

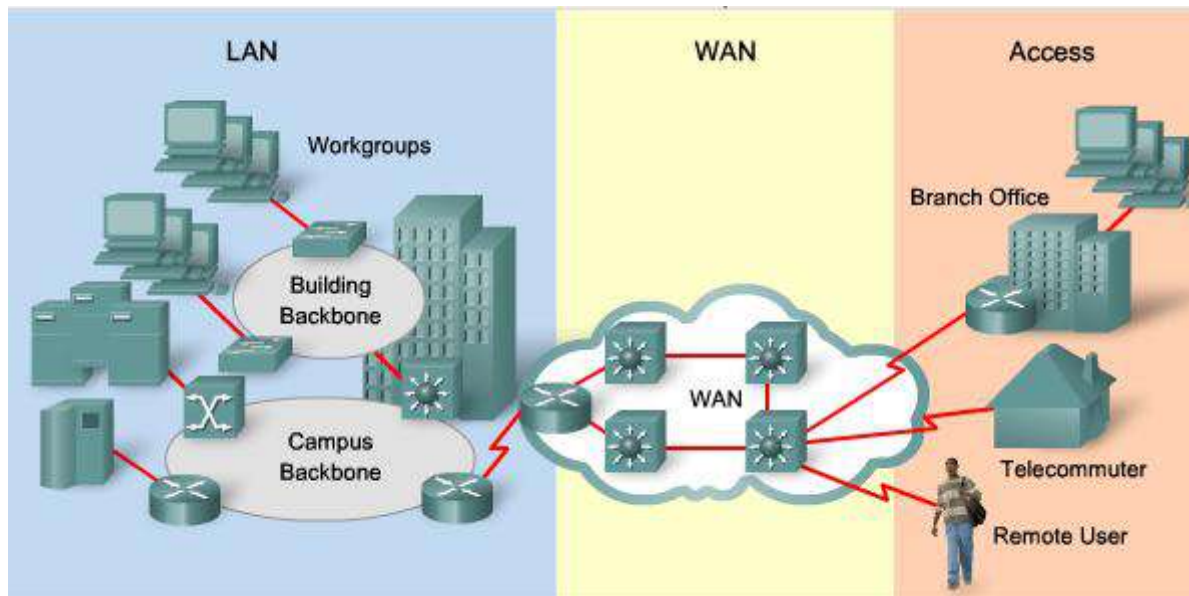
WAN AND ISDN

Mohammad S. Hasan

Wide Area Networks (WANs)

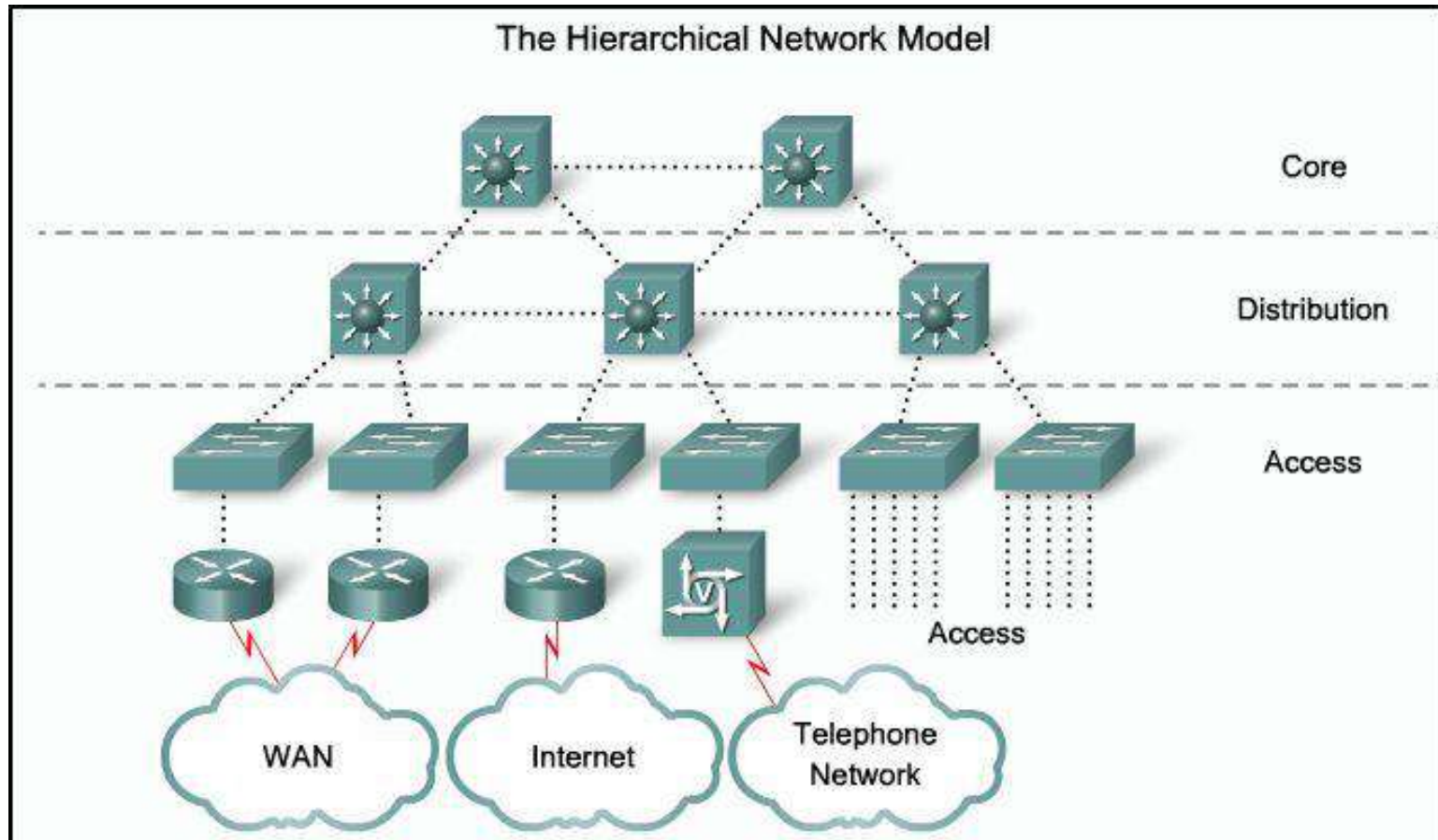
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- A data communications network that serves users across a broad geographic area and often uses transmission devices provided by common carriers



Hierarchical Network Model

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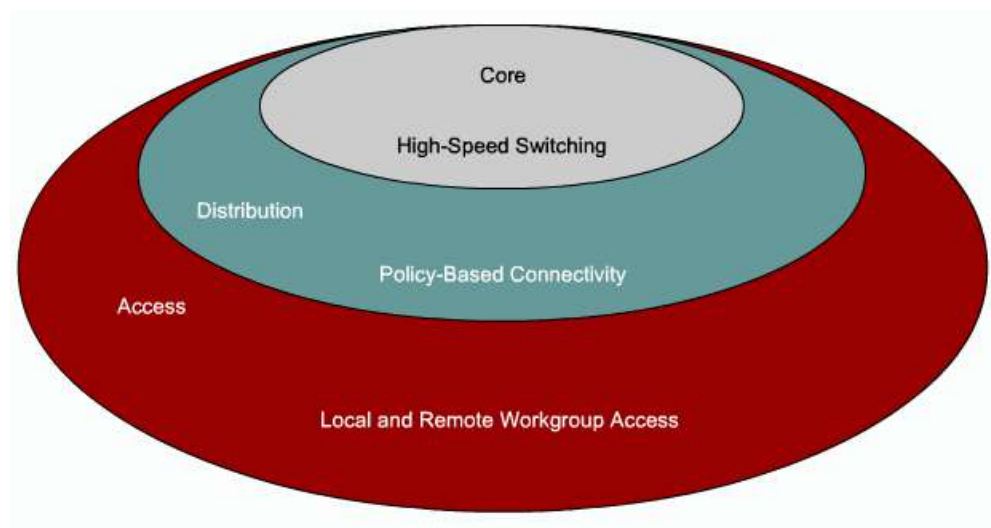


WAN and ISDN

Hierarchical Network Model – Access Layer

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- User access to network devices.
- In a network campus, the access layer generally incorporates switched LAN devices with ports that provide connectivity to workstations and servers

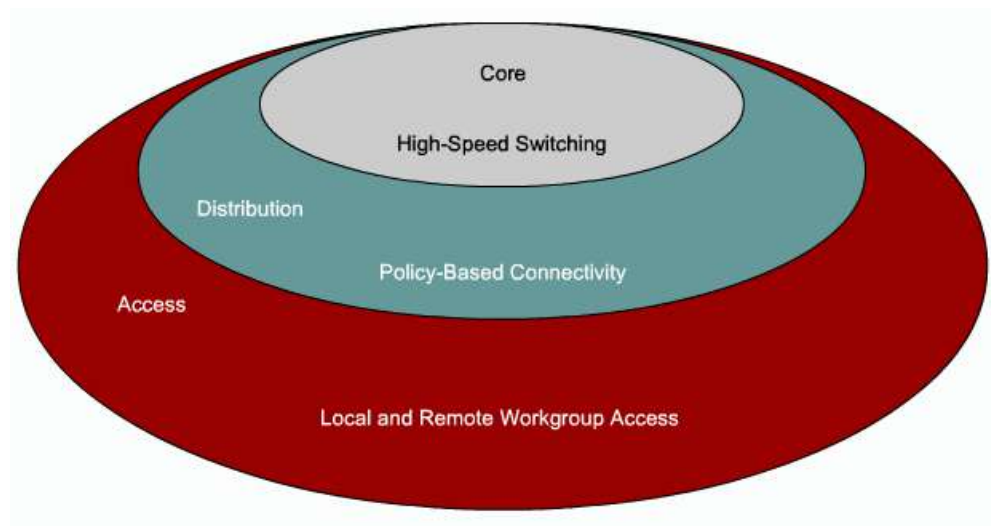


WAN and ISDN

Hierarchical Network Model – Distribution Layer

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- Aggregates the wiring closets, using switches to segment workgroups and isolate network problems in a campus environment.
- Provides policy-based connectivity.

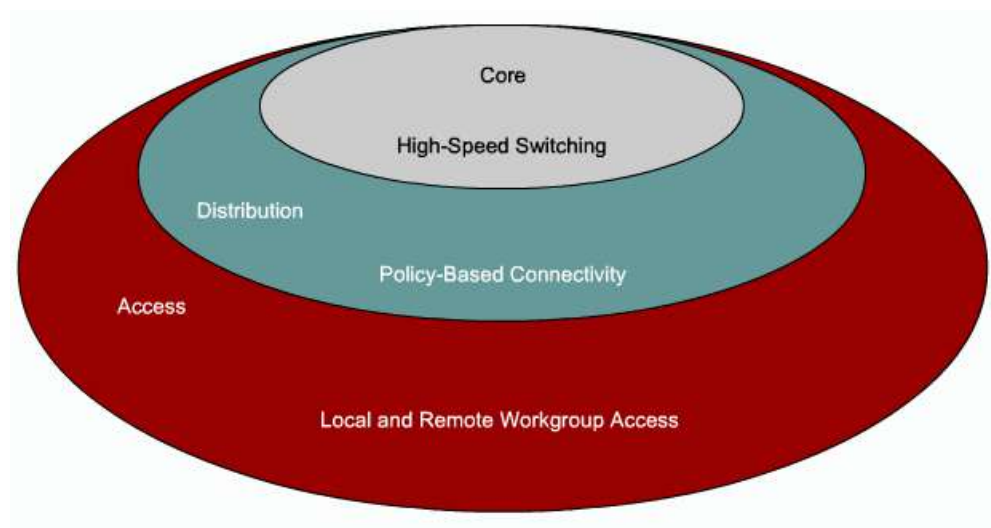


WAN and ISDN

Hierarchical Network Model – Core Layer

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- A high-speed backbone that is designed to switch packets as fast as possible.
- The core is critical for connectivity, it must provide a high level of availability and adapt to changes very quickly.



WAN and ISDN

Enterprise Composite Network Model

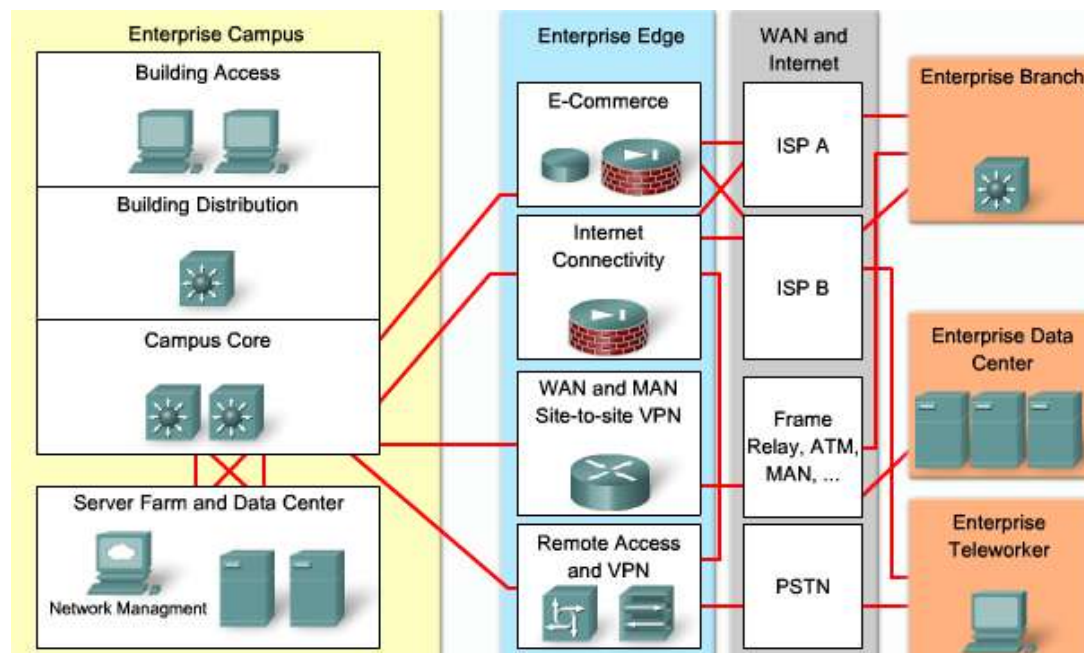
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- Unfortunately, often networks grow in a haphazard way as new components are added in response to immediate needs.
- Over time, those networks become complex and expensive to manage.
 - ▣ the network is a mixture of newer and older technologies, it can be difficult to support and maintain.
- So we modularise the design

Enterprise Composite Network Model

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- Each module has a distinct network infrastructure with services and network applications that extend across the modules.

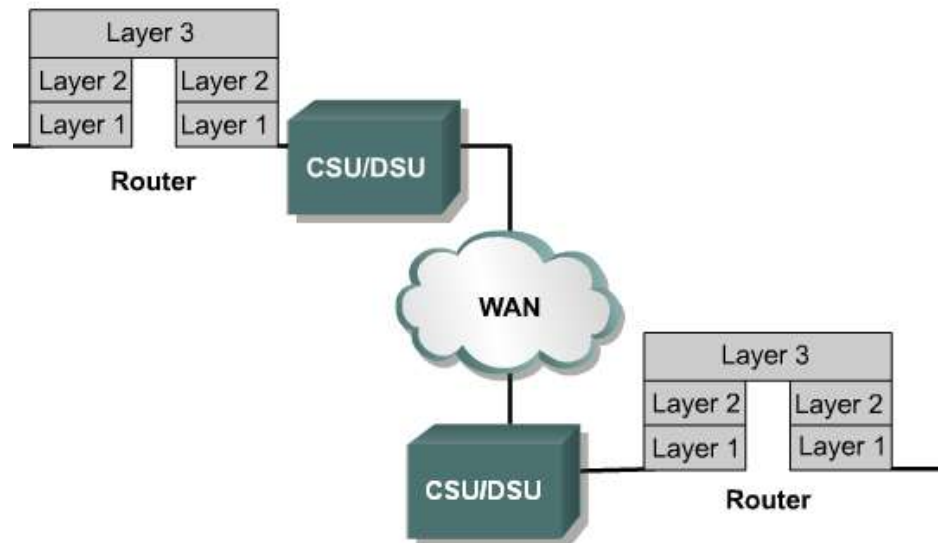


WAN and ISDN

WAN Layers

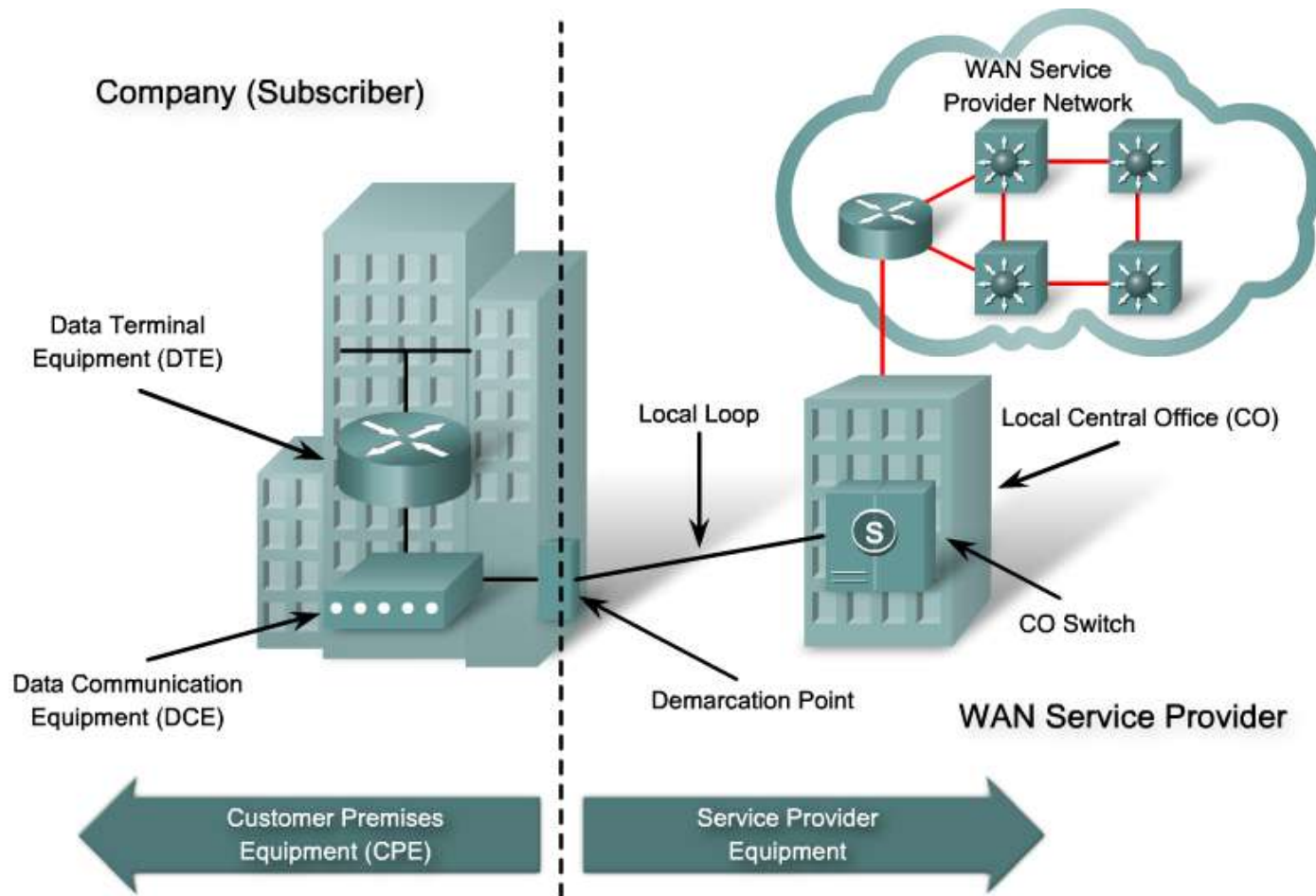
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- The WAN is a set of interconnections between LAN based routers, there are no services on the WAN.
- WAN technologies function at the lower two layers of the OSI reference model.
- CSU / DSU
 - ▣ Channel Service Unit
 - ▣ Data Service Unit



WAN Physical Layer Terminology

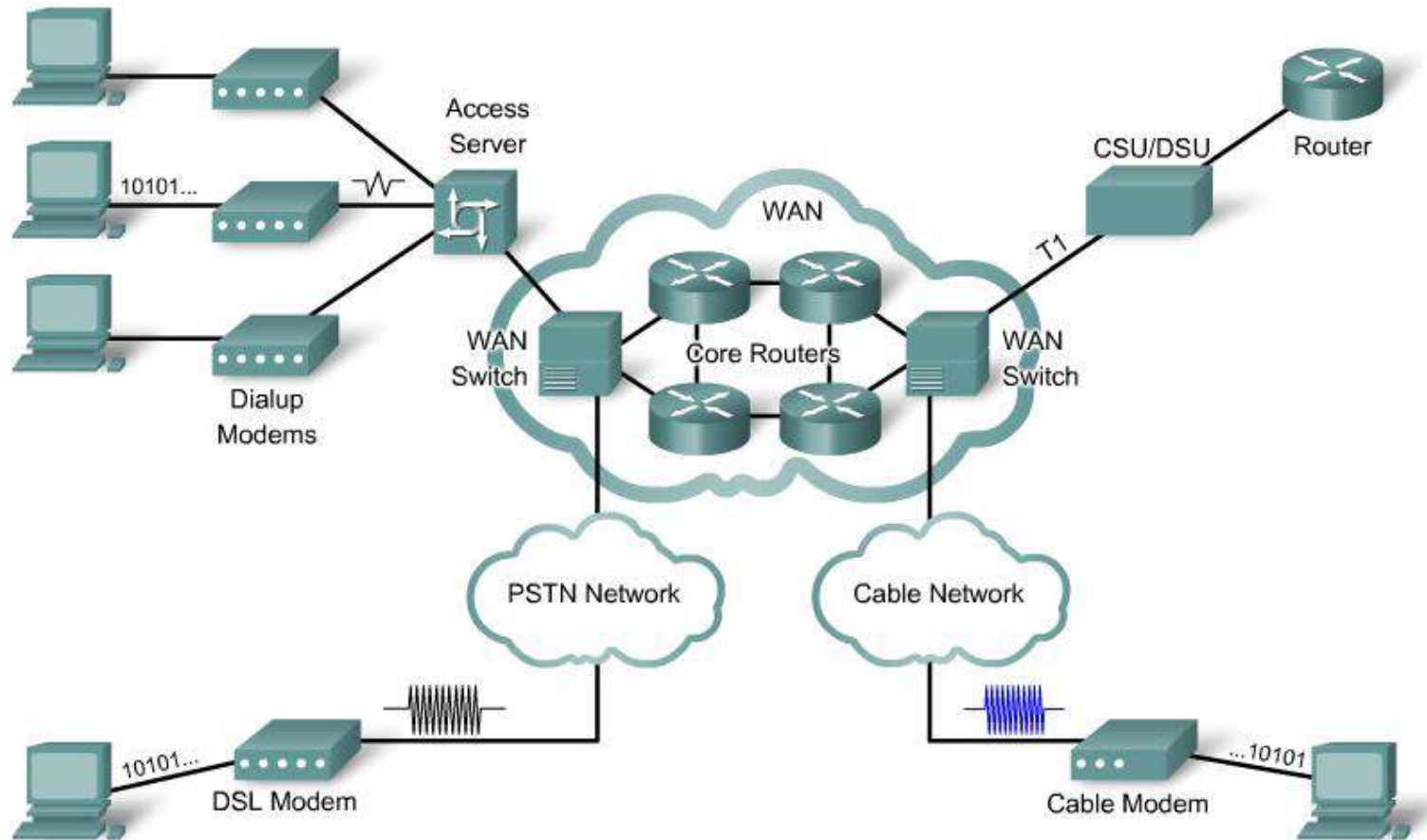
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WAN and ISDN

WAN Devices

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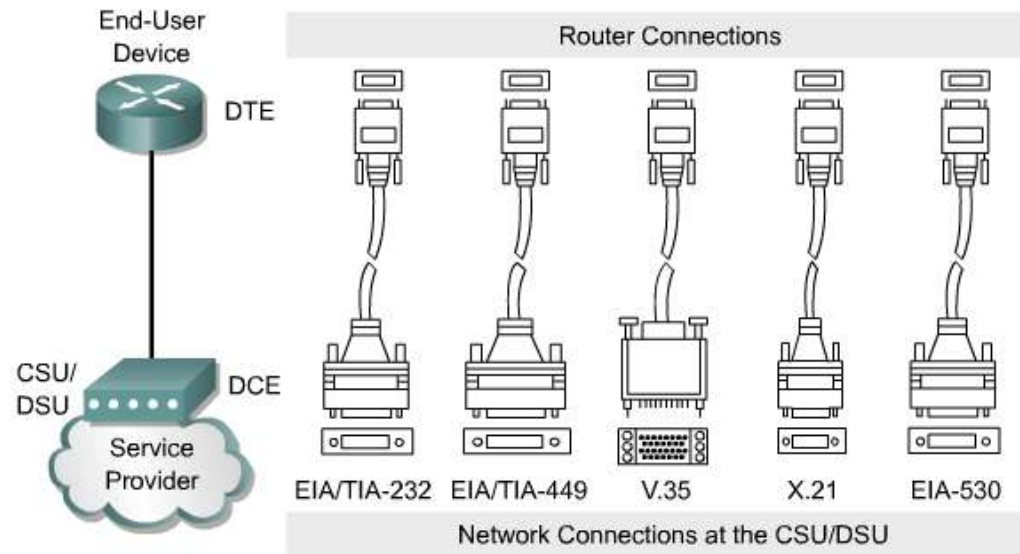


WAN and ISDN

WAN Physical Layer Interfaces

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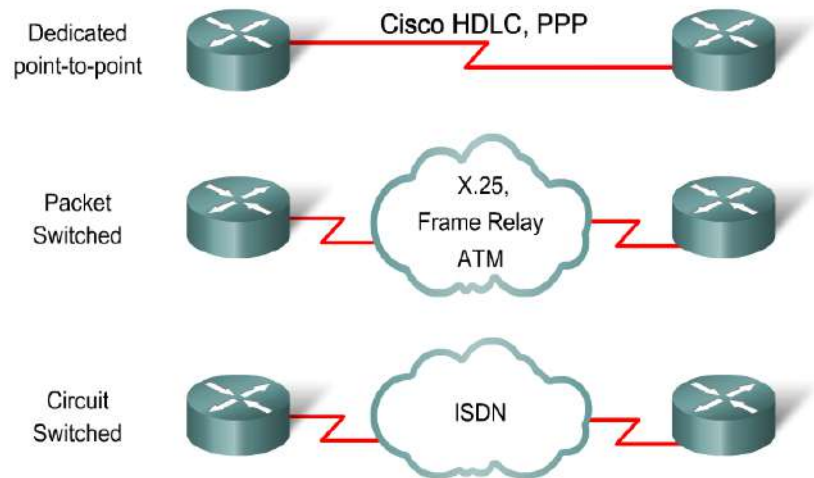
- WAN physical-layer protocols describe how to provide
 - ▣ electrical, mechanical, operational, and functional connections
 - ▣ the interface between the DTE and the DCE.



WAN Datalink Protocols

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- Data link layer protocols establish the link across the communication line from the sending to the receiving device.



Protocol	Usage
Link Access Procedure Balanced (LAPB)	X.25
Link Access Procedure D Channel (LAPD)	ISDN D channel
Link Access Procedure Frame (LAPF)	Frame Relay
High-Level Data Link Control (HDLC)	Cisco default
Point-to-Point Protocol (PPP)	Serial WAN switched connections

WAN Frame Encapsulation

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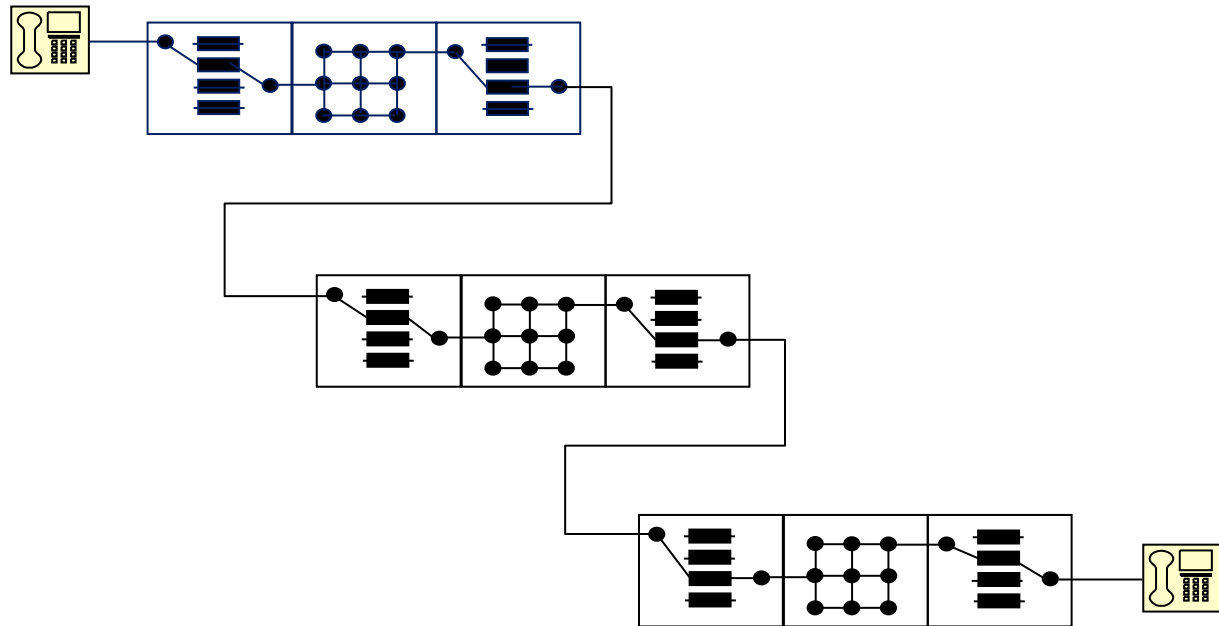
- Flag - identifies beginning and end of frame, also provides synchronisation
- Address – usually a broadcast address on a point-to-point link
- Control – used to provide flow & error control
- Information / Data – data field, length depends on network type (Frame Relay, X25, etc)
- FCS – 2 or 4 Byte, ITU-T CRC

Flag	Address	Control	Data	FCS	Flag
01111110					01111110

Circuit Switching

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- Circuit path doesn't change for the duration of the call, and is not shared with other users
- Continuous, Exclusive, Temporary



WAN and ISDN

Circuit Switched Networks

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- Sets up dedicated line similar to a phone call.
- Data connections initiated when needed.
- Terminated on completion of data transfer.
- What uses circuit switching?
 - ▣ ISDN uses circuit switching.
 - ▣ Dial up modems use circuit switching.

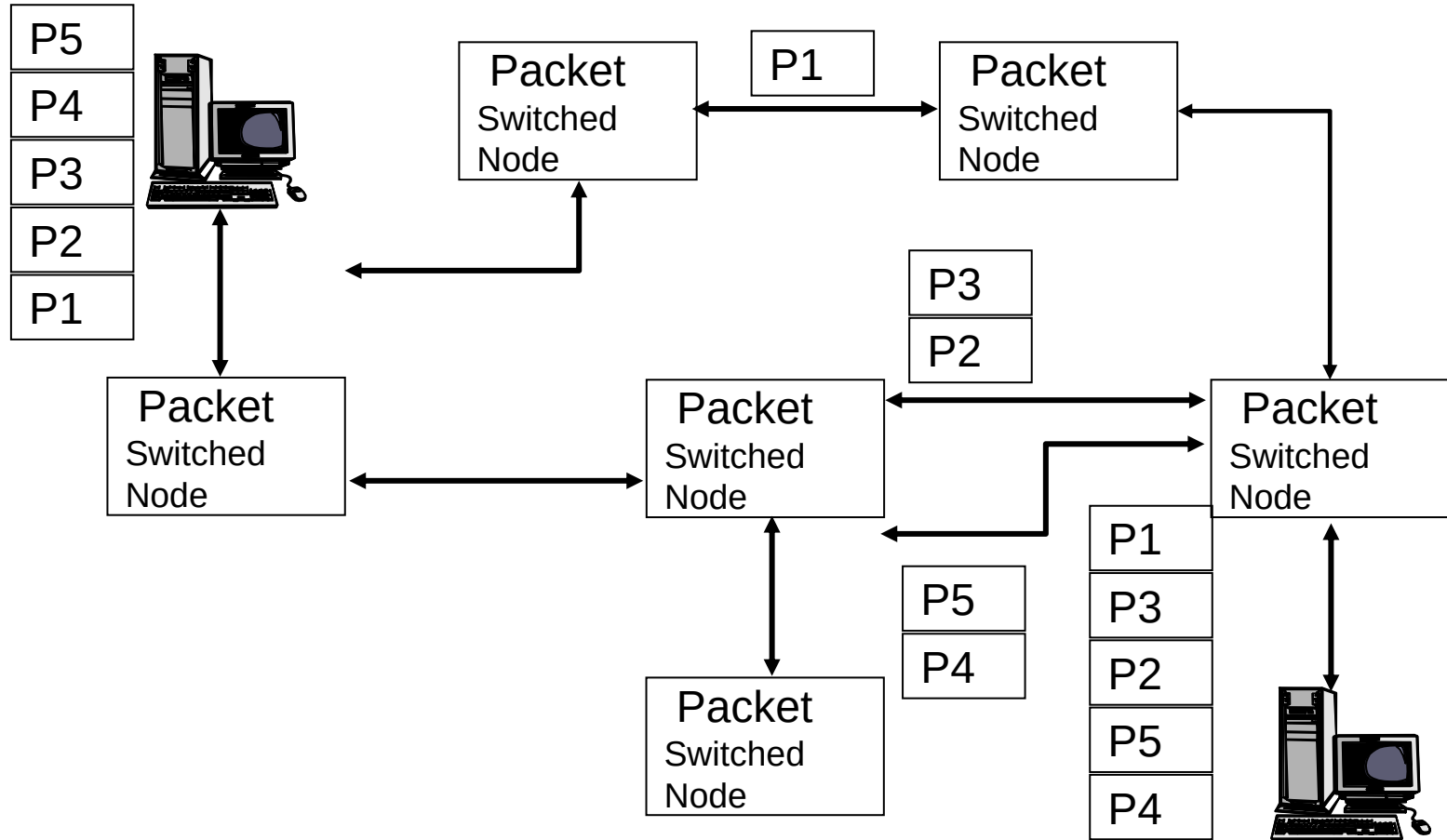
Packet Switching

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- Data transfer inherently ‘bursty’
 - ▣ internet traffic is a prime example
- Transmission of ‘bursty’ data over circuit-switched system wasteful of bandwidth.
- Packet switching specifically developed for transfer of digital data, to improve bandwidth efficiencies.

Packet Switching - Connectionless

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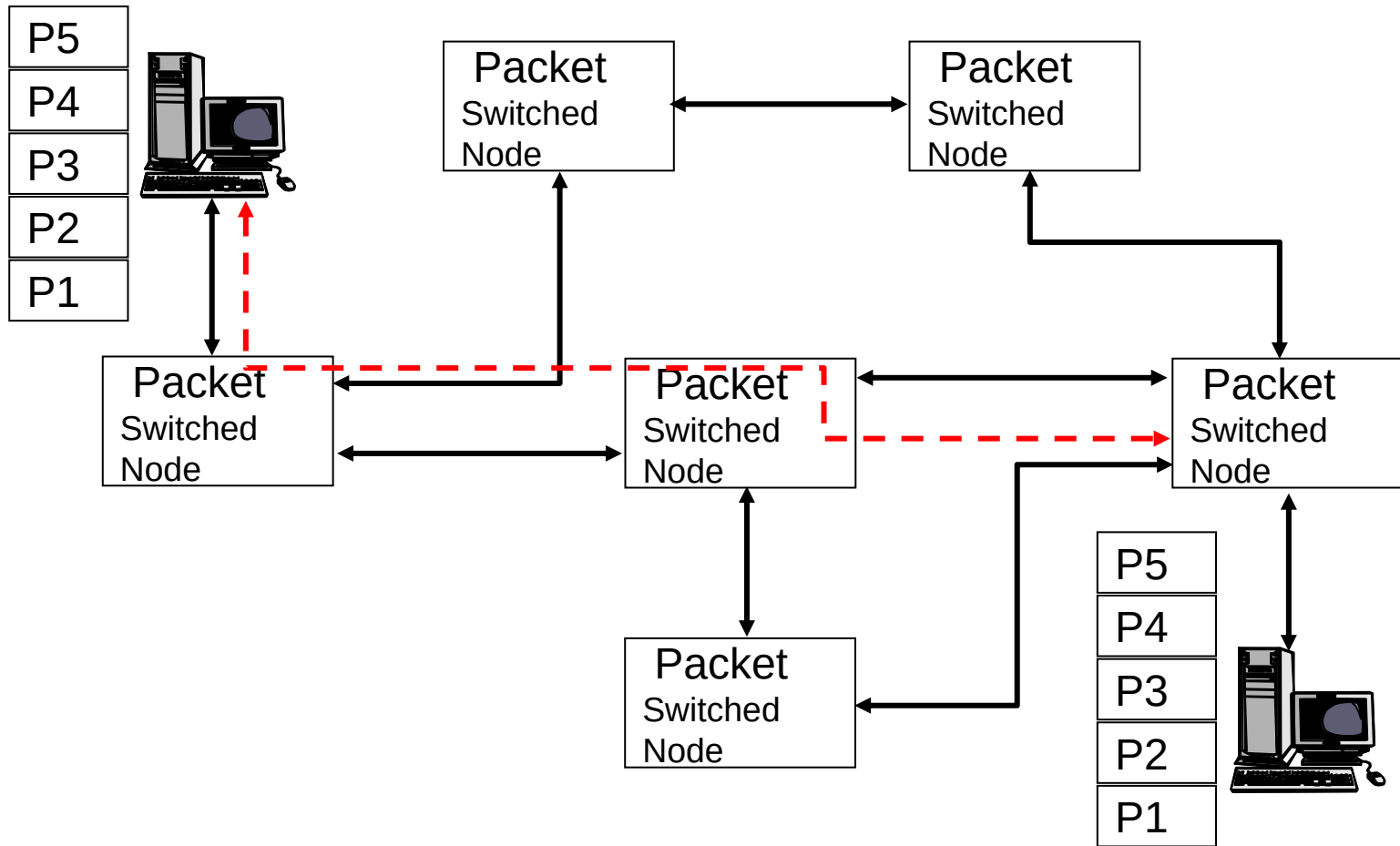
Packet Switching – Connection less Service

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- ❑ Datagram Service
- ❑ Connectionless communication.
- ❑ The datagram is a data packet that is sent over an IP network.
- ❑ The network layer accepts each message as an independent unit and attempts to deliver it.
 - ❑ Packets may be out of order.
- ❑ Datagram is fairly primitive, yet may add error and sequence control at the transport layer.

Packet Switching – Connection Orientated Service

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Packet Switching – Connection Orientated Service

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- Virtual Circuit Service
- A direct connection between 2 devices, yet may be circuitous physical route.
- Connection-orientated (transport layer)
 - ▣ Little or no errors, messages delivered in same order as supplied.
- User defines destination, virtual circuit is set up, messages are sent and the circuit is closed.

Virtual Circuits

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□ Switched Virtual Circuits

- ▣ established by the user sending an initial packet into the network carrying the destination and source address.

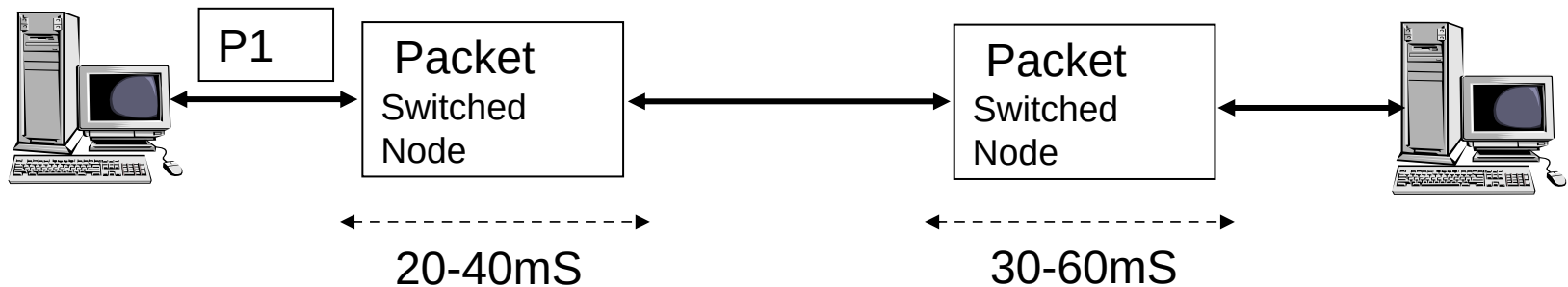
□ Permanent Virtual Circuit

- ▣ established by programming the frame-relay switch with required connection information.
- ▣ Data can thus be sent without any call set-up process – faster.

Packet Switching – Jitter

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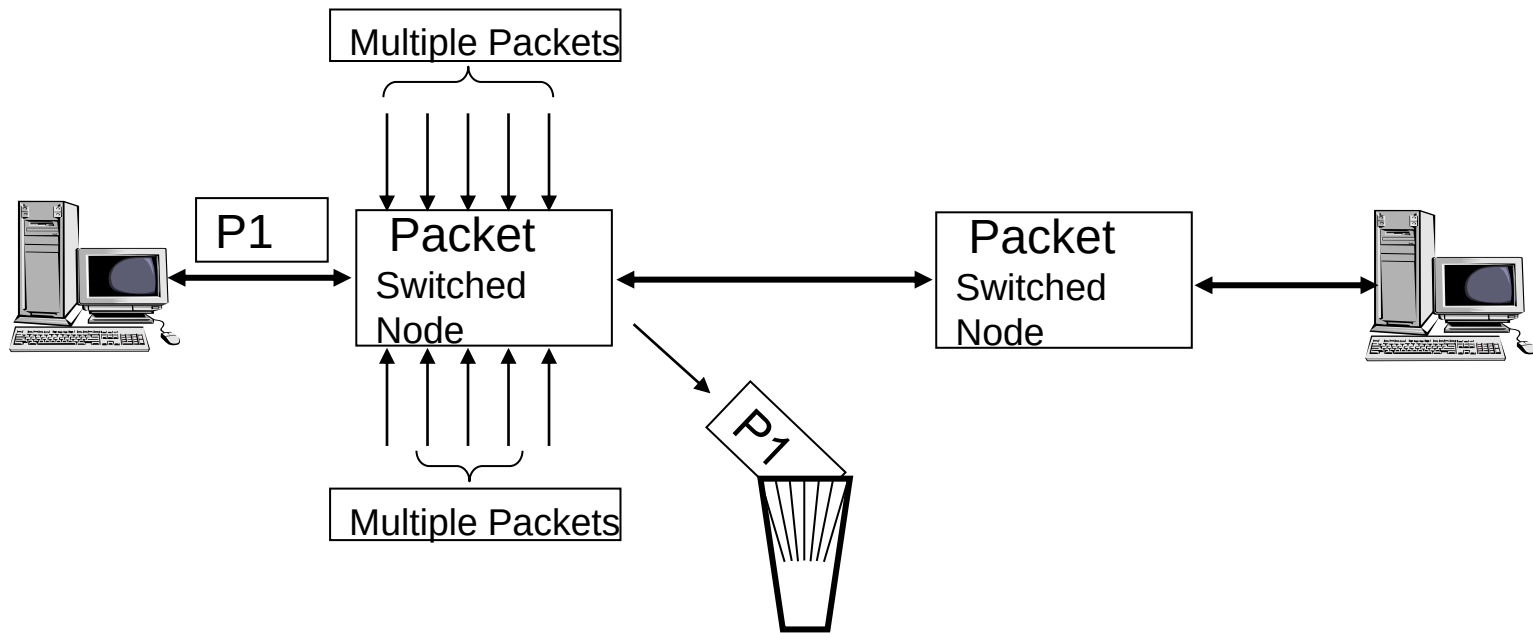
- Difference in delay between packet switches
- Involved in a virtual circuit.
- Variation in delay can hamper the operation of some applications – streaming video, audio
- Voice has a maximum round trip delay of 250ms (150ms latency per direction) ITU-T G.114



Packet Switching – Packet Loss

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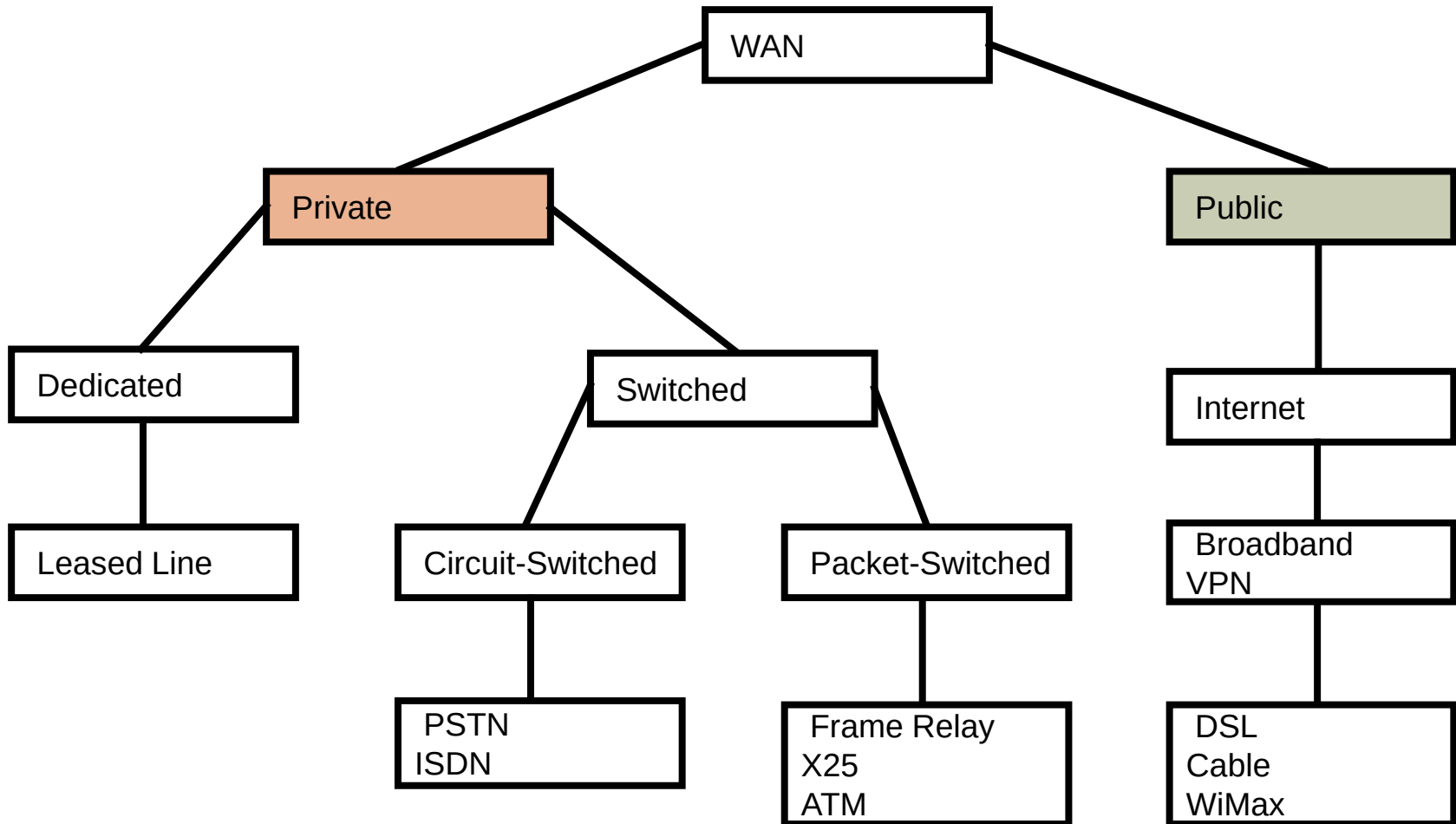
- Nodes may become congested with packets from multiple users
 - ▣ leading to packet loss.



WAN and ISDN

WAN Link Connection Options

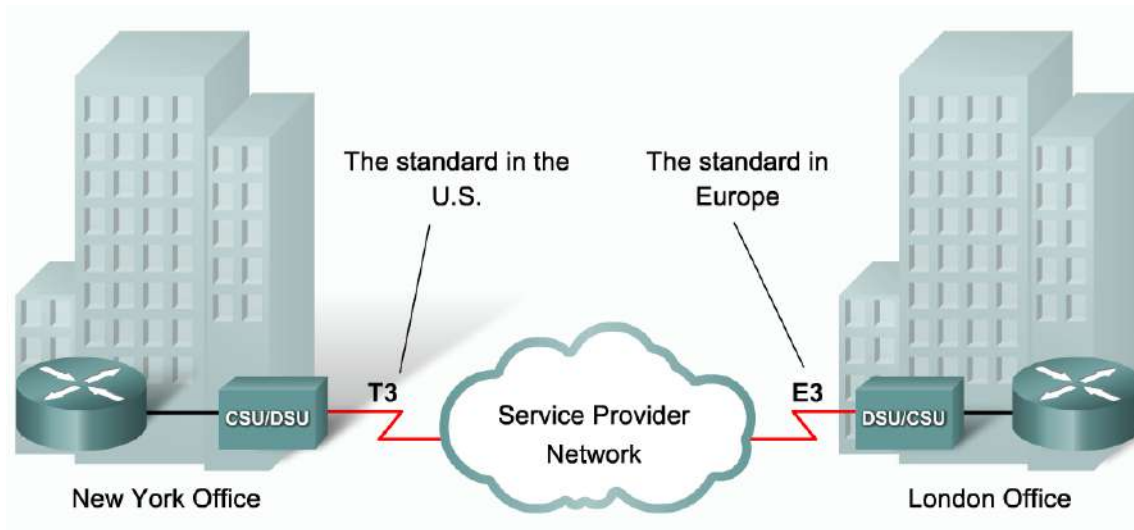
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WAN and ISDN

Dedicated Connection Link Options

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Line Type	Bit Rate Capacity
56	56 kb/s
64	64 kb/s
T1	1.544 Mb/s
E1	2.048 Mb/s
J1	2.048 Mb/s
E3	34.064 Mb/s
T3	44.736 Mb/s
OC-1	51.84 Mb/s
OC-3	155.54 Mb/s

Line Type	Bit Rate Capacity
OC-9	466.56 Mb/s
OC-12	622.08 Mb/s
OC-18	933.12 Mb/s
OC-24	1244.16 Mb/s
OC-36	1866.24 Mb/s
OC-48	2488.32 Mb/s
OC-96	4976.64 Mb/s
OC-192	9953.28 Mb/s
OC-768	39813.12 Mb/s

Dedicated Connection Link Options

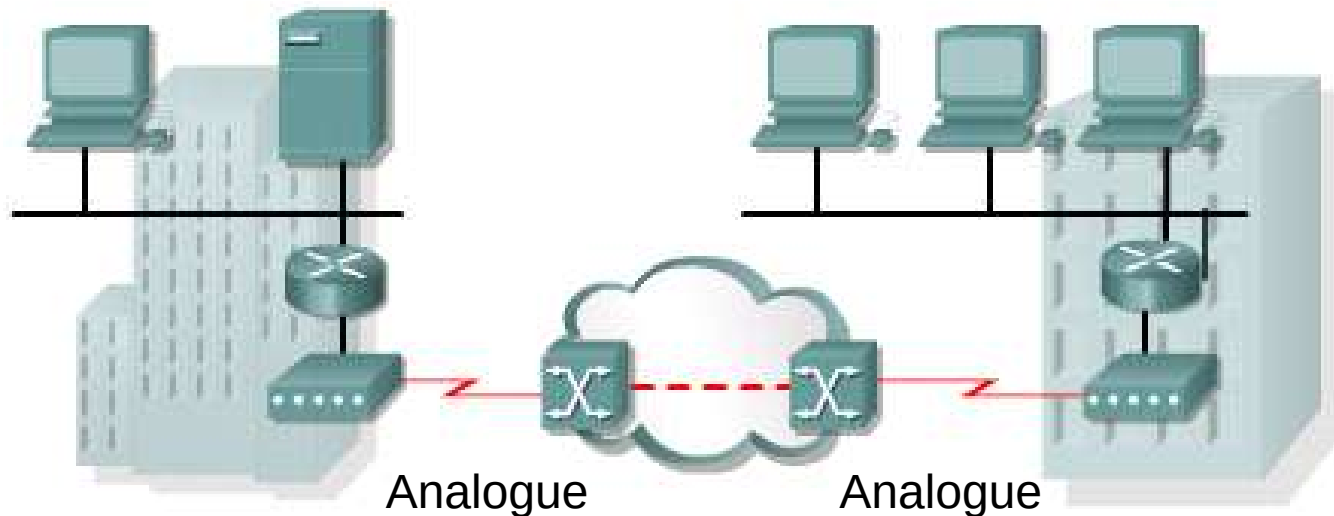
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- When permanent dedicated connections are required
 - ▣ a point-to-point link is used to provide a pre-established WAN communications path from the customer premises through the provider network to a remote destination.
- Point-to-point lines are usually leased from a carrier and are called leased lines.

Circuit Switched - Dial-Up Modem

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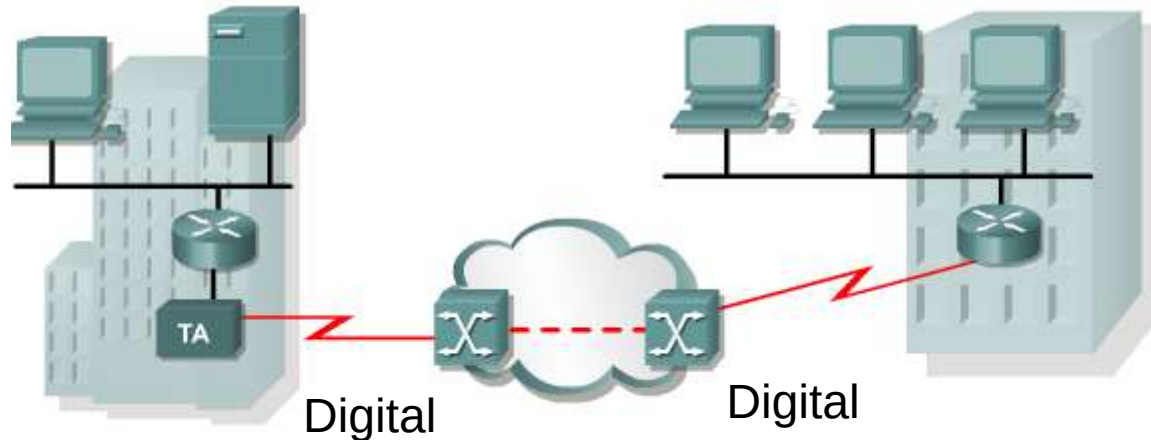
- Dial-up allows a WAN to be built with intermittent connections using a modem and the PSTN



Circuit Switched - Integrated Services Digital Network (ISDN)

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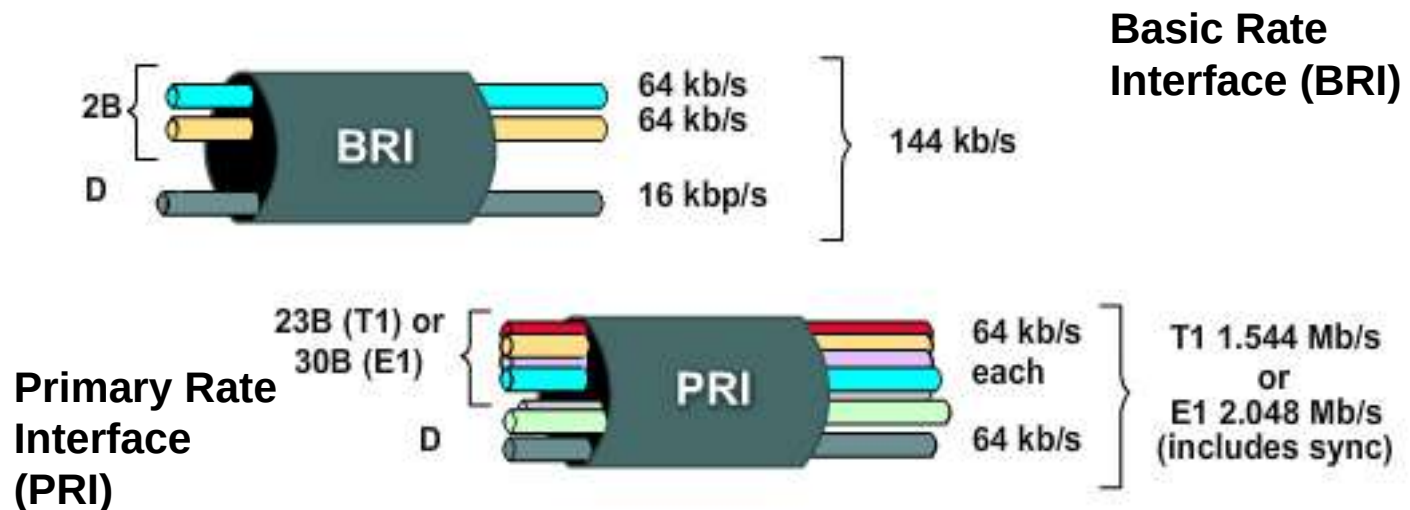
- ISDN is a circuit-switching technology
- It enables the local loop of a PSTN to carry digital signals, resulting in higher capacity switched connections.



Integrated Services Digital Network (ISDN)

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- Still an important technology for telephone service provider networks
- Less popular as an Internet connection option with the introduction of high-speed DSL and other broadband services.



Integrated Services Digital Network (ISDN)

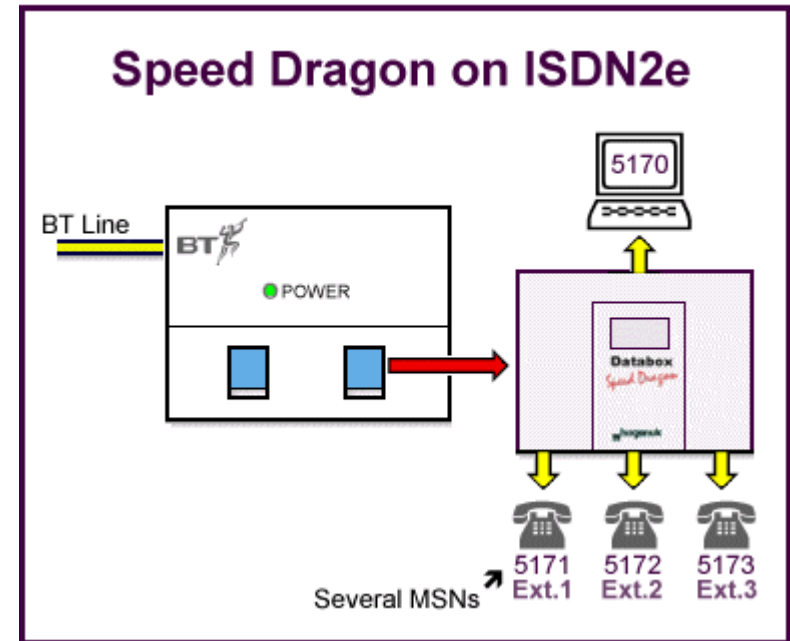
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- A digital line to your home/business
- A PC connects to the line via a TA (Terminal Adaptor)
 - ▣ this saves having to convert the data to sound
- A BRI (Basic Rate Interface)
 - ▣ 2 x 64kbps channels (full duplex) called B channels (bearer) and carry the data
 - ▣ 1 x 16kbps (D-Channel, also known as DS0 provides voice and signalling)

ISDN connections

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- ISDN2e – all PC's and telephones are plugged into a connecting device (ISDN router)
- MSN = Multi Subscriber Numbering
 - ▣ more than telephone number allocated

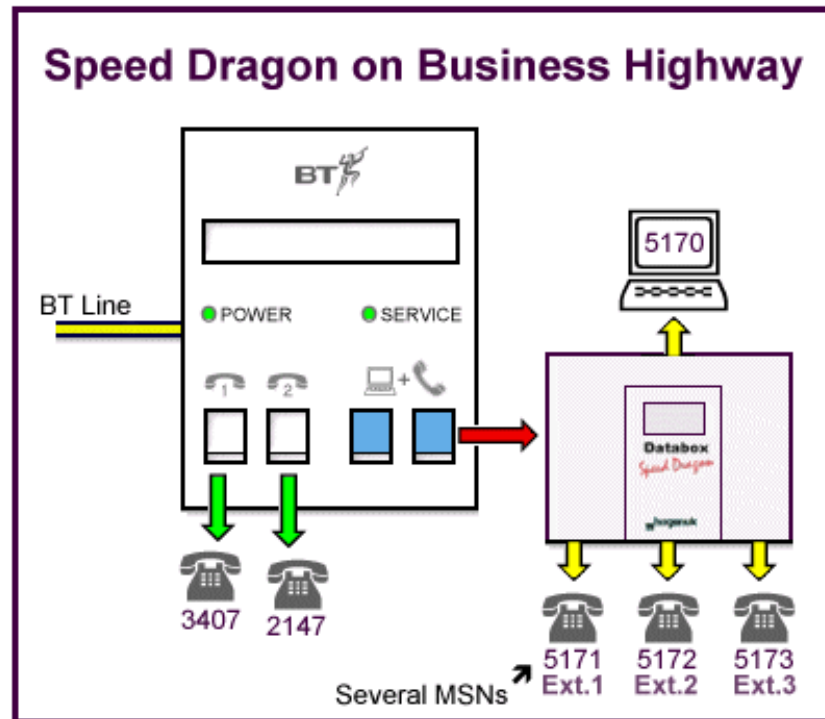


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Business Highway

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- Business highway gives two analogue sockets for analogue equipment e.g. telephone

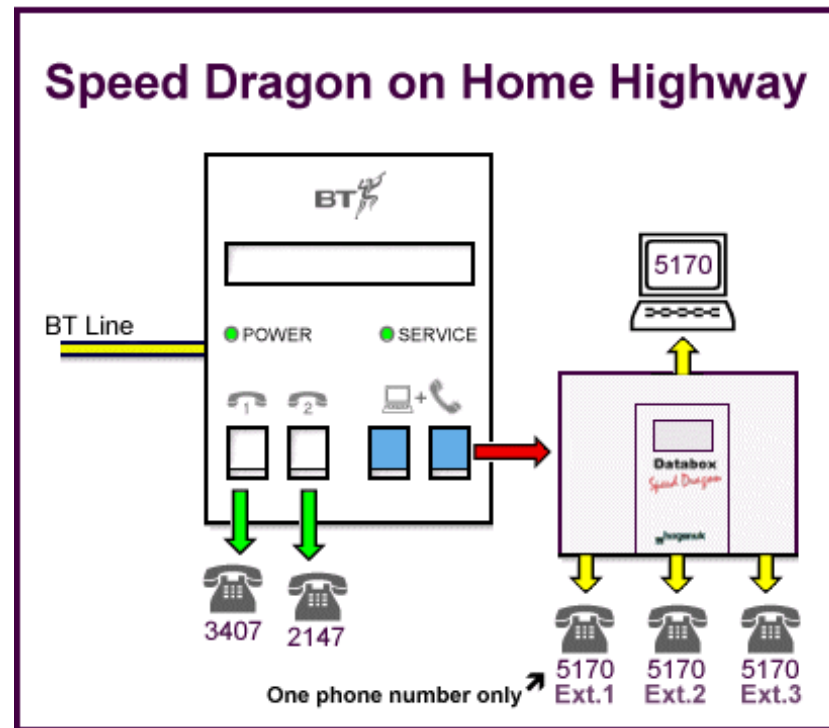


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Home highway

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- The same as Business highway except no MSN feature



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Configuring ISDN Dial Backup

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- If FR bandwidth utilisation $\geq 70\%$ then use ISDN
- If FR bandwidth utilisation $< 70\%$ then drop ISDN
- Routing is NOT used across ISDN link

