D).

33. *Telecommunications Act of 1996*, Sec. 252 (d)(1)(A) and (B).

34. MTS and WATS Market Structure Inquiry, CC Docket No. 78-72, *Phase I: Third Report and Order (Access Charge Order),* 93 FCC 2d 241 (1982) [hereinafter referred to as *Access Charge Proceeding*]. For the full citation of this proceeding, see *Behind the Telephone Debates*, pages 191-193. For a discussion of the access charge proceeding and the introduction of the CCLC and the SLC, see pages 115-118.

35. Transport charges from a tandem switch also include a per minute tandem switching charge and a per minute tandem transport.

36. The *Interconnection Proceeding*, ¶ 139, refers to a ***Transport Interconnection Charge (TIC)***, which is just another name for the RIC.

37. For details on these subsidy mechanisms, see Carol Weinhaus; Bob Lock; et al., *Overview of Universal Service, Presentation at the Communications Media Center, New York Law School*, December 6, 1995, Telecommunications Industries Analysis Project, Boston, MA, 02138. Carol Weinhaus; Sandra Makeeff; et al., *What is the Price of Universal Service? Impact of Deaveraging Nationwide Urban/Rural Rates,* Presentation at the National Association of Regulatory Utility Commissioners Meeting, San Francisco, California, July 25, 1993, Telecommunications Industries Analysis Project, Boston, MA, 02138. For details on the RIC, see Carol Weinhaus; Mark Jamison; et al., *New Wine and Old Wineskins: Modeling Effects of Competition and Expanded Interconnection in the Local Exchange,* Presentation at the National Association of Regulatory Utility Commissioners Meeting, Seattle, Washington, July 27, 1992. Carol Weinhaus; Sandra Makeeff; et al., *Who Pays Whom? Cash Flow For Some Support Mechanisms and Potential Modeling of Alternative Telecommunications Policies*, Presentation at the National Association of Regulatory Utility Commissioners Meeting, Los Angeles, California, November 15, 1992.

38. The SLC is also called the **End User Common Line Charge (EUCLC).**

39. This does not include private line services.

40. A private line is a dedicated connection between two customer locations or a dedicated connection from a customer's location to the long distance network. For example, private lines use LEC facilities to reach a specific destination. A private line service guarantees a given capacity and service quality throughout the leased facilities without specifying how the LEC actually routes the traffic.

41. This was true at the time of the AT&T breakup. The AT&T *Plan of Reorganization* that states "exchange functions...include sending dial tones, interpreting customer dialing, providing ringing or busy tones for incoming calls, connecting customer lines to interoffice trunks and recording information for billing purposes. This description applies only to ordinary local telephone service; certain specialized switching (e.g. 800 service) is not considered an end office [exchange] function." pages 14-15. For a discussion, see *Behind the Telephone Debates*, page 218, endnote 8.

42. Traditionally 800 services were only offered to business customers except, for the movie star Elizabeth Taylor, who had a residential 800 number. Recently some companies are making these services available to consumers.

43. "A cellular system is a *common carrier* and not merely a customer; interconnection arrangements should therefore be reasonably designed so as to minimize unnecessary duplication of switching facilities and the associated cost to the ultimate consumer. The particular arrangements involved in interconnection of a given cellular system should be negotiated among the carriers involved and be made the subject of an interexchange carrier agreement" [emphasis added]. *In the Matter of An Inquiry into the Use of the Bands 825-845 MHZ and 870-890 MHZ for Cellular Communications Systems; and Amendment of Parts 2 and 22 of the Commission's Rules Relative to Cellular Communications Systems* [hereinafter cited as *Cellular Docket*], CC Docket No. 79-318, *Report and Order*, FCC No. 81-161, May 4, 1981, ¶ 56.

    "We shall expect all telephone companies to furnish appropriate interconnection to cellular systems upon reasonable demand, however, and upon terms no less favorable than those offered to the cellular systems of affiliated entities or *independent telephone companies* [emphasis added]. *Ibid.*, ¶ 57.

44. In New York, cellular companies are compensated for terminating wireline (landline) calls. NY PSC, Case 93-C-0103, *Petition of Rochester Telephone Corporation for Approval of Proposed Restructuring Plan*, and Case 93-C-0033, *Petition of Rochester Telephone Corporation for Approval of a New Multi Year Rate Stability Agreement,* Opinion No. 94-25, *Opinion and Order Approving Joint Stipulation and Agreement*, November 10, 1994. NY PSC, Case 92-C-0665, *Performance-Based Incentive Regulatory Plans for New York Telephone Company – Track II, Order Approving Performance Regulatory Plan Subject to Modification*, June 16, 1995.

45. "The Commission's general interconnection policy for cellular systems,...is that telephone companies are required to provide...a form of interconnection...to be *negotiated* by the cellular carrier and the wireline telephone company....A cellular system operator is a *common carrier*, rather than a customer or end user, and as such is entitled to interconnection arrangements that 'minimize unnecessary duplication of switching facilities and the associated costs to the ultimate consumer" [emphasis added]. *In the Matter of the Need to Promote Competition and Efficient Use of Spectrum for Radio Common Carrier Services, Memorandum Opinion and Order*, FCC No. 86-85, March 5, 1986, Appendix B, ¶2.

"Compensation may, however, be paid under contract or tariff provided that the tariff is not an access tariff treating cellular carriers as interexchange carriers." *Ibid.*, ¶ 5.

46. FCC, *In the Matter of Implementation of Sections 3(n) and 332 of the Communications Act, Regulatory Treatment of Mobile Services,* GN Docket No. 93-252, *Second Report and Order,* FCC Order No. 94-31, March 7, 1994, ¶ 227-239.

47. The FCC generally requires Type II rates to be lower than Type I rates. "Certain distinctions between Type 1 and Type 2 interconnection produce differences in their respective costs....In most cases, the provision of Type 2 interconnection should be less expensive than the provision of Type 1." FCC, *In the Matter of the Need to Promote Competition and Efficient Use of Spectrum for Radio Common Carrier Services (Cellular Interconnection Proceeding),* Report No. CL-379, *Memorandum Opinion and Order on Reconsideration*, FCC No. 89-60, 4 FCC Rcd No. 6, March 15, 1989, ¶ 30 and 34.

48. The FCC is currently examining LEC-CMRS interconnection, including bill and keep arrangements. FCC, *In the Matter of Interconnection between Local Exchange Carriers and Commercial Mobile Radio Service Providers*, CC Docket No. 95-185 and CC Docket No. 94-54, *Notice of Proposed Rulemaking*, January 11, 1996.

49. "In this order we also retain the current enhanced service provider (ESP) exemption in its current form." FCC, *In the Matter of Amendments of Part 69 of the Commission's Rules Relating to the Creation of Access Charge Subelements for Open Network Architecture* [hereinafter cited as *ONA Proceeding*], CC Docket No. 89-79, *Policy and Rules concerning Rates for Dominance Carriers*, CC Docket No. 87-313, *Report and Order and Order on Further Reconsideration and Supplemental Notice of Proposed Rulemaking*, July 11, 1991, ¶ 1. The ESP exemption is defined in the *ONA Proceeding, Notice of Proposed Rulemaking*, 4 FCC Rcd at 3983, ¶ 29-30, (1989). The FCC permits the ESPs to use local business lines or other state-tarrifed forms of access for their interstate traffic, thereby exempting them from federal access charges. "As a result, many ESPs currently pay state-tariffed business line rates and subscriber line charges for their switched interstate access connections." ¶ 30.

50. In its *Expanded Interconnection Proceeding*, the FCC stated that "central office collocation of ESP equipment is not essential to ensuring fair competition in the provision of enhances services," and that "given the much greater variety of ESP equipment, expanding this [expanded interconnection] requirement to include such equipment would cause significantly greater burdens, however. As a result, we decline to modify *Computer III* to require the LECs to permit collocation of ESP equipment." *In the Matter of Expanded Interconnection with Local Telephone* [hereinafter cited as *Expanded Interconnection Proceeding*], CC Docket No. 91-141, and *Amendment of the Part 69 of General Support Facility Costs*, CC Docket No. 92-222, *Report and Order and Notice of Proposed Rulemaking*, FCC No. 92-440, October 19, 1992, ¶ 93 - 94.

X. Notes, cont.

Notes: Section V, Summary

51. "If a television signal will require 45 mbps [megabits per second]...and local telephone service is priced at a penny a minute - the marginal cost of an intraLATA call - a two hour movie would cost $843.75 just for transmission....Alternatively, if the broadband video transport is priced at a flat rate of $15 per month - comparable to basic cable television rates today - then flat rate loop telephone service would be priced at two cents per month." Robert M. Pepper, *Through the Looking Glass: Integrated Broadband Networks, Regulatory Policies, and Institutional Change, Office of Plans and Policy,* FCC, Washington, DC, November 1988, OPP Working Paper No. 24, page 47.

Notes: Section VI, Appendix A: Monopoly/Competition Time Line

52. The first telephone patent was issued in 1875 and the second patent was issued in 1877. Patent law protected the Bell Telephone Company from competition from Western Union and independent carriers. In return, the Bell Company "agreed not to compete with Western Union in the public message-lowercase telegraph field." Bell Telephone Laboratories, Inc., *A History on Engineering and Science in the Bell System: The Early Years* (1875-1921), M.D. Fagen (Editor), 1975, pages 11-17, 30-31. For details on telephone history, see Behind the Telephone Debates, pages 6-14, and generally, Gerald Brock, *The Telecommunications Industry: The Dynamics of Market Structure, Harvard University Press,* Cambridge, MA, 1981.

53. *A History on Engineering*, pages 33 and 34.

54. *Communications Act of 1934*, Pub. L. No. 4, 57 tat. 5 (1943). An FCC investigation on the telephone industry conducted between 1934 and 1939 used the term "natural monopoly" to characterize the industry. *Report of the FCC on the Investigation of the Telephone Industry in the United States*, H.R. Doc. 340, 76th Cong., 1st. Sess. 602 (1939), page 597. See also *Behind the Telephone Debates*, pages 10-11.

55. Initially limited to government and semi-public institutions (such as airlines, electric utilities, and stock and commodity exchanges), this decision authorized in-house communications services for both voice and data transmission. These customers could also share privately owned transmission facilities. *Behind the Telephone Debates*, pages 13-14. FCC, *Allocation of Frequencies in the Bands above 890 Mc.*, FCC Docket No. 11866.

56. While this paper focuses on switch interconnection, the customer site is another interconnection point. At the same time the network was opening up to competition, there was also a move to open the terminal equipment market with the *Hush-A-Phone* (1957) and *Carterfone* (1968) court decisions. *Hush- A-Phone Corp. v. AT&T et al.*, FCC Docket No. 9189, *Decision and Order*, 20 FCC 391 (1955); *Decision and Order on Remand*, 22 FCC 112 (1957); and *Hush-A-Phone v. United States*, 238 F.2d 266 (D.C. Cir. 1956). *In the Matter of Use of the Carterfone Device in Message Toll Telephone Service*, FCC Docket Nos. 16942, 17073, *Decision and Order*, 13 FCC 2d 240 (1968); *Reconsideration Denied, Memorandum and Opinion Order*, 14 FCC 2d 571 (1968).

57. Key decisions include: *Execunet*, FCC Docket No. 20640, *Order*, FCC 75-799, July 2, (1975); *Decision*, 60 FCC 2d 25 (1976). *MCI Telecommunications Corp. v. FCC (Execunet I),* 561 F. 2d 365 (D.C. Cir. 1977), *cert. denied*, 434 U.S. 1040 (1978); also *Execunet II*, 580 F. 2d 590 (D.C. Cir. 1978), *cert. denied*, 439 U.S. 980 (1978). *Bell System Tariff Offerings*, FCC Docket No. 19896, *Decision*, 46 FCC 2d 413 (1974), *aff'd*, 503 F.2d 1250 (3rd Cir. 1974); *cert.denied*, 422 U.S. 1026 (1974); *reh'g denied*, 423 U.S. 886 (1975). *Lincoln Telephone and Telegraph Company*, 72 FCC 2d 724, 74 FCC 2d 196 (1979), 78 FCC 2d 1219 (1980), *aff'd* 659 F.2d 365 (D.C. Cir.1981). *United Tel. Co., Memorandum Opinion and Order,* 77 FCC 2d 1015 (1980). ENFIA. *MCI Telecommunications Corp.* v. FCC, 712 F. 2d 517, 524 (D.C. Cir. 1983).

58. For a discussion of the decisions leading up to the concept of "access," see pages 13-14, and pages 219-220 of *Behind the Telephone Debates*. Also see Charles F. Phillips, Jr., *The Regulation of Public Utilities: Theory and Practice*, Public Utilities Reports, Inc., Arlington, VA, 1993, pages 806-807, footnotes 127-131 for additional discussion and cites to key decisions.

59. *Access Charge Proceeding*.

60. *Access Charge Proceeding, ONA Proceeding, and Expanded Interconnection Proceeding*.

61. Formerly called Commercial Mobile Radio Services (CMRS).

62. Conversely, with wireline services, the communications appliance used by the customer is linked to a network by wires, such as copper wire, coaxial cable, and/or fiber optic cable. For a discussion of the evolution of mobile services, see the *PCS Primer*.

63. FCC, *In the Matter of Amendment of commission's Rules to Establish New Personal Communications Services* (hereinafter referred to as the PCS Docket), GEN Docket No. 90-314, *Notice of Proposed Rule Making and Tentative Decision*, FCC No. 92-333, August 14, 1992, ¶ 29, page 14. Also, *Memorandum Opinion and Order*, FCC No. 94-144, June 13, 1994, ¶2, page 3.

64. The court decision was in 1982, but the actual divestiture took place in 1984, *MFJ. Behind the Telephone Debates*, page 10.

65. Teleport has been in operation in New York City since 1985. The CAP connected to the IXC's point of interconnection (called a *point of presence, or POP*) with the LEC. This was called special access. Also, another early CAP, called LOCATE, started service in New York City, Detroit, Boston, and Chicago in 1983 according to the Yankee Group, *A CAP Market Update: No Future for the Independents?,* pages 6-17, 1993.

66. In its *Order Instituting Proceeding*, February 10, 1994, Case 94-C-0095, the NY PSC required pending completion of "Competition II" providing that carriers seeking certification to provide local service meet the same requirements imposed on the ILECs. On October 4, 1993, Case 92-C-0665, the NY PSC declared that MFS and Teleport were eligible for NXX codes (MFS and Teleport claimed this made them "LECs") but were not allowed to participate in reciprocal compensation.

67. Prior to the passage of the *Telecommunications Act of 1996*, a few of the smaller electric utilities, such as municipally owned Glasgow (Kentucky) Electric Plant Board, provided telecommunications or cable services; however, the *Public Utility Holding Company Act*, Title

I, prohibited most major utility companies from providing telecommunications services. *The Public Utility Act of 1935*, Pub. L. No. 74-333, 49 Stat. 803 (1935), also known as the *Wheeler-Rayburn Act*.

Some electric utility companies already use fiber optic lines for their internal voice and data communications needs and are planning on expanding their fiber optic networks for the more efficient management of electrical supply networks. In a move to tailor their products to individual customer needs, these companies are starting to string fiber to the home (the equivalent of a loop in telecommunications terms) and can provide telecommunications and information services once they are authorized as "exempt telecommunications companies" by the FCC pursuant to Section 34 of the 1996 *Act*.

Notes: Section IX, Appendix D: Switch Modeling Definitions and Assumptions

68. DS-1, or Digital Service 1, is 1.544 mbps (the bandwidth at which voice/data flows through the switch using copper or fiber technology). DS-30, or Digital Service 30, is 45 mbps (the bandwidth at which voice/data flows through the switch using copper or fiber technology); also referred to as DS-3. DS-512, or Digital Service 512 is 782 mbps (the bandwidth at which voice/data flows through transport facilities using fiber technology).