



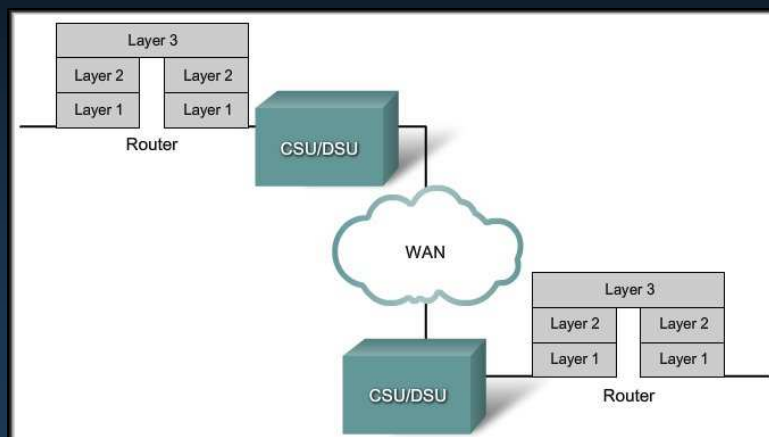
Chapter 8

Network Troubleshooting

Part II

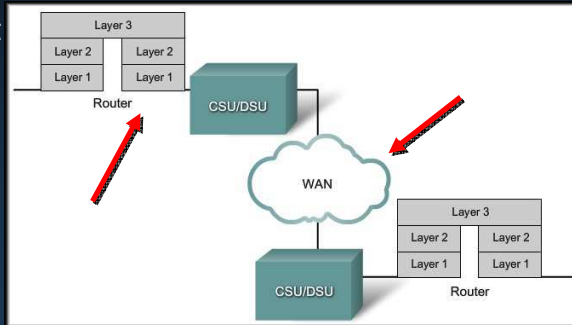
Network Troubleshooting

Review of WAN Communications



WAN Communications

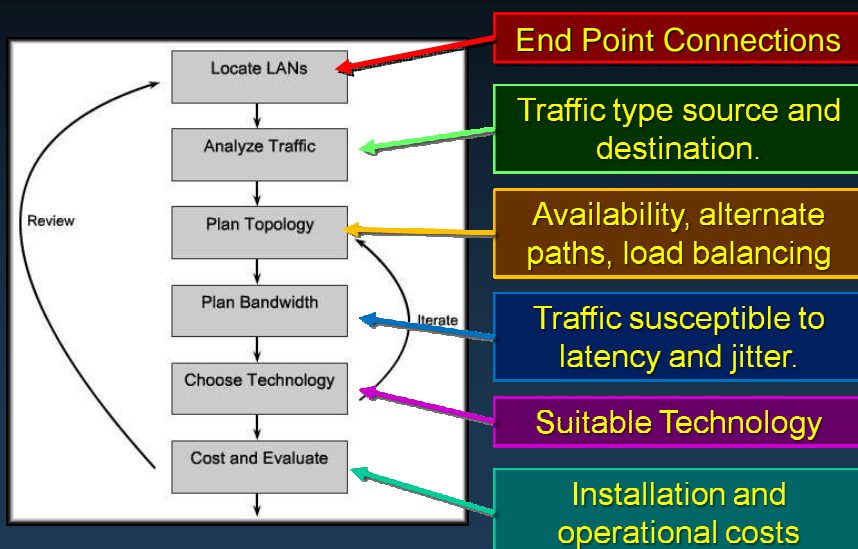
- Function at the **lower three layers** of the OSI model.
- A **communications provider normally owns** the data links.
- Made available to subscribers for a fee.
- Used to **interconnect LANs** or connect to **remote networks**.
- **Bandwidth** is considerably **slower** than the LAN.
- The **charges** are the **major cost** element.
- **Implementation** must aim to provide **maximum bandwidth** at **acceptable cost**.



CCNA4-3

Chapter 8-2

Steps in WAN Design



CCNA4-4

Chapter 8-2

WAN Traffic Considerations

- Wide variety of traffic types and their varying requirements of bandwidth, latency, and jitter that WAN links are required to carry.

Traffic	Latency	Jitter	Bandwidth
Voice	Low	Low	Medium
Transaction data (for example, SNA)	Medium	Medium	Medium
Messaging (e-mail)	High	High	High
File transfer	High	High	High
Batch data	High	High	High
Network management	High	High	Low
Videoconferencing	Low	Low	High

WAN Traffic Considerations

- To determine traffic flow conditions and timing of a WAN link, you need to analyze the traffic characteristics specific to each LAN that is connected to the WAN.

Characteristic	Description
Connectivity and volume flows	Where does this traffic flow and how much traffic flows there?
Client/server data	What kind of traffic flows between the client and server?
Latency tolerance, including length and variability	Can the users tolerate delays? How much and how often?
Network availability tolerance	How critical is network availability to the users of this LAN? Can they tolerate WAN outages or would their work grind to a halt?
Error-rate tolerance	Is this noisy traffic?
Priority	Does this traffic have priority over other traffic? For example, network management messages should have a higher priority than e-mail.
Protocol type	What types of protocol operate within the network?
Average packet length	What is the average size of packets being transmitted?

WAN Topology Considerations

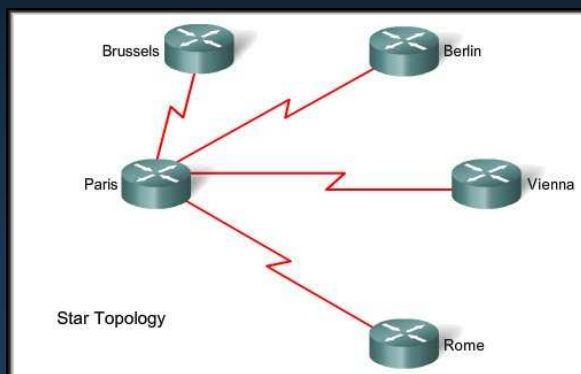
- Designing a WAN topology consists of the following:
 - Selecting an **interconnection pattern or layout** for the links between the various locations.
 - Selecting the **technologies for those links** to meet the enterprise **requirements** at an **acceptable cost**.
 - **More links increase the cost** of the network services, but having **multiple paths** between destinations **increases reliability**.
 - Adding more network devices to the data path **increases latency and decreases reliability**.

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Chapter 8-2

WAN Topology Considerations

- Many WANs use a **Star Topology**.
 - As the enterprise grows and new branches are added, the branches are connected back to the head office, producing a traditional star topology.

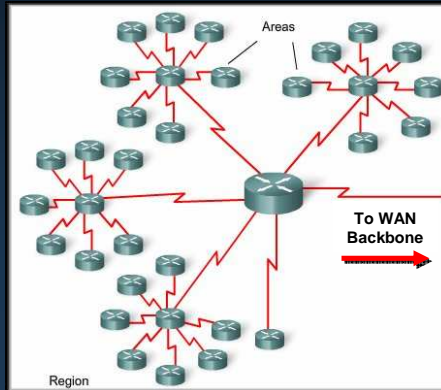


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Chapter 8-2

WAN Topology Considerations

- When many locations must be joined, a **hierarchical solution** is recommended.
- A mesh network is clearly not feasible because there would be hundreds of thousands of links.
- A **three-layer hierarchy** is often useful when the network traffic **mirrors the enterprise branch structure** and is divided into regions, areas, and branches.

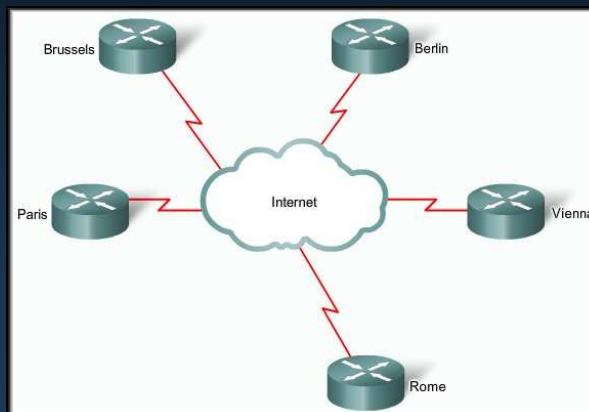


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Chapter 8-2

WAN Topology Considerations

- Many enterprise WANs have connections to the **Internet**.
 - Although the Internet may pose a security problem it does provide an alternative for inter-branch traffic.
 - Part of the traffic that must be considered during design is **going to or coming from the Internet**.



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Chapter 8-2

WAN Connection Technologies

- A typical private WAN uses a **combination of technologies** that are usually chosen based on traffic type and volume.

Technology	Charge	Typical Bit Rate	Other
Leased Line	Distance, capacity	up to 45 Mb/s (E3/T3)	Permanent fixed capacity
Basic Telephone	Distance, time	33-56 kb/s	Dialed, slow connection
ISDN	Distance, time	64 or 128 kb/s up to 2 Mb/s, PRI	Dialed, slow connection
X.25	Volume	up to 48 kb/s	Switched fixed capacity
ATM	Capacity	up to 155 Mb/s	Permanent variable capacity
Frame Relay	Capacity	up to 45 Mb/s	Permanent variable capacity
DSL	Monthly subscription	up to 3 Mb/s	Always on shared Internet
Metro Ethernet	Monthly subscription	up to 500 Mb/s	Limited geographical scope

Individual branches to an area.

WAN Connection Technologies

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External areas to the backbone.

WAN Connection Technologies

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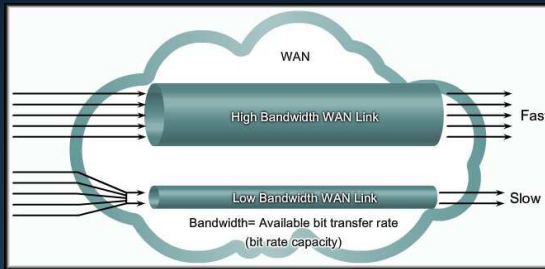
Form the backbone.

WAN Connection Technologies

- **Frame Relay and ATM** are examples of shared networks.
 - Because several customers are sharing the link, the cost to each is generally less than the cost of a direct link of the same capacity.
 - **Frame Relay** may also be used for delay-sensitive traffic, often using QoS mechanisms to give priority to the more sensitive data.
 - **ATM** has been designed to produce minimal latency and jitter through high-speed internal links sending easily manageable units of data, called **cells**.
 - ATM cells have a **fixed length of 53 bytes, 48 bytes for data and 5 bytes for the header**. ATM is widely used for carrying delay-sensitive traffic.

WAN Bandwidth Considerations

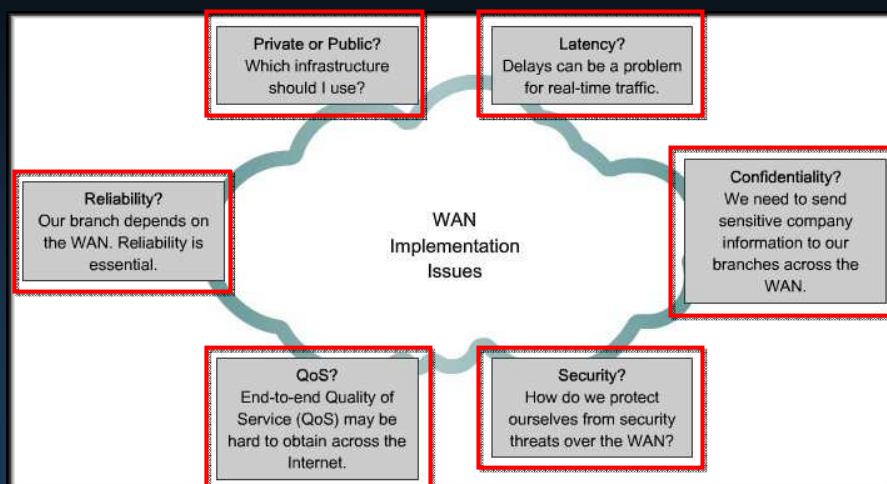
- Many companies rely on the **high-speed transfer** of data between remote locations.
 - Consequently, higher bandwidth is crucial because it allows more data to be transmitted in a given time.
 - When bandwidth is **inadequate**, competition between various types of traffic causes **response times to increase**, which reduces employee productivity and slows down critical web-based business processes.



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Chapter 8-2

Common WAN Implementation Issues

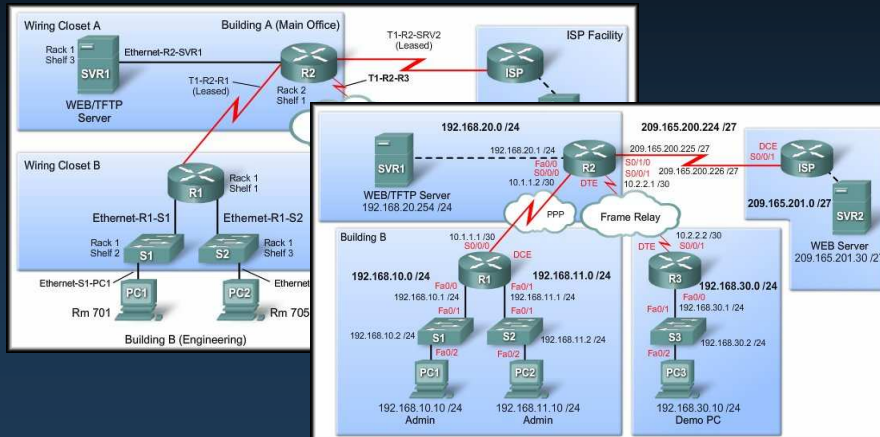


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Chapter 8-2

Network Troubleshooting

Network Troubleshooting

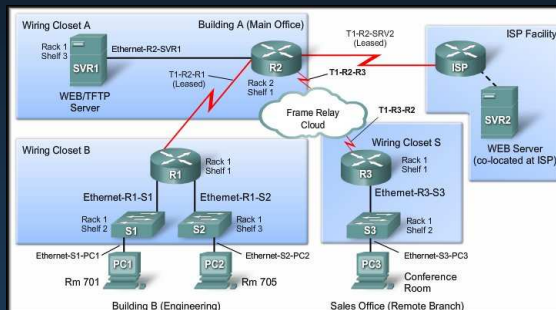


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Chapter 8-2

Network Troubleshooting

- **Interpreting Network Diagrams:**
 - **Physical Topology** shows the physical layout of the devices connected to the network.
 - Device Type.
 - Model and manufacturer.
 - OS Version.
 - Cable type and identifier.
 - Cable Spec.
 - Connector Type.
 - Cabling Endpoints.

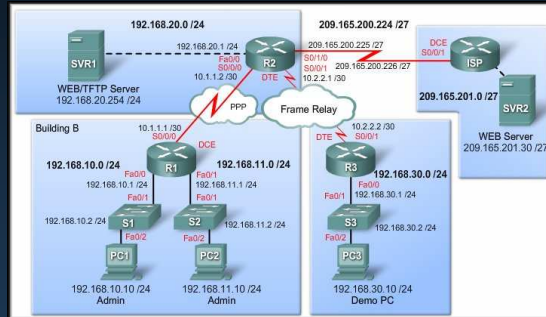


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Chapter 8-2

Network Troubleshooting

- **Interpreting Network Diagrams:**
 - **Logical Topology** shows how data is transferred on the network.
 - Device IDs.
 - IP Address and subnet mask.
 - Interface IDs.
 - DLCI for PVCs.
 - VPNs.
 - Routing Protocols.
 - Static Routes.
 - Data Link protocols and WAN Technologies.

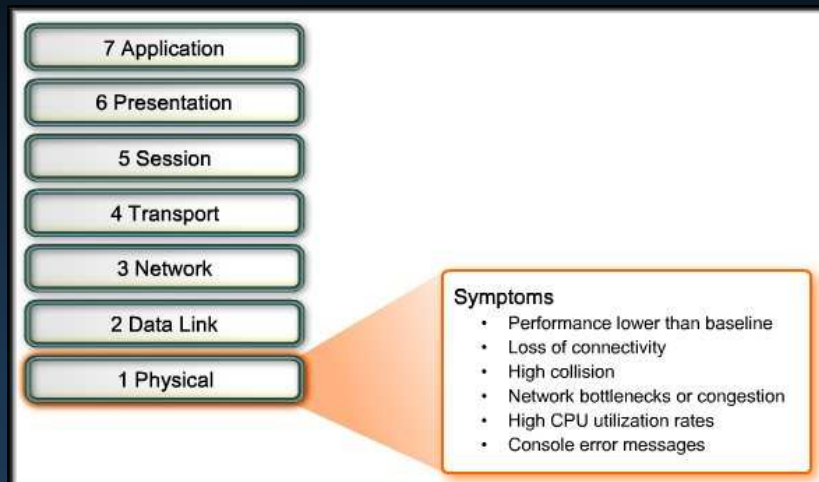


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Chapter 8-2

Physical Layer Troubleshooting

- **Symptoms of Physical Layer Problems:**

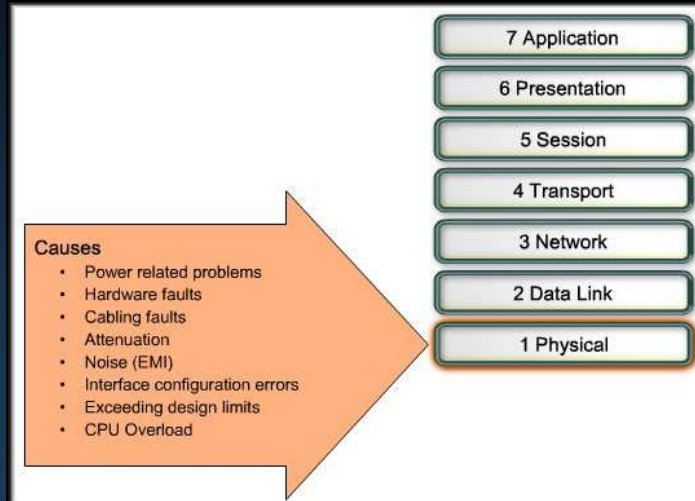


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Chapter 8-2

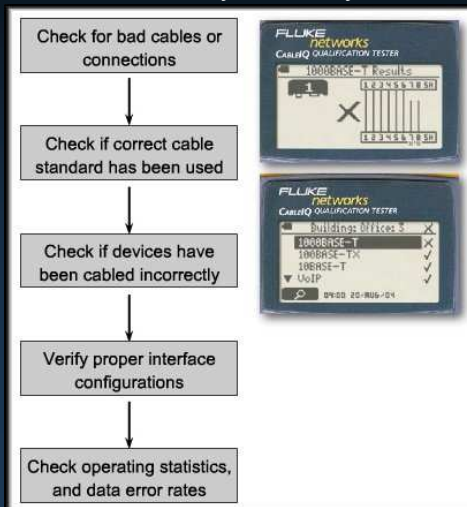
Physical Layer Troubleshooting

- Causes of Physical Layer Problems:



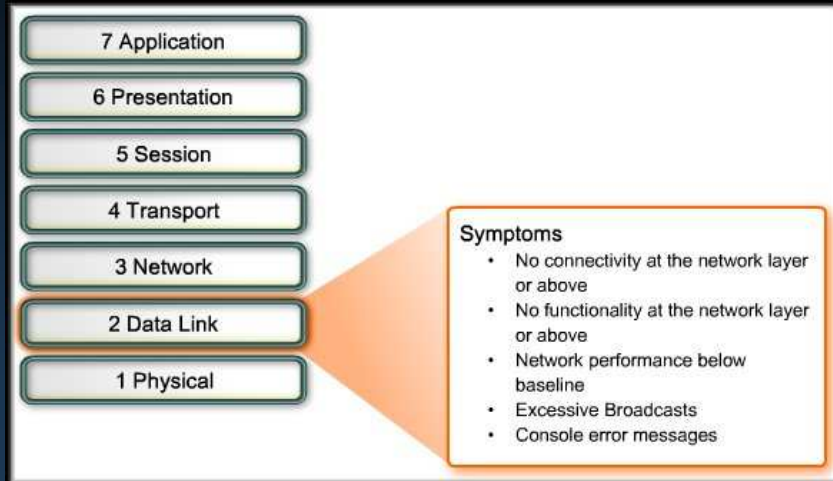
Physical Layer Troubleshooting

- Isolating Problems at the Physical Layer:



Data Link Layer Troubleshooting

- Symptoms of Data Link Layer Problems:

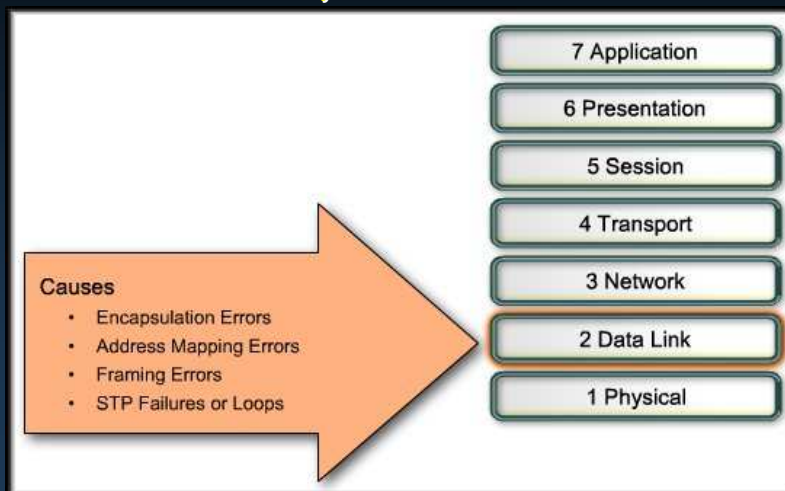


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Chapter 8-2

Data Link Layer Troubleshooting

- Causes of Data Link Layer Problems:



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Chapter 8-2

Data Link Layer Troubleshooting

- Troubleshooting Layer 2: PPP
 - Most PPP problems involve link negotiation.



```
R2#show interfaces serial 0/0/0  
Serial0/0/0 is up, line protocol is up  
Hardware is GT96K Serial  
Internet address is 10.1.1.2/30  
MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,  
reliability 255/255, txload 1/255, rxload 1/255  
Encapsulation HDLC, loopback not set
```

Step 1: Check that the appropriate encapsulation is in use at both ends.

Data Link Layer Troubleshooting

- Troubleshooting Layer 2: PPP
 - Most PPP problems involve link negotiation.



```
R2#show interface serial 0/0/0  
Serial0/0/0 is up, line protocol is up  
Hardware is GT96K Serial  
Internet address is 10.1.1.2/30  
MTU 1500 bytes, BW 128 Kbit, DLY 20000 usec,  
reliability 255/255, txload 1/255, rxload 1/255  
Encapsulation PPP LCP Open
```

Step 2: Confirm that the Link Control Protocol (LCP) negotiations have succeeded.

Data Link Layer Troubleshooting

- Troubleshooting Layer 2: PPP
 - Most PPP problems involve link negotiation.

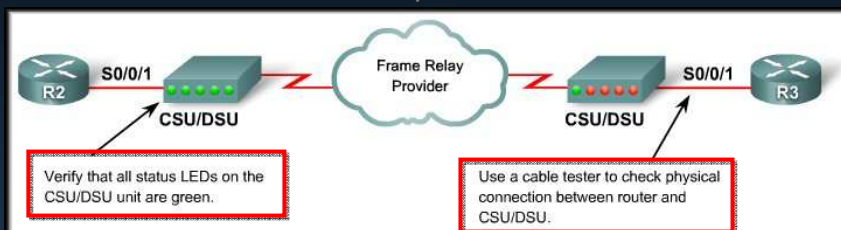


```
R1# debug ppp authentication  
Serial0: Unable to authenticate. No name received from peer.  
Serial0: Unable to validate CHAP response. USERNAME R2 not found.  
Serial0: Unable to validate CHAP response. No password defined for USERNAME R2.  
Serial0: Failed CHAP authentication with remote.  
Remote message is: Username name  
...
```

Step 3: Verify authentication on both sides of the link.

Data Link Layer Troubleshooting

- Troubleshooting Layer 2: Frame Relay
 - Can be broken into 4 steps.

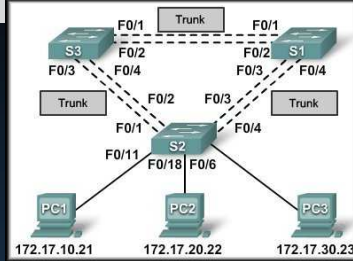


Step 1: Verify the physical connection between the CSU/DSU and the router.

Data Link Layer Troubleshooting

- **Troubleshooting Layer 2: STP Loops**

- **Step 1.** Identify that an STP loop is occurring.
- **Symptoms:**
 - Loss of connectivity.
 - High CPU utilization on routers.
 - High link utilization (often 100 percent).
 - High switch backplane utilization.
 - Hot Standby, Router Protocol, Duplicate IP Address Syslog messages indicate packet looping.
 - Syslog messages that indicate constant address relearning or MAC address flapping messages.



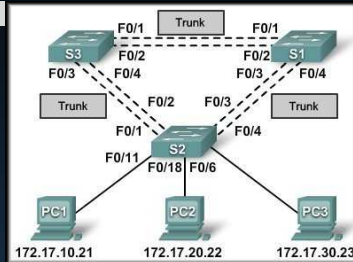
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Chapter 8-2

Data Link Layer Troubleshooting

- **Troubleshooting Layer 2: STP Loops**

- **Step 2.** Discover the topology (**scope**) of the loop.
 - The **highest priority** is to stop the loop and restore network operation.
 - To stop the loop, you must know which ports are involved.
 - Look at the ports with the **highest link utilization** (packets per second).
 - Use the **show interface** command to display the **utilization for each interface** and **record this information** before proceeding to the next step.



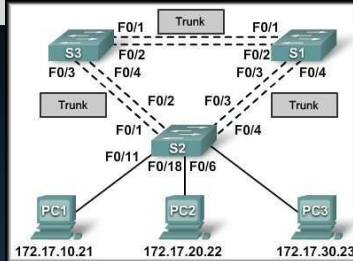
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Chapter 8-2

Data Link Layer Troubleshooting

- Troubleshooting Layer 2: STP Loops

- Step 3. Break the loop.
 - Shut down or disconnect the involved ports one at a time.
 - After you disable or disconnect **each port**, check whether the **switch backplane utilization is back to a normal level**.
 - **Document** your findings.



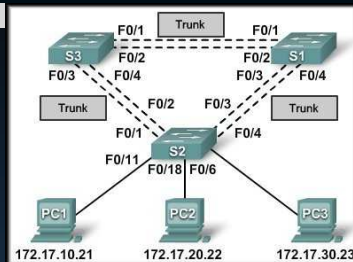
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Chapter 8-2

Data Link Layer Troubleshooting

- Troubleshooting Layer 2: STP Loops

- Step 4. Find and fix the cause of the loop.
 - Investigate the topology diagram to **find a redundant path**.
 - **For every switch on the redundant path:**
 - Does the switch know the correct STP root?
 - Is the root port identified correctly?
 - Are BPDUs received regularly on the root port and on ports that are supposed to be blocking?
 - Are BPDUs sent regularly on non-root, designated ports?



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Chapter 8-2

Data Link Layer Troubleshooting

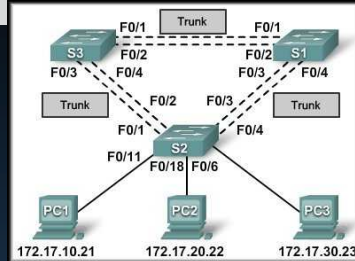
- **Troubleshooting Layer 2: STP Loops**

- **Step 5.** Restore the redundancy.

- After the device or link that is causing the loop has been found and the problem has been resolved, **restore the redundant links** that were disconnected.
 - We have only touched lightly on the subject of troubleshooting STP loops.
 - **For More Information:**

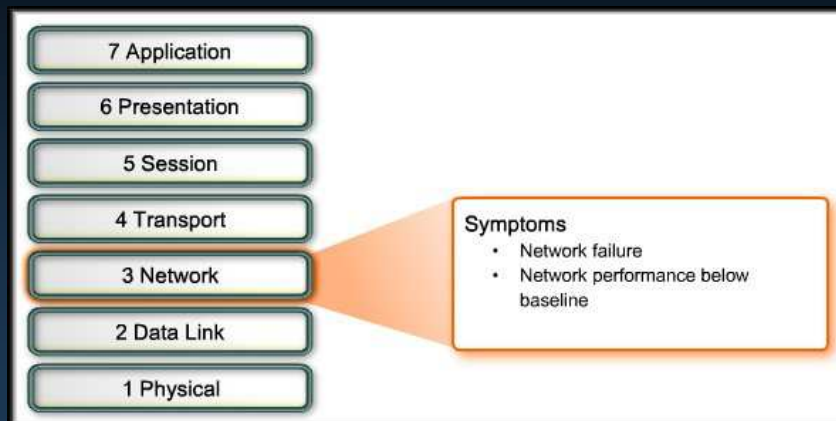
<http://cisco.com/en/US/tech/tk389/tk621>

/technologies_tech_note09186a0080136673.shtml



Network Layer Troubleshooting

- **Symptoms of Network Layer Problems:**



Network Layer Troubleshooting

- **Symptoms of Network Layer Problems:**
 - Network layer problems include any problem that involves a Layer 3 protocol.
 - Both **routed and routing** protocols.
 - **Network Failure:**
 - The network is nearly or completely nonfunctional.
 - These failures are usually noticed quickly by users and network administrators (*Yah Think?*).
 - Obviously critical to the productivity of a company.

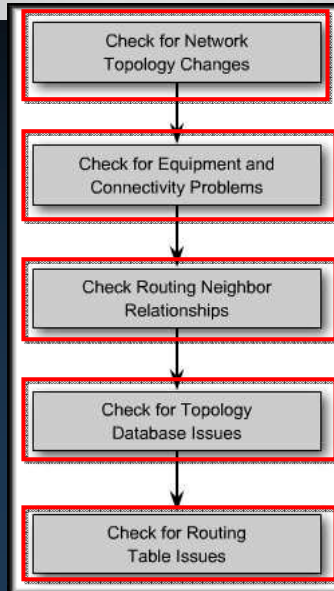
Network Layer Troubleshooting

- **Symptoms of Network Layer Problems:**
 - Network layer problems include any problem that involves a Layer 3 protocol.
 - Both **routed and routing** protocols.
 - **Network optimization problems:**
 - Usually involve a subset of users, applications, destinations, or a particular type of traffic.
 - Optimization issues in general can be more **difficult to detect** and even **harder to isolate and diagnose**.
 - They usually involve **multiple layers** or the host computer itself.
 - Determining that the problem is a Network layer problem **can take time**.

Network Layer Troubleshooting

- **Troubleshooting Network Layer Problems:**

Has anything been changed?



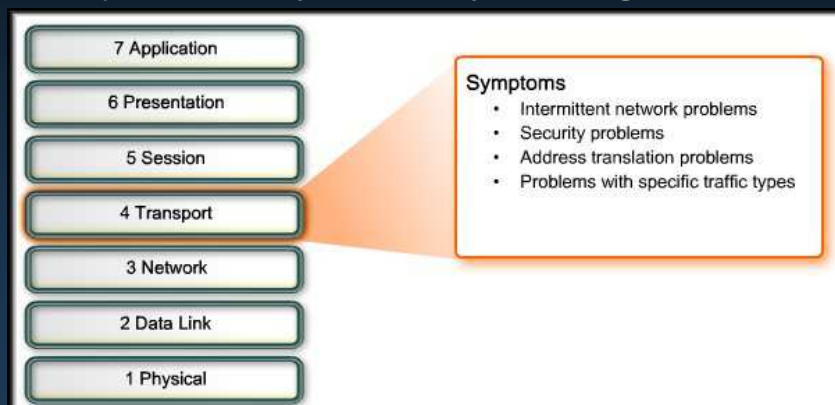
Is anyone working on the infrastructure?

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Chapter 8-2

Transport Layer Troubleshooting

- **Symptoms of Transport Layer Problems:**
 - We will discuss **ACLs and NAT**, the most commonly implemented Layer 4 security technologies.

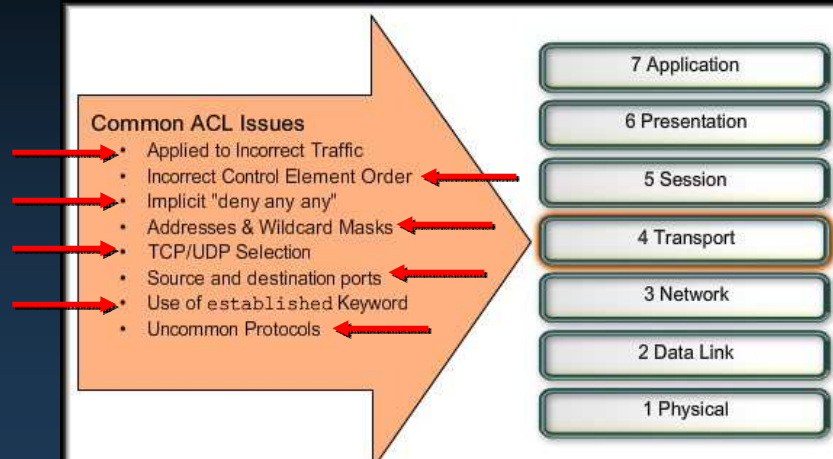


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Chapter 8-2

Transport Layer Troubleshooting

- Common Access Control List (ACL) Issues:



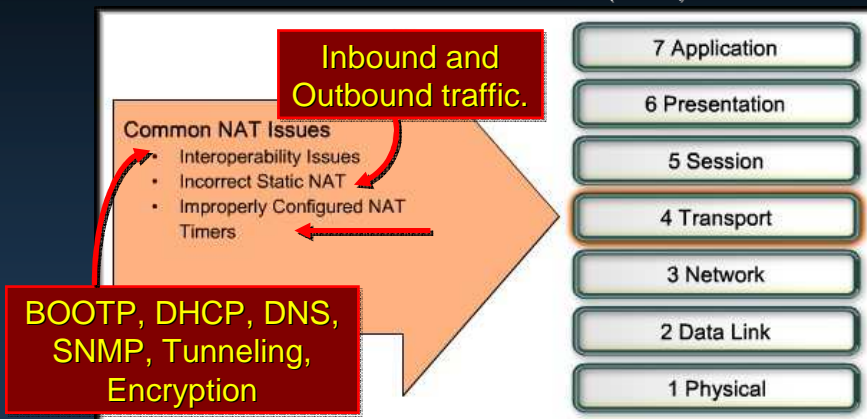
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Useful command: The **log keyword** on ACL entries.

8-2

Transport Layer Troubleshooting

- Common Network Address Translation (NAT) Issues:



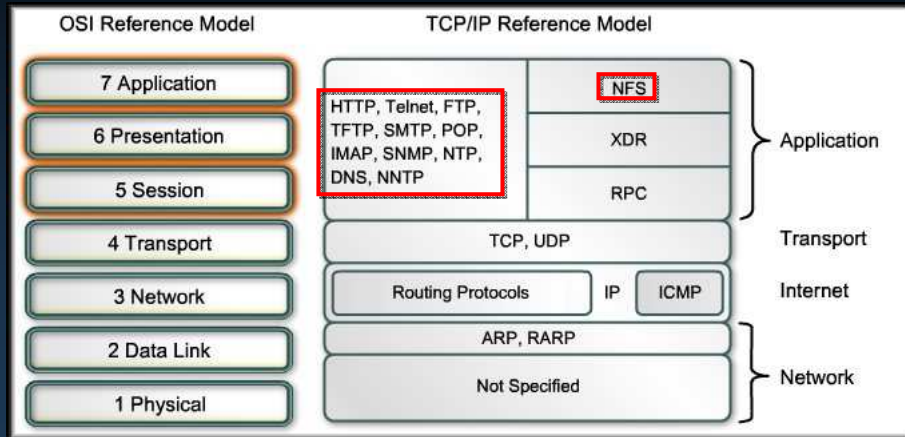
BOOTP, DHCP, DNS, SNMP, Tunneling, Encryption

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Chapter 8-2

Application Layer Troubleshooting

- Application Layer Overview:



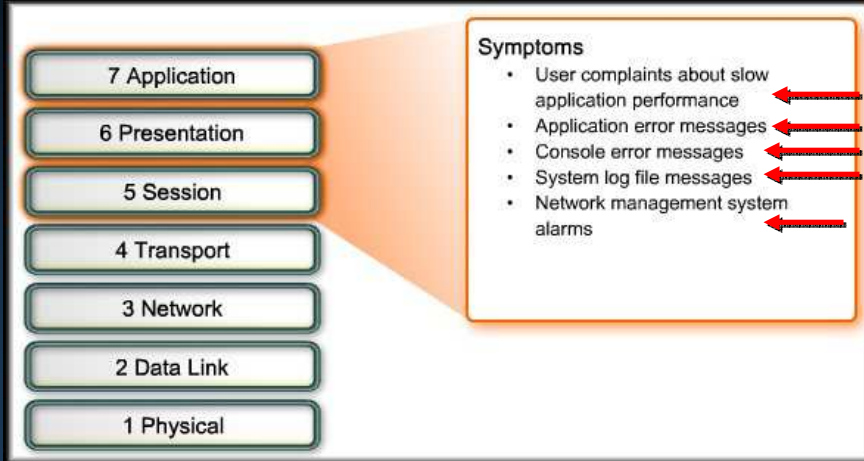
Application Layer Troubleshooting

- Application Protocols and Ports:

Application	Protocol	Transport	Port
WWW Browser	HTTP	TCP	80
File Transfer	FTP	TCP	20, 21
Terminal Emulation	Telnet	TCP	23
Electronic Mail	POP3	TCP	100
	SMTP	TCP	25
	IMAP4	TCP	143
Network Management	SNMP	UDP	161
Distributed File Service	X-Windows	UDP	6000-6063
	NFS, XDR, RPC	UDP	111

Application Layer Troubleshooting

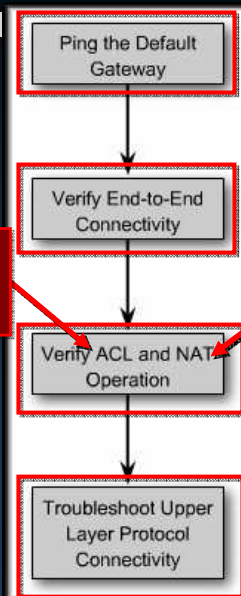
- Symptoms of Application Layer Problems:



Application Layer Troubleshooting

- Troubleshooting Application Layer Problems:

```
show access-list
clear access-list
counters
```



```
show ip nat
translations
clear ip nat
translations
debug ip nat
```

Are the inside and outside interfaces properly defined?

Application Layer Troubleshooting

- Correcting Application Layer Problems:

