Performance Evaluation of Computer Systems and Networks
AA 2023 - 2024

Remote Sensing System

Francesco Taverna

Gabriele Pianigiani

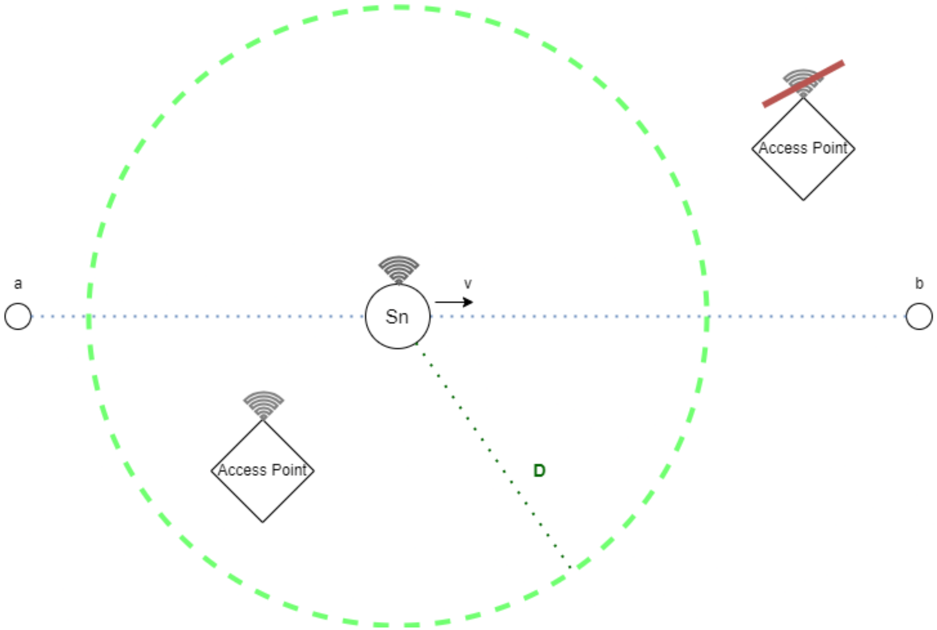
Saverio Mosti

Road Map

1. Introduction of the problem and the objective
2. The Model
3. The Implementation
4. Verification
5. Simulation
6. Experiments
7. Conclusion

Introduction

- **N** sensing nodes
- **M** access points.
- A working plan of **H** x **L** meters.
- Sensing nodes **periodically** transmit a **broadcast** message every **T** second, with a transmission range of **D** meters.
- Whenever an access point receive a message, it will be **directly forwarded** to a Sink Node.
- Access point position is randomly generated inside the working plan.
- Sensing nodes are moving with a constant speed between two waypoints.
  - When it reaches one, another waypoint will be generated.



Objective

The objective of the project is testing the **effectiveness** and **efficiency** of a series of different scenarios obtained by varying determined parameters such as:

- Dimension of the working plan.
- Quality of the receiver.
- Transmission range of a sensing node.
- Maximum speed of a sensing node.

Effectiveness: *Maximization of the number of unique packets correctly sent to the sink node per unit of time.*

Efficiency: *Minimization of the number of duplicates per message.*

We want to find out what are the parameters that changing have the **most influence** on the two above.

Moreover, will be analysed the **best “trade-off”** configuration of most important parameters.

Model

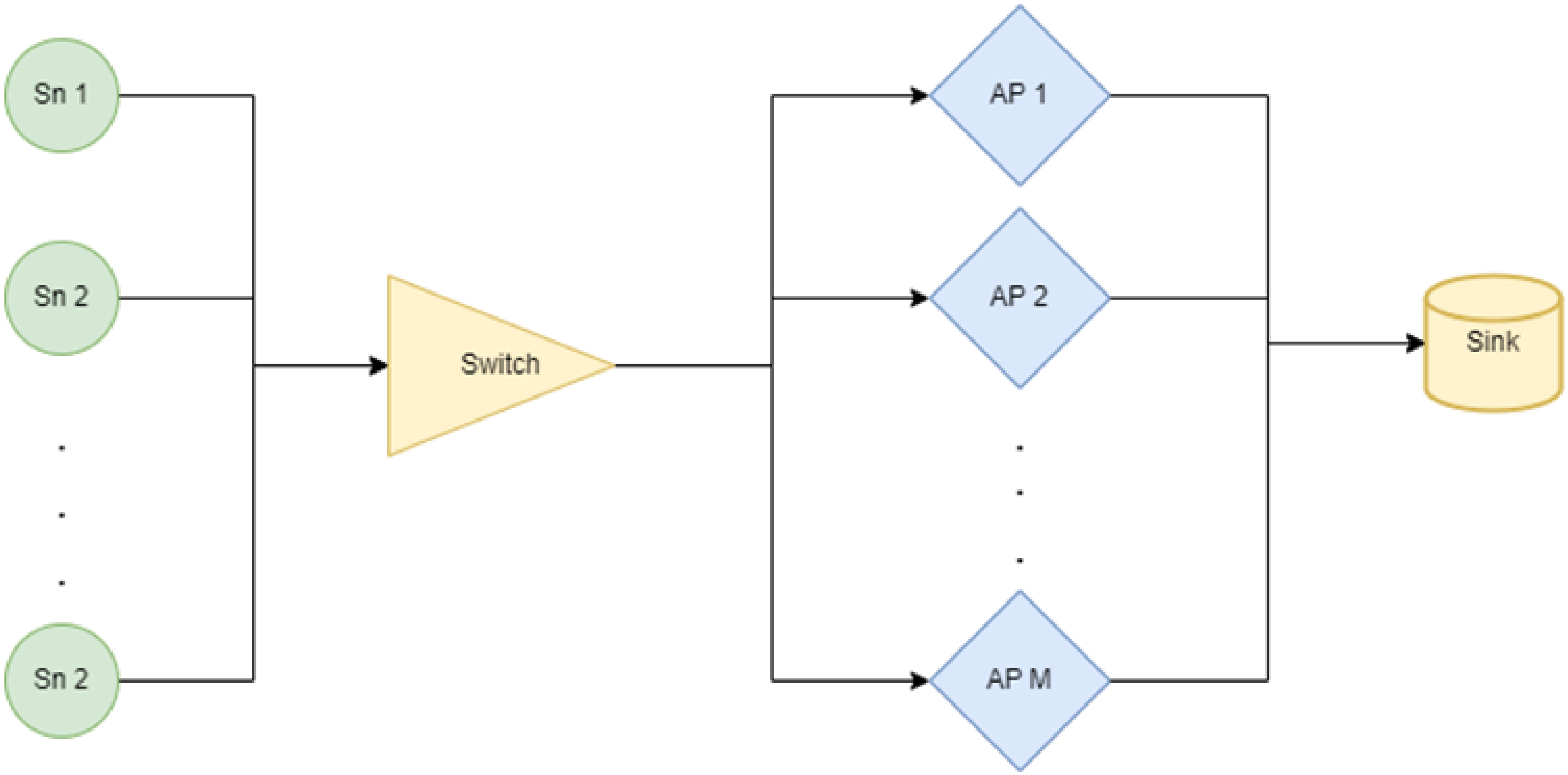
Assumptions

- Transmission time is null.
- Sink node has no queuing.
  - We only care about the number of messages that reach the sink node, not how many message it can elaborate per second.
- All the distribution are uniform.

Factors

- M: Number of AP.
- D: Transmission range of a SN.
- N: Number of SN.
- H & L: Dimensions of the working plan.
- T: Transmission period of a SN.
- Vmax: Maximum speed of a SN.
- Psucc: Probability of a correct reception by an AP.

Implementation



Verification

- Degeneracy Tests
  - No Sensing Nodes (**N** = 0)
  - No Access Points (**M** = 0)
  - **D** ∈ { 0 ; 2H }
  - **Vmax** = 0 *(Theoretical Verification)*
  - **Psucc** ∈ { 0 ; 1 }
- Consistency Tests
  - **T** ∈ { 1 s ; 4 s }
- Continuity Tests
  - Psucc ∈ { 0.65 ; 0.7 ; 0.75 }
  - D ∈ { 70 m ; 80 m ; 90 m }

Simulation - Calibration

Sensing nodes “*follow*” the standard 802.11 for a common wireless device:

- **D** ~ 100m
- **T** ~ 200ms (*beacon periodically sent by an Access Point*)

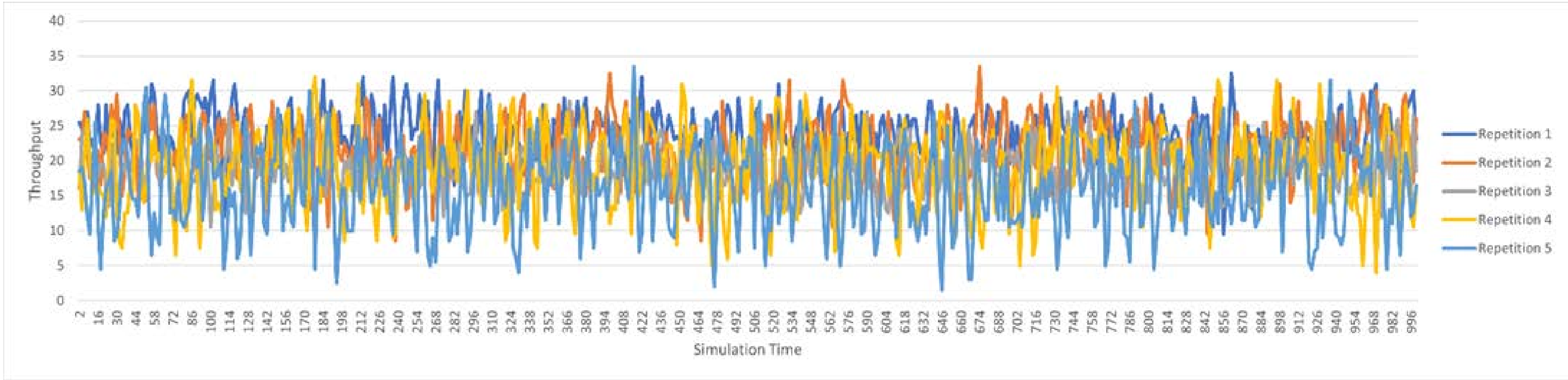
A sensing node moves like a Human: Speed ~ 3m/s

The working plan is a square dimensioned like 3 cities of various dimensions:

- From (2500 x 2500) to (8000 x 8000)

Psucc ∈ [0.3 ; 0.8] Urban environment, so very noisy channel.

Simulation - Warm-up time and Simulation Time

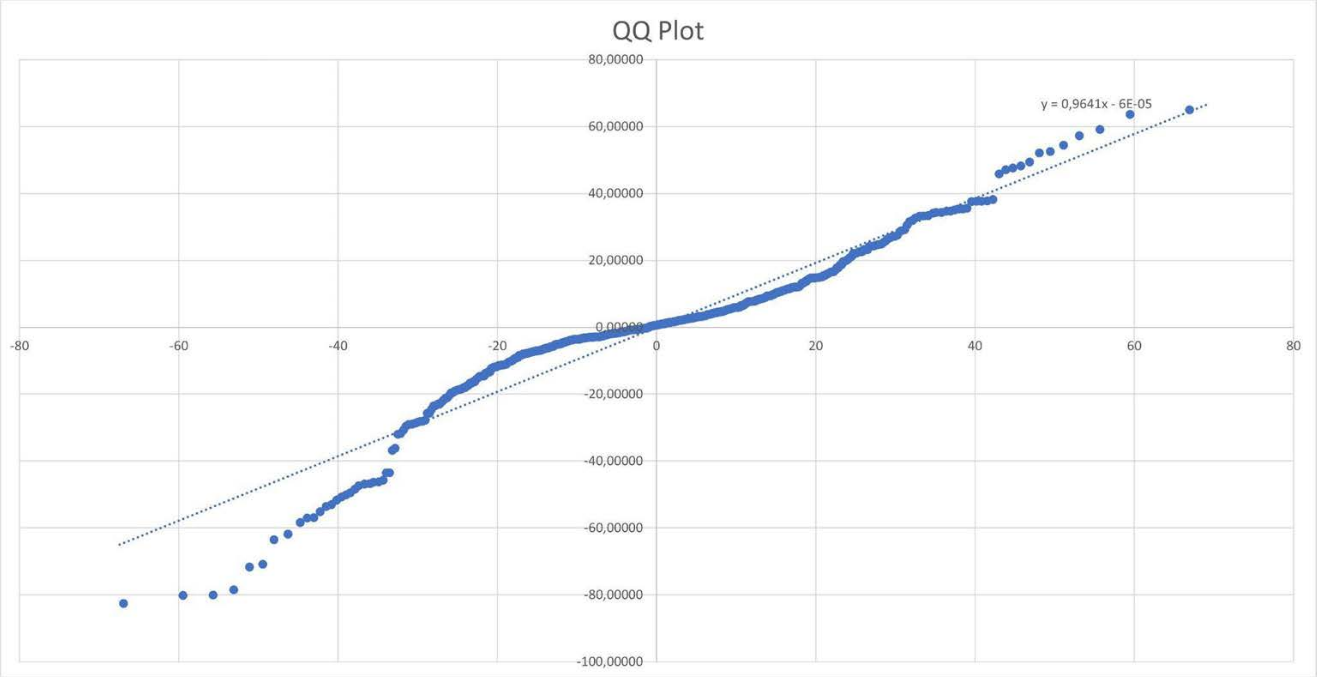


Warm-up time: 2,5 s

Simulation time: 1800 s

Experiments

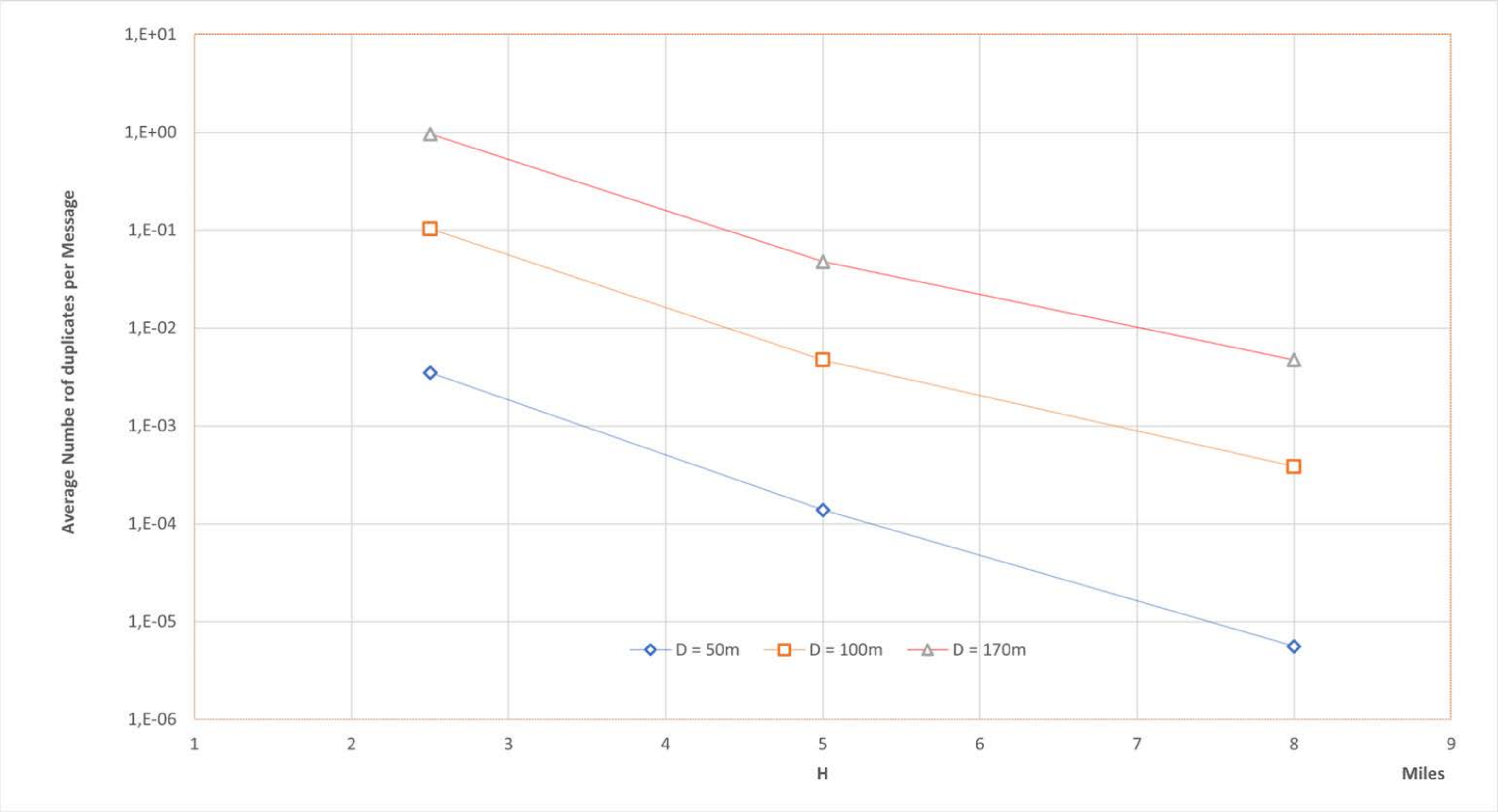
2kr: Rate of successful unique messages



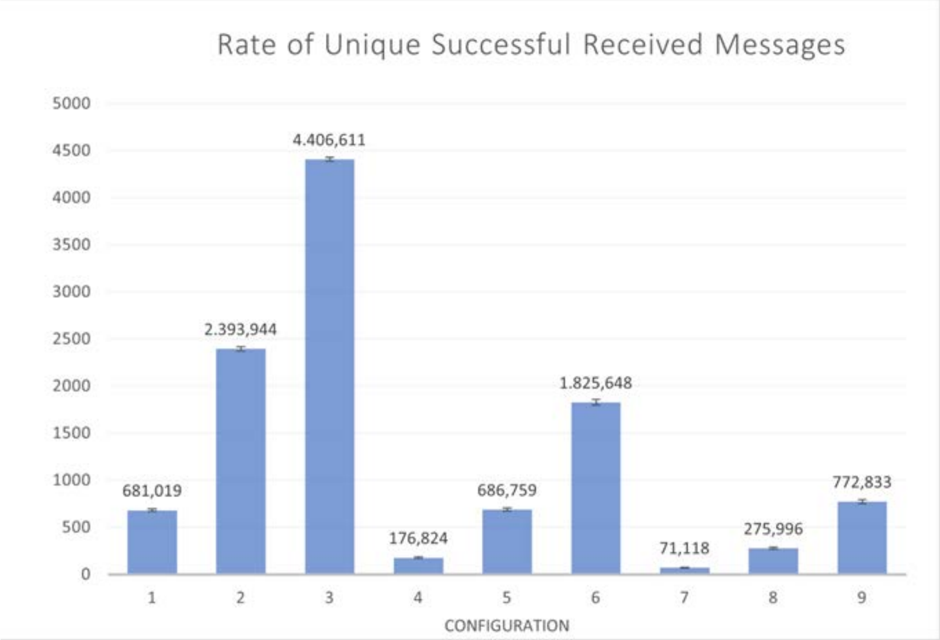
Factor	Variation
H	32.55%
D	35.16%
Psucc	6.92%
H + D	17.95%
H + Psucc	2.93%
D + Psucc	3.29%
H + D + Psucc	1.11%
Others	< 1%

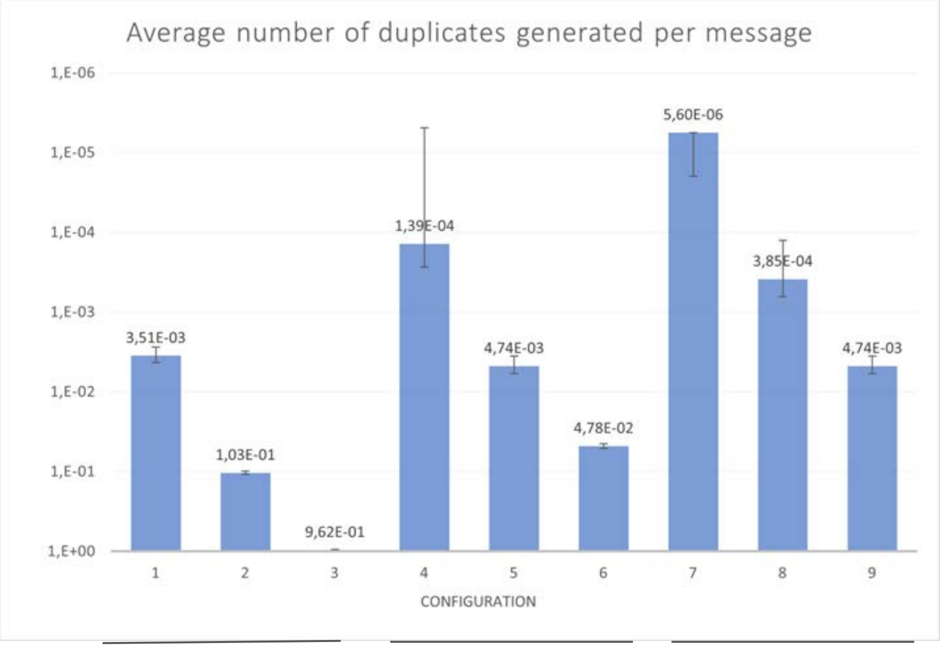
Experiments

Full Factorial Analysis - Average number of duplicates generated per message



Conclusions





H =2500 m | H =5000 m | H =8000 m

H =2500 m | H =5000 m | H =8000 m

D = 50 m | 100 m | 170 m