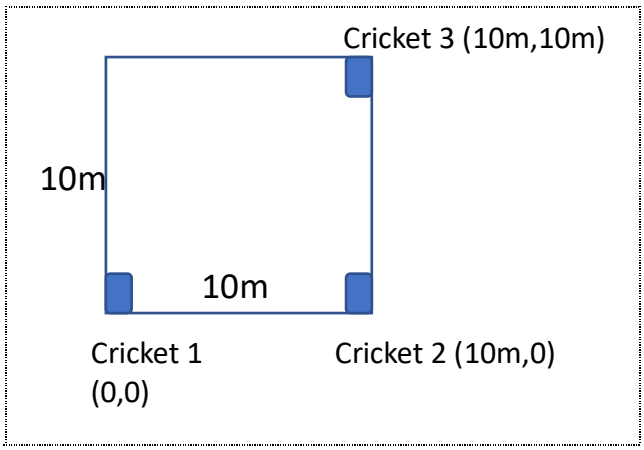
CS4222/CS5422 Semester 2, 2022/2023

Tutorial for Week 9 (March 6th, 2023)

Question 1: The figure below shows a 2D square of 10m by 10m with three cricket nodes placed at different locations. The table below shows the wall clock time for the radio and audio signals from the node to be localized to reach each of the three cricket nodes. You can assume that the speed of light is 2x10^8 m/s and the speed of sound is 300m/s. You can also ignore the processing time. Your task is to estimate the (x,y) coordinates of the node to be localized in meters, using cricket 1 as the origin (0,0).



	Cricket 1	Cricket 2	Cricket 3
Radio	1s	1s	1s
Audio	1.028s	1.020s	1.020s

Answer 1: Using a simple approximation:

Y = 5, since the audio reaches cricket 2 and 3 at the same time.

Consider Cricket 1, for audio, in 0.028s, distance is 0.028 * 300 = 8.4m

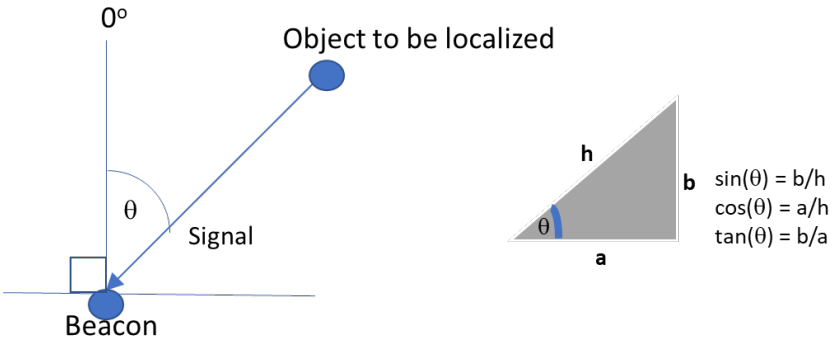
So 8.4^2 = 5^ + x^2, x = 6.75m.

Consider Cricket 2, for audio, in 0.02s, distance is 0.02 * 300 = 6m

So 6^2 = 5^ + (10-x)^2, x = 6.75m. So (10-x) = 3.32, x = 6.68

So answer is roughly (6.7, 5)

Question 2: Consider a 2-D plane with two beacons. Beacon 1 is located at (0,0) and beacon 2 at (10,0). Let the (unknown) position of the object to be localized be (X,Y). The angle of signal arrival from the object to Beacon 1 is 40 degree and the signal angle of arrival from object to Beacon 2 is 300 degree. Write down 2 equations that determines the unknown location (X,Y) and find the values of X and Y.



Answer 2:

tan (40) = x/y, tan(60) = (10-x)/ y

tan 40 = 0.8391 = x/y, x = 0.8391y

tan 60 = 1.732 = (10-x)/y, 1.732 y = 10 – 0.8391y,

y = 3.889

x = 3.263

Question 3: You are tasked to design an app that tracks the user's location using GPS. The GPS sensor consumes 400mW of energy, while the accelerometer sensor consumes only 5mW. You know that the user is mostly stationary when using the app. How can you design an energy-efficient and accurate app that can track the user's outdoor location? Explain your approach and its advantages.

Answer 3: One possible way to reduce the power consumption of a high-power sensor is to use a low-power sensor as a trigger. For example, we can use an accelerometer to detect the movement of the device and activate the GPS only when needed. This way, we can save power by turning off the GPS when the device is stationary or moving slowly. Moreover, we can use the accelerometer to estimate small changes in location and rely on the GPS less frequently for distance measurement. This approach can be sufficiently accurate as location changes are infrequent and we only use the GPS occasionally.

Question 4: The ALOHA and slotted ALOHA protocols have a maximum channel utilization of 18% and 36%, respectively. However, the CSMA/CA protocol can achieve much higher utilization. How does CSMA/CA do this? Explain the main difference between CSMA/CA and ALOHA protocols and how it affects the channel efficiency.

Answer 4:

(1) With carrier sensing, a station should transmit only if it detects that channel is idle, reduces collision significantly.

(2) Collision detection overhead should be small compare to the amount of work that can be done per packet transmission.