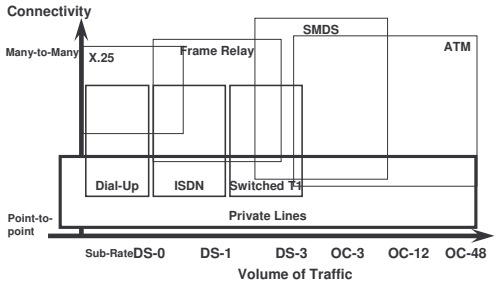
Private Subscriber Lines

Agenda

- Anatomy of a Private Line
- The Bandwidth Hierarchy
- The Digital Cross Connect (DCS/DACS)
- Customer Applications
- Service Options
- Configuration Options
- Pricing

Areas of Competitive Strength

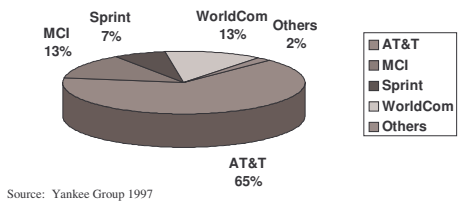


Private Line Overview

- IXC's have a family of several dedicated, point-to-point, digital communications services which operate at speeds between 2.4 Kbps (DS-0 Subrate) and 622 Mbps (OC-12).
- Customers use these Private Line Services to carry intracompany communications traffic between Local Access and Transport Areas (LATAs).
- The traffic may contain data, voice, or video communications.

Competitive Comparison

- The industry grew only 10% in 1997,

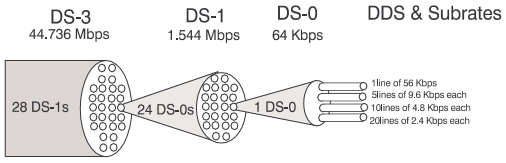


Source: Yankee Group 1997

Family of Private Line Services

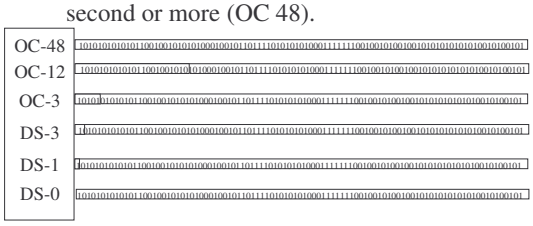
- DS-0 (ISDN Basic Rate Interface)
- FT-1 (Fractional T-1)
- DS-1 (Full T-1)
- FT-3 (Fractional T-3)
- DS-3 (Full T-3)
- OC-3 and OC-12 (as of early 2000's)
- OC-48 and OC-192 (as of mid 2000's)

DS Hierarchy



Bandwidth Hierarchy

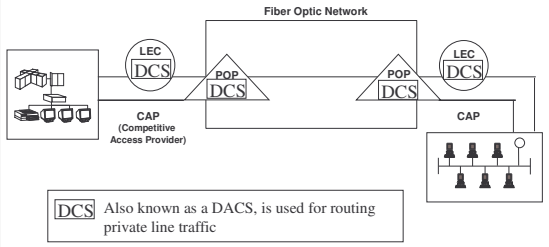
- Much of a IXC backbone network can transmit as many as 2.4 billion bits per second or more (OC 48).



Private Line Overview

- Private Line Services operate on a nationwide fiber optic network using Digital Cross-connect Systems (DCS).
- The services are provided from Points of Presence (POPs), with Local Service Agreements, in the 181 LATAs.

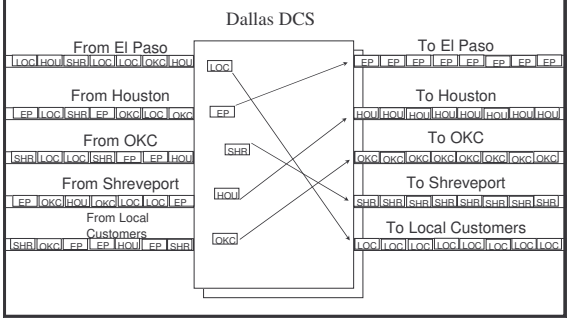
Circuit Illustration



The DCS/DACS

- Synchronized streams of bits enter the Digital Cross Connect System (DCS) from various sources.
- Customer traffic is assigned “time slots” in this stream of bits
- The DCS takes bits from an input source and places them on the appropriate output.

The DCS/DACS



Typical Customer Profile

- Majority use the services to move data
- Frequently send large volume of data or voice traffic between a small number of distant locations
- Need a line always available for immediate use - no set up time
- Need a highly reliable line that is not prone to transmission errors
- Desire a fixed charge for services, as opposed to a bill that varies by usage

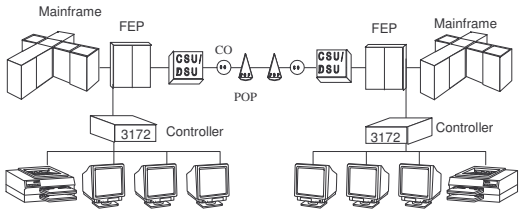
Private Line Network CPE

- DSU/CSU
- Channel Bank
- Multiplexer
- Front End Processor (FEP)
- Controllers
- Bridges/Routers
- Modem
- Video CODEC
- PBX
- Key System

Customer Applications

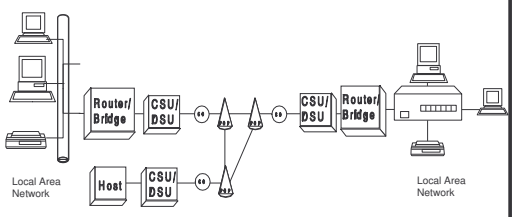
- Peer-to-Peer Mainframe Connectivity
- LAN-to-LAN and LAN-to-Host Connectivity
- High-Speed Tie Lines
- Videoconferencing
- Imaging

Peer-to-Peer Mainframe Connectivity

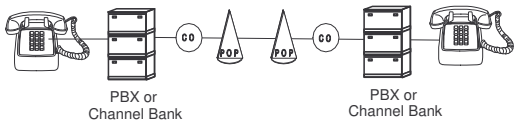


FEP: Front End Processor
CO: Central Office

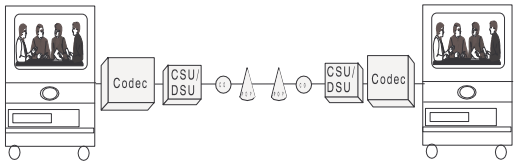
LAN-to-LAN / LAN-to-Host Connectivity



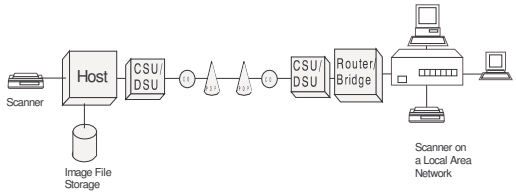
High-Speed Tie Lines



Videoconferencing



Imaging



Performance Characteristics

- Availability
  - Availability measures network up-time.
  - It is a percentage representing the total amount of time within the last year that the service was operative.
  - An example: An IXC's DS-1 Private Line service is operative 99.98% for a 250 mile circuit.
    - Down for approximately 3 hours in an entire year!

Performance Characteristics

- Error-Free Seconds
  - Error-free seconds measures the quality of the signal being transmitted.
  - It is a percentage representing the total amount of time over a 24-hour period that the signal contained bit errors and it is calculated using a test pattern defined in CCITT Recommendation 0.151.
  - An example: An IXC DS-1 Private Line service averages 99.99% of error free seconds per day on a 1000 mile circuit.
    - This represents 1/10 of a second per day.

Service Options

- Diverse Routing
- Signal Formatting
- Line Coding
- Echo Cancellation

Diverse Routing

IXC Route Avoidance & Special Routing

- IXC route avoidance occurs when a circuit is provisioned to avoid a particular route or route-segment.
- Special routing encompasses any request the customer may have for a specific route or to avoid one. The customer pays normal rates for both the IXC and local loop.

Signal Formatting Options

- D4 Format
  - Data transmission format comprised of 12 frames of 192 bits each. A single 193rd bit is used for link control and error checking.
  - As an industry standard, D4, also known as Super Frame (SF), has been superseded by the Extended Super Frame (ESF) format.
  - However, because ESF is not backward compatible, and there is still a large installed base of channel banks and T-1 multiplexers that are based on D4, it is still the default private line formatting technique.

Signal Formatting Options

- Extended Super Frame (ESF)
  - Extended Super Frame is an enhanced version of D4 formatting, and it is the current industry standard. ESF is composed of 24 frames of 192 bits each. ESF provides 16 signaling states in the 193rd bit to ensure synchronization, supervisory control, and maintenance capabilities.

Line Coding Options

- Alternate Mark Inversion (AMI)
  - Normal line coding scheme for private line service. It is a method of line coding that alternates successive pulses (1s) between positive & negative polarities creating a maximum throughput of 56 Kbps on a DS-0.

Line Coding Options

- B8ZS (Bipolar 8 Zero Substitution) - Clear Channel
  - Allows the DS 1 user to obtain greater throughput and functionality from their DS-1 facilities.
  - The use of B8ZS allows users to transmit data at a rate of 64 Kbps per DS-0, achieving what is referred to as a clear channel.
  - Applied against all 24 DS-0s on a DS-1, the effective data throughput of the DS 1 facility is increased with B8ZS from 1.344 Mbps to DS-136 Mbps, a 14% increase in throughput.
  - CSUs with B8ZS support are required on both ends of the DS-1 or Fractional DS-1 circuit.

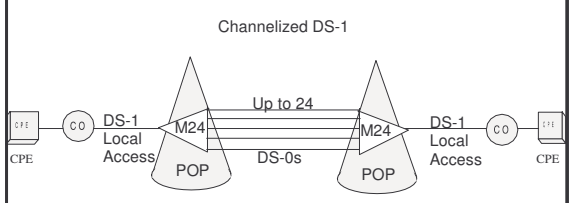
Echo Cancellation Option

- Noticeable echo can occur in voice circuits if the round trip delay of a signal exceeds 45 msec.
- Echo cancellation is a technique used with voice circuits to isolate and filter unwanted signal energy which accompanies analog transmissions.
- Extra charges can apply.

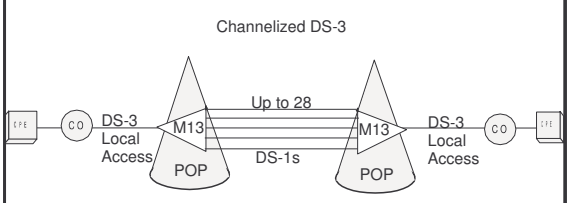
Configuration Options

- Point-to-Point
- Fan-In from Multiple Locations
- Fan-Out to Multiple Locations
- Integrated Local Access with DS-1 IXC
- Drop and Insert

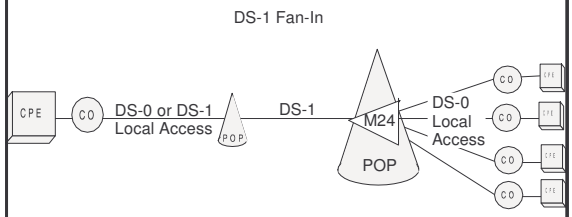
Point-to-Point Configuration



Point-to-Point Configuration

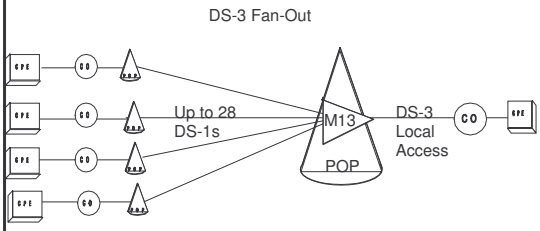


Fan-In from Multiple Locations



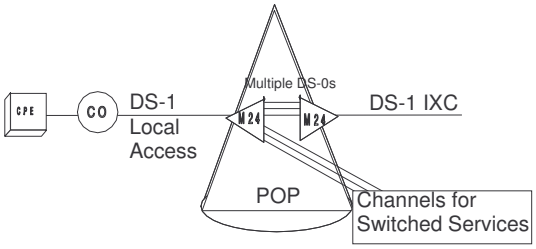
private lines can also be configured in a DS-3 Fan-In

Fan-Out from Multiple Locations

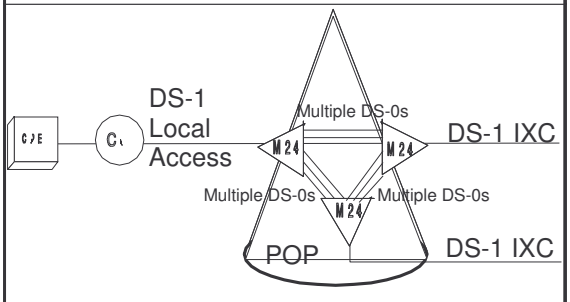


private lines can also be configured in a DS-1 Fan-Out

Integrated Local Access with DS-1



Drop and Insert

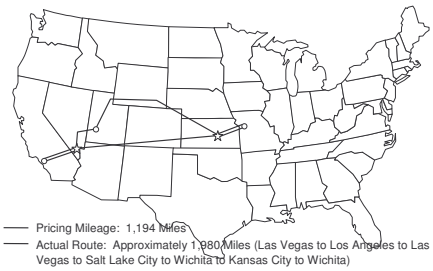


Private Line Pricing

- pricing has three basic parts:
  - IXC charges, which have monthly recurring and non-recurring rates
  - LEC charges, which have monthly recurring and non-recurring rates
  - Ancillary charges
- Both the IXC and LEC have mileage-based pricing components.
- Pricing is normally based on miles between the V & H (vertical and horizontal) coordinates of the two circuit end points.

Pricing Example

DS-0 From Las Vegas to Wichita



Pricing Mileage: 1,194 Miles

Actual Route: Approximately 1,980 Miles (Las Vegas to Los Angeles to Las Vegas to Salt Lake City to Wichita to Kansas City to Wichita)

Private Line Services:

DS-0

- Digital Data Service
- Point-to-point, digital communications service which operates at speeds between 2.4 and 64 Kbps (DS-0 level).
- The most common use for a DS-0 is to connect computers at a remote office to a host computer at a central location for frequent interactive transmissions.

DS-0 Overview

- DS-0 can operate on copper wire or fiber optic network using 1/0 Digital Cross-connect Systems (DCS) and Time Division Multiplexing (TDM) equipment.
- It supports synchronous transmission of full duplex digital data at speeds of 2.4, 4.8, 9.6, 56 and 64 Kbps.

DS-0 Pricing:

IXC Monthly Recurring Charges (MRC)

Miles	Fixed Cost	Cost Per Mile
1 +	$378.00	$.30

Note:
Example only and Normally Volume & Term discounts are available

FT-1

- Point-to-point, digital communications service operating at speeds from 128 Kbps to 1.472 Mbps.
- Provides a synchronous, full-duplex transmission service in multiples of DS-0s in either a channelized form (i.e., discrete 64 Kbps channels) or a contiguous bandwidth form (e.g., 128 Kbps, 192 Kbps, 256 Kbps, etc.) up to a DS-1.
- One of the most common uses for a FT-1 is to connect videoconferencing sites at 384 or 768 Kbps.

FT-1 Overview

- Channelized service uses AMI line coding.
- Contiguous bandwidth requires B8ZS line coding technique.
- Local access may be either analog or digital.

FT-1 Pricing

Mileage Bands	Fixed	Per Mile
1+	$378.00	$0.30

Multi-Channel Discounts

Channels	Discount	
2-3	7.5%	
4-7	15%	
8-10	20%	
11-13+	25%	
14+	30%	

Note:
Example only and Normally Volume & Term discounts are available

DS-1

- Private line, point-to-point, digital communications service which operates at 1.544 Mbps.
- Customers use DS-1 to carry intracompany communications traffic between LATAs.
- The most common use for DS-1 is as a network backbone, i.e. connecting major locations within a company's network which act as hubs, or concentration points for company sites within geographic areas.

DS-1 Overview

- It provides full-duplex, synchronous transmission which, at the customer's option, may be channelized into 24 separate DS-0s (56 Kbps) or provided as contiguous 1.544 Mbps of bandwidth.
- It provides full-duplex, synchronous transmission which, at the customer's option, may be channelized into 24 separate DS-0s (56 Kbps) or provided as contiguous 1.544 Mbps of bandwidth.

DS-1 Pricing

Mileage Bands	Fixed	Per Mile
1+	$3,816.00	$4.56

Note:
Example only and Normally Volume & Term discounts are available

FT-3

- Private line, point-to-point, digital communications service which operates at speeds between 1.544 Mbps and 44.736 Mbps.
- It provides a synchronous, full-duplex transmission service in multiples of DS-1s (e.g., 6.2, 7.7, 9.3 Mbps etc.) with a required minimum of four DS-1s.
- Customers typically have outgrown their existing DS-1 service, but they cannot yet justify the expense of DS-3 service. FT-3 fills this gap.

FT-3 Overview

- FT-3 is the maximum you can do on copper wires. It normally operates on a nation-wide fiber optic network utilizing 3/1 Digital Cross-connect Systems (DCS) which controls the number of channels provided to the customer.
- DS-3 local access is required; it may be either analog or digital.

FT-3 Pricing

Mileage Bands	Fixed	Per Mile
1+	$3,816.00	$4.56

Multi-Channel Discounts

Channels	Discount	
4-6	10%	
7-9	12.5%	
10-12	15%	
13+	17.5%	

Note:
Example only and Normally Volume & Term discounts are available

DS-3

- Private line, point-to-point, digital communications service which operates at 44.736 Mbps.
- DS-3 generally serves as a network backbone, i.e., connecting major locations within a company's network which act as hubs, or concentration points for company sites within geographic areas.

DS-3 Overview

- It provides full-duplex, isochronous transmission which, at the customer's option, may be channelized into 28 separate DS-1s (DS-144 Mbps) or provided as contiguous 44.736 Mbps of bandwidth.

DS-3 Pricing

Mileage Bands	Fixed	Per Mile
0-100	$27,000.00	$120.00
101-500	$31,000.00	$80.00
501+	$33,100.00	$83.00

Note:
Example only and Normally Volume & Term discounts are available

OC-3 & OC-12

- Private line, point-to-point, digital communications service which operates between 155 Mbps (OC-3) and 622 Mbps (OC-12).
- OC-3 / OC-12 generally serves as a network backbone, i.e., connecting major locations within a company's network which act as hubs, or concentration points for company sites within geographic areas.
- Based on Synchronous Optical Network (SONET) technology.

SONET

- Synchronous Optical Network
- A form of Fiber Optic Transmission Systems (FOTS).
- Designed for fiber optic systems & specifies the speeds at which equipment can mux signals from various sources onto high speed carrier services.
- Expected to eventually displace the DS protocols ("T-Carriers"), which were designed to carry electrical signals over copper.

SONET Transmission Rates

Optical	OC-192	OC-48	OC-12	OC-3	OC-1	-	-
Electrical	STS-192	STS-48	STS-12	STS-3	STS-1	VT	Virtual Tributaries
Mbps	9,952	2,488	622	155	51.84	6.176	1.544
DS-3	192	48	12	3	1	-	-
DS-1	5,376	1,344	336	84	28	4	1-4

SONET

- SONET networks employ a ring topology in which a working channel is supported by a protect channel.
- If failure occurs on the working channel, traffic will reroute to the protect channel within 50 milliseconds.
- Customers up to 2,500 miles from a POP will have 99.99% SONET availability, a 99.9% bit error-free rate and 3 hours mean time to restore.

OC-3 & OC-12 Applications

- Peer-to-Peer mainframe connectivity
- Public & Private ATM Networks
- Backbone Networks for Internet Service Providers (ISPs), IXCs, or LECs.
- High-speed tie lines
- High-speed trunking for feature group services
- Videoconferencing
- Imaging
- Distance Learning

OC-3 & OC-12 Pricing

- Normally, OC-3 service is roughly 3x the price of DS-3, and OC-12 service 12x price of DS-3.