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Curriculum Development Centers Program

Awardee of The Office of the National Coordinator for Health Information Technology

Component 9 – Networking and Health Information Exchange

Unit 1-2
ISO Open Systems Interconnection (OSI)

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Unit Objectives

- Explain the concept of the Network Layer
- Explain the concept of the Data Link Layer
- Explain the concept of the Physical Layer
- Explain connection-oriented versus connectionless communication
- Explain the use of network addressing including security considerations and vulnerabilities

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Network Layer

- **Internet Protocol (IP)** is used to assign IP addresses to network devices.
  - Connectionless
  - Best effort delivery
  - Relies on TCP for reliable, error free delivery

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IP Addresses

- Two Current Versions
  - IPv4
    - 32 bits
    - Dotted-quad
    - Binary example: 11000000.00101000.01101110.11100001
    - Decimal example: 192.40.110.225
  - IPv6
    - 128 bits
    - Example: 3eef:1800:4625:7:100:c8fd:ae21:57bf

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IPv4 Addresses

Class	First Octet	Default Subnet Mask
A	1-127	255.0.0.0
B	128-191	255.255.0.0
C	192-223	255.255.255.0
D	224-239	NA
E	240-255	NA

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Special IP Addresses

- 127.0.0.1 – reserved for loopback
- Private Addresses

Class	Private Address Range
A	10.0.0.0 – 10.255.255.255
B	172.16.0.0 – 172.31.255.255
C	192.168.0.0 – 192.168.255.255

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Forms of Transmission

- Unicast
- Broadcast
- Multicast

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Parts of an IP Address

1637 Lawson Street

Bldg # Street

192.168.12.14
255.255.255.0

Network Host

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Subnetting

172.16.0.0	>1 network
255.255.0.0	>65,000 hosts
255.255.240.0	16 networks
	>4,000 hosts

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Subnetting Continued

172.16.0.0

255.255.240.0 ← New Subnet Mask

New networks

172.16.16.0 –Building A

172.16.32.0 – Building B

172.16.48.0 – Building C

172.16.64.0 – Building D

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Routers

Moves packets from one network to another

Uses IP addresses

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Routing Protocols

- Two types:
  - Static routing
  - Dynamic routing
- Hop
  - Term used to describe the movement of data from one router to another
- Time to Live (TTL)

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Internet Control Message Protocol (ICMP)

- Used to send some messages back to sender in case of a delivery error
- Common messages
  - Unreachable destination or service
  - Time exceeded
  - Route redirection
  - Source quench
- Used with PING and TRACERT

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PING

```
C:\Users>ping 192.168.2.1

Pinging 192.168.2.1 with 32 bytes of data:
Reply from 192.168.2.1: bytes=32 time=5ms TTL=64
Reply from 192.168.2.1: bytes=32 time=3ms TTL=64
Reply from 192.168.2.1: bytes=32 time=3ms TTL=64
Reply from 192.168.2.1: bytes=32 time=3ms TTL=64

Ping statistics for 192.168.2.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 3ms, Maximum = 5ms, Average = 3ms
```


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TRACERT

```
C:\Users\Michele>tracert www.cisco.com

Tracing route to origin-www.cisco.com [72.163.4.161]
over a maximum of 30 hops:

  1     3 ms     3 ms     3 ms  192.168.2.1
  2     3 ms     2 ms     3 ms  dslrouter [192.168.1.1]
  3    25 ms    29 ms    26 ms  L100.RLGRNC-VFL-02.verizon-gni.net [71.111.192.1
]
  4    30 ms    26 ms    27 ms  P1-0.RLGRNC-LCR-02.nsnetwork.net [184.17.247.6]

  5    36 ms    41 ms    38 ms  so-5-1-3-0.RES-BB-RTR2.verizon-gni.net [100.57.1
28.166]
  6    41 ms    38 ms    38 ms  0.so-1-2-0.XL4.IAD8.ALTER.NET [152.63.37.121]
  7    79 ms    73 ms    73 ms  0.so-5-1-0.XT4.DPV9.ALTER.NET [152.63.1.230]
  8    73 ms    76 ms    74 ms  GigabitEthernet7-0-0.GW14.DPV9.ALTER.NET [152.63
.96.69]
  9    74 ms    75 ms    76 ms  cisco-gw.customer.alter.net [157.130.134.198]
 10    75 ms    75 ms    74 ms  rcdn9-cd1-dmzbb-gw1-ten2-1.cisco.com [72.163.0.9
]
 11    75 ms    76 ms    75 ms  rcdn9-cd2-dmzdcc-gw2-por-1.cisco.com [72.163.0.1
98]
 12    74 ms    75 ms    75 ms  rcdn9-14a-dcz05n-gw1-ten5-5.cisco.com [72.163.0.
230]
 13    74 ms    82 ms    78 ms  www1.cisco.com [72.163.4.161]

Trace complete.
```

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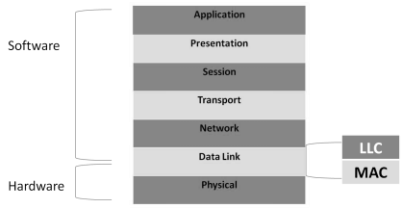
Data Link Layer



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MAC addresses

00 60 2F	*2A 36 9B*
Organizational Unique Identifier (OUI)	Vender Assigned
Cisco	Particular Device

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Media Access Control

- Controlled
  - Also called deterministic
  - Every device has to wait its turn
  - Only 1 device can transmit data at a time
  - No collisions
  - Examples
    - Token Ring
    - Fiber Data Distributed Interface (FDDI)

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Media Access Control Continued

- Contention-based
  - Also called non-deterministic
  - Devices can transmit at any time
  - Collisions can occur
  - Examples
    - Ethernet
    - Wireless

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Ethernet

- Uses CSMA/CD
  - Carrier Sense Multiple Access (CSMA)
    - "Listens" to media to see if there are any signals
    - If media is busy, it will wait and try again
    - If media isn't busy, the device will transmit its data
  - Collision Detection (CD)
    - If another device transmitted at the same time there would be a collision
    - Data from both devices are corrupt and will need to be resent

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Wireless

- Uses CSMA/CA
  - Carrier Sense Multiple Access (CSMA)
    - "Listens" to media to see if there are any signals
    - If media is busy, it will wait and try again
  - Collision Avoidance (CA)
    - If the media is free the device will send out a signal letting other devices know that it is getting ready to use the media
    - The device then transmits data
- Used by 802.11 standards

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Other Data Link Protocols

- Frame Relay
- Point-to-Point Protocol (PPP)
- Asynchronous Transfer Mode (ATM)

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Physical Layer

- Hardware Specifications
- Encoding
  - Non Return to Zero (NRZ)
  - Manchester
- Transmits and Receives Data
- Network Topology