Update on Modeling Process and Key Components of Technology Deployment

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

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Project Information

Alternative Costing Methods Project:
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List of Acronyms

AA\DM	Add\Drop Multiplexer
ARMIS	Automated Reporting Management Information System
ATM	Asynchronous Transfer Mode
CAP	Competitive Access Provider
CO	Central Office
CPE	Customer Premises Equipment
ESP	Enhanced Service Provider
FCC	Federal Communications Commission
IN	Intelligent Network
ISDN	Integrated Services Digital Network
IXC	Interexchange Carrier
LAN	Local Area Network
LEC	Local Exchange Carrier
LTS	Long Term Support
LATA	Local Access and Transport Area
mbps	Megabits per Second
MFJ	*Modification of Final Judgement*
MOU	Minutes of Use
MTS	Message Telecommunications Services
ONU	Optical Network Unit
PONs	Passive Optical Network
SCP	Service Control Point
SMS	Service Management System
SS7	Signaling System Seven
STP	Signal Transfer Point
SONET	Synchronous Optical Network
TO	Tandem Office
USF	Universal Service Fund
USOAR	Uniform System of Accounts Revised
WATS	Wide Area Telecommunications Services

I. Modeling Process

Modeling Process: Introduction

This paper provides an update on the status of the Alternative Costing Methods project. The modeling process can be used to analyze the impact of future actions or outside forces. 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 costing process.

The project focuses on broad, industry-wide questions, such as:

- Will decisions made on current issues impact the long-range future of the telecommunications industry?
- What is the impact of the transport issue? Of the proposal to allow interconnection of competitive access providers?[1] Of proposed legislation for a broadband network?
- What steps are needed to analyze these issues? Other issues?
- Is the necessary data available?

The project shows patterns, trends, or trigger-points:

- What characteristics make a company gain or lose under a given scenario?
- At what point do conditions become unacceptable to some sets of stakeholders? What are the political trends? What are the economic trends?

The objective of the project is to provide data analysis for policy debates. 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.

[1]See *Interim Report of the Alternative Costing Methods Project: Examples of Modeling — Transport and Competitive Access Provision Issues*, Presentation by Carol Weinhaus and Mark Jamison, NARUC Conference, San Francisco, CA, July 21, 1991, for a discussion of these three issues.

I. Modeling Process, cont.

The traditional telecommunications industry faces changing regulation and increasing competition. The objective of the project is to help the industry, its regulators, its customers, and its competitors make informed decisions.

Modeling Process: Multiple Viewpoints on Policy Alternatives

The project uses models to set the stage for public policy debates. Our project has two objectives:

- Provide multiple viewpoints. Explore how changes in the current cost structure affect the traditional telecommunications industry.
- Provide a neutral forum for expressing these views.

Figure 1 lists the project participants. Each participant is committed to producing an alternative to the current cost structure. This cost structure forms a base case model which serves as an index for changes. While each participant may choose whatever alternative they wish to model, every alternative must be in a format to enable comparisons.

To allow for multiple viewpoints, each participant will be given the option to develop their own version of other participant's models. Once these models are completed, they will be subject to general review. Interested parties outside the project will be allowed to briefly comment on the various models. The intent of the models and the review process is to indicate trends and the direction of possible effects of alternative policy decisions.

Modeling Process: Status of Database

The foundation for analysis of national issues is industry-wide data. To quickly perform this type of analysis, the following questions must be answered:

- What steps should be taken to analyze stakeholder positions in the future?

Figure 1
List of Participants in the Alternative Costing Methods Project

1 State Regulators	NARUC
7 Regional Holding Companies	Ameritech Bell Atlantic BellSouth NYNEX Pacific Telesis Southwestern Bell US West
4 Large Independents	Centel Southern New England Telephone United Telecom GTE
1 Small Telephone Representative	NTCA
1 Interexchange Carrier	AT&T
1 Harvard	
15 Total	

Assisting with public data:

Federal Communications Commission
National Exchange Carriers Association

- Is the necessary data available?
- Is the data easy to access?

The project is building a database which uses *public* data; **Figure 2** provides the data sources. Participants are still in the process of verifying this public data.

The project uses Paradox software to store data and to create user-friendly screens. This software, with the appropriate data and file structure, places enormous capabilities directly into the hands of a knowledgeable user. The project's simplified menu structure extends many of these capabilities to the less knowledgeable user. All project participants in the Alternative Costing Methods project will receive their own copy of the database.

The current prototype of the database contains some of the data sources listed in **Figure 2**. This prototype contains the following data: ARMIS reports, network usage, Universal Service Fund (USF), Lifeline, and some Federal Communications Commission (FCC) plant statistics. This version of the prototype does not include the ability to easily roll-up data by levels of aggregation, such as state, ownership, or size. There is as yet no documentation.

One possible use of this data is to track trends into the future. Keep in mind that any historical data only provides a starting point. In the future, accounting practices may change, new technology may be introduced, and the reporting structure for the data itself may alter. Therefore, these trends serve as indicators, but not as exact roadmaps. Another use of this data is to model alternative actions. The results may tell individuals whether they are better off or worse off as a result of a given action.

Modeling Process: Status of Base Case Model

The models and the base case may help answer the following types of questions:

- What are the effects of alternative forms of regulation?
- Are some forms of regulation better than others? And for what purposes?

Figure 2
List of Public Data Sources

ARMIS Reports: 4301, 4302, 4303, and 4304

Universal Service Fund

Lifeline

Network Usage

Plant Statistics

U.S. Census Bureau: Telephone Penetration Rates

Other

- What are the effects of no change in regulation?

Some of the project participants are currently working on a draft version of this base case model. The base case and the alternatives will use Lotus 1-2-3 software for spreadsheet development.

Figure 3 is the layout of the base case spreadsheet. The upper left hand corner indicates input of data from the Paradox database. This input range indicates the different data sources.

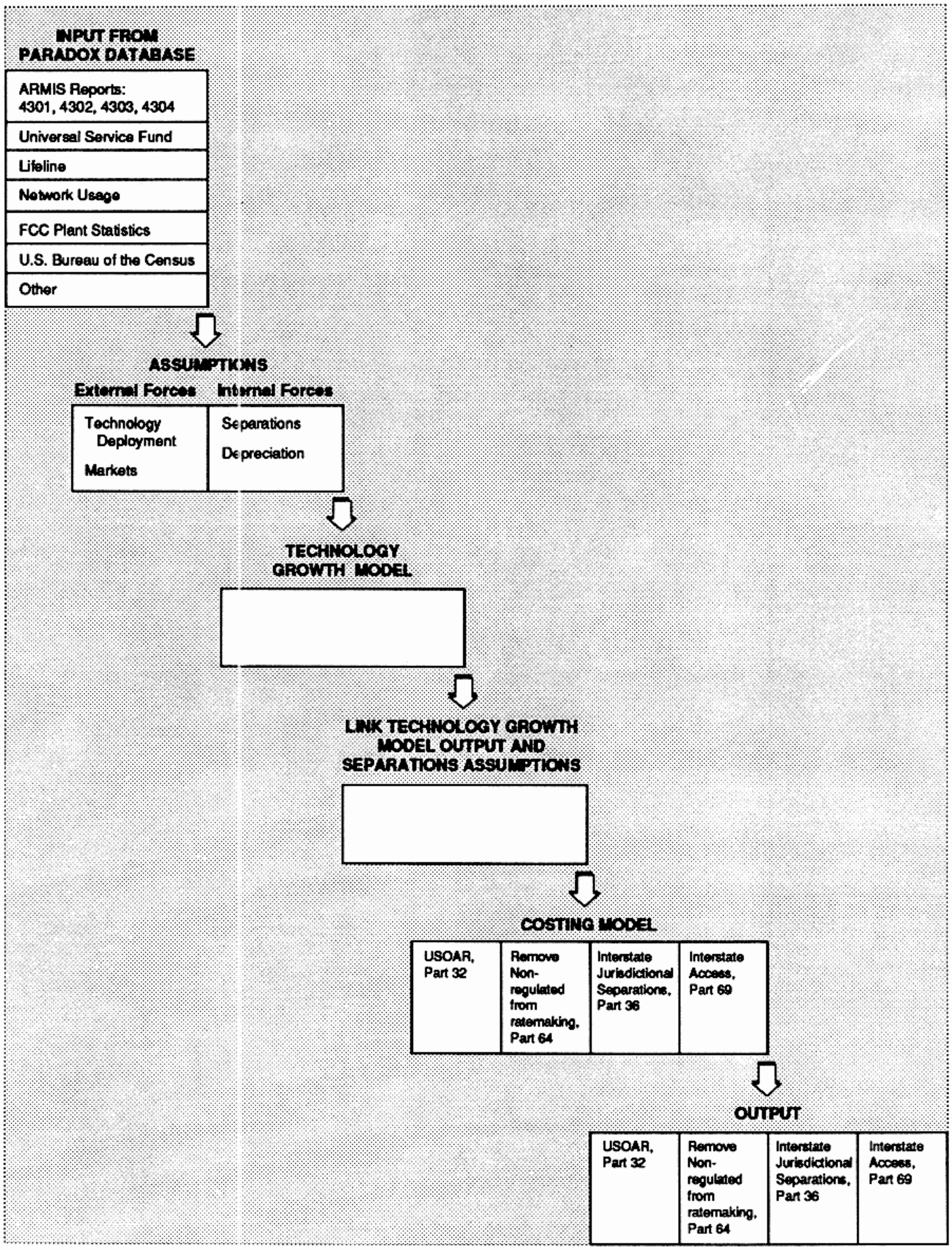
The next step is to alter any assumptions or to accept the default assumptions. This section of the base case has four subdivisions based on both external forces and internal forces:

- Technology Deployment:
  Facilities growth.
  New technology implementation.

- Markets:
  Adjustments to subscriber line charge revenues.
  Number of subscribers.
  Customer mix.
  Minutes of use (MOU).
  Adjust service revenues (ARMIS Report 4302).

- Costing:
  Uniform System of Accounts Revised — USOAR (Part 32).
  Removal of non-regulated costs from rate base (Part 64).
  Interstate Jurisdictional Separations (Part 36) — state and interstate totals.
  Interstate access (Part 69).
  Support mechanism identification.
  Averaging/deaveraging.

Figure 3
Layout of Base Case Model



- Depreciation:
  Based on technology deployment model and associated assumptions.
  Follows history where appropriate.

If no changes are made, the base case uses default assumptions.

The assumptions for external forces feed into the next section — the Technology Growth Model. This section of the modeling process recognizes that technology is changing. This section looks beyond existing technology and will have the flexibility to incorporate the deployment of new technologies. It also includes the ability to alter the rate of technology deployment, the cost of components associated with deployment, and the underlying architecture.

The output from the Technology Growth Model is then linked with outputs from internal forces assumptions (Separations and depreciation). This link is indicated as another range on the spreadsheet. If no changes are made for technology deployment, the base case model operates solely as a Costing Model.

The Costing Model contains four sections which follow traditional telecommunications industry regulated cost structure:[2]

- USOAR (Part 32)
- Removal of non-regulated costs from rate base (Part 64)
- Jurisdictional Separations conformed to USOAR (Part 36)
- Interstate access (Part 69)

Each of these four sections is a major component of the current regulated industry. The framework of the Costing Model mirrors the successive steps from the individual accounts (USOAR) to interstate access definitions.

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[2]For details on the regulated cost structure, see *Interim Report: Examples of Modeling — Transport and Competitive Access Provision Issues*, Figure 1.

There are individual outputs for each of these four sections. For example, an individual can model alternatives to just the accounting structure (USOAR), ignoring the rest of the regulated cost structure. Similarly, alternatives may apply to the other three outputs of the Costing Model.

Figure 4 is a draft list of alternatives under consideration for modeling by participants in the project.

Figure 4
Draft List of Alternatives

Interim alternatives (each limited to one participant):

1. Base Case Carried into the Future
2. Simplification of the Current System

Changes in Network Configuration and Measurement:

3. New measure of use for high-speed packet network and other intelligent network services:
   a. Packet
   b. Loop
   c. Jurisdiction
4. Parallel networks or pricing of network based on communications nodes: customers choose among multiple providers.
5. Multiple networks: a single provider with multiple networks.
6. Fiber technology replacement:
   a. Entire network.
   b. Local loop.

Changes in Service and Pricing Structures:

7. Redefine basic service:
   a. Narrowband v. broadband
   b. Basic/Enhanced
8. Pricing by market

Broad changes in policy (in oversight mechanisms for jurisdictional splits, intercompany payments, and monopoly constraints):

9. Change existing cost/price structure:
   a. Replace or eliminate:
      1. Cost separations
      2. Access charges
   b. Place all local exchange carrier plant under state regulation
   c. Eliminate interLATA and intraLATA distinctions
10. Lift MFJ restrictions
    a. Information services
    b. Manufacturing
    c. Eliminate interLATA and intraLATA distinctions*

*Entry listed twice since it falls under two alternatives: Changing Existing Structure and Lift MFJ Provision,

II. Network Configuration

Network Configuration: Key Assumptions

The following text provides a brief description of the key technology components assumed for technology deployment, as illustrated in the second box of **Figure 3**. The objective of this portion of the model is to take complex network deployment issues (involving both growth and rehabilitation), simplify them, and produce useable results. The model is a flexible tool for analyzing deployment patterns.

In the model, the assumptions allow for network evolution from earlier (but currently deployed) technologies to new ones:

- Analog to digital.
- Narrow-band to broad-band, greater than 1.544 megabits per second (mbps).
- Asychronous to synchronous.
- Unintelligent to intelligent.
- Circuit-switched and packet-switch to cell-based (combines a dual-fabric switching mode into a single mode).

For the future network configuration, the modeling process assumes the following components:

- Passive Optical Networks (PONs).
- Synchronous Optical Network (SONET).
- Digital switches capable of Integrated Services Digital Network (ISDN) services for the near term.
- Cell-based switching adjuncts (Asynchronous Transfer Mode or ATM).
- Advanced Intelligent Network (IN).
- Integration of operational support systems.

The integrated deployment of these key components provides a variable bandwidth and broadband-capable infrastructure for large business customers. This network evolution intentionally includes the deployment of improved communications capabilities to the small business and residential customers.

Network Configuration: Passive Optical Network (PON)

Until the last decade, copper wire pair technology predominated for residential and small business customer links to the public switched network. **Figure 5** shows a simplified diagram of these customers linked to their local exchange carrier's (LEC) network, which in turn provides access to other service providers, such as interexchange carriers (IXCs), enhanced services providers (ESPs), or competitive access providers (CAPs). In **Figure 5**, each customer line is a pair of copper wires running from the customer's premises to the LEC central office switch. The loop bundles these lines together to provide economies of scale along the route. The drop is that portion of the transmission path where the copper wire pair is unbundled from other wire pairs in the loop and "drops" off to the customer's premises.

One of the new technologies for this link is fiber optics. Already, optical fibers are the preferred technology for interoffice trunks, institutional local area networks (LANs), and point-to-point links to large business subscribers. **Figure 6** shows the basic components of the fiber optic link — called passive optical networks, or PONs — for residential and business customers to the LEC central office.

Unlike copper wire technology which requires individual wires running the entire route from each customer to the central office, optical fibers may be split into multiple branches somewhere along the route. **Figure 6** indicates the PON termination in the central office. A splitter allows numerous customers to share a single feeder fiber. **Figure 6** shows fibers linked to three representative optical network units (ONUs). In this figure, the optical network transforms the incoming optical signal (i.e., light pulses) into an electrical signal recognized by the customer's inside wiring. In other words, the splitter broadcasts a single multiplexed signal among a number of ONUs.

Figure 5
Local Exchange Carrier Loop and Central Office Plant

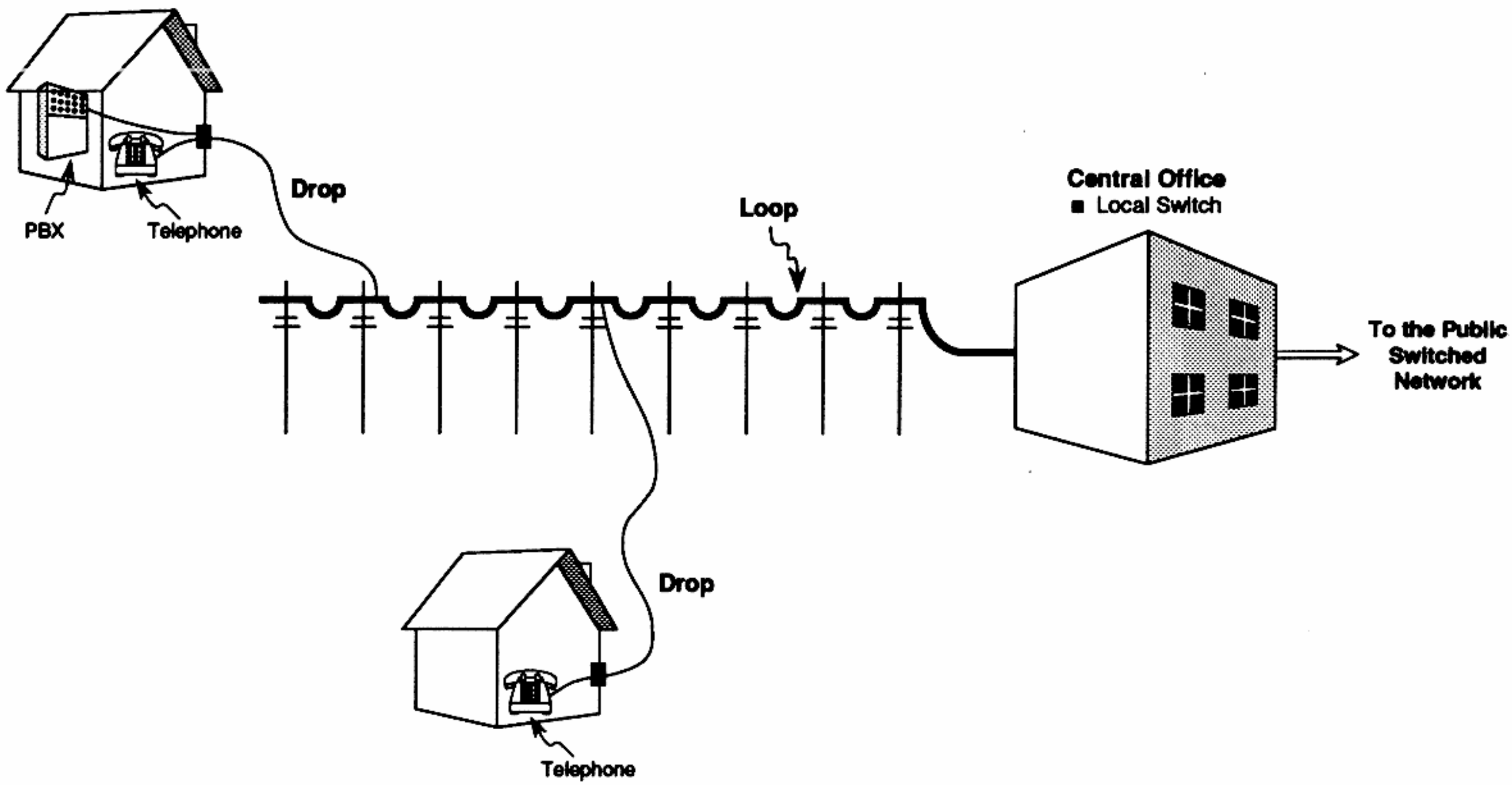

Figure 6
Passive Optical Network (PON)

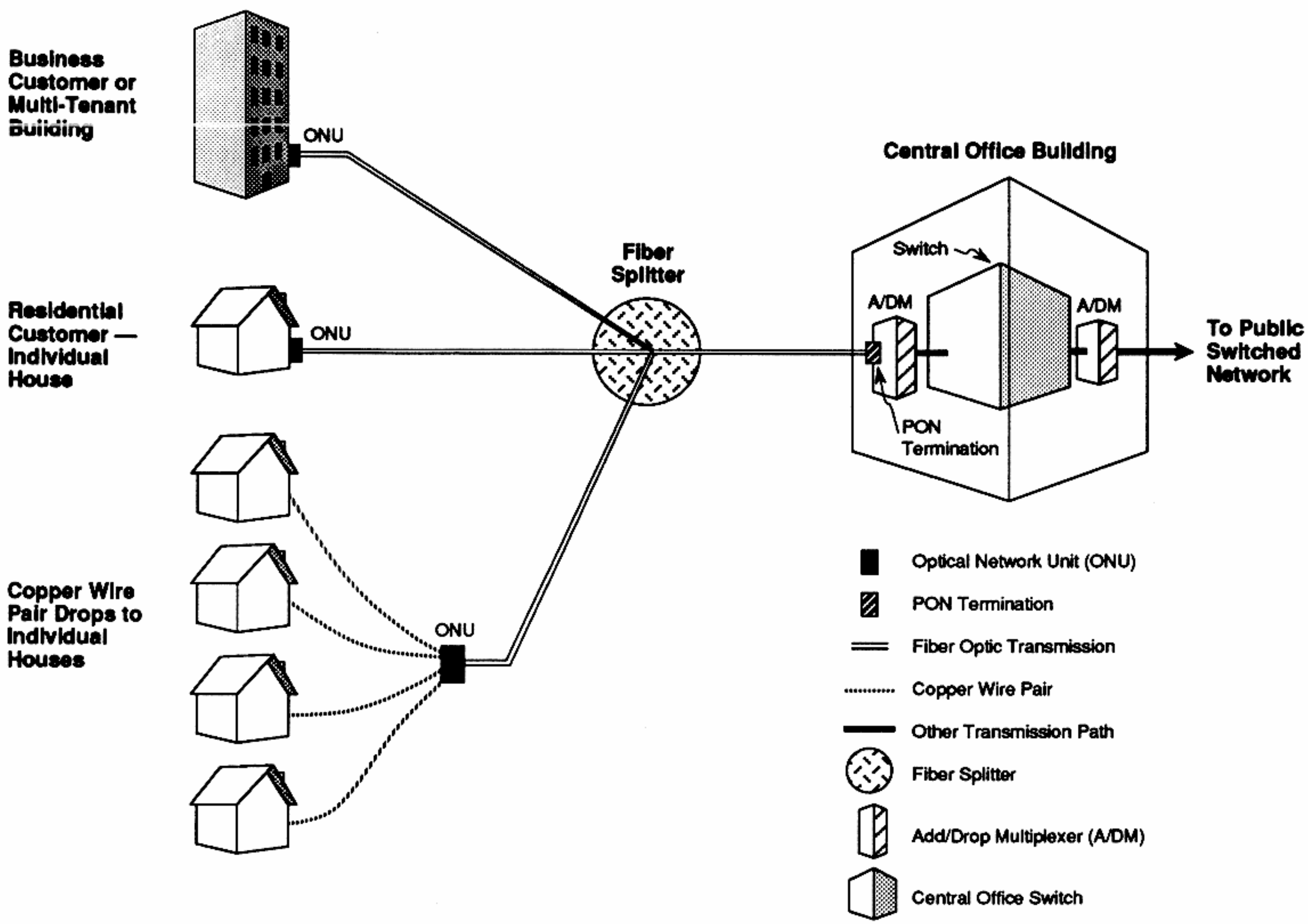

Figure 6 indicates three representative types of customer ONUs:

- **Business customer or multi-tenant building:** The ONU may be in the basement with copper wire serving as the inside wire technology or individual tenants may have their own fiber optic links.
- **Residential Customer – Individual House:** The ONU is typically on the outside of the house.
- **Copper Wire Pair Drops to Individual Houses:** A single ONU serves four sets of copper wire pairs. Upgrading this copper wire drop to fiber technology requires the addition of a smaller splitter at the ONU and a second ONU on the customer's premises.

As the requirements for greater bandwidth services exceed those for current narrow-band services, optical amplifiers could be added to provide additional bandwidth. This means that the network can grow smoothly as customer needs dictate.

Network Configuration: Synchronous Optical Network (SONET)

SONET is an international standard interface which performs the following functions:

- Allows interconnection of equipment produced by multiple manufacturers.
- Provides increasingly faster transmission rates based on a basic SONET bit-rate (51.84 mbps). Provides transmission rates greater than 45 mbps, the DS3 basic rate.
- Provides space for additional bandwidth within communications paths. This additional bandwidth may provide faster maintenance and may reduce the number of equipment conversions between electrical and optical signals.

Also with SONET technology, the customer may be able to dynamically configure his allocated bandwidth into different services (i.e., Private Line, MTS, WATS, packet, or new services).

Figure 7 shows the components called the frame structure of the SONET signal. There are two major divisions:

- **Overhead:** Provides routing, maintenance, and other information processing associated with sending the attached payload through the optical transmission network.

- **Payload:** Contains digitized information. Payloads may vary by type of signaling technology and by type of service. For example, the payload in **Figure 7** consists entirely of asynchronous transfer mode (ATM) cells.

The overhead section of the SONET frame structure is subdivided into layers. As a SONET frame structure moves through a node, these layers allow access to only the required portions of the overhead and payload. This creates the ability to find any signal of any technology within a payload without demultiplexing the entire SONET signal.

Network Configuration: Integrated Services Digital Network (ISDN) and Asynchronous Transfer Mode (ATM)

ISDN both merges and standardizes customer access to two different communications networks — analog and digital packet.[3]

ATM, or cell-based technology, enables the merging (or integration) of all possible service characteristics within any given network node. This technology separates customer information and system operations data from the switching fabric. ATM switches can flexibly support a wide variety of services with different information transfer rates.

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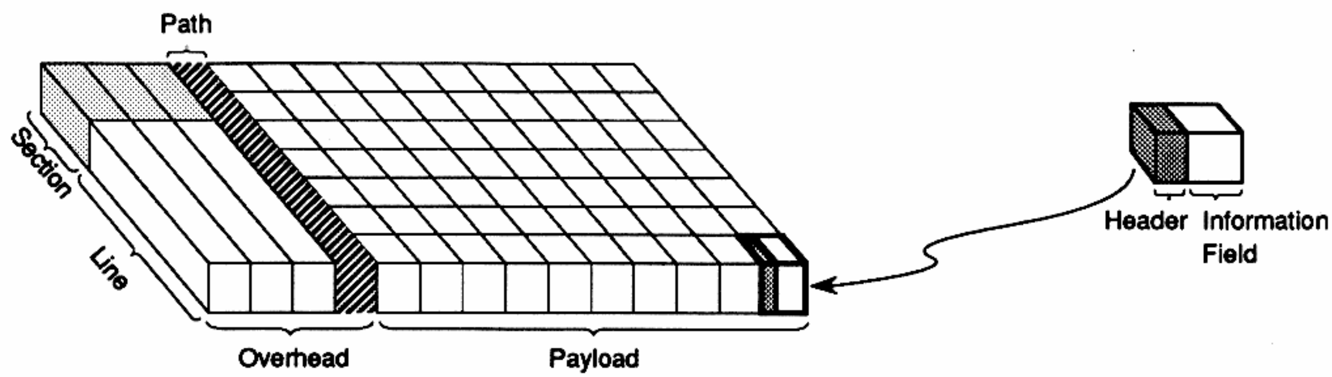
[3]The older technology is analog, circuit-switched, voice-grade, or the traditional basic voice service. The relatively newer technology is digital, packet-switched protocol X.25 services.

Figure 7
SONET Frame and ATM Cell Structures



Components of Synchronous Optical Network Frame Structure:		**Components of Asynchronous Transfer Mode (ATM) cell:**	
Overhead:	**Payload:**	**Header:**	**Information Field:**
• Maintenance • Channel identification — identifies contents of payload • Routing — based on contents of ATM headers inside the payload • Allows user control of ATM cells in the payload • Other information processing	Type varies by signaling technology and by service • ATM cells (shown above) • Asynchronous DS1 • Asynchronous DS3 • DS1 circuits • DS2 circuits • 2.048 mbps signals • etc.	Routes ATM cell through nodes (switches, multiplexers) in the SONET network.	Digitally encoded data.

Figure 8
Intelligent Network (IN) Configuration: with SONET and PONs

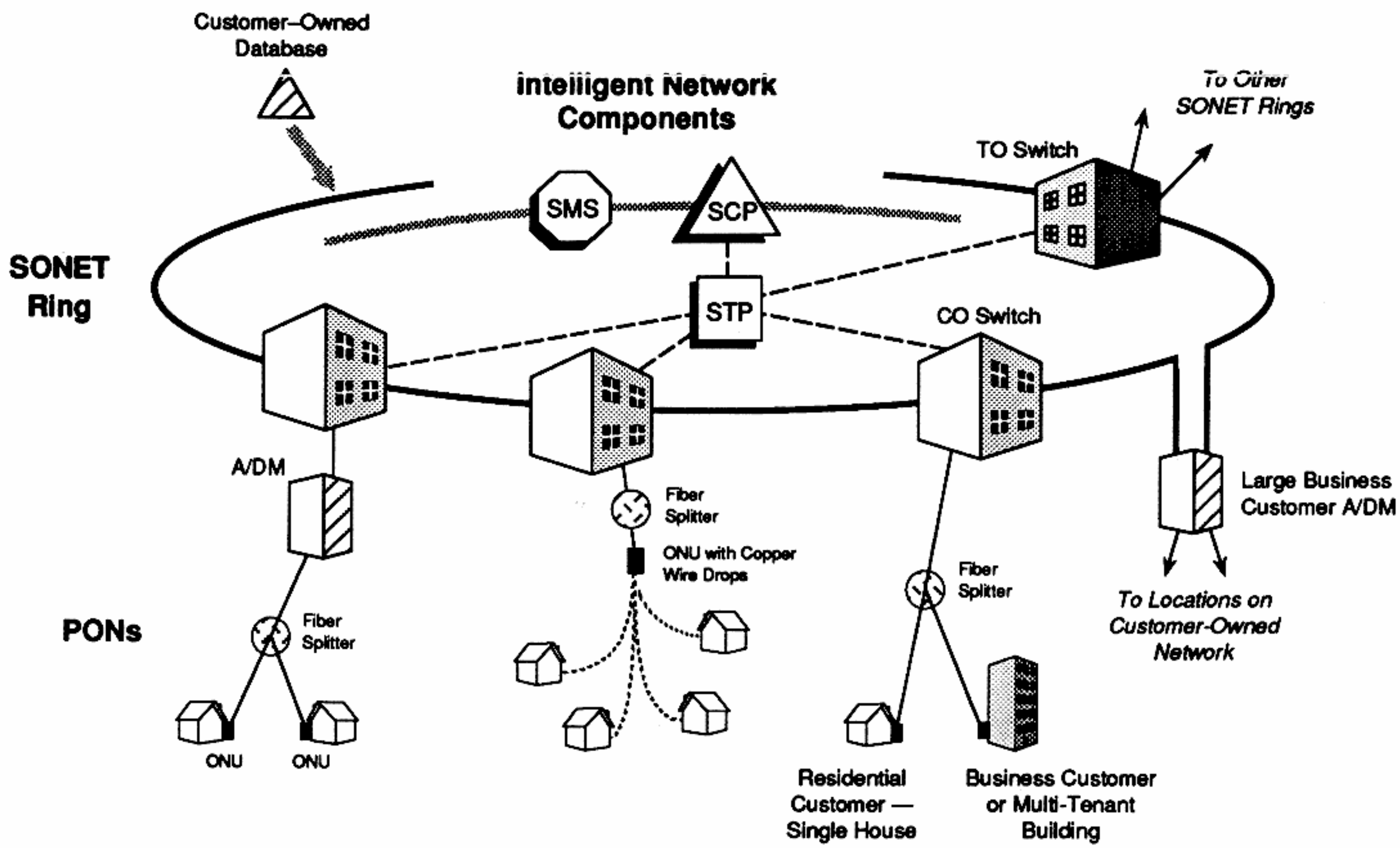


Figure 8 Legend

Intelligent Network Components:

- SCP — Service Control Point: Database with information on customers and their service requirements.
- SMS — Service Management System: Database for system operations and support.
- Links between IN databases.
- Customer-Owned Database

SONET and PONs Components:

- Central Office (CO) Switch
- Tandem Office (TO) Switch
- STP — Signal Transfer Point: A fast packet switch. Routes information between Central Office and SCPs.
- Add/Drop Multiplexer (A/DM)
- Fiber Splitter
- Optical Network Unit (ONU)
- Synchronous Optical Network (SONET) Transmission Links
- Signaling System 7 (SS7) Transmission Links
- Passive Optical Network (PON) Transmission Links
- Copper Wire Transmission Links

Network Configuration: Intelligent Network (IN)

The term "Intelligent Network" denotes the use of database technology to provide flexible network communications configurations — routing, terminating, and intermediate call processing functions — that can be used for enhanced customer communications.

The initial application for Intelligent Network is the creation of enhanced network service capabilities. This allows multiple vendors to develop network services in less time and at less cost than can be accomplished today. The major themes of Intelligent Network are:

- Distributed databases for customer data.
- Network element location and interconnection.
- Operational support systems.

Figure 8 shows the topology of an Intelligent Network with integrated access and transport based on SONET.