



دانشگاه صنعتی اصفهان  
دانشکده مهندسی برق و کامپیوتر

عنوان: تکلیف دوم درس مهندسی فناوری اطلاعات

نام و نام خانوادگی: علیرضا ابره فروش

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مدرس: دکتر محمدحسین منشئی

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## a ۱.۱

$$\text{Subinterfaces of the router} = \begin{cases} 187.135.10.0/24 \\ 187.135.20.0/24 \end{cases}$$

$$\text{VLAN IDs of the router} = \begin{cases} 187.135.10.1 & \text{EE} \\ 187.135.20.1 & \text{CE} \end{cases}$$

IP address of the EE devices = 187.135.10.i  $\forall$  device  $i \in$  EE department

IP address of the CE devices = 187.135.20.i  $\forall$  device  $i \in$  CE department

## b ۲.۱

An IP datagram going from the EE to the CS department would first cross the EE VLAN to reach the router and then be forwarded by the router back over the CS VLAN to the CS host.

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سوئیچ‌های لایه ۳ عملکردی مشابه با سوئیچ‌های لایه ۲ دارند؛ با این تفاوت که بر مبنای آدرس لایه‌ی شبکه (معمولاً آدرس آی‌پی) کار می‌کنند. این سوئیچ‌ها مزیت‌های سوئیچ‌ها و روترها را با هم دارند. می‌توان آن‌ها را جای روترها به کار برد و از فواید سوئیچ‌های لایه ۲ سنتی شامل انتقال سریع‌تر و تعداد پورت بیشتر همزمان فعال نسبت به روترها بهره برد.

ATTRIBUTE	LAYER 3 SWITCH	ROUTER
Scope	LAN for Office, Data Center or Campus environment	WAN for Office, Data Center or Campus environment
Key Functionality	Routes across different subnets or VLANs on a campus LAN	Routes across different networks across WAN are communicated and Routed by a Router
MPLS and VPN Services	Does not support MPLS and VPN services	Router provides MPLS and VPN services like PPP etc.
Edge Technologies Support	Not supported.	NAT, firewalling, tunneling, IPSec
Size of Routing Table	Smaller Routing table compared to Router	Considerably bigger to support multiple Route entries.
Forwarding Decision	Forwarding is performed by specialized ASICs	Performed by Software
Example Of Routers	Cisco 3650, 3560 and 6500 Series are examples of Layer 3 Switches.	Cisco 3900 , 4000 Series ISR Routers
Interface Support	As general case L3 Switches support Ethernet ports (Copper and Fiber). Does not support SONET, OC-N, T-1/T-3	Support Ethernet ports (Fiber and Copper). Also support interfaces like SONT,OC-N, T1/T3 etc.
Throughout	High Throughput	Lower than Layer 3 Switches
Switching Capacity	High Switching Capacity	Lower than Layer 3 Switches
Cost	Low Cost	High Cost
Port Density	High	Low

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## a ۱.۳

با توجه به VLAN-based BB Network Design یک روتر، یک سوئیچ مرکزی (مثلاً 10base-T switched) و کابل (مثلاً Category 5e). همه‌ی device‌ها را به سوئیچ مرکزی وصل می‌کنیم و به ازای هر office یک VLAN تعریف می‌کنیم و device‌های نظیر آن office را به VLAN اضافه می‌کنیم تا device‌های نظیر آن office با هم ارتباط داشته باشند و ترافیک هر دو office مجزا از هم جدا باشند.

b ۲.۳

$$required\ bandwidth = 8\ floors \times \frac{10\ offices}{1\ floor} \times \frac{7\ devices}{1\ offices} \times \frac{8\ Mbps}{1\ device} = 4.480\ Gbps$$

c ۳.۳

در هر طبقه با توجه به شعاع تحت پوشش access point مورد استفاده، به تعداد مورد نیاز access point قرار می‌دهیم.

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Transmits 1 bit in each of 16 sub channels using BPSK with FEC rate =  $\frac{1}{2}$  and 4 bits in each remaining sub channels using 16QAM FEC rate =  $\frac{3}{4}$  sent at  $250\text{KHz}$ . Thus we have:

$$1b \times \frac{1}{2} \times 16 \times 250\text{KHz} + 4b \times \frac{3}{4} \times (48 - 16) \times 250\text{KHz} = 26\text{Mbps}$$

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Bit	Barker Sequence Code
0	10111010000
1	01000101111

Input Data = 01110011

Barker Sequence Codes = 10111010000 01000101111 01000101111 01000101111

10111010000 10111010000 01000101111 01000101111

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Following are the features of WiFi-6 (i.e. IEEE 802.11 ax ) wireless technology:

- Higher modulation scheme such as 1024-QAM
- More number of OFDM subcarriers in a symbol or long OFDM symbol
- Multiplexing users using MU-MIMO concept both in the uplink and downlink
- Beamforming and OFDMA technique
- 8 simultaneous MU-MIMO streams
- Uplink scheduling without any contention
- BSS color codes
- Use of both 2.4 GHz and 5 GHz bands

802.11 ax (i.e. WiFi 6) physical layer supports different bandwidth options such as 20 MHz, 40 MHz, 80 MHz, 80+80 MHz and 160 MHz. It supports FFT sizes e.g. 256, 512, 1024 and 2048. The subcarrier spacing is 78.125KHz. The symbol duration is  $12.8 \mu s + 0.8/1.6/3.2 \mu s$  CP.

Following are the benefits or advantages of WiFi 6 or 802.11 ax technology:

- It has been developed to deliver 40% high peak data rates using single client device. Average throughput per user is improved by at least 4 times in dense environments.
- It offers four times increase in network efficiency compare to 802.11ac.
- It is backward compatible with 802.11n and 802.11ac devices.
- It uses OFDMA and hence multiple users can transmit at the same. The OFDMA based scheduling helps in reducing overhead and latency both.
- The battery life of 802.11 ax client devices have been enhanced due to introduction of new feature called TWT (Target Wake Time). TWT feature allows client devices to sleep and wake up at scheduled times.
- Mitigation of co-channel interference is possible using BSS color codes. This codes help 11ax stations to identify transmission from another network.
- It offers robust high efficiency signaling for better operation at significantly lower RSSI.
- It performs well both the the indoor and outdoor environments. To achieve the same, it uses longer symbol duration and cyclic prefix (CP) in outdoor environment where as it uses shorter CP in indoor environment.

802.11 network standards											
Frequency range, or type	PHY	Protocol	Release date	Frequency (GHz)	Bandwidth (GHz)	Maximum Linkrate (Mbps)	Stream data rate (Mbps)	Allowable MIMO streams	Modulation	Approximate range	
										Indoor	Outdoor
1-6 GHz	ERP-OFDM	802.11g	Jun 2003	2.4	5/10/20	6 to 54	6, 9, 12, 18, 24, 36, 48, 54 (for 20 MHz bandwidth, divide by 2 and 4 for 10 and 5 MHz)	-	OFDM	38 m (125 ft)	140 m (460 ft)
	HT-OFDM	802.11n (Wi-Fi 4)	Oct 2009	2.4/5	20	72 to 600	Up to 288.8	4	MIMO-OFDM (64-QAM)	70 m (230 ft)	250 m (820 ft)
					40		Up to 600				
	HE-OFDMA	802.11ax (Wi-Fi 6, Wi-Fi 6E)	May 2021	2.4/5/6	20	574 to 9608	Up to 1147	8	UL/DL MU-MIMO OFDMA (1024-QAM)	30 m (98 ft)	120 m (390 ft)
					40		Up to 2294				
					80		Up to 4804				
					80+80		Up to 9608				

## منابع

[1] <https://www.rfwireless-world.com/Terminology/Advantages-and-Disadvantages-of-802-11ax.html>

[2] <https://ipwithease.com/difference-between-router-and-layer-3-switch/>