COMP4336/9336 Mobile data networking
Quiz-3 Niche WiFi: 802.11af/ah/ad/ay

Q1. If a mobile device is fitted with an 802.11af chip and attains a data rate of 106.68 Mbps without resorting to channel bonding, how many antennas is it probably outfitted with? Please consider that the WiFi configuration uses 6MHz channels.

A1. 4

Maximum data rate with single stream (no MIMO) over 6MHz un-bonded channel: 26.67 Mbps

With 4 antennas, it can enjoy a maximum of 4 MIMO streams, which increases its maximum data rate to 4x26.67 = 106.68 Mbps

Q2. In a scenario where a smart TV is furnished with an 802.11ad WiFi chipset offering 64 antenna sectors and your mobile phone has an 802.11ad WiFi chip with just 8 antenna sectors, you aim to mirror your mobile phone screen on the TV using WiFi. Consequently, both the TV and the mobile phone must identify the optimal sector pairs for reliable directional communication. When considering an omnidirectional approach for finding the best sector pair, how much reduction in training effort, as a percentage, can be achieved compared to the exhaustive search method?

A2.
Exhaustive Search: 64x8 = 512 training
Omnidirectional Search: 64+8 = 72 training
Reduction in training: {(512-72)/512}x100 = 85.94%

Q3.

Consider an 802.11ad PBSS (Partial Basic Service Set) configuration in which all stations are equipped with 12 antenna sectors. The table below presents the sector pairs acquired through sector-level beam training among six stations, denoted as A to F. For instance, in the first row of the table, it is indicated that station A employs its sector #1 for communication with station B, while station B utilizes its sector #7 for communication with station A.

Station Pair	Sector Pair
(A,B)	(1,7)
(A,E)	(4,12)

(B,E)	(7,2)
(B,F)	(9,10)
(C,D)	(10,4)
(A,F)	(2,7)
(E,F)	(3,7)

The data provided in the table is currently insufficient for the PCP/AP to determine whether it can concurrently schedule communications for both A-B and C-D without encountering interference. To make an informed decision, the table must be expanded to include sector pair values for (A,C), (A,D), (B,C), and (B,D). Which of the following configurations would enable simultaneous scheduling of communications for both A-B and C-D without interference?

a) **(A,C) (2,9) ; (A,D) (3,3); (B,C) (6,8) ; (B,D) (9,10)**
b) (A,C) (2,10) ; (A,D) (3,3); (B,C) (6,8) ; (B,D) (9,10)
c) (A,C) (1,9) ; (A,D) (3,3); (B,C) (6,8) ; (B,D) (9,10)
d) (A,C) (2,9) ; (A,D) (1,3); (B,C) (6,8) ; (B,D) (9,10)
e) (A,C) (2,9) ; (A,D) (3,4); (B,C) (6,8) ; (B,D) (9,10)

A.

For (A, B) communications, A will use #1 and B #7 (from Table I). For simultaneous communication between (C, D), where C uses #10 and D uses #4, we need to make sure that C does not use #10 for communicating with either A or B and D does not use #4 for communicating with either A or B. Similarly, we also need to make sure that A does not use #1 for communicating with either C or D, and B does not use #7 for communicating with either C or D. We also need to make sure that beam numbers are drawn from 1-12 as there are 12 sectors.

A possible set of beam pairs would be:
(A,C) (2,9) ; C avoids #10 to comm with A, and A avoids #1 to comm with C
(A,D) (3,3) ; D avoids #4 to comm with A, and A avoids #1 to comm with D
(B,C) (6,8) ; C avoids #10 to comm with B, and B avoids #7 to comm with C
(B,D) (9,10) ; D avoids #4 to comm with B, and B avoids #7 to comm with D

Q4. In IEEE 802.11ad, which of the following statements regarding the order of frame types is correct?

a) BRP precedes SLS. b) SLS precedes BRP. c) BRP and SLS are transmitted simultaneously. d) The order of BRP and SLS can vary. e) None of the above.

A4. B) SLS is always performed first. BRP is optional that can follow SLS if more fine grained beamforming is required.

Q5. Two 802.11ad devices have exchanged 64 SLS frames to train their antenna sectors using the exhaustive search option. Which of the following scenarios is the most likely?

a) Both devices are fitted with 4-sector antennas
b) One device is fitted with a 4-sector antenna, while the other is fitted with a 16-sector antenna
c) One device is fitted with an 8-sector antenna, while the other is fitted with a 16-sector antenna
d) Both devices are fitted with 16-sector antennas
e) Both devices are fitted with 32-sector antennas

A5. B) 4x16 = 64

Q6. During the execution of the beam refinement protocol (BRP), what is the primary outcome for a pair of devices?

a) Expanding the beam width selected during sector-level sweep (SLS). b) **Narrowing the beam width selected during sector-level sweep (SLS).** c) Streamlining the process of beam alignment. d) Enabling simultaneous communication with two devices. e) Omitting the sector-level sweep (SLS) phase.

A. B)

Q7. TVWS databases are primarily designed for:

A. Facilitating whitespace utilization without the need for radios to sense and detect free TV channels. B. Squeezing more data into a given TV channel, C. Monitoring the adherence of TV broadcasts against the advertised schedules, D. Monitoring the quantity of TV stations within a specific region. E. Enhancing the data rates of cellular networks

A. a) The information about free TV channels can be retrieved from the database directly.

Q8. The following table shows the received signal strength (RSS) at the responder for each transmitted training frame from the beam training initiator during SLS. There are four sectors for both initiator and responder, and the number after the station letter denotes the sector number. For example, A.1 in the first row refers to the SLS frame transmitted by station A on its antenna sector 1. What is the optimum sector pair for (A,B) discovered after the SLS?

SLS training between stations A and B								
Transmitted Sector	A.1	A.2	A.3	A.4	B.1	B.2	B.3	B.4
RSSS at Responder (dBm)	-70	-62	-50	-49	-49	-71	-75	-48

A) (4,4)
B) (4,2)
C) (2,4)
D) (3,1)
E) (1,3)

A8. A) is the correct answer. A.4 provides the strongest signal to B. Similarly, B.4 provides the strongest signal to A. Therefore, both stations would select sector 4 to communicate with the other station.

Q9. 802.11ay can achieve higher speed compared to 802.11ad because it uses higher transmission power, supports MIMO, uses higher frequency, and uses higher channel bandwidth.

a) TRUE, **B) FALSE**

Q10. You are tasked with designing an advanced version of 802.11ad that can double the maximum data rate. However, you are allowed to achieve this by only introducing a new modulation and coding scheme (MCS). Which of the following would be a valid MCS?

a) 4096-QAM with 13/16 coding rate.

b) 128-QAM with 3/4 coding rate.

c) 2048-QAM with 13/16 coding rate.

d) 1024-QAM with 7/8 coding rate.

e) None of these.

Sol.

Correct answer is a)

4096 = 2^{12}; 12 bits per symbol, which is double the 6 bits per symbol (64-QAM) currently used for the maximum data rate for 802.11ad.

Al other options would fail to double the maximum data rate.

End of Quiz-Niche-Wifi