

Midterm Summary and Feedback

ELEC-C7420 Basic Principles in Networking



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Lectures

- Ethernet
- WLAN
- IP
- TCP/UDP
- HTTP
- DNS, CDN

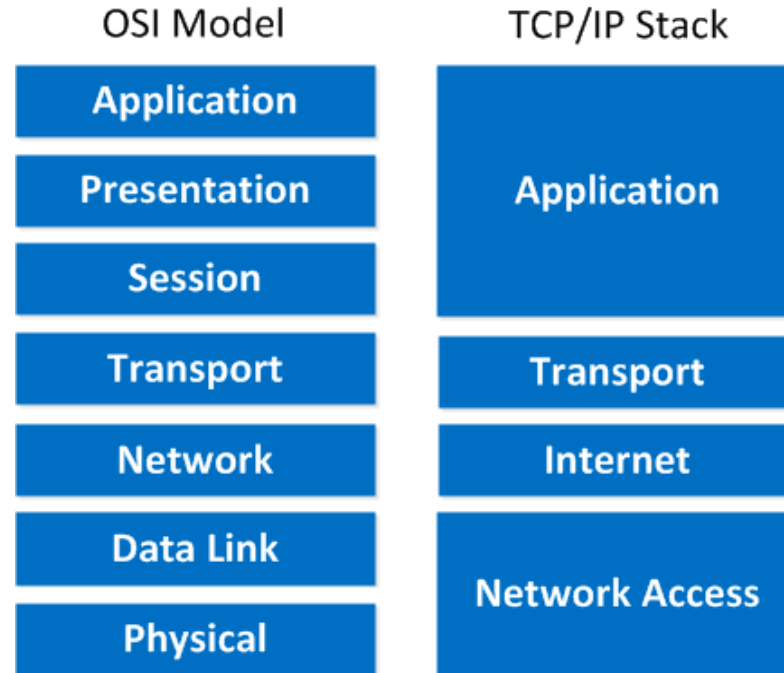
Types of Communications

- **Unicast, Multicast, Broadcast, Anycast**
- **Full duplex vs Half-duplex**

Addresses

- **MAC Address**
- **IP Address**
- **Socket address**

OSI Model & Data Encapsulation



How Radio Waves are Propagated

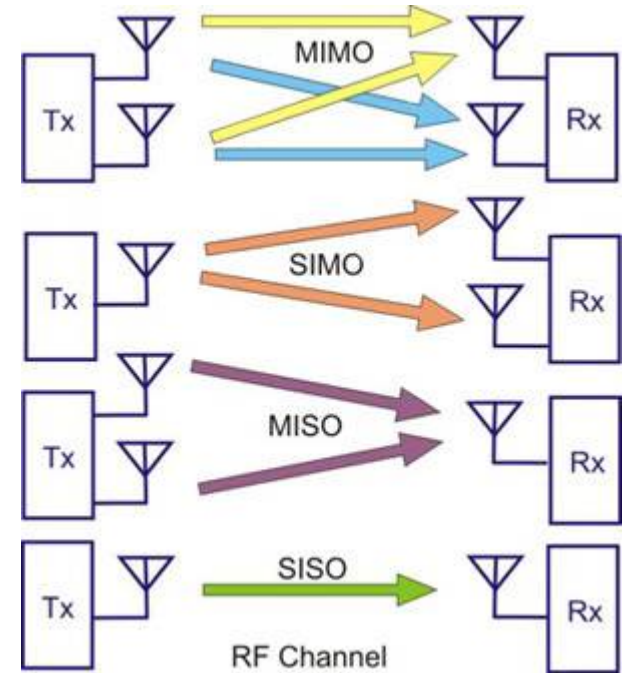


Wi-Fi

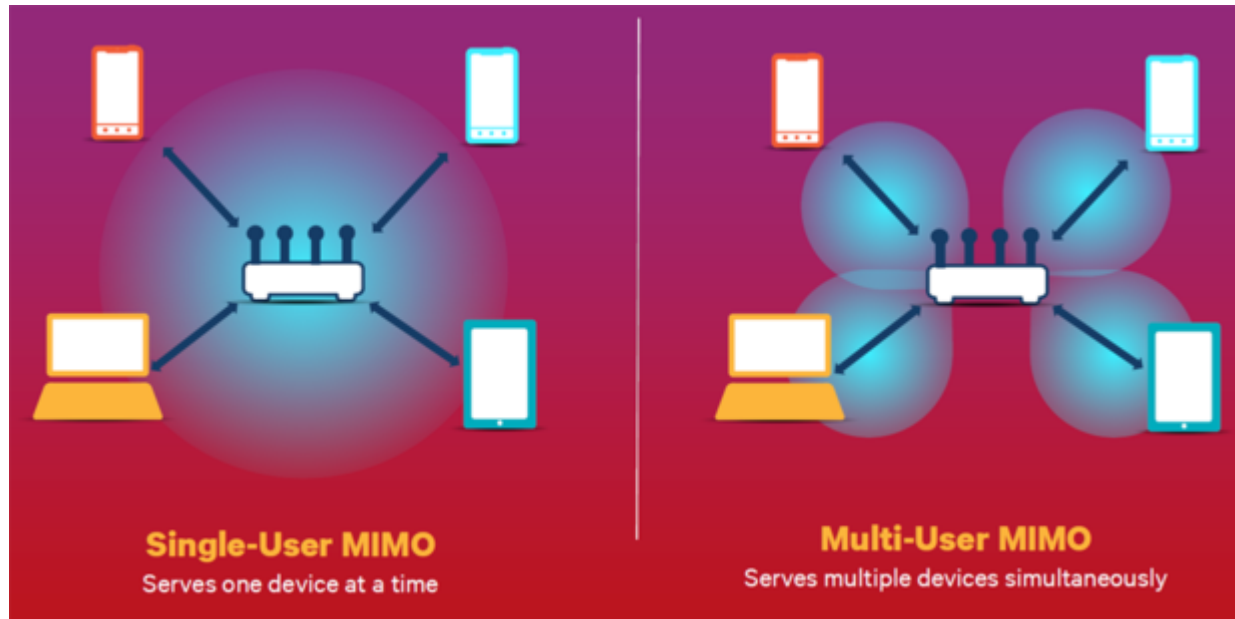
- **Scanning**
- **Association**
- **Beacon**
- **RF interference**
- **Carrier Sense Collision Avoidance**

Multiple Input Multiple Output (MIMO)

- MIMO is commonly used in Wi-Fi, WiMax and cellular networks
- To use N streams, both sender and receiver must have N antennas; all the antennas use the same frequency channels but each transmitter antenna sends a different data stream.
- More antennas → higher data rate, but also more power, space?



SU-MIMO vs. MU-MIMO

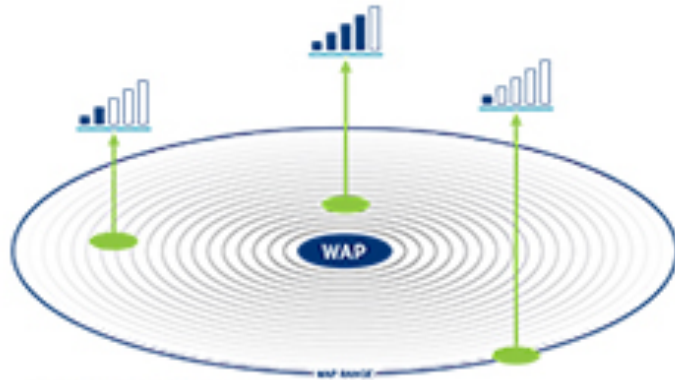


MU-MIMO becomes available in 802.11ac Wave 2 but only applies to downlink.

Source: Qualcomm

Beamforming

- **Beamforming:** Shape the transmit signal in the way that the transmit energy is focused on a particular direction



An omni-directional signal.
Signal is equally distributed
on all sides and forms a
circular pattern.



Beam-formed signal

Beamforming

- Beamforming uses antenna arrays to dynamically alter the transmission pattern of the AP, and the transmission pattern can be changed on a per-frame basis.

How Does Beamforming Work?

Introduction Video:

<https://www.youtube.com/watch?v=QKj0PsTXHr8>

Chapter 4 Beamforming in 802.11ac. 802.11ac: A survival guide by Matthew S. Gast. <https://www.oreilly.com/library/view/80211ac-a-survival/9781449357702/ch04.html>

Internet Protocol

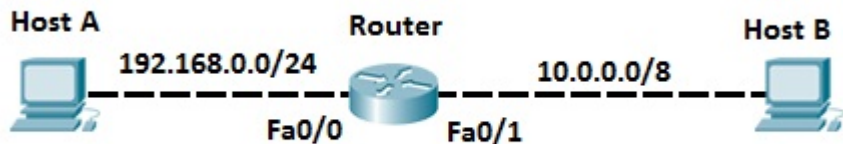
- **IP packets**
- **Process of IP routing**
- **Internet Control Message Protocol (ICMP)**

display routing table information for an Internet interface

%netstat -r -f inet

3 Types of Routes in Routing Table

- **Connected Routes:** subnets directly connected to a router's interface are added to the router's routing table



Both Fa0/0 and Fa0/1 should be in active states

```
Router#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

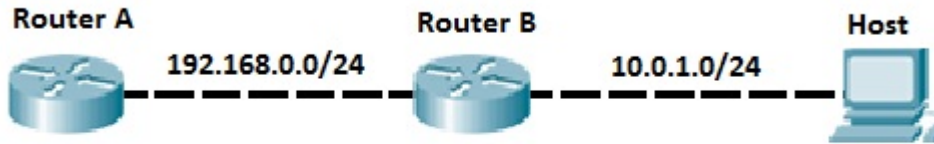
C    10.0.0.0/8 is directly connected, FastEthernet0/1
C    192.168.0.0/24 is directly connected, FastEthernet0/0
Router#
Router#
```

3 Types of Routes (2)

- **Static Routes:** configured manually by typing the global configuration mode command

```
% ip route DESTINATION_NETWORK SUBNET_MASK  
NEXT_HOP_IP_ADDRESS
```

```
%ip route DEST_NETWORK NEXT_HOP_INTERFACE
```



On Router A,
#ip route 10.0.1.0 255.255.255.0 192.168.0.2
Or,
#ip route 10.0.1.0 255.255.255.0 fa0/0

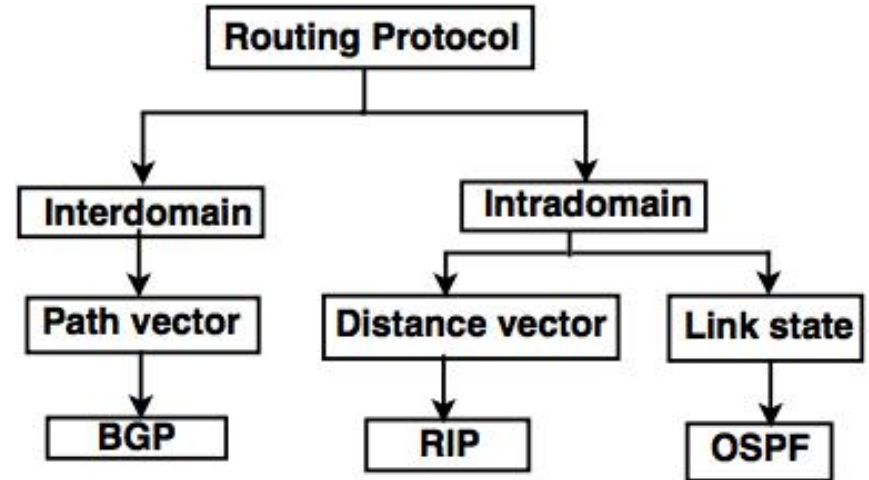
3 Types of Routes (3)

- **Dynamic routes**
 - A router can learn dynamic routes if a routing protocol is enabled.
 - A routing protocol is used by routers to exchange routing information with each other.

The **disadvantage of dynamic routing** is that it increases memory and CPU usage on a router, because every router has to process received routing information and calculate its routing table.

Routing Update Algorithms

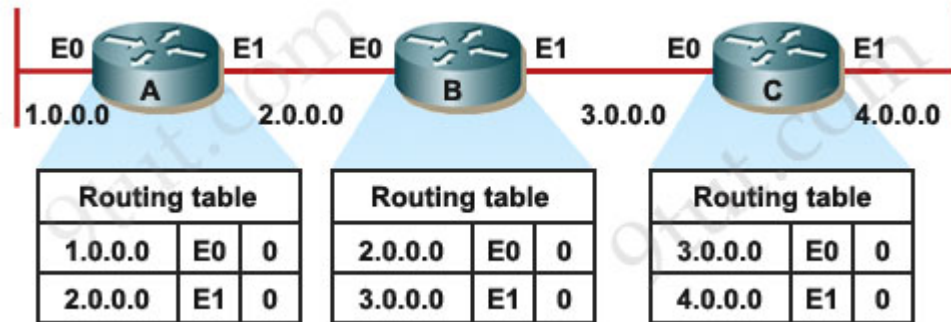
- Routing Information Protocol (RIP)
- Open Shortest Path First (OSPF)
- Border Gateway Protocol (BGP)

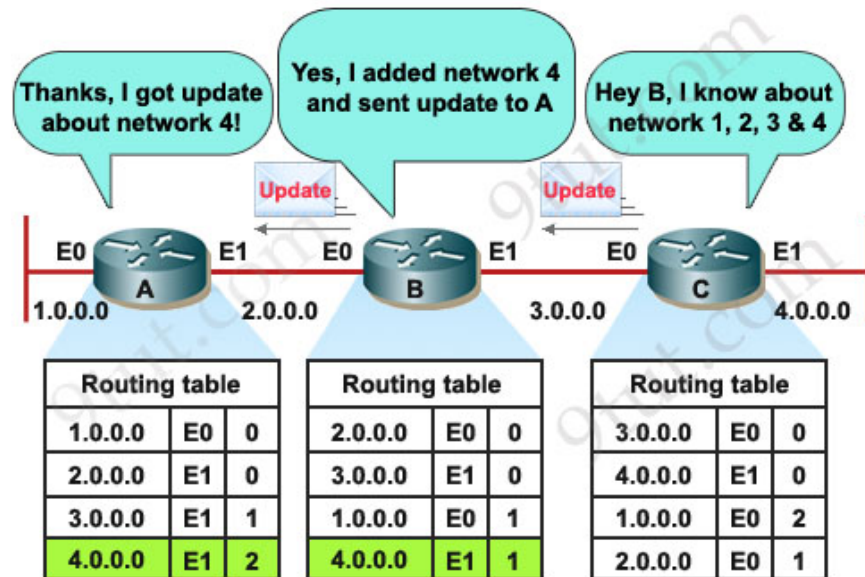
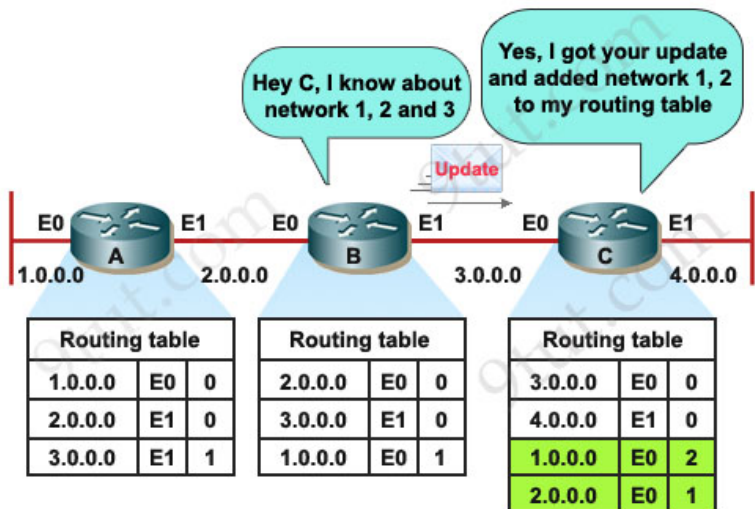
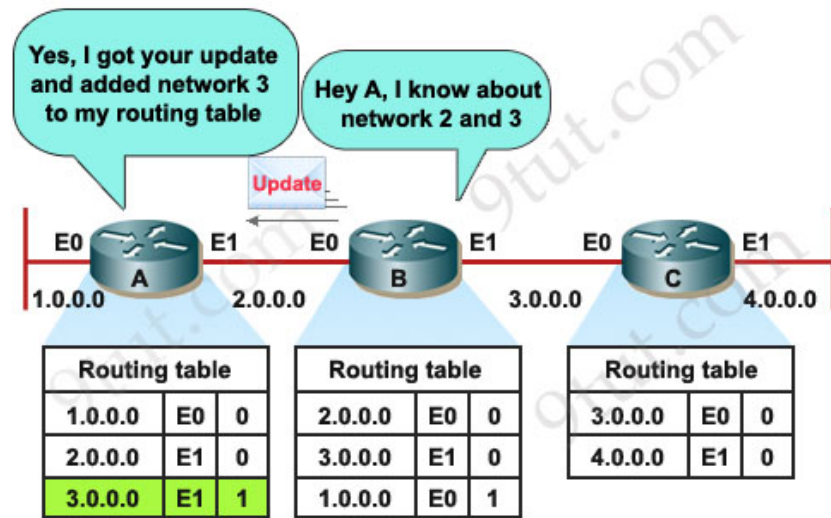
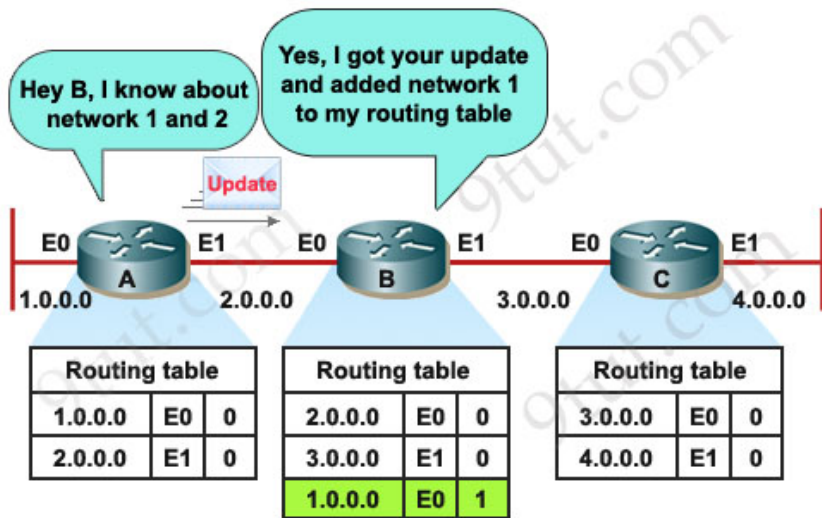


Classification of routing protocol

Distance-Vector Routing Update

- **Distance** – hop count (how many routers that these packets will have to go through to reach the destination)
- **Vector** – next hop router
- Each router creates its routing table on route information exchanged between neighbours



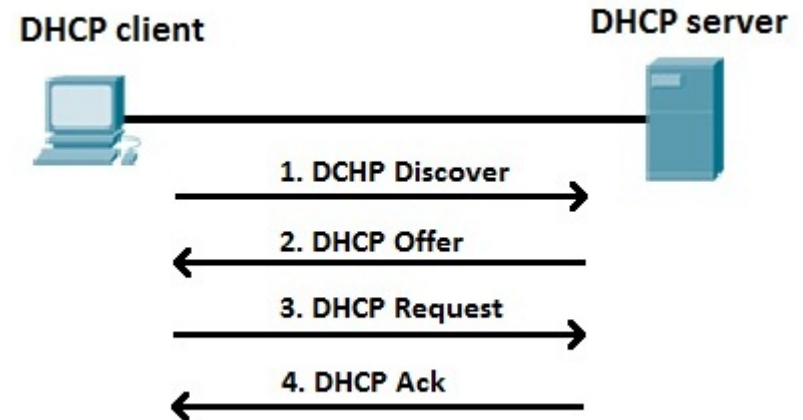


Other Routing Update Algorithms

- OSPF was developed so that the shortest path through a network was calculated based on the **cost** of the route, taking into account bandwidth, delay and load
- BGP makes routing decisions based on paths, network policies, or rule-sets configured by a network administrator and is involved in making core routing decisions.

Dynamic Host Configuration Protocol (DHCP)

- DHCP is a network management protocol that is used to assign an IP address and various network parameters to a device.
- It runs on top of UDP/IP



DHCP uses a well-known UDP port number 67 for the DHCP server, and the UDP port number 68 for the client.

DHCP

- 1: A DHCP client sends a broadcast packet (**DHCP Discover**) to discover DHCP servers on the LAN segment.
- 2: The DHCP servers receive the DHCP Discover packet and respond with **DHCP Offer** packets, offering IP addressing information.
- 3: If the client receives the DHCP Offer packets from multiple DHCP servers, the first DHCP Offer packet is accepted. The client responds by broadcasting a **DHCP Request** packet, requesting the network parameters from the server that responded first.
- 4: The DHCP server approves the lease with a **DHCP Acknowledgement** packet. The packet includes the lease duration and other configuration information.

TCP/UDP

- TCP vs. UDP
- TCP flow control, congestion control
- Socket programming

HTTP

- **HTTP semantics**
- **RESTful Model**

CDN

- DNS query
- Selection of CDN

Feedback on Assignment III

Different roles of YouTube servers?

IP addresses and locations of YouTube servers?

Workflow?

Ping to content server?

Time to get first byte?

Impact of content popularity, location, time of day?

Which content server to select? (depending on latency, distance, hops or some other factors?)