## Lecture 1

# **Network Fundamentals**



# **Network Fundamentals**



resolving the standards dilemma multiple incompatible standards

### standardizes the internal functions partitioning it into abstraction layers

a device operates at a certain layer device implements the functionality of that layer

### The Open Systems Interconnection model (OSI)



## **OSI Model**

Layer	Central Devic Protocols	æ/
Application (7) Serves as the window for users and application processes to access the network services.	User Applications SMTP	
Presentation (6) Formats the data to be presented to the Application layer. It can be viewed as the "Translator" for the network.	JPEG/ASCII EBDIC/TIFF/GIF PICT	G
Session (5) Allows session establishment between processes running on different stations.	RPC/SQL/NFS NetBIOS names	Ŧ
Transport (4) Ensures that messages are delivered error-free, in sequence, and with no losses or duplications.	TCP/SPX/UDP	N N
Network (3) Controls the operations of the subnet, deciding which physical path the data takes.	Routers	Y Can be used
Data Link (2) Provides error-free transfer of data frames from one node to another over the Physical layer.	Switch Bridge WAP PPP/SLIP Land Based	on all layers
Physical (1) Concerned with the transmission and reception of the unstructured raw bit stream over the physical medium.	Hub	

## **Communication between Layers**



## **OSI Layer 1. Physical Layer**



transmitting and receiving data over a transmission media

- Transmission media
- Connector
- Data encoding and synchronization
- Transmission technique

## **OSI Layer 1 functionality**

### Transmission medium

### Connector

The path over which a data signal is carried. Transmission can be sent through a physical medium, such as copper wire or fiber optic cable, or it can be sent wirelessly using radio waves.

The Physical layer provides the direct connection between nodes (node - term used to refer to a connection point on a network, typically a computer or other network device).

## **OSI Layer 1 functionality**

### **Data encoding**

### Transmission technique

In the context of the Physical layer, it refers to converting data into a transmission format.

How to tell the start and end of a frame, and how data is synchronized. Physical layer also determine the transmission technique. Data can be sent using either a digital or analog transmission. Fiber optic transmissions, for example, are digital transmissions.

## **OSI Layer 2. Data Link Layer**



ensuring that data is transmitted between nodes without errors

### Link control

- Access management
- Traffic control
  - Sequencing
    - Acknowledgement
      - Delimiting
        - Error correction

### **OSI Layer 2 functionality**



## **OSI Layer 2 functionality**

Traffic control	Sequencing
	Acknowledgement
	Delimiting
	Error correction

### **OSI Layer 2. MAC address**

### Media Access Control (MAC) address

### The first three octets

The remaining three octets

### **OSI Layer 2. MAC Address**



## Adapter's physical address

### ipconfig/all

### adapter's physical address

Host Name	C:\Windows\system32\cmd.exe		23
Connection-specific DNS Suffix . Description	Host Name Win7 Primary Dns Suffix		• III
	Connection-specific DNS Suffix . Description	Ethernet eferred> 48 AM 03 PM 6-F8-2E-:	19

## **OSI Layer 3. Network Layer**



### routed networks

- Network address
  - Traffic routing
    - Fragmentation/ reassembly

### **Network Address**



### configuration

identifies the

node and the subnetwork

# 123.20.210.3

## **OSI Layer 3 functionality**



## **OSI Layer 4. Transport Layer**



### layer is responsible for error-free delivery message

- Segmentation
  - Acknowledgement
    - Traffic control
      - Multiplexing

### **Transport Layer functionality**

Segmentation	• Splits the message (if necessary) for reassembly by the receiving Transport layer.
Acknowledgement	• Uses acknowledgements to provide reliable delivery.
Traffic control	• Enables transmission only when a message is available.
Multiplexing	• Manages transmission of multiple messages.
	adds header information

## **OSI Layer 5. Session Layer**



• Establishing sessions between hosts

to support the session

- Managing/maintaining sessions
- Terminating sessions when it is no longer needed.

## **OSI Layer 6. Presentation Layer**



#### layer is responsible for formatting data

### Character translation

- ASCII
- EBCDIC
- Conversion
- Compression
- Encryption

### **Presentation Layer functionality**



## **OSI Layer 7. Application Layer**



#### access to network services

- Remote file and printer access
- Resource sharing
- Communications between processes
- Electronic messaging and e-mail
- Directory services
- Virtual devices and virtual communications
- Web browsing

## Summary

- Layer 1, the Physical layer, is responsible for data transmission at the transmission media level.
- Layer 2, the Data Link layer, is responsible for low-level link control and traffic control.
- Layer 3, the Network layer, is responsible for network addressing and routing traffic through a network.
- Layer 4, the Transport layer, is responsible for ensuring error-free message delivery.
- Layer 5, the Session layer, establishes and manages communication sessions between hosts.
- Layer 6, the Presentation layer, is responsible for data translation and formatting.
- Layer 7, the Application layer, provides users and applications with access to networking functionality and network services.

## Network Fundamentals





The Transmission Control Protocol/Internet Protocol (TCP/IP)



### **TCP/IP Model**



### **TCP/IP Model.** Network Access Layer



### **TCP/IP Model. Internet Layer**

TCP/IP Model (DoD Model)	TCP/IP – Internet Protocol Suite	<ul> <li>network addressing</li> <li>host addressing</li> <li>routing</li> </ul>
Application	FTP, NNTP, HTTP, SNMP, DNS, SSH,	<ul> <li>packaging data for transmission</li> <li>fragmenting packets for transmission and</li> </ul>
Transport	TCP, UDP	reassembling packets
Internet	IP, ICMP, ARP, DHCP	
Network Access	Ethernet, PPP, ADSL	

### **Internet Protocol version 4 (IPv4)**

It is responsible for addressing and routing packets.

It is responsible for delivering packets from the source host to the destination host solely based on the IP addresses.

It is a connectionless protocol, so it does not establish a connection between the source and destination hosts.

## **Internet Protocol version 4 (IPv4)**



## **Internet Protocol version 6 (IPv6)**

extend the address space

## fe80:bde1:d46f:5f6c:bff1:30db

### **Address Resolution Protocol (ARP)**

deserves special mention is ARP

map IP addresses to MAC addresses

MAC address information is collected through the use of broadcast transmissions

is maintained dynamically as the result of ARP broadcasts

### **ARP Command**

### arp -a

C:\Windows\system32\cmd.exe

C:\Users\Frank>arp -a

	Interface: 192.168.1.10	1 0xe	
	Internet Address	Physical Address	Type
	192.168.1.1	00-0f-66-36-ff-70	dynamic
	192.168.1.102	4c-0f-6e-66-05-0d	dynamic
	192.168.1.106	e0-ca-94-2c-d4-14	dynamic
	192.168.1.107	00-1f-16-f8-2e-19	dynamic
	192.168.1.112	e0-ca-94-7d-98-d4	dynamic
	192.168.1.255	ff-ff-ff-ff-ff-ff	static
	224.0.0.22	01-00-5e-00-00-16	static
	224.0.0.251	01-00-5e-00-00-fb	static
1	224.0.0.252	01-00-5e-00-00-fc	static
	239.255.255.250	01-00-5e-7f-ff-fa	static
	255.255.255.255	ff-ff-ff-ff-ff-ff	static
	Interface: 192.168.40.1	0×10	
	Internet Address	Physical Address	Туре
	192.168.40.255	ff-ff-ff-ff-ff-ff	static
	224.0.0.22	01-00-5e-00-00-16	static
	224.0.0.251	01-00-5e-00-00-fb	static
	224.0.0.252	01-00-5e-00-00-fc	static
	239.255.255.250	01-00-5e-7f-ff-fa	static
	255.255.255.255	ff-ff-ff-ff-ff-ff	static

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### **TCP/IP Model.** Transport Layer


### **TCP and UDP protocols**

**Transmission Control Protocol (TCP) is a connection-oriented protocol** 

**User Datagram Protocol (UDP) is a connectionless protocol** 

#### **TCP/IP Model.** Application Layer



# It is the interface between a computer's users and applications

#### **Application layer protocols:**

 Telnet, SSH, SNMP (Simple Network Management Protocol), FTP (File Transfer Protocol), HTTP (Hypertext Transfer Protocol), SMTP (Simple Mail Transfer Protocol), DNS (Domain Naming System), DHCP (Dynamic Host Configuration Protocol).





# Network Fundamentals



### Ethernet

## family of computer networking

technologies

#### a low-level communication

protocol

#### IEEE 802.3 standard

## **Ethernet History**



- Transmission media and Connector types;
- Cable segment lengths;
- Transmission signals;
- Frame format;
- Network access method.

# **Ethernet specifications**





# **Current Ethernet standard**

Name	Data rate	Standard	Note
10BaseT	10 Mbps	802.3i	<b>Requires two twisted pairs</b>
100BaseT	100 Mbps	802.3u	<b>Requires two twisted pairs</b>
1000BaseT	1 Gbps	802.3ab	<b>Requires four twisted pairs</b>
10GBaseT	10 Gbps	802.3an	<b>Requires four twisted pairs</b>

### **Ethernet Frame**

Preamble	Start of frame delimiter	MAC destination	MAC source	802.1Q tag (optional)	Ethertype (Ethernet II) or length (IEEE 802.3)	Payload	Frame check sequence (32-bit CRC)	Interpacket gap
7 octets	1 octet	6 octets	6 octets	(4 octets)	2 octets	46(42) <sup>[b]</sup> -1500 octets	4 octets	12 octets
			<i></i>	÷	- 64–1518(1522) octets	3→		

#### source and destination MAC addresses

#### 1500 bytes of payload entire frame size is 1518

bytes

# **Ethernet Traffic Types**

#### Unicast

#### **Broadcast**

#### **Multicast**

#### Anycast





When a collision occurs:

- All involved hosts will stop transmitting.
- Both frames are discarded.
- Both stations will wait a random time and attempt to transmit until successful.

with a maximum transmission

attempt count.

are built with switches

through the appropriate port at the switch

### **Collision Domain**



#### VLAN

#### segmentation through VLANs



### **VLAN and Ethernet**





# Network Fundamentals



# Wireless Networking



#### **Defined by 802.11 standards**

## **Current Wireless Standards**

Standard	Frequency	Maximum data rate
802.11a	5 GHz	54 Mbps
802.11b	<b>2.4 GHz</b>	11 Mbps
802.11g	<b>2.4 GHz</b>	54 Mbps
802.11n	2.4/5 GHz	Up to 600 Mbps
802.11ac	5 GHz	Up to 1.3 Gbps



# Access points



Most 802.11 wireless network configurations are based around one or more access points (APs).

### **Access method**

**CSMA/CA (Carrier Sense Multiple Access with Collision Avoidance)** 

to ensure the availability of the channel





# Network Fundamentals



# **Security Basics**

 Authentication and resource access •Data and communication security

#### **Authentication and resource access**

Authentication	• Identify verification	
Authorization	• Access control and access permissions	
Accounting	• Tracking access to resources	

#### **AAA framework**

# **Authentication Forms**



you have taken part in an

#### authentication process



### Authorization



### Accounting

Accounting systems could be used to track the amount of time that a user is connected or the amount of data uploaded or downloaded by the user

to collect data for

network planning



(RADIUS) manage centralized

#### be used to provide AAA support for Internet sites, internal wired networks, and wireless networks.





## **Data Integrity Technology**

#### for keeping data safe and secure



• Making sure that unauthorized changes are not made to your data. For example, preventing a hacker from intercepting a file, making changes to the file, and then passing it on to its destination.

### **Data Integrity Technology**

is the use of data

#### encryption.

A special value, known as a key, is used to encrypt and decrypt the data

Symmetric encryption	• Encryption method in which the same key is used to encrypt and decrypt data.
Asymmetric encryption	• Encryption method based on using two different keys, one for data encryption and one for decryption.

### **Symmetric Encryption**

# Stream cipherBlock cipher

#### stream cipher is RC4.





- Advanced Encryption Standard (AES)
- Data Encryption Standard (DES)
- Triple DES (3DES)


## a private key



