Assignment 2

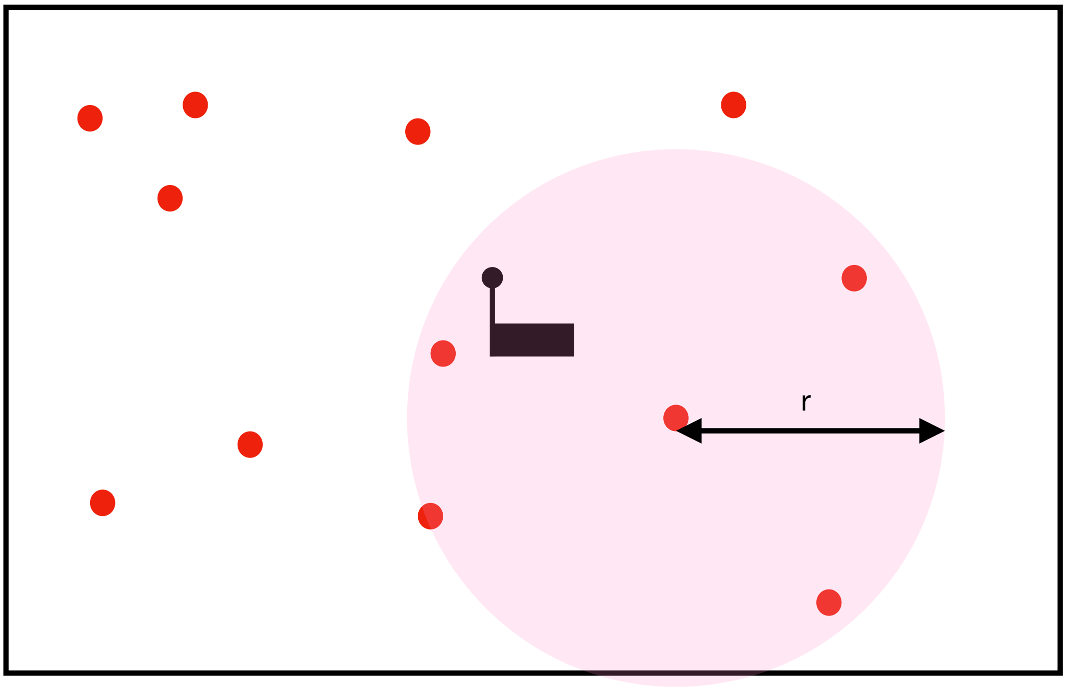
EITN95 Simulation

Task 1, IoT network performance

In this task you will simulate the behaviour of a city-wide Internet of Things (IoT) system and investigate the performance of the radio network. Since this is a large-scale system you should use the process interaction method and design a framework for scripting the simulation set-up.

The simulation scenario is as follows:

The city has a surface of 10 x 10 km with a centralised gateway placed in the center of the plane. In order to make the task feasible, you will approximate the radio characteristics so that each transmitter has a unit disk graph coverage (covers a circle around it with a radius r so that nodes within this radius can overhear a transmission). There are a number of sensors (n) deployed throughout the city according to a uniform distribution (the x,y coordinates of the sensors are both U(0,10km)). Two sensors cannot be located at the same coordinates.



The sensors operate in a cyclic manner where they sleep during an interval and then wake up to send a measurement report to the gateway. The time it takes to send the message is T_p s and we deem the propagation time negligible (it takes no time for the message to reach the gateway). The sleep interval is exponentially distributed with mean t_s.

Use the following parameters: n = [1000, 2000, 3000, 4000, 5000, 6000, 7000, 8000, 9000, 10000] T_p = 1 s, t_s = 4000 s and r = 7 km.

If any part of a transmission overlaps in time with another transmission, both transmissions are deemed unsuccessful.

Design a file format for a configuration file which is read into the simulator at the beginning of a run. The file should then be populated with the configuration of the scenario including all parameters for both the gateway and the sensor nodes (times, coordinates etc.) before the simulation starts using a separate program/script. The file format should be properly documented and explained.

The first task (1a) is to investigate how the throughput varies with the load of the network, i.e. how many successful transmissions there are compared to the traffic put on the network. Vary n according to the values given above and plot the throughput versus the load in a diagram. The result is well known and theoretically given for this kind of access strategy as:

$$T_{put} = \lambda_p T_p e^{(-2\lambda_p T_p)}$$

where T_{put} = throughput, lambda = arrival rate and T_p transmission time for a message. Use this to verify your simulation.

The second task (1b) is to measure the packet loss probability, i.e. the probability that a packet is lost because of a collision and plot this against the load. Run the simulation until no confidence intervals are overlapping and include these in the plot.

The third task (1c) is to repeat tasks 1a and 1b (using the same configuration files) with a modification to the transmission strategy named strategy 2. In this task, each sensor will wake up and sense the channel before transmitting. If another transmission is detected, the sensor will generate a uniform random value U(lb,ub), and wait this time before transmitting the message. Plot and compare this curve with the original strategy for both the throughput and the packet loss probability with varying n.

Answer the following question: How does the performance compare with the first case? How does it change with varying lb and ub? Remember to draw conclusions when your confidence intervals allow you to.

The fourth task (1d) is to use strategy 2, set n = 2000 and vary r = [6, 7, 8, 9, 10, 11] km.

Plot the throughput against r and explain the behaviour of the curve. What happens when r is varied?

Task 2, socialising algorithm

In this task you will simulate a social experiment where a number of students get to socialise and meet new people in an organised way at a mingling event. The event happens in a rather majestic hall (stained led windows, chandeliers, chocolate fountain, you get the picture). The floor of the hall is 20 x 20 m and divided into a grid of squares, 1 x 1 m in size (400 of those). Initially, 20 students are randomly placed on starting squares and randomly select a direction to move according to fig 2.

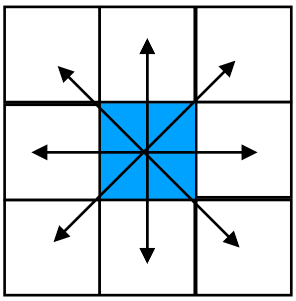


Fig 2, possible movement from a starting point

The student then walks until she/he hits a wall or a random number of squares U(1,10), whichever happens first, and selects a new direction to move. All possible directions are equally probable. If two students find themselves in the same square at the same time, they stop for a period t_t minutes, and get acquainted before continuing their walk as before. If a student enters a square where two students are already talking, they just continue walking. If two students have met before, they still spend the same time getting to know each other better. Your task is to determine how long it takes for all students in the room to meet and get to know each other and also find the distribution of how well they know each other (the time each student has spent with another student). Plot the frequency from 0 minutes to the maximum number of minutes recorded by any student.

In the first experiment, t_t = 1 minute and all students move at a velocity v = 2 m/s.

In the second experiment, t_t = 1 minute and students move at v = 4 m/s.

In the third experiment, t_t = 1 minute and students move at v = U(1,7) m/s.

Simulate until appropriate confidence intervals are obtained and explain the results obtained from the three experiments.