UNIVERSITÀ DI PISA

Aeronautical Communications (2)

Performance Evaluation of Computer Networks and Systems

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Introduction and Model

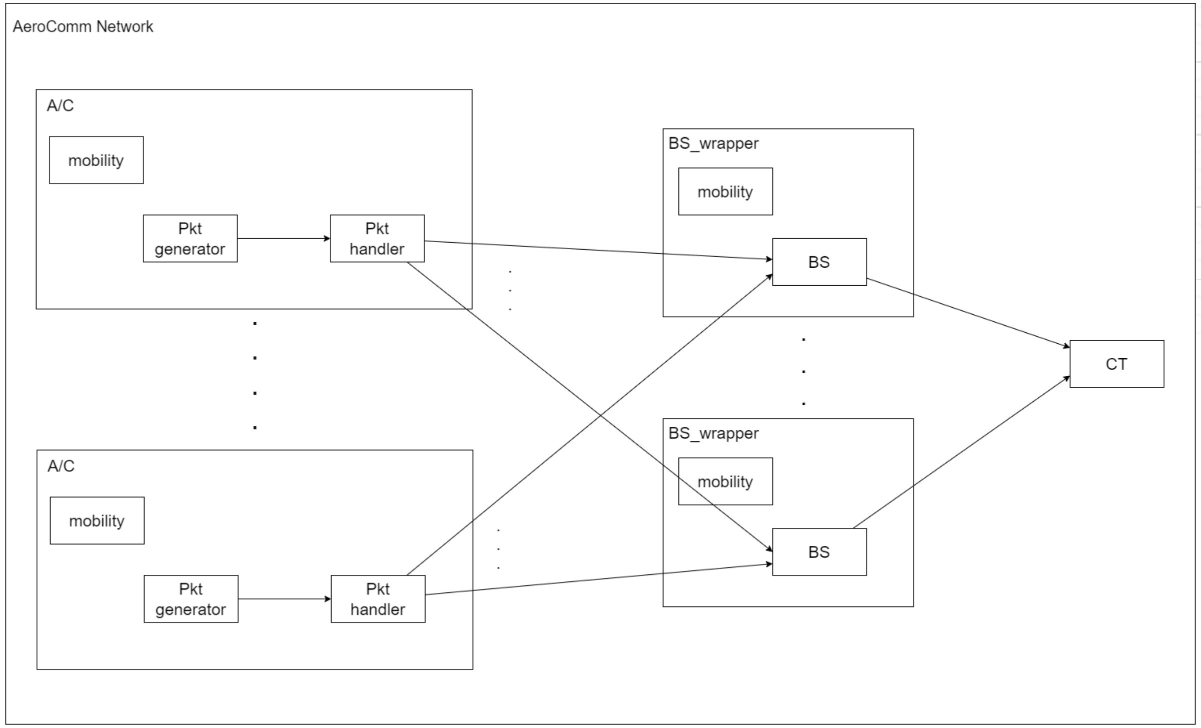
Objectives:
- Study the end-to-end delay
- Study the queue length

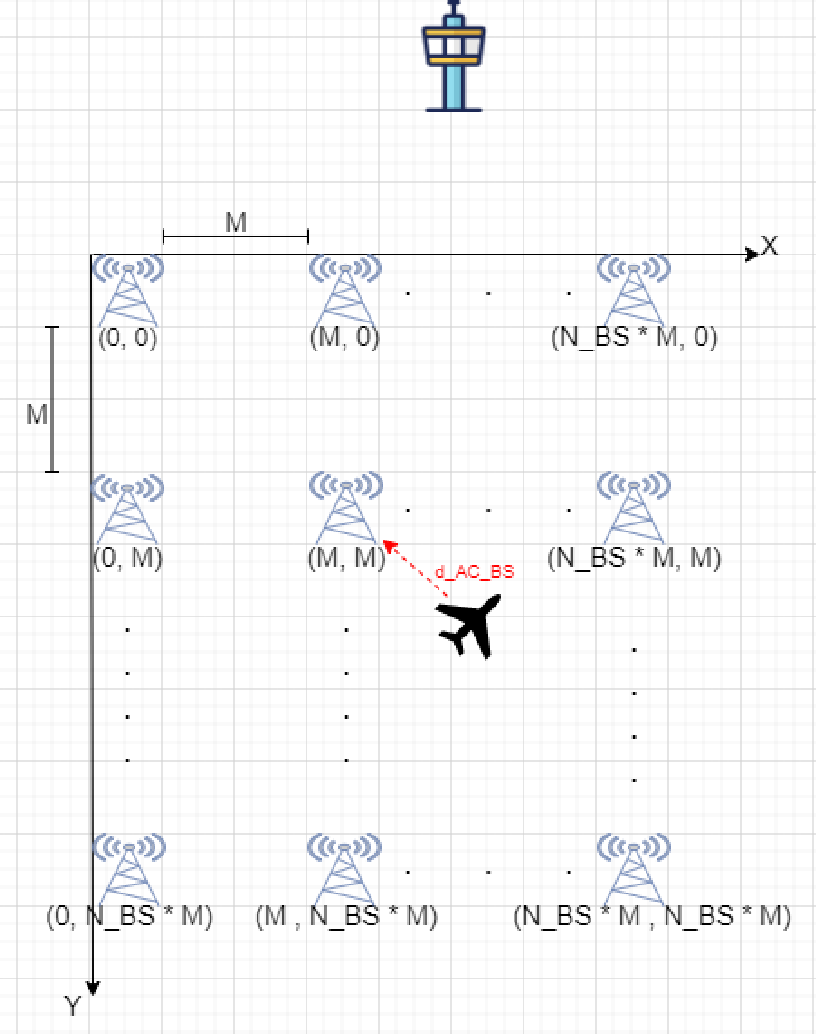
KPIs:
- Mean response time E[R]
- Mean number of packets in queue E[Nq]

Scenarios:
- Results are obtained varying k (inter-arrival time) and t (handover period)
- k uniform
- k exponential
- t deterministic

Repetitions:
- 30

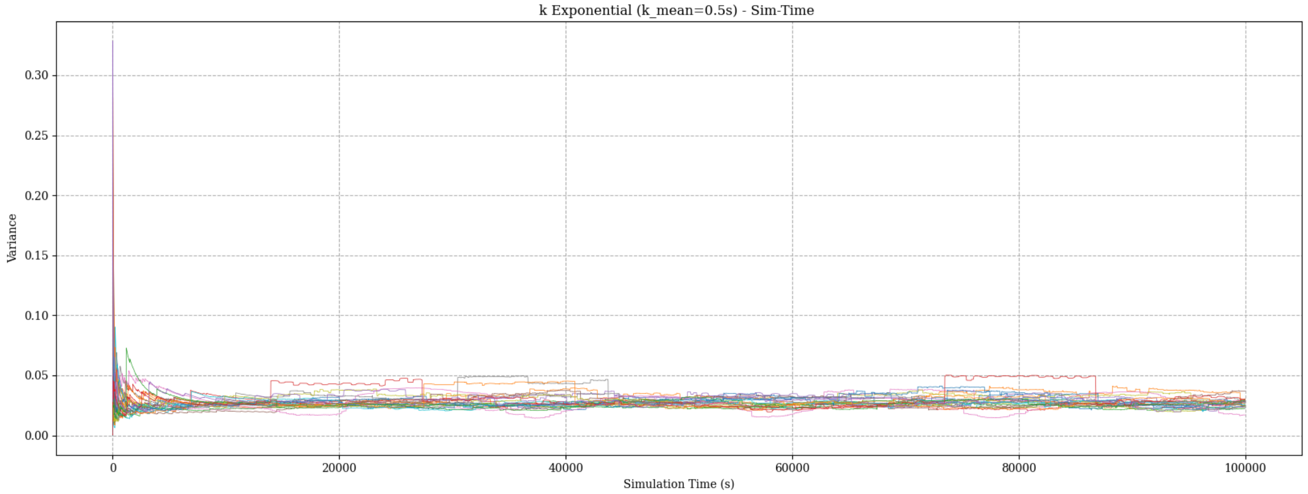
CI:
- 99%

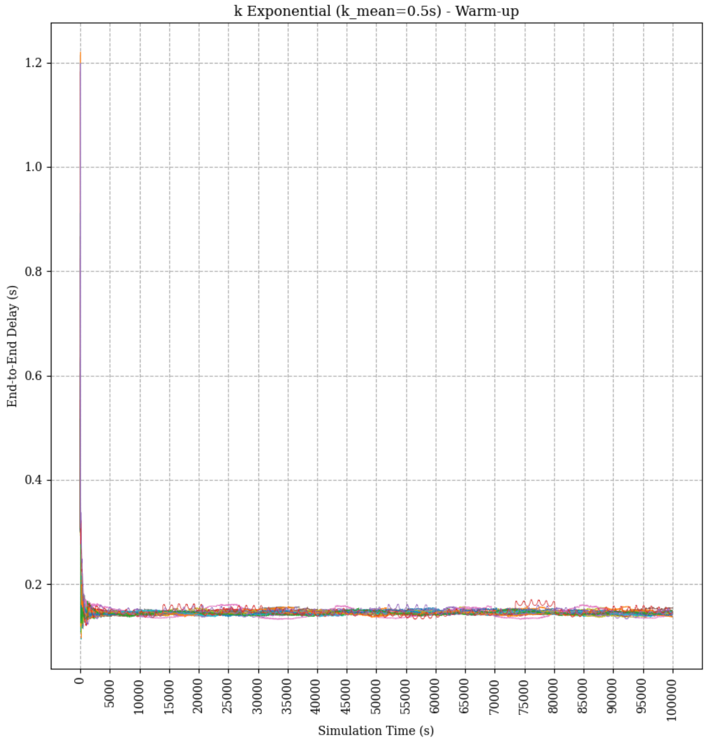




Warmup period and Simulation time Calibration

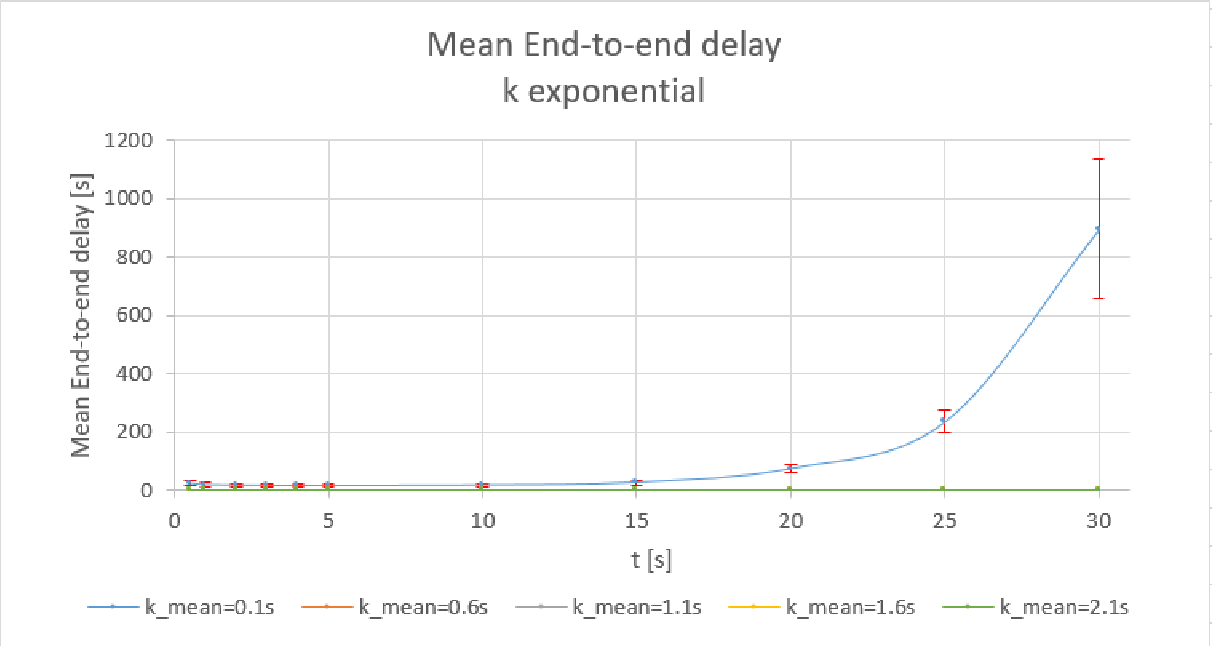
- **Reference**: A/C end-to-end delay of the packets E[R]
- **Repetitions**: 30
- **Warm-up time**: 5000s
    - We observed the trajectory of the mean end-to-end delay to see when the transitory has passed
- **Simulation time**: 20000s
    - We observed the trajectory of the variance among different repetitions
- In both cases we considered the worst-case scenario, and we used them for all simulations





Factors Calibration

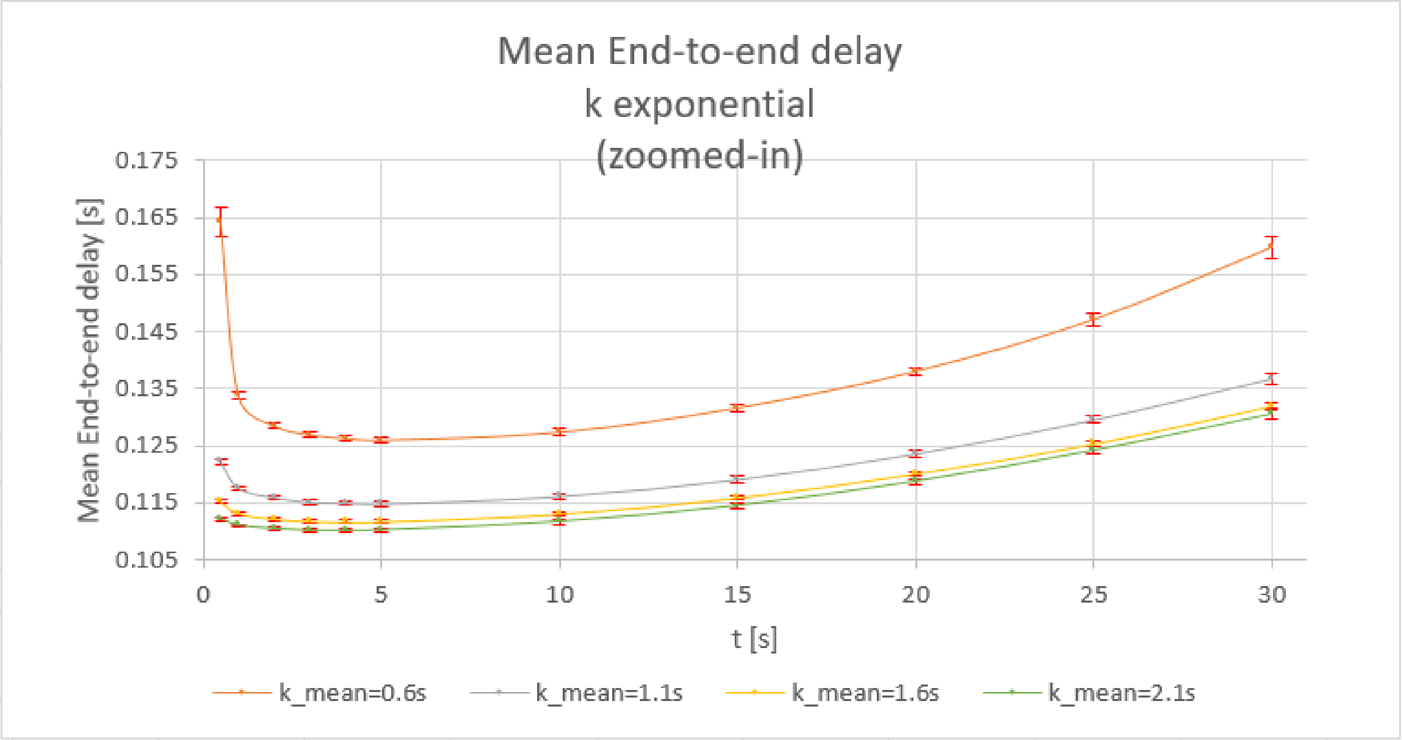
Parameter	Interval
t	[5s, 25s]
k_max	[0.2s, 4.2s]
k_mean	[0.1s, 2.1s]



t negatively affects the performance in two cases:

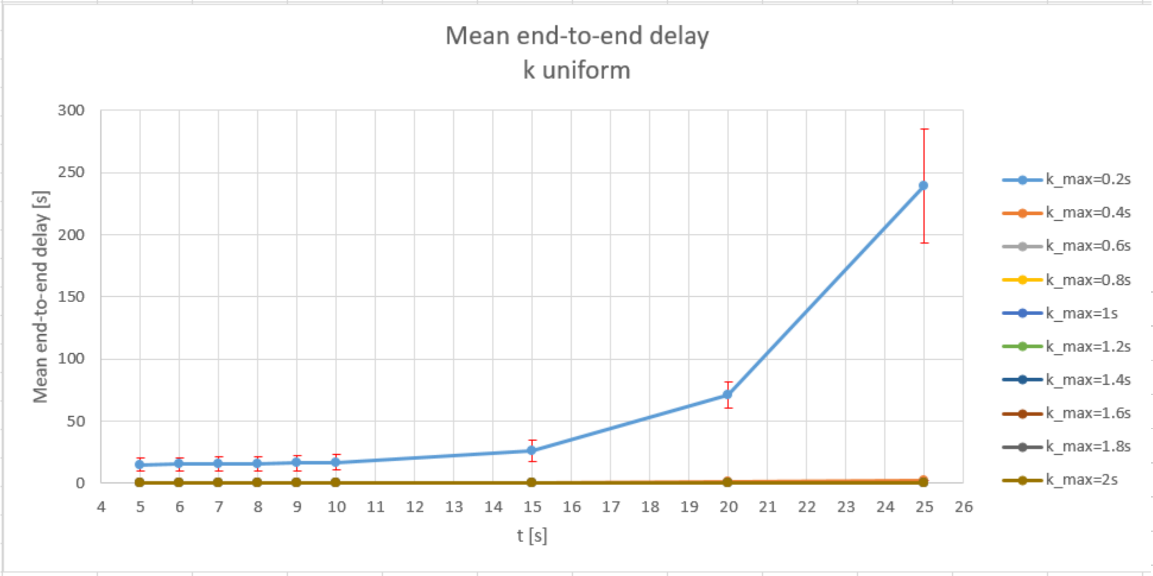
- t small → unnecessary handover operations are performed, i.e. handover operations do not lead to an actual change in serving BS
- t large → handover is done infrequently, so A/C is always too far away from its serving BS

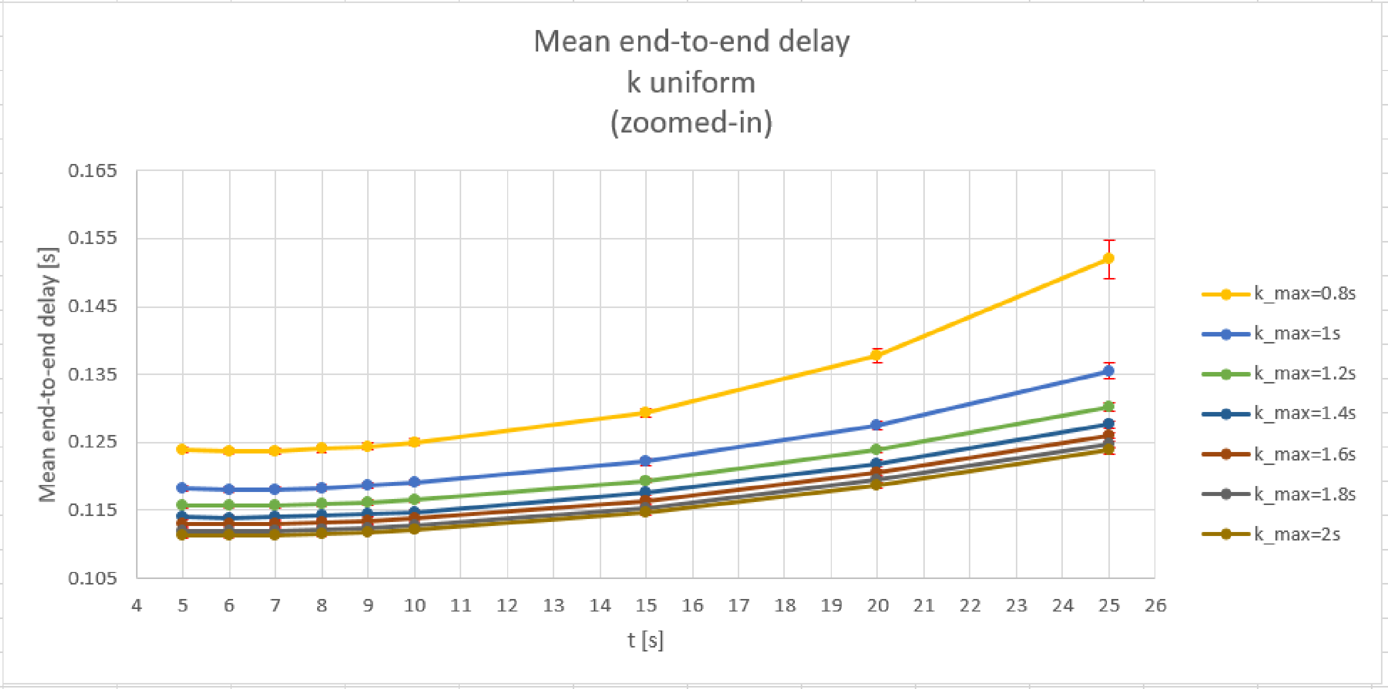
We decided to set t between 5s and 25s and observe the overall behavior of the system



End-to-end Delay analysis (Uniform)

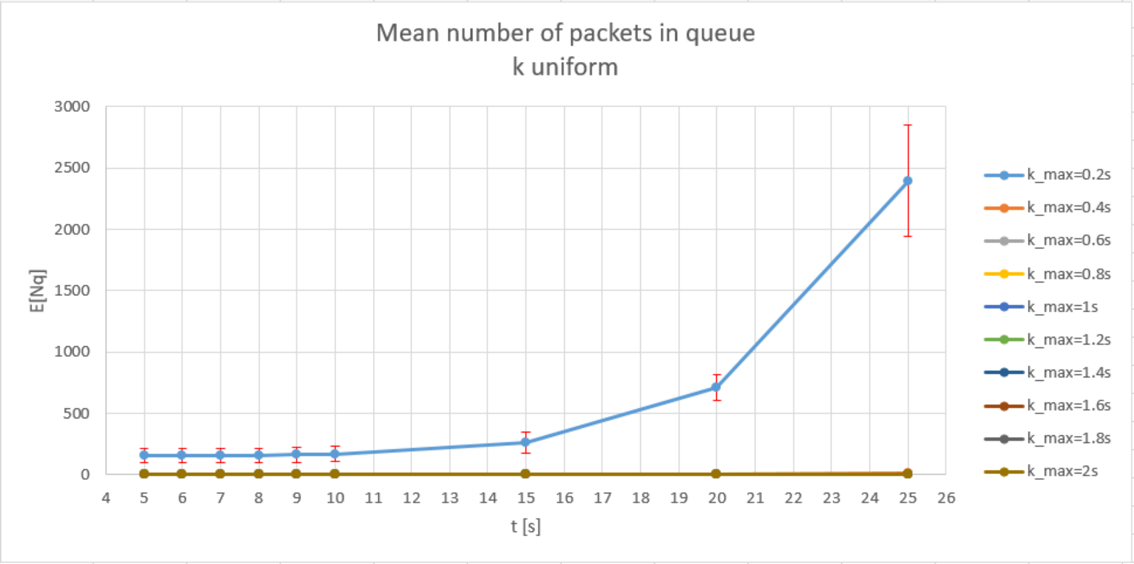
- The mean end-to-end delay highly depend on the mean inter-arrival time (k).
- The system becomes unstable for k_max ≤ 1s
- The mean end-to-end delay increase for t ≥ 10s

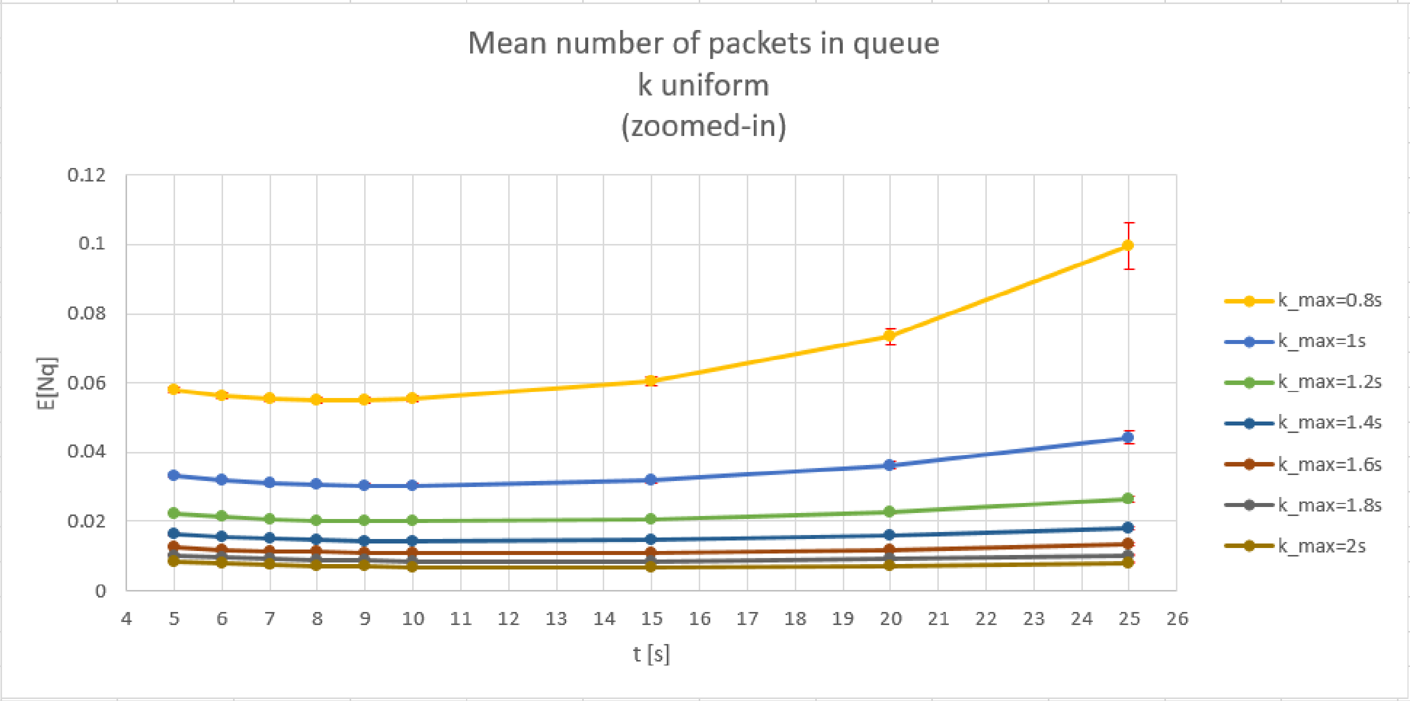




Number of packets in queue analysis (Uniform)

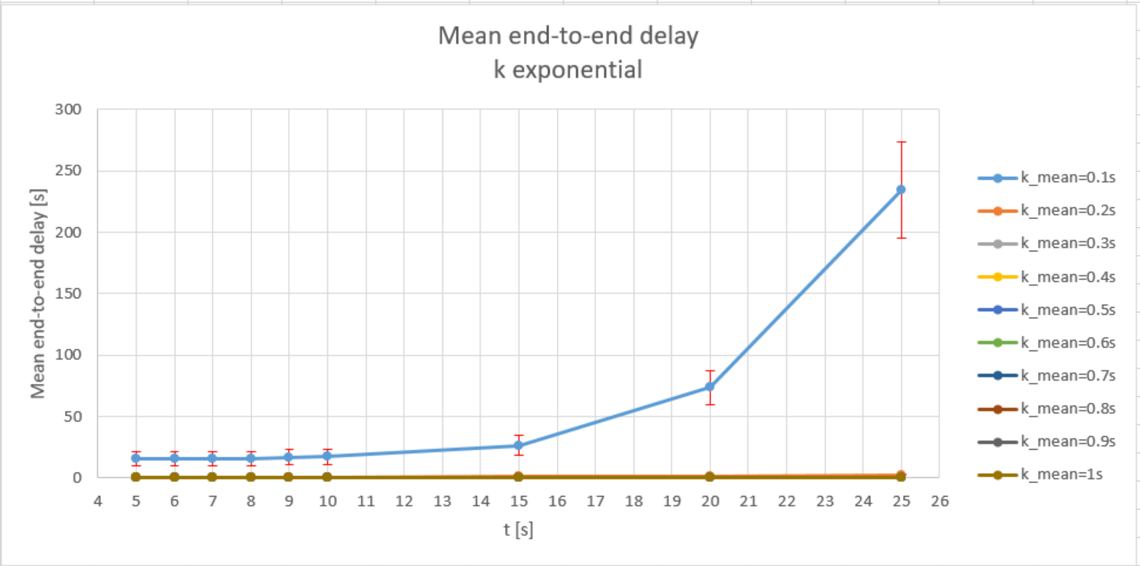
- The mean number of packets in queue highly depend on the mean inter-arrival time (k).
- The system becomes unstable for k_max ≤ 1s
- The mean number of packets in queue increase for t ≥ 10s

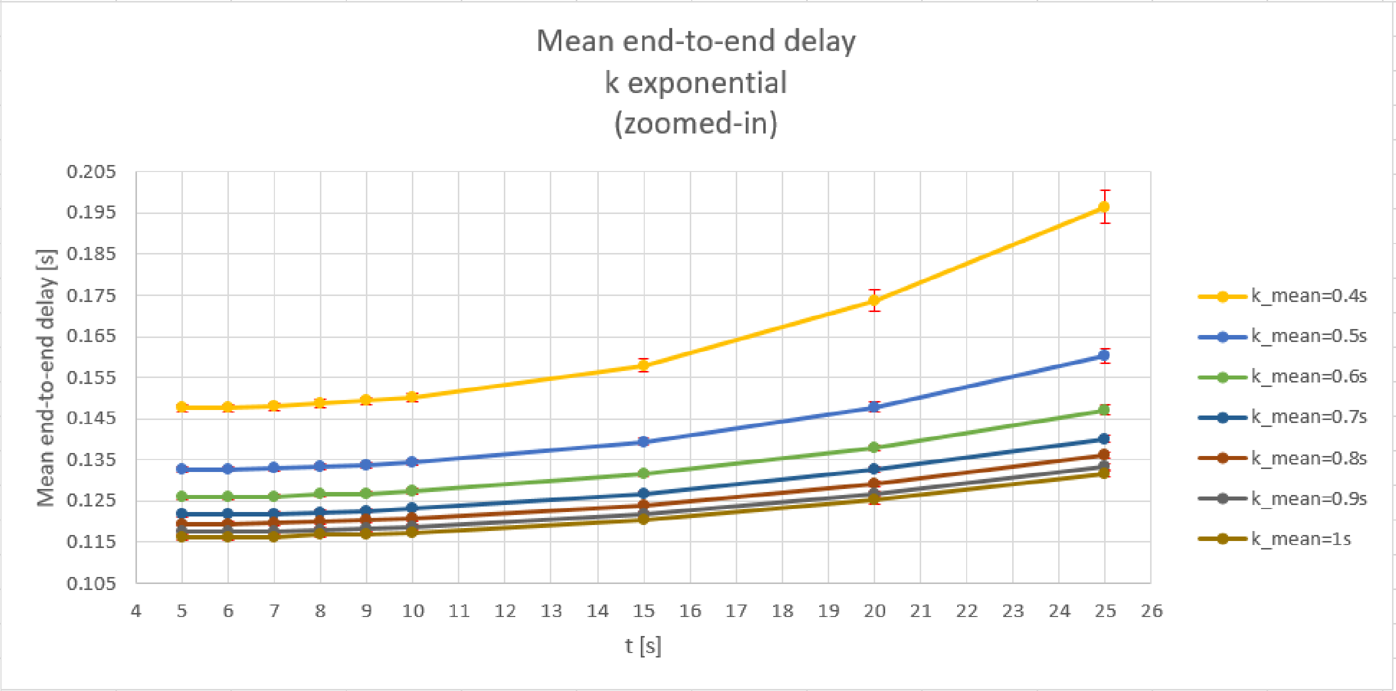




End-to-end Delay analysis (Exponential)

- The mean end-to-end delay highly depend on the mean inter-arrival time (k).
- The system becomes unstable for k_mean ≤ 0.5s
- The mean end-to-end delay increase for t ≥ 10s





Number of packets in queue analysis (Exponential)

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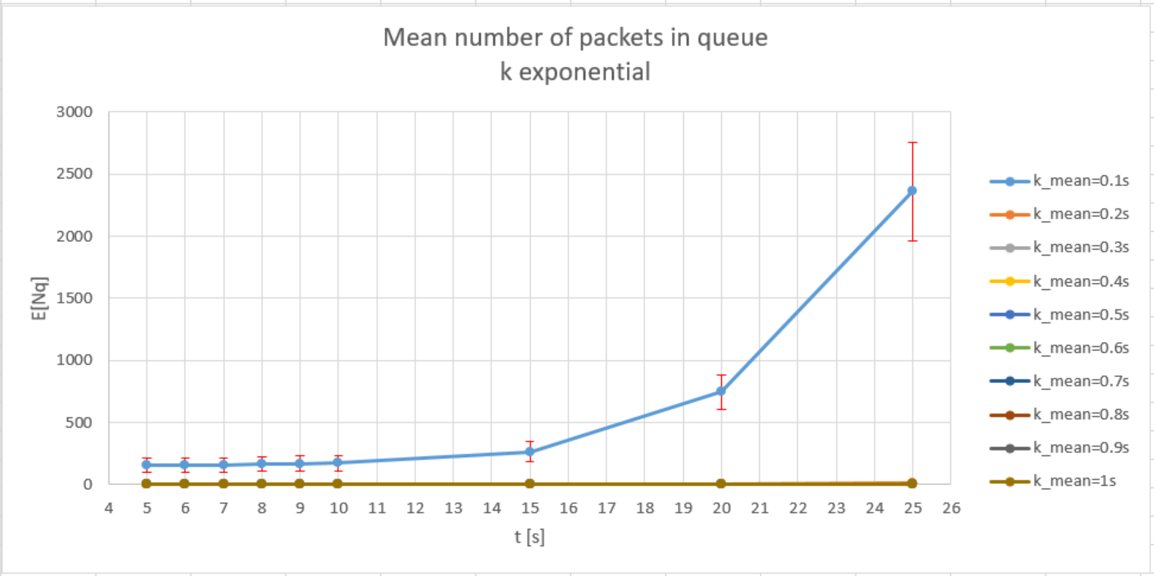

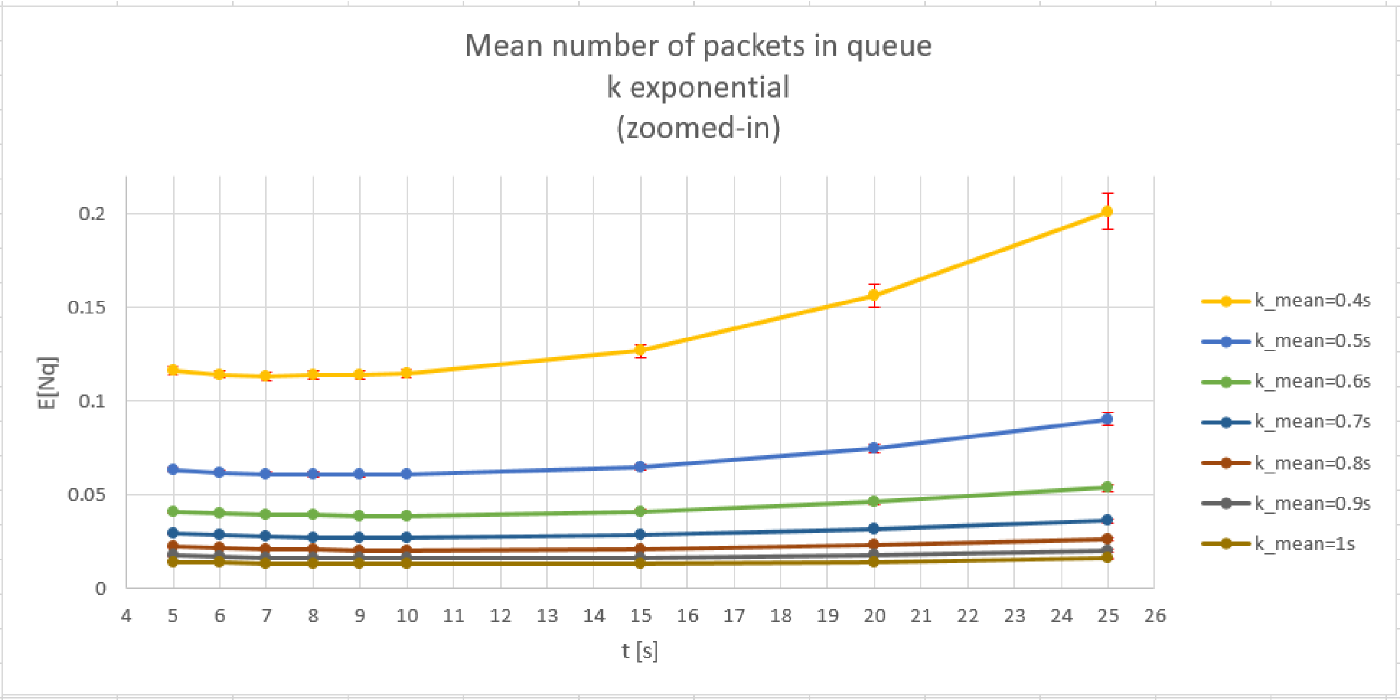

Conclusions

- Uniform and exponential scenarios give us the same results
- The best performances are observed for t between 5 and 10s, more specifically with t around 7s-8s
- Suggested values for k mean are above 0.5s because, for lower values, end-to-end delay and queue length begin to be relevant
- Any other consideration regarding k should be made by a flight expert, who should choose between having a fresher piece of information, but less frequently, or a less frequent piece of information but fresher