Examples of Modeling— Transport and Other Issues

Presentation at the July 21, 1991
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Current Status, Alternative Costing Methods Project

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List of Acronyms

ARMIS	Automated Reporting Management Information System
ATM	Asynchronous Transfer Mode
Cat	Separations Category
COE	Central Office Equipment
COE Cat 2	Tandem Switching Equipment
COE Cat 4.12	Exchange Trunk Circuit Equipment (Wideband and Non-Wideband)
COE Cat 4.23	All other Interexchange Circuit
COE Cat 4.3	Host/Remote Circuit Equipment
C&WF	Cable and Wire Facilities
C&WF Cat 2	Wideband and Exchange Trunk Cable and Wire Facilities
C&WF Cat 3	Interexchange Cable and Wire Facilities
C&WF Cat 4	Host/Remote Cable and Wire Facilities
CAP	Competitive Access Provider
CCL	Carrier Common Line
FCC	Federal Communications Commission
IXC	Interexchange Carrier
LEC	Local Exchange Carrier
LATA	Local Access and Transport Area
MFJ	*Modification of Final Judgement*
MOU	Minutes of Use
MTS	Message Telecommunications Services
NECA	National Exchange Carriers Association
POP	Point of Presence
REA	Rural Electrification Administration
SLC	Subscriber Line Charge
SWC	Serving Wire Center
TS	Traffic-Sensitive
USF	Universal Service Fund
USOAR	Uniform System of Accounts Revised
WATS	Wide Area Telecommunications Services

I. Introduction

Modeling Policy Alternatives

Today's telecommunications markets have changed dramatically with the introduction of competition, the breakup of the Bell System, and the rapidly increasing rate of change for new technologies.

Do current cost and price structures meet the needs of providers and customers in these markets? How can the benefits of the competitive marketplace (including the introduction of new services) be realized while ensuring overall public service? For example, what are some of the ramifications of the introduction of broadband technologies and services in the next ten years? Twenty years? Thirty years?

Do policies need to be changed? Are those policies developed for the pre-divestiture regulated monopolies still relevant? If not, what policies might be implemented? What is the impact of changes in policy on traditional telephone companies, their regulators, their customers, and their competitors? What happens if costs, technology, markets or regulations change?

The Harvard Program's Alternative Costing Methods project is building an analytical tool to help answer these types of questions. Its purpose is to create a tool to help policy makers produce more informed decisions. This handout illustrates how public policy issues may be modeled without siding with individual parties. The project looks for effects while remaining neutral; it does not advocate one policy over another.

For the last two and one half years, this project has brought together telecommunications industry representatives — local exchange and interexchange carriers, federal and state regulators — to model alternatives to the current cost structure.

This paper demonstrates how the modeling process can be used to analyze an issue. The paper focuses on one issue — the current transport proceedings before the Federal Communications Commission (FCC).[1] Also, **Appendices A through E** contain

[1] For background on the transport issue, see *In the Matter of MTS and WATS Market Structure*, CC Docket No. 78-72 (Phase I), FCC Order No. DA 91-37, January 16, 1991.

work in progress on several issues: public policy issues associated with the competitive access proceeding currently before the FCC,[2] proposed Congressional legislation for a broadband network,[3] and background graphs and charts associated with modeling the transport issue.

[2] CC Docket No. 91-141, *In the Matter of Expanded Interconnection with Local Telephone Company Facilities*, FCC Order No. 91-159, June 6, 1991.

[3] S. 1200 and H.R. 2546, *Communications Competitiveness and Infrastructure Modernization Act of 1991*, released June 4, 1991.

II. Transport

Transport: Magnitude of Issue

The interstate transport issue was chosen as an example of the modeling process because the dollars associated with this issue are significant. **Figure 1** shows the relative magnitude of transport in relation to total local exchange carrier (LEC) interstate facilities investment and to total LEC interstate reference revenues.[4]

In 1989, interstate transport facilities investment was $9.2 billion of an interstate total of $58.0 billion. Interstate transport revenues were $3.9 billion of an interstate total of $21.3 billion.

Figure 2 shows the components of these interstate totals. Transport is 15.9% of the interstate facilities investment and 18.3% of the interstate revenues. In both cases, transport is a significant share of the pie. Therefore, decisions made regarding transport affect a significant portion of the whole. **Appendix C, Figure 15,** provides the dollars associated with the components in the **Figure 2** pie charts.

There are other types of facilities that may be subject to competition. Decisions on transport may set precedents for the treatment of other facilities or revenue components. On the facilities side, transport is approximately equal to central office switching equipment investment (13.3%). On the revenue side, transport is approximately equal to traffic-sensitive (TS) switching revenues (16.9%).

This project's modeling process can help set the stage for public policy debates on issues such as transport. The project has two objectives:

- Provide multiple viewpoints. Explore how changes in the current Separations and access cost structures affect the traditional telecommunications industry.

- Provide a neutral forum for expressing these views.

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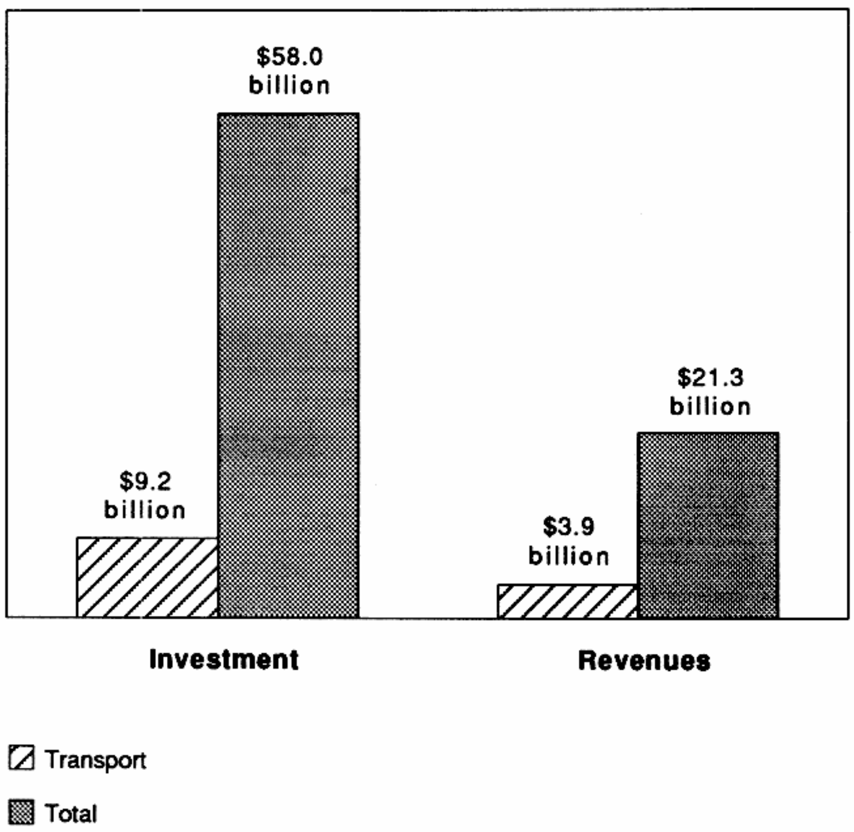
[4] 1989 Tier 1 local exchange carriers.

I. Transport, cont.

To meet these objectives, the project applies data analysis and simplified computer modeling to provide multiple viewpoints on policy issues stemming from the deployment of new technologies or from changing the cost accounting processes.

The examples in this paper set the stage for policy discussions by quantifying selected aspects of some issues.

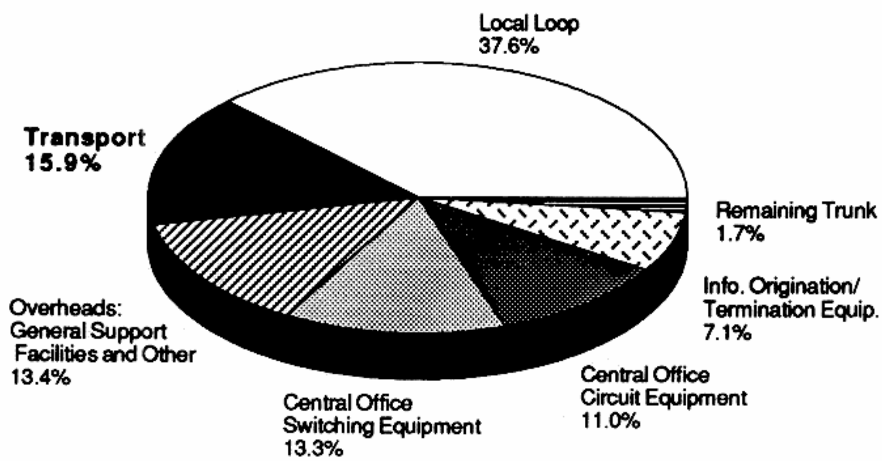
Figure 1
Interstate Transport Facilities Investment and Revenues Compared to Interstate Totals: 1989 Tier 1 Local Exchange Carriers



Source: ARMIS Report 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 2
Comparison of Interstate Facilities Investment and Revenues: 1989 Tier 1 Local Exchange Carriers

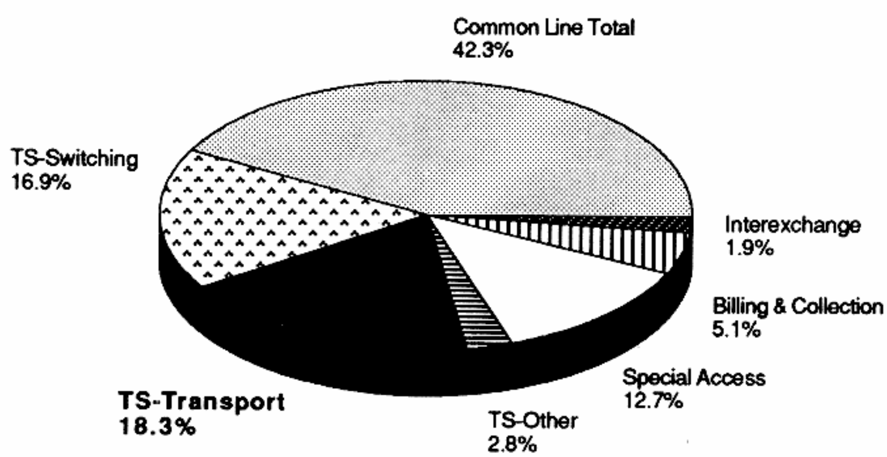
Chart A: Industry Composition of Interstate Facilities Investment



Total Interstate Facilities*
$58.0 billion

*line #1540, Column d, ARMIS 43-04

Chart B: Industry Composition of Interstate Revenues



Total Interstate Revenues**
$21.3 billion

**line #4050, Column d, ARMIS 43-04

Note: The local loop investment includes only C&WF Cat 1. Another definition of local loop investment would include COE Cat 4.13 as well as C&WF Cat 1. This would increase the investment in local loop to $24.8 billion and would decrease COE circuit equipment to $3.3 billion. The corresponding percent of total plant investment would increase to 42.8% for local loop and decrease to 5.8% for COE circuit

Source: ARMIS Report 43-04, 1989 Tier 1 Local Exchange Carriers. Compiled from Industry Totals.

Transport: Definitions of Dedicated and Common

At the heart of the transport issue is the question of whether to take currently averaged costs and deaverage them.

The FCC's *Access Charge Order* (Part 69) split local transport costs into two rate elements — dedicated transport and common transport. These rules conflicted with the *Modification of Final Judgment* (MFJ), which required that LECs charge all interexchange carriers (IXCs) an equal charge for an equal unit of traffic for use of transport facilities until September 1, 1991.[5] To reconcile the FCC's rules with the court's decision, the FCC waived its transport rules indefinitely. In effect, the FCC's waiver averaged transport costs into a single unit.

The question before the FCC is whether to continue the policy of averaging transport costs. Local transport costs are those associated with carrying an IXC's traffic to the LEC's central office, for eventual transmission to the end user.

Figure 3 shows the FCC rules that distribute LEC costs to categories of facilities investment and expense assignments. These cost categories are key to the local transport issue. This figure traces the derivation of interstate transport costs (indicated by boldface). In turn, these costs provide the basis for average transport rates, setting the stage for modeling alternatives. In creating models, the Alternative Costing Methods project uses costs, such as these, as a starting point. The current accounting structure coupled with public data[6] provides the baseline for comparisons with proposed policy, market, or technological changes.

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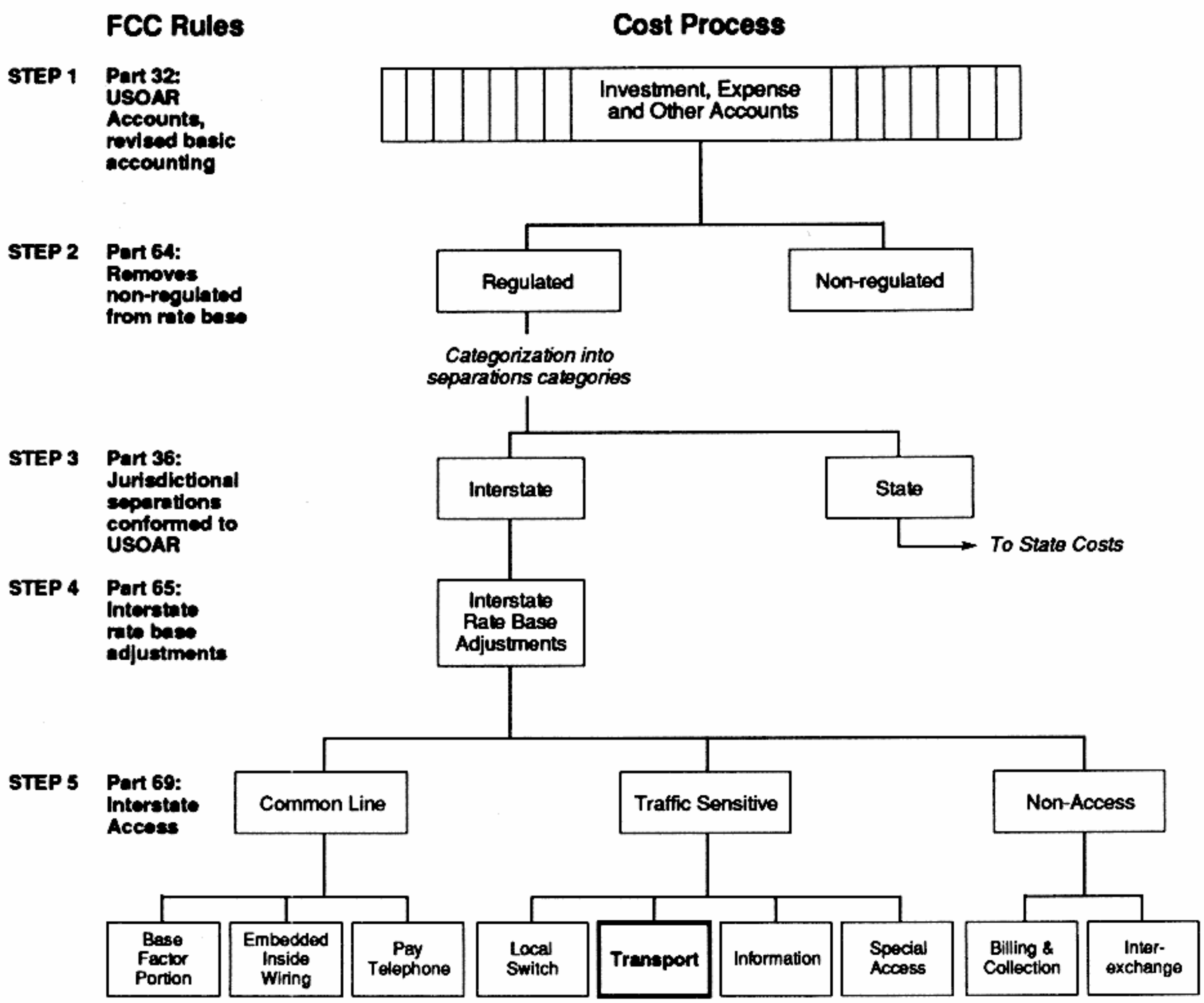
[5] *U.S. v. AT&T, Modification of Final Judgment*, 552 F. Supp. 131, 233-234 (D.D.C. 1982), *aff'd mem.*, 103 S.Ct. 1240 (1983).

[6] Accounting structure consists of the Uniform System of Accounts Revised (USOAR), the Jurisdictional Separations of Costs and the Access Cost rules. The public data sources are FCC ARMIS (Automated Reporting Management Information System) Reports, other FCC statistics, National Exchange Carrier Association (NECA) data, and U.S. Bureau of the Census data. Members of the Alternative Costing Methods project are still in the process of verifying the public data. For a description of the USOAR, see *Behind the Telephone Debates*, Carol L. Weinhaus and Anthony G. Oettinger, Ablex Publishing Corp., Norwood, NJ, 1988, pages 33-41.

Figure 3
Federal Communications Commission (FCC) Rules for Distribution of LEC Costs



Step 1: Accounting rules place LEC investments, expenses, and other costs into specific USOAR acconts (Part 32).

Step 2: Part 64 rules remove non-regulated costs from the rate base.

Step 3: LECs categorize all of their regulated costs by account into Separations categories (Part 36) for division between state and interstate jurisdictions.

Step 4: Part 65 performs interstate rate base adjustments (allowances and disallowances).

Step 5: Interstate access rules (Part 69) categorize the remaining interstate costs. (These rules have implications for intrastate as well.)

A return to the original FCC rules divides local transport facilities into two elements — dedicated and common. There are two viewpoints as to how these elements are defined:

Facilities:

Dedicated — those used solely by an individual IXC.

Common — those shared by more than one IXC.

Services:

Dedicated Transport Service — transport facilities used solely by an individual IXC.

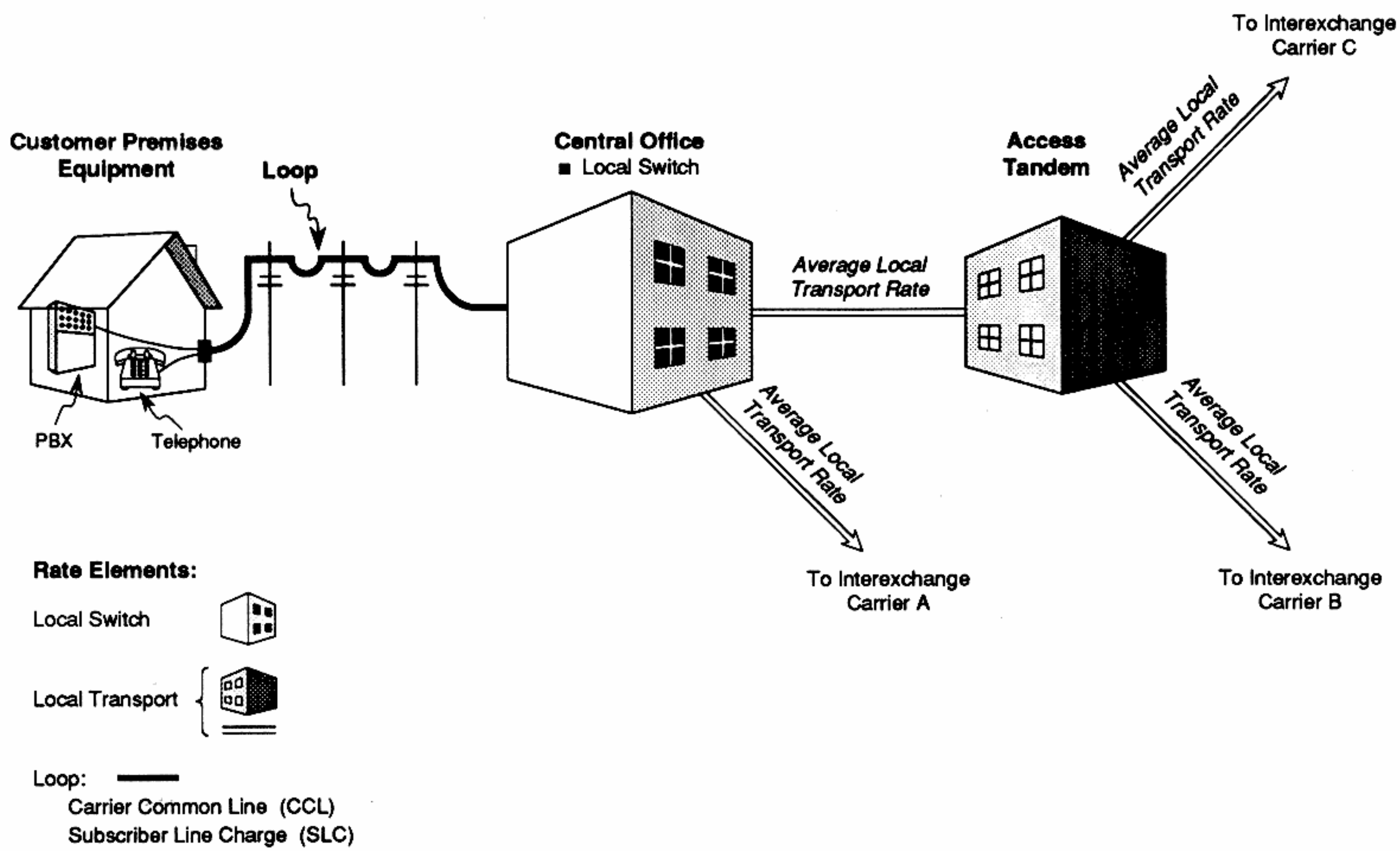
Common Transport Service — transport facilities, including an access tandem switch, any part of which is used by more than one IXC. These transport facilities may be a mix of dedicated and common.

Transport: LEC Rate Configurations

Figure 4 shows basic LEC transport rate configurations associated with providing interstate access. In this diagram, traffic originates and terminates with customer-owned premises equipment. LEC facilities start with the loop carrying traffic into the first switch in the network, called the central office switch or local switch. **Figure 4** then shows the LEC facilities used to transport traffic between an IXC and its end users. For certain customer requirements, the access tandem switch concentrates traffic for more than one IXC for transmission to and from end offices. Note that in this example all trunk facilities and the access tandem switch constitute local transport.[7] Also, transport includes a central office circuit equipment component not indicated in **Figure 4**.

[7]Many LECs use the same access tandem along with the trunk and circuit equipment between this access tandem and the local switch to carry their own intraLATA toll traffic as well as IXC traffic. For the purposes of simplification, and due to the nature of the data used in the models, this paper assumes these LEC facilities carry IXC traffic only. This simplification may skew the results. A more comprehensive model would include this intraLATA toll traffic.

Figure 4
Current LEC Local Transport Rate Configurations: With Waiver of FCC Rules



Under the FCC waiver of the *Access Charge Order,* the transport costs for all routes are averaged:

$$\frac{\text{Total Local Transport Revenue Requirement}^{8}}{\text{Number of Local Transport Minutes of Use}} = \text{Average Cost per Minute by Mileage Band}^{9}$$

The result of the MFJ policy of an equal charge for an equal unit of traffic is that IXCs pay the same rate regardless of the route used to carry their traffic.

Transport: Elimination of FCC Local Transport Waiver

Elimination of the FCC's local transport waiver and a return to the original rules allows for distinct rates — dedicated and common — for local transport.

Figure 5 shows the development of dedicated and common transport costs from interstate access (Part 69) transport costs. With the elimination of the FCC waiver, the dedicated and common transport costs form the basis for the associated dedicated and common transport rates.

Figure 6 shows rate and facilities configurations with two viewpoints on the transport rate for shared facilities.

Route A: IXCs with high traffic volume between an IXC and the LEC end office may use dedicated transport facilities and pay dedicated rates.

[8] Expenses + Taxes + Return = Revenue Requirement.

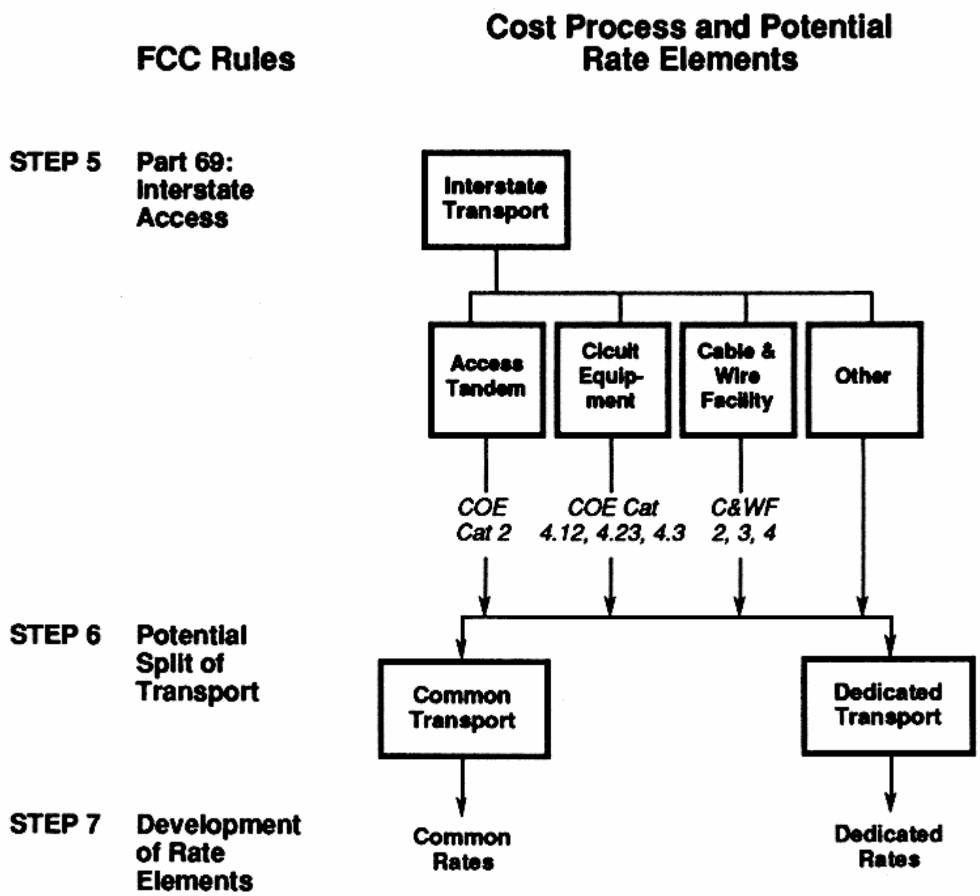
[9] For the FCC's rules on common transport, see 47 C.F.R. § 69.111. The exact components of this calculation vary among companies. For example, some carriers further divide common transport into two elements — transport termination and transport facility.

Viewpoint 1, Route B: IXCs with a lower volume of traffic may need to share both links between their facilities and the LEC access tandem as well as the link to the local switch. The rate structure for both links is common transport.

Viewpoint 2, Route B: IXCs with a lower volume of traffic may need to share both links between the LEC access tandem and the LEC local switch. However, the rate structure between the access tandem and the IXC facilities is dedicated.[10]

[10]The link between the LEC access tandem and the IXC facilities has two rate elements: a common transport rate from the LEC access tandem to the LEC serving wire center (SWC); a dedicated rate from the SWC to the IXC facilities. In simplified terms, the SWC (or point of interface) is where the LECs start measuring transport mileage from an IXC to the LEC's end office.

Figure 5
Potential Transport Cost Categories:
Rate Elements Under Existing FCC Rules (Waiver Eliminated)

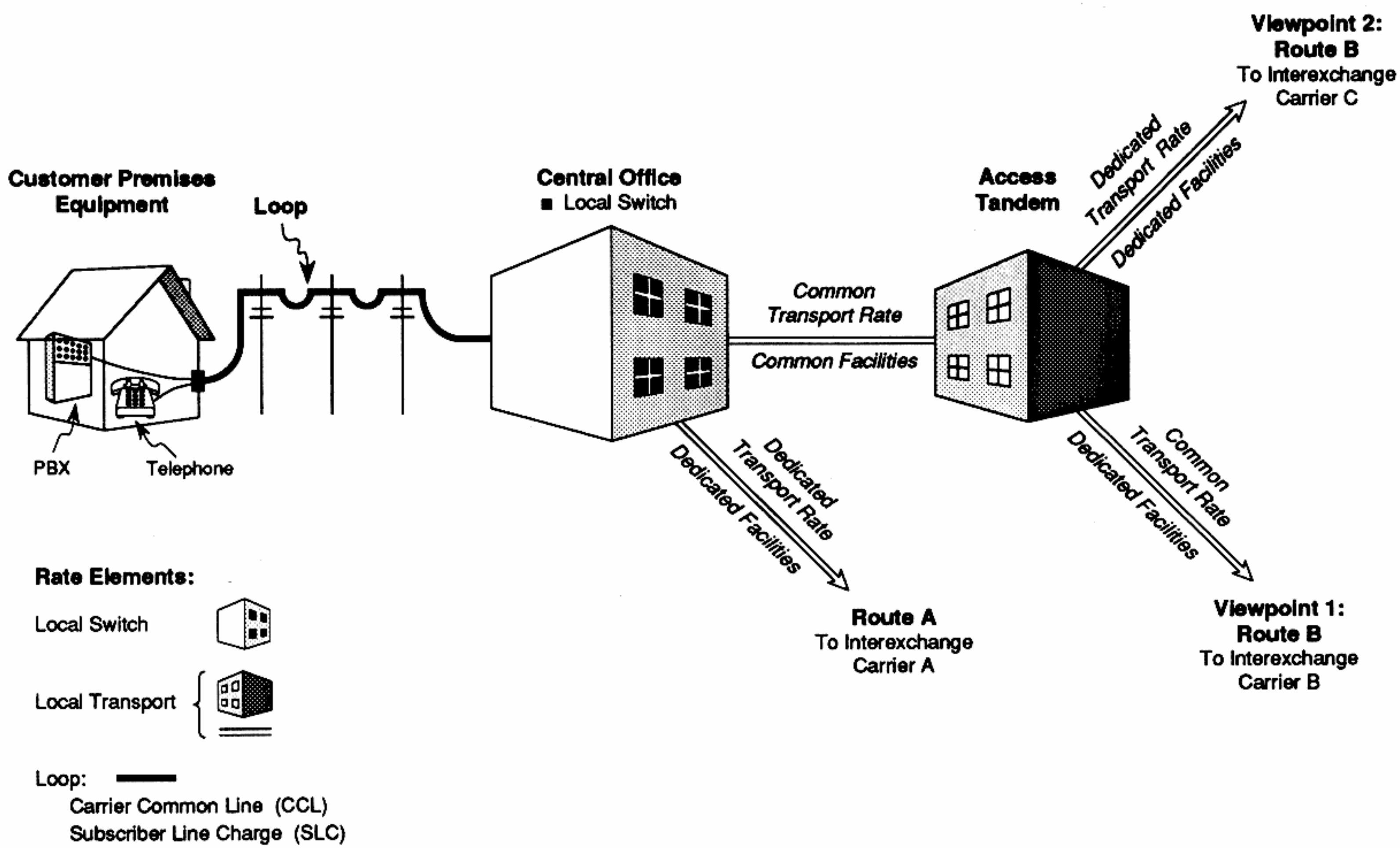


Step 5: Interstate access rules (Part 69) categorize the remaining interstate costs. (These rules have implications for intrastate as well.

Step 6: Potential split of interstate transport costs into common and dedicated transport categories.

Step 7: Development of common and dedicated interstate transport rate elements.

Figure 6
LEC Local Transport Rate and Facilities Configurations:
Under Existing Rules (Waiver Eliminated), Dedicated and Common Choices



Transport: Modeling a Public Policy Issue

Figure 7 shows the potential impact of deaveraging interstate transport costs into dedicated and common elements. These elements provide the basis for the development of dedicated and common rates (**Figure 5**). The dedicated cost per minute of use (MOU) is lower than the 1989 average transport cost per MOU. Conversely, the cost per MOU for common transport is higher than this average.[11]

The corresponding dedicated and common transport costs fall respectively below and above the 1989 average transport cost. The lower dedicated costs (translated into lower dedicated rates) provide incentives for high-volume IXCs to choose dedicated services. If this occurs, traffic moves off common transport facilities onto dedicated facilities. The result may be a higher cost per MOU for those IXCs using common transport facilities.

While the calculations used to develop **Figure 7** run from 100/0% common/ dedicated traffic to 10/90% common/dedicated, this range does not apply to all situations. Instead, there are "zones of reasonableness" along this x-axis. For example, it is unlikely that densely populated urban areas will have no dedicated traffic. Therefore, it may be more reasonable to look at a zone that assumes there is a significant amount of dedicated traffic.

Figure 7 looks at the range where high-volume IXCs are likely to choose dedicated services over common. The range runs from a 50/50% split of common and dedicated traffic to a 10/90% split. For a detailed discussion of "zones of reasonableness" and the assumptions used for facilities investment, see **Appendix D, Other Transport Comparisons — Dedicated/Common Costs.**

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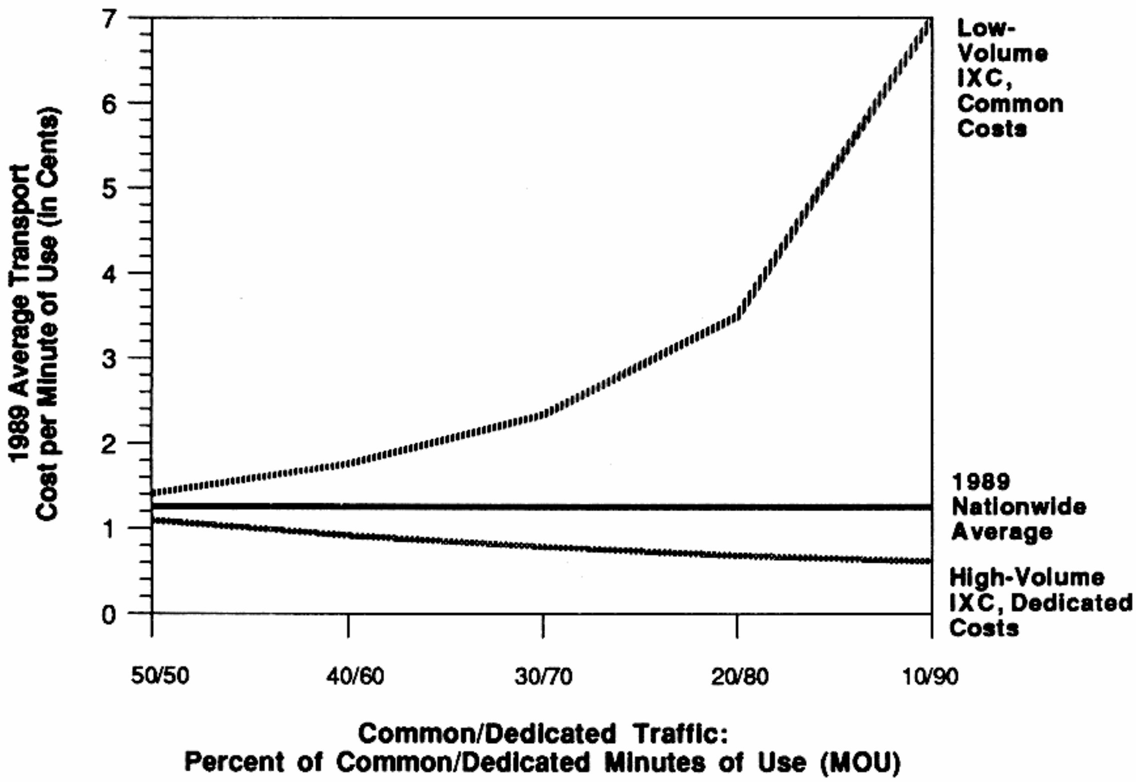
[11] For the development of cost per MOU used in **Figure 7** and for more details on the transport issue in general, see *Interim Report of the Alternative Costing Methods Project, An Example of Modeling an Issue, Transport: Equal Charge for Equal Unit of Traffic,* Carol Weinhaus and Rob Seaver, Program on Information Resources Policy, Harvard University, Cambridge, MA, April 19, 1991.

Figure 7
Potential Impact of Deaveraging Interstate Transport Costs: Interexchange Carrier (IXC) Service Incentives



Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

At what point does a traffic shift from common transport to dedicated have a significant impact? **Figure 8** shows the potential impact of customer selection on rates for dedicated and common transport services. The examples in **Charts A and B** use data from several rural and urban areas. For a low-density geographic area (indicated as rural), it is likely that the traffic is predominantly common. Therefore, **Figure 8** looks at the rate of change for common transport costs per MOU between 90% common traffic and 60%. This range is a "zone of reasonableness" comparing only those data points which approximate reality.

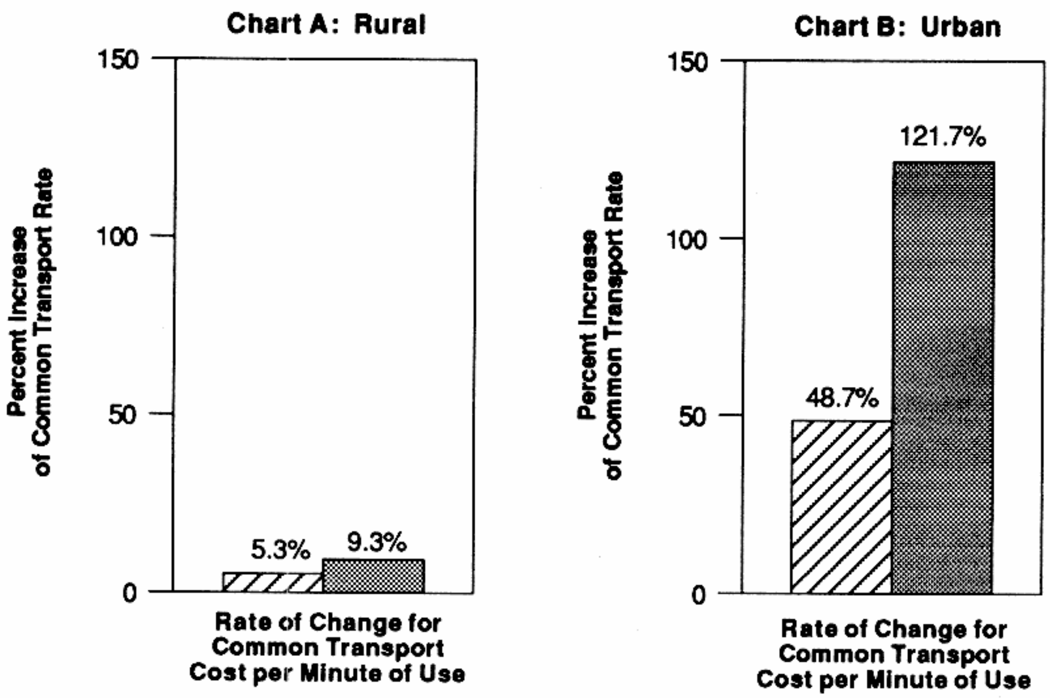
There is a dramatic increase in common transport rates as more traffic moves to dedicated facilities. In **Chart A**, the rural example, a 20% shift of transport traffic from common to dedicated results in a 5.3% increase in common transport rates. A 30% shift of transport traffic from common to dedicated results in a 9.3% increase in common transport rates. This percent increase in common rates is dramatically higher.

The same pattern applies in **Chart B** to the high-density geographic area (indicated as urban). In this case, the "zone of reasonableness" assumes a lower percent of common transport traffic and a correspondingly higher percent of dedicated. A 40% shift to dedicated results in a 48.7% increase in common transport rates. Similarly, a 50% shift to dedicated results in a 121.7% increase in common transport rates. Once again, this percent increase in common rates is dramatically higher.

The extreme change reflected in the urban area example is the result of the fixed costs of the access tandem facilities which are being spread over a much smaller base. This extreme change would be reduced to the extent that the access tandem switch carries intraLATA toll traffic.

The modeling method used to create **Figures 7 and 8** assumes that all access tandem costs are common transport and there are fixed costs. By the 10% common traffic mark on the x-axis in **Figure 7**, almost all common transport costs are access tandem. Almost all the other non-access tandem transport costs have shifted over to dedicated. For a detailed discussion of rural and urban areas, see **Appendix D**.

Figure 8
Comparison of Several Rural and Urban Study Areas: Potential Impact of Traffic Shifts from Common Transport to Dedicated Transport



Rate Increases for Common Tranport:

- After 20% of traffic has shifted from common to dedicated transport.
- After 30% of traffic has shifted from common to dedicated transport.

Rate Increases for Common Tranport:

- After 40% of traffic has shifted from common to dedicated transport.
- After 50% of traffic has shifted from common to dedicated transport.

Source: ARMIS Report 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 8 explains why there is an incentive for high-volume IXCs to choose dedicated services (based on relatively lower transport costs).

Figures 7 and 8 indicate one approach to modeling the transport issue. There are questions raised by these figures:

- If transport costs are deaveraged, would this affect cost recovery for other facilities providing interstate access?
- What are the implications of having different cost recovery mechanisms for what once was a single mechanism? The network hasn't changed; the costs haven't changed. It's just the cost recovery options that have changed.

For an update of the current status of developing an industry-wide cost model, see *Interim Report of the Alternative Costing Methods Project: Update on Modeling Process*. The value of this project is the ability to take complex issues, run them through a simplified model, and produce usable results. The project will continue to model alternatives to provide multiple viewpoints on the future.

Appendix A
Competitive Access Provision

Competitive Access Provision

There has been an increase in companies competing with LECs for interconnection with IXCs. There has also been an increase in companies providing direct interconnection between customers without involving a LEC.

The current FCC proceeding on competitive access provision raises the following questions on whether:

> [Local operating companies shall] offer expanded opportunities for interconnection with their local carrier networks for the provision of interstate special access service....[and] interstate switched transport service.
>
> [To] broaden interstate access competition...[and] to proceed with a broader proposal for interstate access competition.[12]

While interconnection of competitors to the traditional industry's network affects a broad array of issues, **Appendix A** focuses on only one aspect — the impact on public policy goals — . This section represents work in progress.

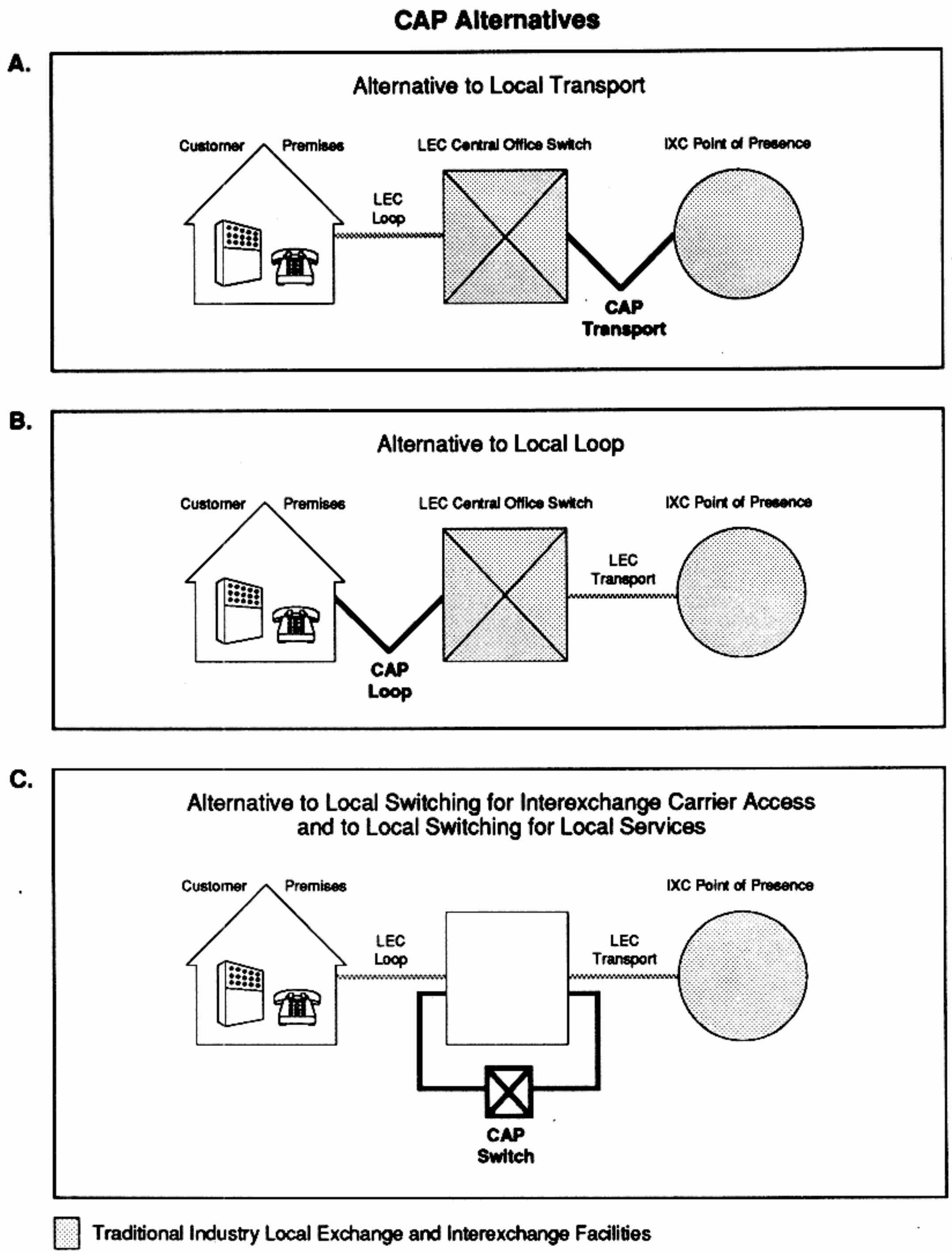
Competitive Access Provision: Alternatives to Traditional Industry Facilities

The shaded portions of **Figure 9** indicate traditional telephone industry local exchange and interexchange facilities. The basic diagram shows an extremely simplified network configuration:

- Customer Premises: Customers own their terminal equipment and inside wiring.
- Loop: LEC facilities carrying traffic between the customer and the central office switch.

[12]CC Docket No. 91-141, *Expanded Interconnection*, pages 2 and 3.

Figure 9
Potential Competitive Access Providers (CAPs):
Alternatives to Traditional Telecomunications Industry Facilities



- Central Office Switch: LEC facilities providing switching among local services and switching for IXC access.
- Transport: LEC facilities interconnecting IXC traffic with the central office switch.
- Point of Presence (POP): IXC facilities providing entry and exit into the LEC network — called access.

The three sections of **Figure 9** indicate potential interconnection of competitive access providers (CAPs) with the traditional industry's network. In these sections, the boldfaced links indicate different alternatives for CAP interconnection:

- **Section A**: Local transport — the CAP provides transport between the IXC POP and the LEC central office switch.
- **Section B**: Local loop — the CAP carries traffic between the LEC central office switch and the customer's premises.
- **Section C**: Interexchange and Local Central Office Switching — the CAP provides local switching for IXC access and for local exchange services.

Figure 9 shows competition for various portions of traditional telephone industry facilities. This raises the question: What is the impact of a competitor entering a traditional industry market and competing for traffic and revenues? Are cost recovery mechanisms appropriate? If yes, what methods? If no, what should replace them?

What are the implications for large and small companies (IXC, LEC, and their competitors)? Is one or the other disadvantaged? What are the implications for competition? What are the implications for network planning and multiple LEC ownership of local transport facilities?

Competitive Access Provision: Who Contributes to Public Policy Goals?

The entry of CAPs raises additional questions on recovery of traditional industry costs. There are support mechanisms embedded in the current cost and price structures that may also be affected by the entry of competition. For example, as indicated by the transport issue, there is extensive averaging of facilities costs which underlie average rates. **Figure 10** provides a more comprehensive list of current policy goals embedded in the traditional industry's cost and price structure. Currently, only the LEC and IXC contribute towards all of these public policy goals.[13]

There are three basic options for future treatment of the public policies listed in **Figure 10**:

- Continue current practices.
- Redefine/expand current practices.
- Eliminate some or all current practices.

What is the impact on these public policy goals of technology? Of competition? Of regulation? If these goals or new ones are to continue, what form should they take?

Figure 11 represents an initial attempt to quantify some of the support mechanisms associated with financial assistance to ensure universal service in targeted high cost areas.[14]

What happens to these public policy goals if competitors enter the traditional telecommunications industry's markets? Should their customers also contribute towards the public policy goals? Should some other contribution mechanism be developed?

---

[13]Some special needs assistance programs receive government funding as well.

[14]Data Sources: Universal Service Fund (USF) data from a May 17, 1989 NECA filing in compliance with the FCC's *Non Traffic-Sensitive Recovery Order*, FCC 87-133, CC Docket No. 78-72, and CC Docket No. 80-286; May 19, 1987. USF data based on December 31, 1987 data. Lifeline Assistance data calculated from same source. Lifeline Assistance, Long Term Support and Transitional Support data in effect from April 1, 1989 to December 31, 1989. Local Switch Support data represents second year of a five-year transition period.

Figure 10

Current Public Policy Goals: Some Support Mechanisms and Forms of Averaging Associated with the Traditional Telecommunications Industry

Rate and Cost Averaging to Achieve Public Policy Goals:

Provide "reasonable" rates on a non-discriminatory basis.

Average interstate transport costs to satisfy MFJ "equal charge for equal unit of traffic" requirement.

Use of fully distributed cost methodology to allocate common overheads.

Etc.

Financial Assistance to Ensure Universal Service for the Following:

Targeted high cost areas:

- Universal Service Fund.
- Long-term support.
- Transitional support.
- Small telephone company local switch support.
- REA loans.

Low income households:

- Lifeline programs.

Offshore areas:

- Assistance to Alaska, Virgin Islands, Puerto Rico, and Hawaii for interconnection to traditional industry network in the contiguous 48 states.

Requirement of Non-Discriminatory Interconnection to the Networks of Local and Interexchange Carriers:

Interstate services pay for a portion of shared local facilities costs through 25% interstate cost allocation:

- Subscriber line charge: local customer contribution for interstate access.
- Carrier common line charge: interexchange carrier contribution for interstate access.
- Special access surcharge: contribution from private line customers for interstate access.

Local interconnection rates for enhanced service providers.

Right to make an interstate or an international call.

Open Network Architecture (ONA).

Special Needs Assistance for Equivalent Access to Telecommunications Network:

Telecommunications services for hearing-impaired and speech-impaired individuals.

Oversight of Jurisdictional Shifts:

Participation through Federal-State Joint Board.

Maintain "reasonable" basic local service rates.

Depreciation Policies to Meet Requirements of the *Communications Act of 1934*.

Participation through Three Way Meetings.

Is there pressure for deaveraging? Does averaging stifle competition? What is the effect on different customers? On business/residential? On urban/rural? On local/toll? On high-volume/low-volume?

The public policy goals quantified in **Figure 11** are a subset of a larger picture. While some entries on the list in **Figure 10** may be quantified, others may not. **Figure 12** provides a range of options for the upcoming FCC decision on transport and competitive access. This figure combines options for both issues because they are both related to the entry of competition and the treatment of interconnection. The transport issue arises from IXC competition. The competitive access issue arises from the entry of alternative providers into traditional industry markets.

Figure 11
Some Traditional Telecommunications Industry Support Mechanisms Associated with Traditional Industry Facilities

Support Mechanism	1989 Dollars
Universal Service Fund	250 million
Lifeline	56 million
Long-Term Support	236 million
Transitional Support	305 million
Small Telephone Company Local Switch Support	31 million

Data Sources:

Universal Service Fund: Data from a May 17, 1989 NECA filing in compliance with the FCC's *Non Traffic-Sensitive Recovery Order;* FCC 87-133, CC Docket No. 78-72, and CC Docket No. 80-286; May 19, 1987. USF data based on December 31, 1987 data.

Lifeline Assistance Data: Calculated from same source as USF; in effect from April 1, 1989 to December 31, 1989.

Long-Term Support Data: In effect from April 1, 1989 to December 31, 1989.

Transitional Support Data: In effect from April 1, 1989 to December 31, 1989.

Local Switch Support Data: Represents second year of a five-year transition period.

Figure 12
Transport and Competitive Access Provision Options

1. Prohibit interconnection/maintain existing rate levels and rate structures.

2. Mandate interconnection/maintain existing rate levels and rate structures.

3. Transport rates based on competitive market costs. Remaining costs recovered through one or more of the following methods:

    - Establish an interconnection element assessed to all customers including competitive access providers (CAPs).

    - Other access service elements.

    - Local Exchange Carrier (LEC) stockholders: Allow for write-offs and/or establishment of depreciation reserves.

4. Retain regulation: Allow greater LEC pricing flexibility to meet competitive and other customer requirements. May include volume discounts; geographic or route by route deaveraging.

5. Transitional deregulation: LECs given greater pricing/earnings flexibility and a portion of the depreciation reserve charged below the line.

6. Flashcut deregulation of transport.

Appendix B
Impact of Proposed Legislation

Impact of Proposed Legislation

This section proposes an issue for potential modeling — technology deployment.[15] The discussion is theoretical and indicates basic questions on this issue.

On June 26, 1991, the House Telecommunications and Finance Subcommittee held hearings on the deployment of a broadband network broadband by the year 2015. In addition, a bill on this same topic — *Communications Competitiveness and Infrastructure Modernization Act of 1991* — is also circulating in the Senate.[16]

If these Congressional bills pass, the traditional telephone industry's non-broadband embedded investment will need to be retired within twenty-four years. This is only part of the picture: new additions to facilities must also be considered.

Regardless of the length of time required to achieve a broadband network, there are three basic underlying questions to answer:

- Will standard yearly facilities retirement practices for embedded facilities eliminate the need for broadband replacement? Or will some facilities remain regardless of yearly replacements?
- Will these yearly replacements be entirely with broadband technology? If not, how does the mix of new and old technologies affect the pace of the transition to an entirely broadband network?
- Are broadband technologies used for the new additions to facilities? If older technologies are used, does this slow the implementation of broadband?

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[15]For a discussion of the Technology Deployment Model under consideration within the project, see Carol Weinhaus and Mark Jamison, *Current Status, Alternative Costing Methods Project: Update on Modeling and Key Component of Technology Deployment Model*, NARUC presentation, San Francisco, CA, July 21, 1991.

[16]S. 1200 and H.R. 2546, *Communications Competitiveness and Infrastructure Modernization Act of 1991*, released June 4, 1991.

To simplify the discussion, **Figures 13 and 14** focus only on the replacement of existing facilities and the mix of replacement technologies. Both figures indicate the future from the vantage point of a given year (marked "current year").

Companies retire a certain amount of the total embedded investment as part of their standard operations. **Figure 13** shows an extremely simplified representation of this replacement. It assumes that the yearly facilities replacements are entirely new technologies. New additions to facilities are ignored. The unshaded area of this chart indicates yearly facilities replacement. The area marked by the diagonal lines indicates the amount of facilities still to be replaced for a given year. The area shaded with gray is the amount of unrecovered depreciation costs for embedded facilities.

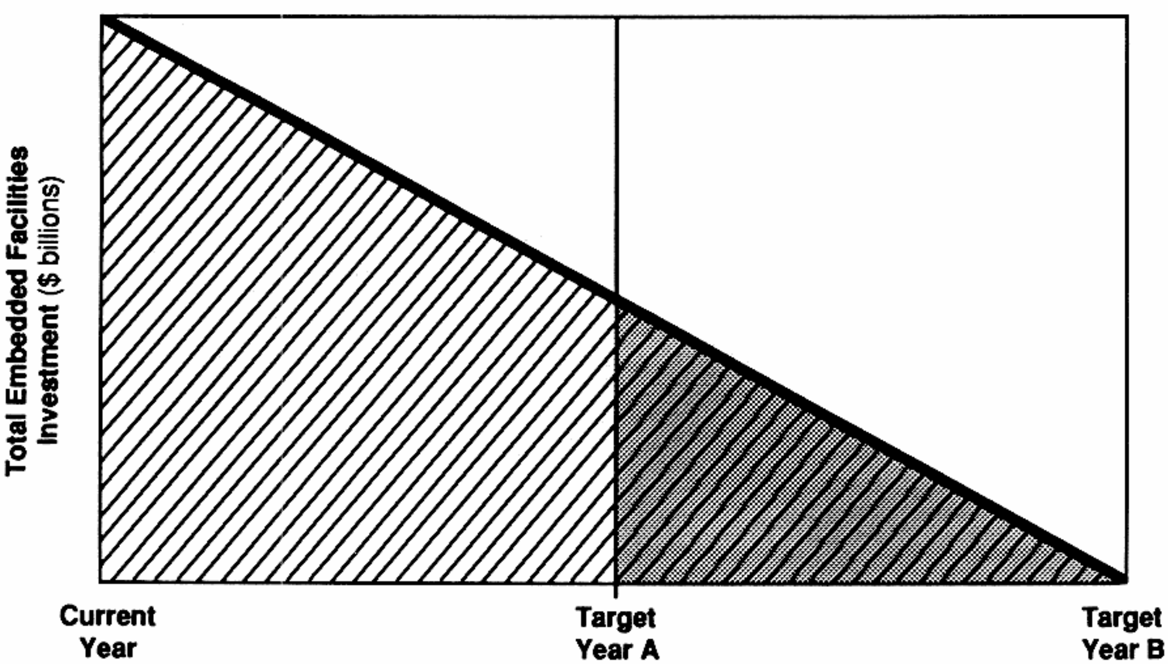
From the vantage point of the current year, **Figure 13** shows two target points in the future. At **Target Year A**, a significant amount of embedded facilities must still be replaced with broadband technology. This is unrecovered depreciation costs for embedded facilities (indicated by the gray area). At **Target Year B**, the entire embedded investment has been replaced as a matter of course.

With the appropriate data, it is possible to model the implications of broadband within a given time frame. For example, if the proposed Congressional legislation passes, where does the target year fit on this graph? What are the results of using a shorter time frame than twenty-four years? At what point do remaining undepreciated facilities no longer form a barrier to conversion to a broadband network?

Repeating **Figure 13's** diagram, **Figure 14** adds another dimension: the impact of the mix of new and old technologies on replacement of embedded investment. By **Target Year B,** *all* embedded facilities have been replaced with new technology.

As before, the area in **Figure 14,** marked by diagonal lines, is the remaining facilities investment. The shaded area is the result of replacing embedded investment with *old* technologies. The unshaded area is the result of replacing embedded investment with *new* technologies.

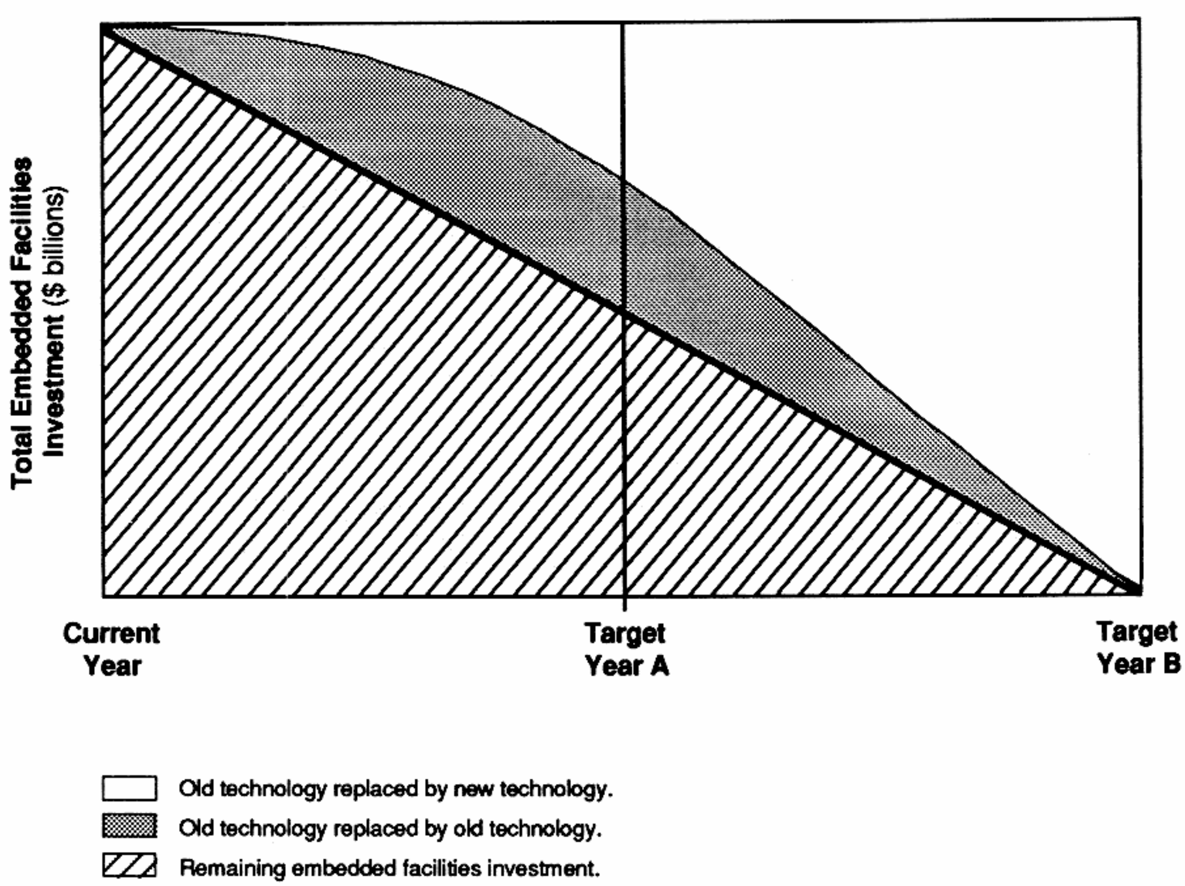
Figure 13
Replacement of Embedded Technology with New Technology



- All old technology replaced with new technology.
- Remaining embedded facilities investment.
- Unrecovered depreciation costs for embedded facilities investment.

Appendix B
Impact of Proposed Legislation, cont.

Figure 14
Replacement of Embedded Technology: Mix of Old and New Technologies



Appendix B
Impact of Proposed Legislation, cont.

The deployment of new technologies, such as broadband, and rate of deployment are issues — the traditional industry's competitors will provide broadband facilities and services. As **Figures 13 and 14** indicate, there are many possible actions.

In addition to the pace of technology deployment, the introduction of a broadband network raises cost recovery questions. For example, what might be an appropriate measure of use for a broadband network? Would rates be averaged? Customer specific? Service specific? Would rates be lower for public institutions such as schools, governments, or hospitals? Or would they be lower for high volume customers? What mechanisms encourage competition without disadvantaging one competitor over another?

Appendix C
Calculations for Telecommunications Industry Interstate Investment and Revenues

Figure 15
Comparison of Interstate Facilities Investment and Revenues: 1989 Tier 1 Local Exchange Carriers

Table A: Industry Composition of Interstate Facilities Investment

	Dollars (in billions)	**Percent of Total Plant Investment**
Local Loop	$21.8	37.6%
Transport	***$9.2***	***15.9%***
Overheads: General Support Facilities & Other	$7.8	13.4%
Central Office Switching Equipment	$7.7	13.3%
Central Office Circuit Equipment	$6.4	11.0%
Information Origination/Termination Equipment (IO/T)	$4.1	7.1%
Remaining Trunk	$1.0	1.7%
Total Interstate Facilities (line #1540, Column d, ARMIS 43-04)	$58.0	100.0%

Table B: Industry Composition of Interstate Revenues

	Dollars (in billions)	**Percent of Total Revenues**
Access Elements:		
Common Line - Total	$9.0	42.3%
Traffic Sensitive:		
TS-Switching	$3.6	16.9%
TS-Transport	***$3.9***	***18.3%***
TS-Other (Information & Equal Access)	$0.6	2.8%
Special Access	$2.7	12.7%
Non-access Elements:		
Billing & Collection	$1.1	5.1%
Interexchange	$0.4	1.9%
Total Interstate Revenues (line #4050, Column d, ARMIS 43-04)	$21.3	100.0%

Note: The local loop investment includes only C&WF Cat 1. Another definition of local loop investment would include COE Cat 4.13 as well as C&WF Cat 1. This would increase the investment in local loop to $24.8 billion and would decrease COE circuit equipment to $3.3 billion. The corresponding percent of total plant investment would increase to 42.8% for local loop and decrease to 5.8% for COE circuit equipment.
Source: ARMIS Report 43-04; 1989 Tier 1 Local Exchange Carriers. Compiled from industry totals.

Appendix D
Other Transport Comparisons

Other Transport Comparisons—Dedicated/Common Costs

This section of the paper contains additional modeling techniques for policy discussions. It shows background analysis on the transport issue for the figures used earlier in this paper.

Figures 16 through 20 illustrate the impact of splitting transport into two classifications — common and dedicated — based upon costs. These figures use simplified interstate transport revenue requirements and MOU to model this issue.

Each figure has its own "zone of reasonableness". While the x-axis runs from 100% common/0% dedicated to 10% common/90% dedicated, these balances do not apply to all situations. For example, it is unlikely that densely populated urban areas will have no dedicated traffic. Therefore, it is more reasonable to look at the zone between 30/70 and 10/90 to analyze urban data.

The spreadsheet model associated with **Figures 16 through 20** allows the user to vary only four assumptions:

- Common and dedicated facilities investment — percent split.
- Common and dedicated interstate switched traffic-sensitive MOU — percent split.
- The rate at which non-access tandem moves to dedicated as dedicated MOU increases. Default in current version is set at one unit of investment for every two units of traffic. (All access tandem switch investment is common transport.)
- Interstate switched traffic-sensitive MOU — percentage growth.

This simplified model is based on an earlier model of the transport issue.[17] The model uses summarized nationwide data for Tier 1 companies, unless otherwise specified.

[17]See Weinhaus, *Interim Report, Transport, April 1991*.

The cost curves in **Figures 16 through 20** indicate how the modeling process helps lay out public policy issues. Individual parties — companies, their regulators, their customers, and their competitors — can determine what's in their best interests.

Our simplified model has a narrow focus. These figures graph the change in common transport facilities cost per minute as the percentage of dedicated traffic increases from 0% to 90%.

- **Figure 16:** Compares two methods of modeling the transport issue.[18] The more complex modeling method uses a ratio to move non-tandem transport investment away from common to dedicated investment as common traffic decreases.

  The simplified modeling method assumes that transport investment (excluding access tandem investment) is split 50/50 between common and dedicated, regardless of any shift in traffic between common and dedicated.

  The nationwide summary curve serves as a benchmark for comparisons with **Figures 17 through 20**, since Y-axis ranges vary in these figures.

- **Figure 17:** Shows the impact of changes in total MOU with the more complex modeling method. An extreme of 20% is used for both the growth and decline in minutes.

- **Figure 18:** Compares several urban and rural study areas with the total industry nationwide summary results using the more complex method.

- **Figure 19:** Approximates rural characteristics using a variation of the complex method.

- **Figure 20:** Approximates urban characteristics using a variation of the simplified method.

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[18] The numbers in these models are nationwide. Results may vary for individual companies or locations.

Other Transport Comparisons: Nationwide Summaries — Complex and Simple Modeling

Figure 16 compares the complex model (**Curve A**) with the simplified model (**Curve B**). Both curves show deaveraged common transport costs for the same nationwide summary data.

While these models show basic trends, the differences indicate that an understanding of the interrelation between facilities and traffic is necessary to select appropriate assumptions that will reasonably reflect reality. For example, a company with a small amount of dedicated investment will follow a very different pattern than a company with a high amount.

For the company with low dedicated investment, there is a trade-off in the benefits realized by moving traffic from common transport to dedicated. The access tandem facilities investment is fixed. If traffic moves away from this facility, the tandem costs are spread over a smaller number of minutes. Therefore, there are higher costs per minute for the tandem portion of transport. However, this result may be counter-balanced by a decrease in trunk efficiencies between the access tandem and the central office. (See **Figure 6** for the rate and facilities diagram).

At the point where common traffic is 90% on **Curve A**, the dedicated traffic is 10%. The common transport investment consists of access tandem costs (which will always be common) and 50% of the non-access tandem costs. The dedicated investment at this point is the other 50% of the non-access tandem. This 50/50 non-access tandem investment split provides a starting point, midway between two different concerns — those companies with high amounts of common; those with low amounts of common. With each 10% decrease of common traffic, 5% of the non-access tandem investment shifts to dedicated. At the 90% common traffic mark, the common investment decreases to 45% of the non-access tandem. Therefore, at intervals of 10% along the x-axis, the common investment continually decreases. By the time **Curve A** reaches 10% common traffic, the dedicated investment is 95% of the non-access tandem investment. The common investment is only 5% of the non-access tandem plus all of the access tandem investment.

For a company with high dedicated investment (and, therefore, low common transport investment), this pattern may not factor as heavily in the results of deaveraging costs. The "zone of reasonableness" for **Figure 16** is 90/10 through 20/80 because the data is nationwide and the intent is to show the general picture, not the extremes.

Other Transport Comparisons: Economic Changes Reflected by Minutes of Use

Figure 16 models a closed system. In reality, markets change. There are periods of economic boom and bust, there are changes in technology, and there are changes in the costs of existing technologies.

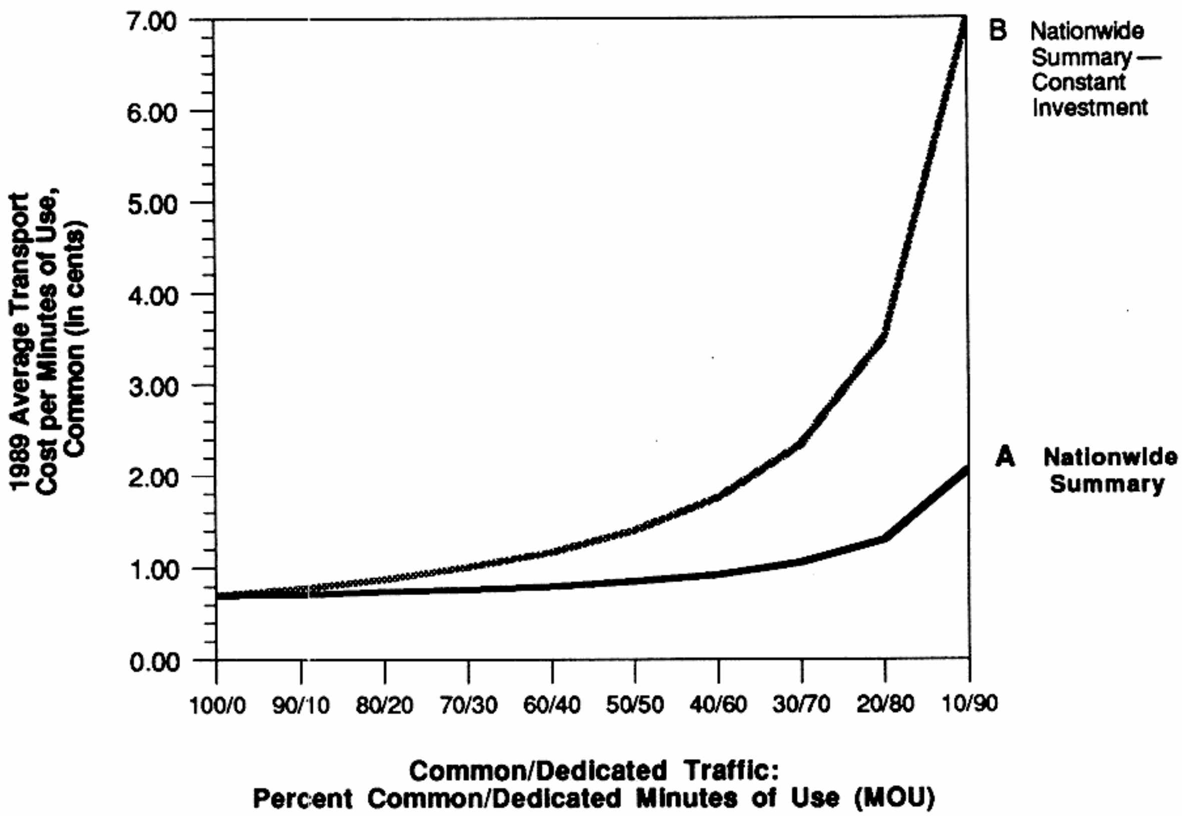
Regardless of the economic climate, traditional telephone industry costs follow a regulated rather than a free market pattern. Under the current method of regulation, if a competitor enters the market and removes traffic and revenues, a traditional company still retains the cost of the inactive facilities on its books (unless the companies other intraLATA services are utilized). This could translate into a higher cost per minute for those facilities. Conversely, the traditional industry benefits if it is able to meet economic growth with existing facilities. In this case, the cost per minute for facilities decreases.[19]

Figure 17 shows the impact of growth and decline in number of minutes. **Curve A** is the same as **Curve A** in **Figure 16**. **Curves C and D** show a 20% decrease and increase respectively in minutes. The three MOU all curves use the complex modeling method and the same investment assumptions.

Figure 17 indicates that during an economic decline, the common transport cost per minute of use will be higher than during an economic upturn. This same pattern may occur with the introduction of competitors, whose entry may either reduce LEC traffic or stimulate markets and increase LEC traffic.

[19] In the telephone industry, this condition is referred to as the "fill factor".

Figure 16
Cost per Minute of Use for Common Transport: Comparisons of 1989 Average Transport Cost with Two Methods of Modeling Dedicated and Common Shifts



Pattern: As common traffic shifts to dedicated facilities, common transport cost per MOU increases.

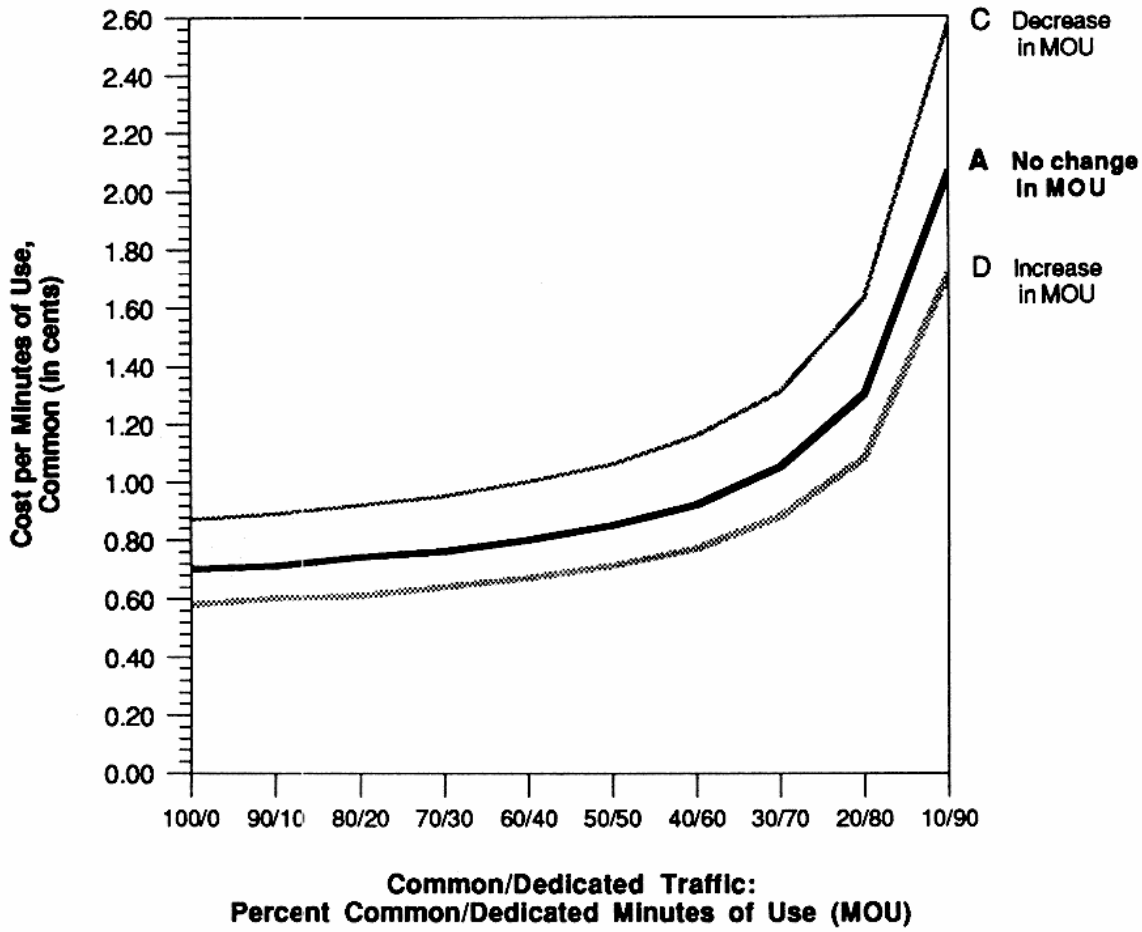
Legend: **Curve A, Nationwide Summary.**

Curve B, Nationwide Summary — Constant Investment: Common Investment held constant at 50% as Common MOU decrease.

Assumptions: Total MOU remains constant.
Access Tandem Investment: 100% throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 17
Cost per Minute of Use for Common Transport: Comparisons of 1989 Average Transport Cost with Impact of Changes in Total Minutes of Use



Pattern: Changes in total number of MOU increase or decrease common transport cost per MOU accordingly.

Legend: **Curve A, No change in Total MOU.**
Curve C, Decrease in Total MOU.
Curve D, Increase in Total MOU.

Assumptions: Access Tandem Investment: 100% throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Invesment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04; 1989 Tier 1 Local Exchange Carriers.

The "zone of reasonableness" for **Figure 17** is the same as that of the preceding figure, 90/10 through 20/80. Once again, the data is nationwide and the intent is to show the general picture, not the extremes.

There are additional questions raised by the transport issue.[20] For example, will a proposed change in transport produce jurisdictional shifts? Within the traditional telephone industry, there has been continual controversy over state and interstate rate disparities.[21] A decision on the transport issue that deaverages costs and, in turn, deaverages rates, may create cost recovery problems in one jurisdiction or another.

Other Transport Comparisons: Rural/Urban Examples

The simple and complex models look at transport in isolation: they assume that the traditional telephone industry is a closed system. In reality, there are existing or potential competitors for all portions of the traditional telephone industry facilities. The current FCC proceeding on CAPs specifically covers competition for LEC transport of interstate switched traffic.[22]

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[20]See *Interim Report*, Figure 1, pp. 6-7, for a list of questions raised by the transport issue, including competition, separations (Part 36), access (Part 69), service incentives, tariffs, and price caps.

[21]In the 1950's, there was a "19-Year War" over inter-company payments. When more than one telephone company carries a call and only one company bills the customer, the traditional industry has mechanisms for reimbursing all involved companies. The 1952 controversy centered on a change that created disparities between state and interstate reimbursement mechanisms.

State and interstate toll rate disparities lay at the heart of this dispute. The definition of toll rate disparity is as follows:

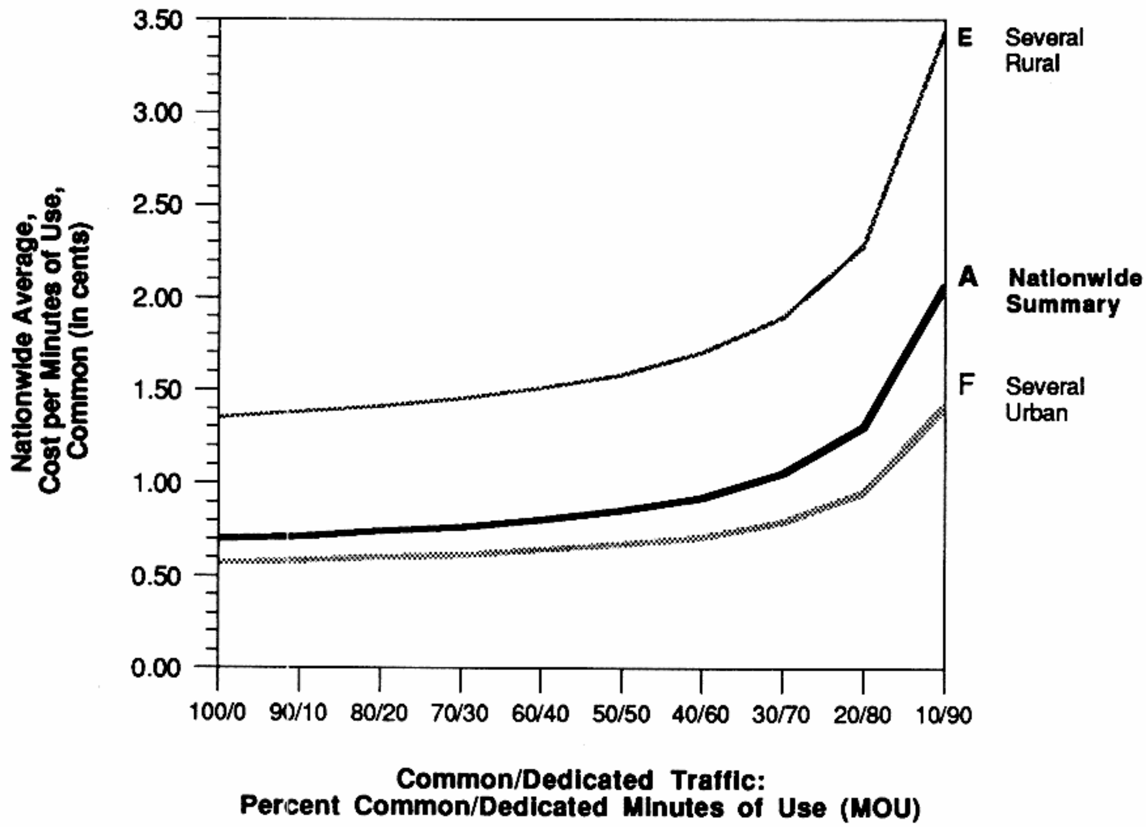
> In essence, interstate toll rates set an upper bound on state toll rates. When, for a given distance, the state toll rates exceeded the interstate toll rates, the customers viewed this difference as a toll rate disparity and pressured the regulators to bring the two into accord. Thus there were limits on state toll rate increases to make up the shortfall....If the collected [state] toll revenues fell below the cost allocation, then [some] companies suffered a loss.

The 1971 *Separations Manual* resolved this controversy by making the reimbursement mechanisms the same for state and interstate jurisdictions.

Weinhaus, *Behind the Telephone Debates*, page 84. For further details on the history of toll rate disparity, see *The Traditional State Side of Telecommunications Cost Allocations*, Anthony G. Oettinger with Carol L. Weinhaus, Program on Information Resources Policy, Harvard University, Cambridge, MA, 1981, Publication No. P-80-7, pages 29, 34-55.

[22]CC Docket No. 91-141, pages 2 and 3.

Figure 18
Cost per Minute of Use for Common Transport: Comparison of Several Rural and Urban Study Areas



Pattern: Some low-density geographic areas (rural) have common transport costs per MOU above the nationwide average. Some high-density geographic areas (urban) have common transport costs per MOU below this average.

Legend: **Curve A, Nationwide Summary.**
Curve E, Several Rural Study Areas.
Curve F, Several Urban Study Areas.

Assumptions: Total MOU: Remains constant.
Access Tandem Investment: 100% throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Invesment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

In terms of the transport issue, are competitors more likely to enter areas with high volume traffic? **Figure 18** uses the complex model to compare several rural and urban study areas with the nationwide summary (**Curve A**) from **Figure 16**.

Curve E, Figure 18 indicates several rural study areas with lower traffic volumes and, therefore, higher starting common transport cost per MOU. **Curve E** is above the nationwide summary (**Curve A**). Conversely, **Curve F** indicates several urban study areas with higher traffic volumes and, therefore, lower starting common transport costs. This curve is below **Curve A**.

Both **Curves E and F** use the same non-access tandem investment split as the nationwide summary curve (**Curve A**) — a 50/50 percent split. However, **Curves E and F** use different summarized data sets for selected study areas.

If the pattern in **Figure 18** is correct, and if current treatment of averaging transport costs continues, there is an additional incentive for competitors to enter high volume markets.

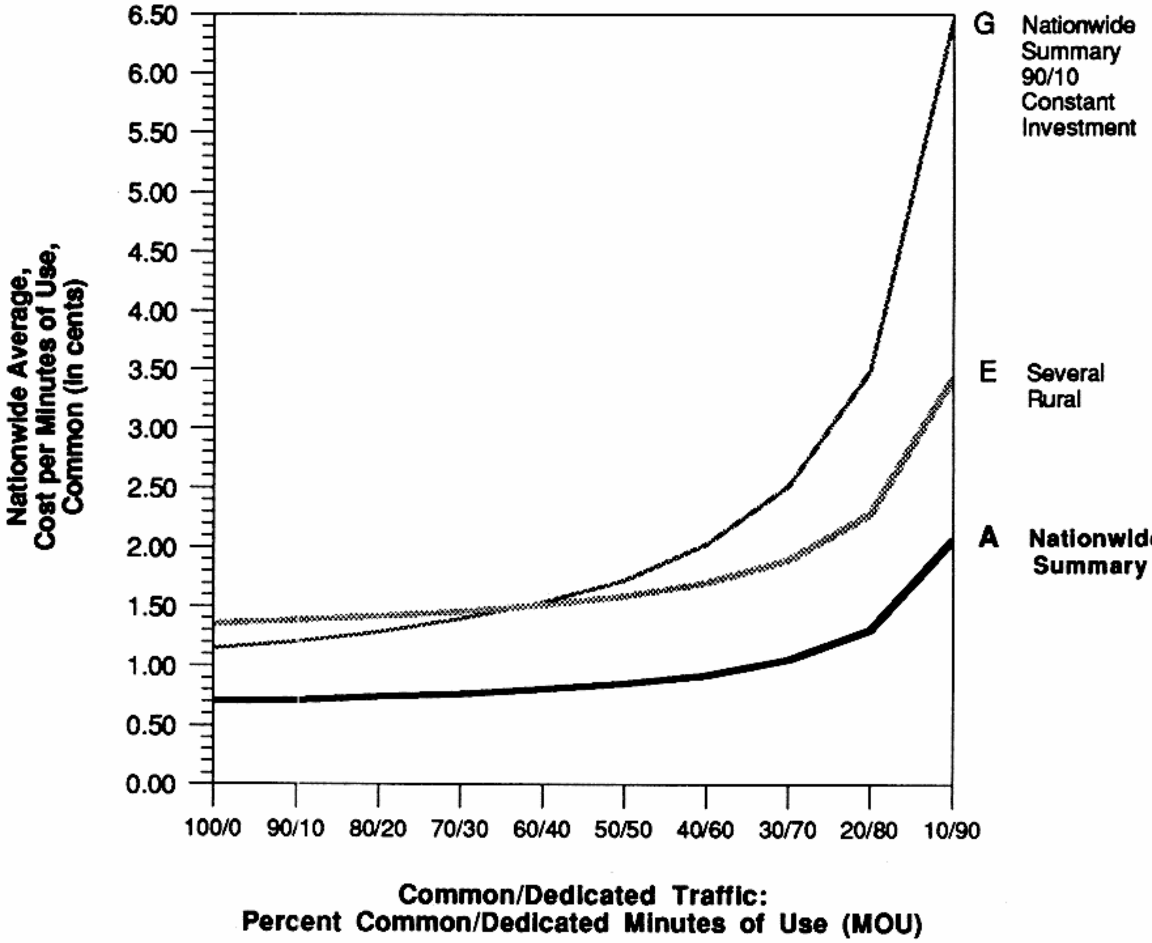
In this figure, the "zone of reasonableness" varies for each curve. For a low-density geographic areas, the zone is more likely to fall within the higher percents of common transport traffic. The converse is true for high-density geographic areas. The next section is an attempt to look more closely at individual characteristics.

Other Transport Comparisons: Modeling Selected Characteristics

In the modeling process, a wise choice of assumptions produces results that approximate reality. It is, therefore, possible to use industry-wide data to analyze patterns for individual companies, states, regions, or markets. **Figures 19 and 20** indicate two different patterns, each using a different mix of assumptions.

Figure 19 compares the curve for several rural study areas (**Curve E**) with two variations of the nationwide summary. **Curve A** is the standard used throughout the

Figure 19
Cost per Minute of Use for Common Transport: Comparisons of Nationwide Average with Several Rural Study Areas and Shifts for Different Investment Splits



Pattern: Using a starting point of relatively high common investment makes the nationwide summary mimic the characteristics of a low-density geographic area (rural). The high ends of the curves make little sense because access tandem switches also carry intraLATA toll traffic.

Legend: **Curve A, Nationwide Summary.**

Curve E, Several Rural Study Areas.

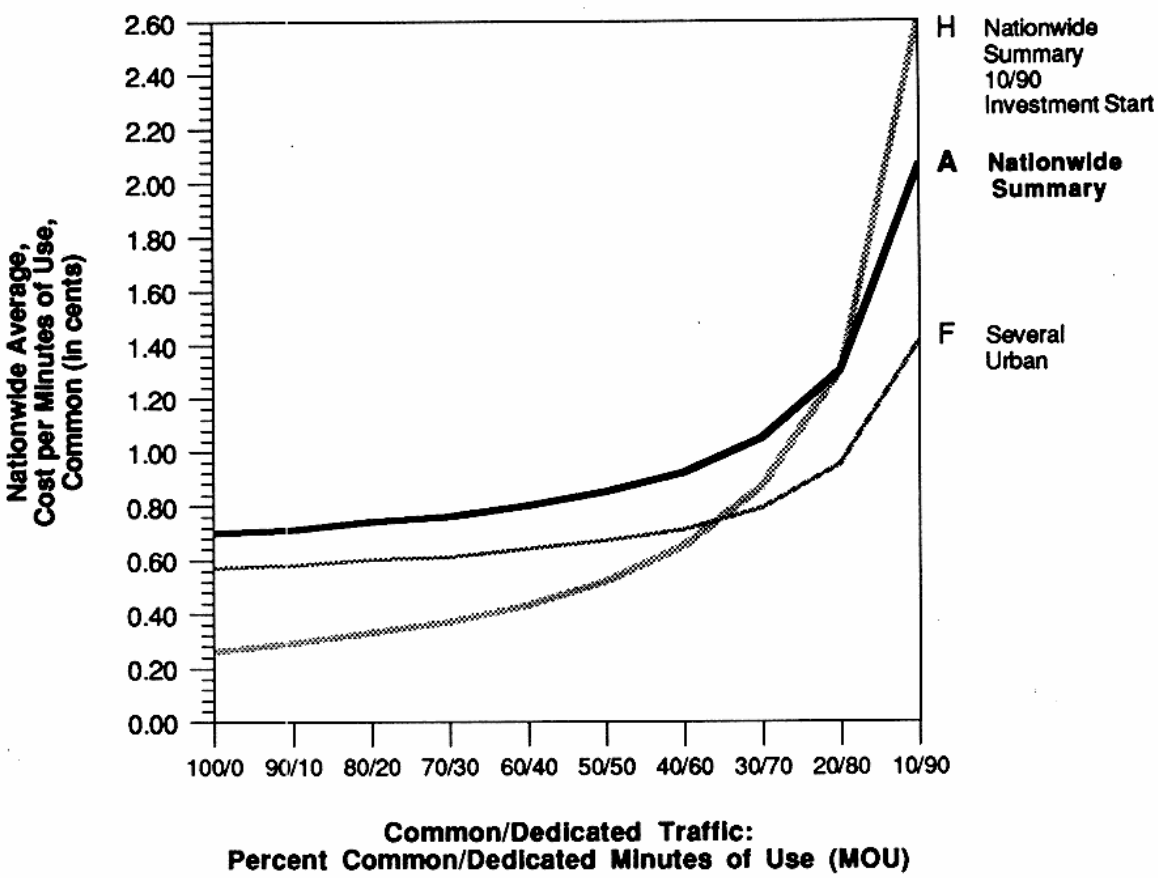
Curve G, Nationwide Summary: Non-Access Tandem Investment 90% Common and 10% Dedicated held constant throughout curve..

Assumptions: Total MOU: Remains constant.
Access Tandem Investment: 100% throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Invesment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 20

Cost per Minute of Use for Common Transport: Comparisons of Nationwide Average with Several Urban Study Areas and Shifts for Different Investment Splits



Pattern: Using high constant dedicated investment makes the nationwide summary mimic the characteristics of a high-density geographic area (urban). The low ends of the curves make little sense because these areas have relatively high amounts of dedicated facilities already in use.

Legend: **Curve A, Nationwide Summary.**

Curve F, Several Urban Study Areas.

Curve H, Nationwide Summary: Non-Access Tandem Investment 10% Common and 90% Dedicated at starting point.

Assumptions: Total MOU: Remains constant.
Access Tandem Investment: 100% throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Invesment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

common transport cost graphs. This curve uses a split of 50/50 between common and dedicated non-access tandem investment as a starting point and the complex investment model. **Curve G** changes this starting assumption to a split of 90/10.

This chart shows that by varying the assumptions for the industry summary, it is possible to mimic patterns for companies with selected characteristics. For example, using a 90/10 starting point (**Curve G**) for the nationwide curve, brings it closer to the rural curve (**Curve E**).

There is a "zone of reasonableness" for this figure. After 30% common transport traffic, neither curve makes much sense because access tandem switches also carry intraLATA toll traffic. Until the curves reach approximately 30% common traffic, **Curve G** closely approximates the results of the rural areas used for **Curve E**. In spite of the fact that these two curves use different starting points, they tell a similar story. After 30%, the use of different starting points makes a significant difference. The common costs increase at a dramatically faster rate in **Curve G** than in **Curve E**. While these two curves do not match exactly, changing other assumptions — such as the rate at which non-access tandem investment follows movement of minutes from common to dedicated — may produce a closer match.

In a similar manner, **Figure 20** attempts to approximate the urban curve (**Curve F**) by altering the nationwide summary, using constant investment (**Curve B**). The simplified model produces a closer fit to the urban curve because urban areas are likely to start with a relatively high non-access tandem investment in dedicated facilities and corresponding low common transport investment. Since the starting investment in dedicated is already high, it is less likely to have a major shift in investment from common to dedicated as traffic moves to dedicated. To mimic this pattern, **Curve H** starts with an initial non-access tandem investment split of 10 percent common and 90 percent dedicated.

The "zone of reasonableness" in this case lies between 50/50 and 10/90 (common/dedicated). This figure focuses on densely populated geographic areas with relatively high amounts of dedicated facilities already in use.

Other Transport Comparisons: Summary of Curves

A more accurate model would reflect the following pattern. For a company with low dedicated investment, the curve initially resembles the complex model. As common transport traffic continues to decrease, the rate at which dedicated investment follows the shift in minutes slows -- until finally the curve resembles the simplified model.

No matter which model is used, as common transport traffic decreases, the cost per minute for common transport investment rises at an increasing pace.

Figure 21 summarizes all the common/dedicated cost per minute curves. **Appendix E** provides the background numbers for these comparisons. Parties can examine the various curves in relation to their own cost and traffic characteristics. This process can help parties determine which policies are in their best interests and the tack opposition is likely to take.

In some respects, the transport issue and competitive access provision are linked. Decisions made in one docket may impact the other since both are based on telephone facilities and its costs.

Figure 21
Comparison of Cost per Minute of Use for Common Transport: Standard v. Variables

Description of Cost Curve	Average Rate of Change from Standard
Nationwide Summary, Curve A *All Figures*	Standard
Nationwide Summary — Constant Investment, Curve B *Figure 16*	+61%
Decrease in Minutes of Use, Curve C 20% Decrease in Total *Figure 17*	+25%
Increase in Minutes of Use, Curve D 20% Increase in Total *Figure 17*	-17%
Several Rural Study Areas, Curve E *Figures 18 and 19*	+85%
Several Urban Study Areas, Curve F *Figures 18 and 20*	-22%
Nationwide Summary, Curve G 90/10 Percent Common and Dedicated Investment at Starting Point *Figure 19*	+101%
Nationwide Summary — Constant Investment, Curve H Transport Investment, 10/90 Percent Common and Dedicated Investment Held Constant *Figure 20*	-40%

Appendix E
Calculations for Transport Costs

Figure 22 (Background for Figure 1)

Interstate Transport Facilities Investment and Revenues Compared to Interstate Totals: 1989 Tier 1 Local Exchange Carriers

	Transport	Total
Facilities Investment	$9.2	$58.0
Revenues	$3.9	$21.3

Dollar amounts in billions.

Source: ARMIS Report 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 23 (Background for Figure 7)

Potential Impact of Deaveraging Interstate Transport Costs: Interexchange Carrier (IXC) Service Incentives

X-Axis	Y-Axis		
Common Traffic: Percent Common Minutes of Use	Low-Volume IXC, Common Cost per Minutes of Use (in cents)	High-Volume IXC, Dedicated Cost per Minutes of Use (in cents)	1989 Nationwide Average Cost per Minutes of Use (in cents)
50	1.40	1.09	1.25
40	1.75	0.91	1.25
30	2.33	0.78	1.25
20	3.49	0.68	1.25
10	6.98	0.61	1.25
0	0.00	0.55	1.25

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 24 (Background for Figure 8)

Comparison of Several Rural and Urban Study Areas: Potential Impact of Traffic Shifts from Common Transport to Dedicated Transport

Chart A: Rural

Percent Common Transport Minutes of Use	Percent Increase of Common Transport Rates
90%->70%	0.053
90%->60%	0.093

Rate Increases for Common Transport:

1. After 20% of traffic has shifted from common to dedicated transport.
2. After 30% of traffic has shifted from common to dedicated transport.

Chart B: Urban

Percent Common Transport Minutes of Use	Percent Increase of Common Transport Rates
60%->20%	0.487
60%->10%	1.217

Rate Increases for Common Transport:

1. After 40% of traffic has shifted from common to dedicated transport.
2. After 50% of traffic has shifted from common to dedicated transport.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 25 (Background for Figure 16)

Cost per Minute of Use for Common Transport: Comparisons of 1989 Average Transport Cost with Two Methods of Modeling Dedicated and Common Shifts

X-Axis	Y-Axis	
	A Nationwide Summary	B Nationwide Summary — Constant Investment
Traffic: Percent Common Minutes of Use	Cost per Minutes of Use, Common (in cents)	Cost per Minutes of Use, Common (in cents)
100	0.70	0.70
90	0.71	0.78
80	0.74	0.87
70	0.76	1.00
60	0.80	1.16
50	0.85	1.40
40	0.92	1.75
30	1.05	2.33
20	1.30	3.49
10	2.06	6.98

Legend: Curve A, Nationwide Summary
Curve B, Nationwide Summary -- Constant Investment:
Common Investment held constant at 50% as Common MOU decreases.

Assumptions: Total Minutes of Use remains constant.
Access Tandem Investment: 100% Common throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 25 (Background for Figure 16)

Cost per Minute of Use for Common Transport: Comparisons of 1989 Average Transport Cost with Two Methods of Modeling Dedicated and Common Shifts

X-Axis	Y-Axis	
	A Nationwide Summary	B Nationwide Summary — Constant Investment
Traffic: Percent Common Minutes of Use	Cost per Minutes of Use, Common (in cents)	Cost per Minutes of Use, Common (in cents)
100	0.70	0.70
90	0.71	0.78
80	0.74	0.87
70	0.76	1.00
60	0.80	1.16
50	0.85	1.40
40	0.92	1.75
30	1.05	2.33
20	1.30	3.49
10	2.06	6.98

Legend: Curve A, Nationwide Summary
Curve B, Nationwide Summary -- Constant Investment:
Common Investment held constant at 50% as Common MOU decreases.

Assumptions: Total Minutes of Use remains constant.
Access Tandem Investment: 100% Common throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 26 (Background for Figure 17)

Cost per Minute of Use for Common Transport: Comparisons of 1989 Average Transport Cost with Impact of Changes in Total Minutes of Use

X-Axis	Y-Axis		
	A	C	D
Traffic: Percent Common Minutes of Use	No Change in Total Minutes of Use, Cost per Minutes of Use, Common (in cents)	20% Decrease in Total Minutes of Use, Cost per Minutes of Use, Common (in cents)	20% Increase in Total Minutes of Use, Cost per Minutes of Use, Common (in cents)
100	0.70	0.87	0.58
90	0.71	0.89	0.60
80	0.74	0.92	0.61
70	0.76	0.95	0.64
60	0.80	1.00	0.67
50	0.85	1.06	0.71
40	0.92	1.16	0.77
30	1.05	1.31	0.88
20	1.30	1.63	1.08
10	2.06	2.57	1.71

Legend:
Curve A, No change in Total MOU.
Curve C, Decrease in Total MOU.
Curve D, Increase in Total MOU.

Assumptions:
Access Tandem Investment: 100% Common throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 27 (Background for Figure 18)

Cost per Minute of Use for Common Transport: Comparison of Several Rural and Urban Study Areas

X-Axis	Y-Axis		
	A	E	F
Traffic: Percent Common Minutes of Use	Nationwide Summary Cost per Minutes of Use, Common (in cents)	Several Rural Study Areas, Cost per Minutes of Use, Common (in cents)	Several Urban Study Areas, Cost per Minutes of Use, Common (in cents)
100	0.70	1.35	0.57
90	0.71	1.38	0.58
80	0.74	1.41	0.60
70	0.76	1.45	0.61
60	0.80	1.51	0.64
50	0.85	1.58	0.67
40	0.92	1.70	0.71
30	1.05	1.89	0.79
20	1.30	2.28	0.95
10	2.06	3.43	1.41

Legend:
Curve A, Nationwide Summary
Curve E, Several Rural Study Areas.
Curve F, Several Urban Study Areas.

Assumptions:
Total MOU: Remains constant.
Access Tandem Investment: 100% Common throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 28 (Background for Figure 19)

Cost per Minute of Use for Common Transport: Comparisons of Nationwide Average with Several Rural Study Areas and Shifts for Different Investment Splits

X-Axis	Y-Axis		
	A	F	H
Traffic: Percent Common Minutes of Use	Nationwide Summary Cost per Minutes of Use, Common (in cents)	Several Rural Study Areas, Cost per Minutes of Use, Common (in cents)	Nationwide Summary, 90/10 Constant Investment Cost per Minutes of Use, Common (in cents)
100	0.70	1.35	1.14
90	0.71	1.38	1.20
80	0.74	1.41	1.28
70	0.76	1.45	1.39
60	0.80	1.51	1.53
50	0.85	1.58	1.72
40	0.92	1.70	2.02
30	1.05	1.89	2.51
20	1.30	2.28	3.49
10	2.06	3.43	6.43

Legend:
Curve A, Nationwide Summary
Curve E, Several Rural Study Areas.
Curve G, Nationwide Summary: Non-Access Tandem Investment 90% Common and 10% Dedicated held constant throughout curve.

Assumptions:
Total MOU: Remains constant.
Access Tandem Investment: 100% Common throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 29 (Background for Figure 20)

Cost per Minute of Use for Common Transport: Comparisons of Nationwide Average with Several Urban Study Areas and Shifts for Different Investment Splits

X-Axis	Y-Axis		
	A Nationwide Summary	F Several Urban Study Areas	H Nationwide Summary, 10/90 Investment at Start
Traffic: Percent Common Minutes of Use	Cost per Minutes of Use, Common (in cents)	Cost per Minutes of Use, Common (in cents)	Cost per Minutes of Use, Common (in cents)
100	0.70	0.57	0.26
90	0.71	0.58	0.29
80	0.74	0.60	0.33
70	0.76	0.61	0.37
60	0.80	0.64	0.43
50	0.85	0.67	0.52
40	0.92	0.71	0.65
30	1.05	0.79	0.87
20	1.30	0.95	1.30
10	2.06	1.41	2.60

Legend:
Curve A, Nationwide Summary
Curve E, Several Rural Study Areas.
Curve H, Nationwide Summary: Non-Access Tandem Investment 10% Common and 90% Dedicated at starting point.

Assumptions:
Total MOU: Remains constant.
Access Tandem Investment: 100% Common throughout graph.
Non-Access Tandem Investment: 50% Common and 50% Dedicated at starting point.
Starting Point: 100% Common Traffic; 0% Dedicated Traffic.
Complex Modeling Method: Relation between Non-Access Tandem Investment and shift in MOU away from Common. With each unit decrease in Common MOU percentage, one-half unit Common Non-Access Tandem Investment shifts to Dedicated.

Source: ARMIS Reports 43-01 and 43-04, 1989 Tier 1 Local Exchange Carriers.

Figure 30 (Background for Figure 21)

Comparison of Cost per Minute of Common Transport: Standard v. Variables

Results of Varying Assumptions

The Standard Relational Investment Curve begins with a 50/50 split in investment between Common and Dedicated, and no growth in Total Switched Traffic Sensitive minutes of use. Unless otherwise noted, the Non-Access Tandem investment shifts from Common to Dedicated at the rate of one-half unit of investment for every unit of revenues. Growth in Total Switched Traffic Sensitive minutes of use is as noted.

Description	A (Standard)	B	C	D	E (Rural)	F (Urban)	G	H
Transport Investment Split	50/50 at Start	50/50 Throughout	50/50 at Start	50/50 at Start	50/50 at Start	50/50 at Start	10/90 at Start	90/10 Throughout
Modeling Method Used	Complex	Simplified	Complex	Complex	Complex	Complex	Complex	Simplified
Growth-Total MOU	0%	0%	20%	-20%	0%	0%	0%	0%
% MOU Common	Cost per Minute of Use, Common							
100%	0.0070	0.0070	0.0087	0.0058	0.0135	0.0057	0.0114	0.0026
90%	0.0071	0.0078	0.0089	0.0060	0.0138	0.0058	0.0120	0.0029
80%	0.0074	0.0087	0.0092	0.0061	0.0141	0.0060	0.0128	0.0033
70%	0.0076	0.0100	0.0095	0.0064	0.0145	0.0061	0.0139	0.0037
60%	0.0080	0.0116	0.0100	0.0067	0.0151	0.0064	0.0153	0.0043
50%	0.0085	0.0140	0.0106	0.0071	0.0158	0.0067	0.0172	0.0052
40%	0.0092	0.0175	0.0116	0.0077	0.0170	0.0071	0.0202	0.0065
30%	0.0105	0.0233	0.0131	0.0088	0.0189	0.0079	0.0251	0.0087
20%	0.0130	0.0349	0.0163	0.0108	0.0228	0.0095	0.0349	0.0130
10%	0.0206	0.0698	0.0257	0.0171	0.0343	0.0141	0.0643	0.0260

Figure 31 (Background for Figure 21)

Comparison of Cost per Minute of Common Transport: Standard v. Variables

Percentage Variance from Standard

The Standard Relational Investment Curve begins with a 50/50 split in investment between Common and Dedicated, and no growth in Total Switched Traffic Sensitive minutes of use. Unless otherwise noted, the Non-Access Tandem investment shifts from Common to Dedicated at the rate of one-half unit of investment for every unit of revenues. Growth in Total Switched Traffic Sensitive minutes of use is as noted.

Description	A (Standard)	B	C	D	E (Rural)	F (Urban)	G	H
Transport Investment	50/50 at Start	50/50 Throughout	50/50 at Start	50/50 at Start	50/50 at Start	50/50 at Start	10/90 at Start	90/10 Throughout
Modeling Method Use	Complex	Simplified	Complex	Complex	Complex	Complex	Complex	Simplified
Growth-Total MOU	0%	0%	20%	-20%	0%	0%	0%	0%
% MOU Common	Deviation from the Standard							
100%	0.00%	0.00%	24.29%	-17.14%	92.86%	-18.57%	62.86%	-62.86%
90%	0.00%	9.86%	25.35%	-15.49%	94.37%	-18.31%	69.01%	-59.15%
80%	0.00%	17.57%	24.32%	-17.57%	90.54%	-18.92%	72.97%	-55.41%
70%	0.00%	31.58%	25.00%	-15.79%	90.79%	-19.74%	82.89%	-51.32%
60%	0.00%	45.00%	25.00%	-16.25%	88.75%	-20.00%	91.25%	-46.25%
50%	0.00%	64.71%	24.71%	-16.47%	85.88%	-21.18%	102.35%	-38.82%
40%	0.00%	90.22%	26.09%	-16.30%	84.78%	-22.83%	119.57%	-29.35%
30%	0.00%	121.90%	24.76%	-16.19%	80.00%	-24.76%	139.05%	-17.14%
20%	0.00%	168.46%	25.38%	-16.92%	75.38%	-26.92%	168.46%	0.00%
10%	0.00%	238.83%	24.76%	-16.99%	66.50%	-31.55%	212.14%	26.21%
Average Deviations (exluding outliers)	0.00%	61.03%	24.97%	-16.51%	84.99%	-22.28%	100.94%	-40.03%