CS 168 Introduction to the Internet: Architecture and Protocols
Spring 2024 Sylvia Ratnasamy & Rob Shakir Discussion 13: Wireless

1 True or False

1. Wireless is a fundamentally shared medium.

   (a) True (b) False

   Solution: True. The wireless medium is a shared physical space instead of wired infrastructure.

2. RTS/CTS with carrier sense solves the exposed terminal problem and the hidden terminal problem.

   (a) True (b) False

   Solution: False. RTS/CTS only solves the hidden terminal problem, but not the exposed terminal problem.

3. The path loss of a wireless transmission is always the same in all directions

   (a) True (b) False

   Solution: False. Obstacles and reflections mean that the reality of wireless transmission is messy and non-uniform.

4. CSMA is a method which listens for other transmissions and does not transmit if others already are transmitting.

   (a) True (b) False

   Solution: True.

5. The physical layer can define data using a change in voltages, amplitudes, frequencies, and or phases.

   (a) True (b) False

   Solution: True. Physical layer modulation can take many different forms including voltages, amplitudes, frequencies, and phases.

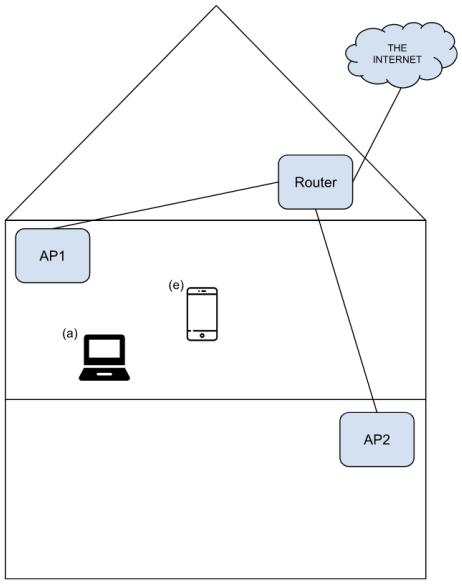
6. Cellular networks are built on top of the same priorities as the internet.

   (a) True (b) False

   Solution: False. Authentication and accounting are central goals and mobility is the central goal.

2 WiFi

Consider the following home network, with multiple users and devices. There are two access points (AP1 and AP2). The router is connected to the internet (ignore the details of this) and the access points are connected to the router over ethernet. Devices connect to access points over WiFi.

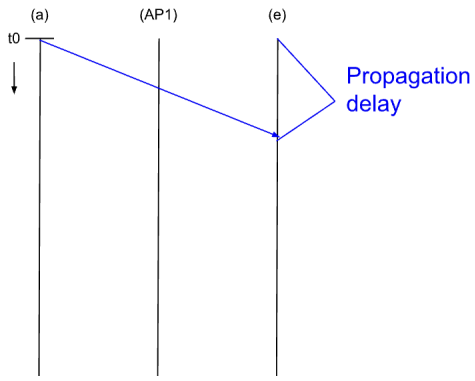


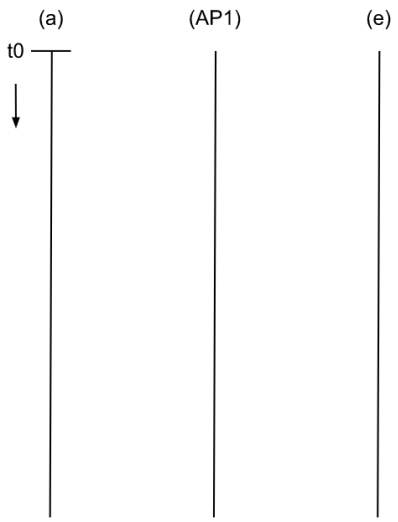
Each access point periodically (100ms) broadcasts beacon messages with SSID and MAC addresses, allowing for discovery. You've been tasked with designing a medium access control algorithm for in-home devices!

1. Devices (a) and (e) both are in range of AP1, but not AP2, they are also in range of each other, so you attempt to use CSMA.

   (a) If (a) starts transmitting first at t0, draw the transmission path and notate the propagation delay to (e) on the following figure.

   Solution: Line from (a) t0 diagonally to (e). Propagation delay is the time it takes to get to (e) notated from t0 to t intersection of line.





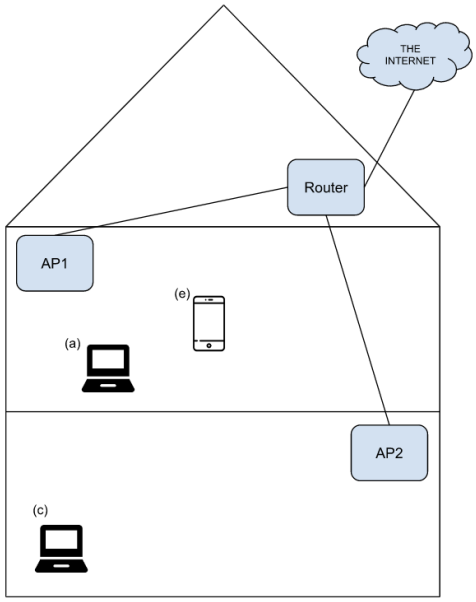
(b) If (e) runs CSMA during this propagation delay, will (e) transmit data and if so what will happen?

Solution: (e) will use carrier sense to measure if anyone else is transmitting. Since the signal from (a) has not propagated to (e), (e) will think no one is transmitting. Therefore (e) will try to transmit data. In this case, collisions will occur since (a) is already transferring data causing drops at AP1.

(c) If (e) runs CSMA after this propagation delay, will (e) transmit data and if so what will happen?

Solution: (e) will use carrier sense to measure if anyone else is transmitting and will hear (a) transmitting. Therefore, (e) will wait until (e)'s transmit is done and then transmit.

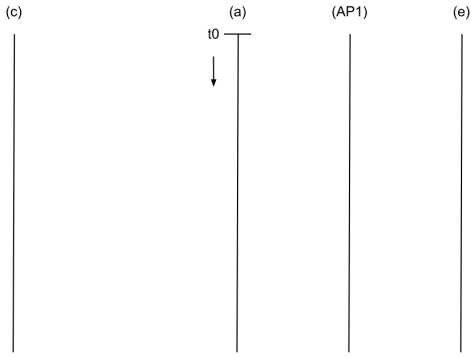
2. In part one, you used CSMA and listened to the medium long enough to allow (a) and (e) to take turns. But now, device (c) is present in the home. Device (c) connects to AP1 as well, but device (e) and device (c) are not in range of each other.



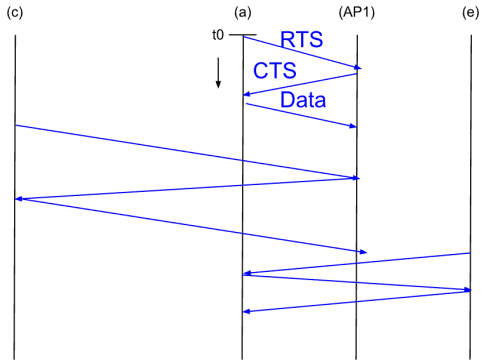
(a) What is the problem with your current CSMA approach in this case?

Solution: In the current CSMA approach device (e) and device (c) are not in range, so they cannot sense that the other is transmitting which is the hidden terminal problem since they will both try and transmit resulting in collisions

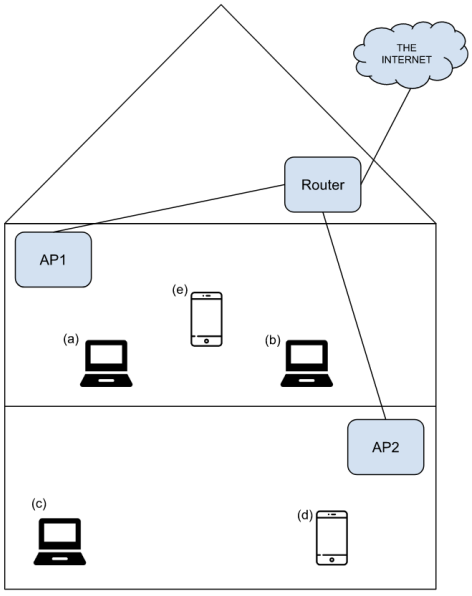
(b) You decide to use RTS/CTS to fix your problem. Notate the transmissions between the participating devices. Assume that (a) transmits first, then (c) and then (e) and that there are no RTS collisions.



Solution: (a) rts to AP, AP cts to (a), (c), (e), (a) sends data. same for (c) and (e)



3. In part two, with three devices there was not an issue with RTS collisions, but now even more devices are added to the network, talking to multiple APs.

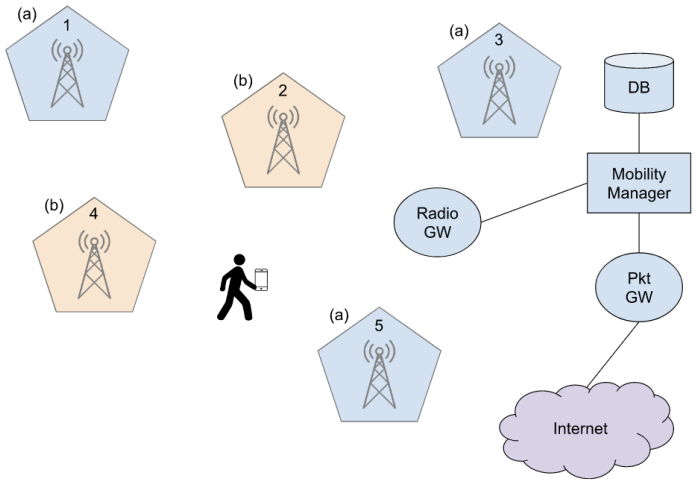


(a) What should a transmitter do if an RTS does not result in a corresponding CTS?

Solution: Since there was not CTS, the RTS likely hit a collision. Therefore the transmitter should back-off for a time period and retry the RTS later.

3 Cellular

In the following cellular architecture, the user is registered with the cellular operator (a) shown in blue and labeled with (a). As the user moves around the area, they discover and transfer data using different cellular towers.



1. The user device is registered with operator (a), and gets the following beacons from the different towers with different received signal strength indicators (RSSI).

Tower	RSSI	Operator
1	-75dBm	(a)
2	-23dBm	(b)
3	-84dBm	(a)
4	-32dBm	(b)
5	-42dBm	(a)

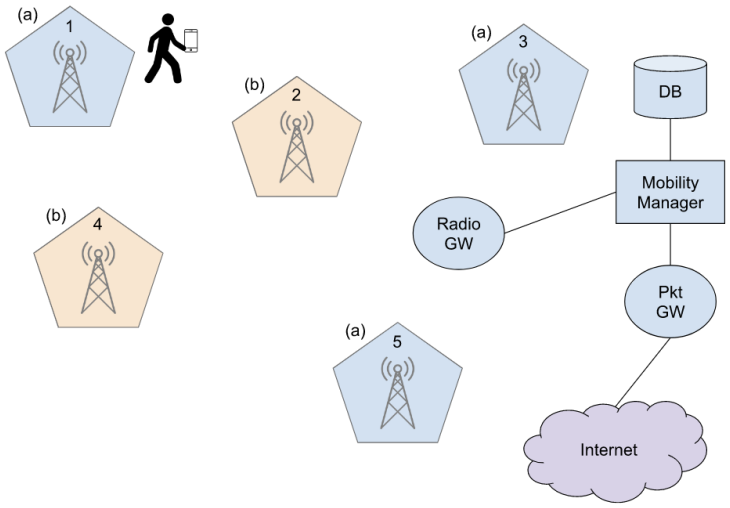
   (a) Which tower should the user device connect to?

   Solution: The user should connect to the tower with the highest signal strength that is in the administrative domain that they have signed up for. In this case, tower 5 has the highest dBm for operator a.

   (b) What entity in the cellular core processes the attach request from the user device?

   Solution: The mobility manager processes the attach request by checking to make sure the user exists in the database, and providing authentication.

2. Now the user moves as shown below and a handoff to tower 1 must occur.



(a) Who participates in the handoff? Circle all that apply.

i. User Device
ii. Packet Gateway
iii. Tower 1
iv. Old Tower (from part 1)
v. Tower 4
vi. Mobility Manager

Solution: i., iii., iv., vi.

(b) Who initiates the handoff?

i. User Device
ii. Packet GW
iii. Tower 1
iv. Old Tower (from part 1)
v. Tower 4
vi. Mobility Manager

Solution: iv.