Project report

Opportunistic Cellular Network

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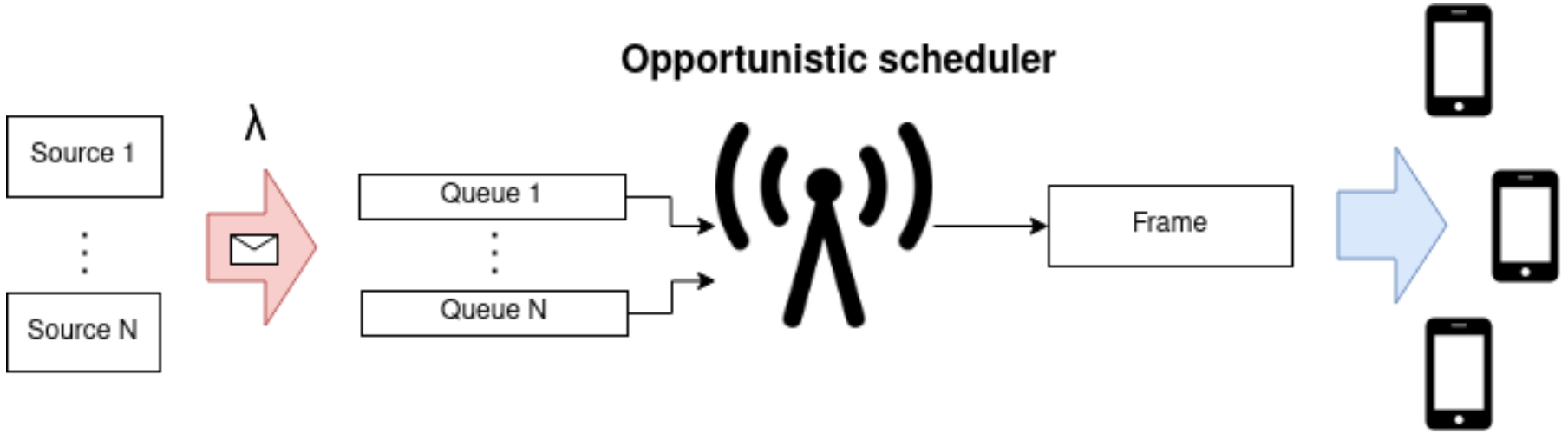
Introduction and Model

Objectives: We want to analyze the perfomance of an opportunistic cellular network using the following KPIs:

- User perfomance
  - Throughput as number of bytes served per timeslot
  - Response time
  - Perceived fairness



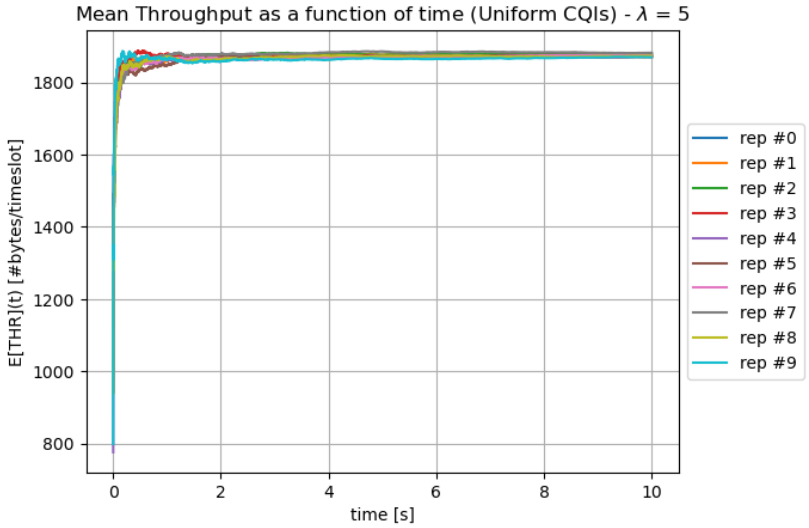
Scenarios

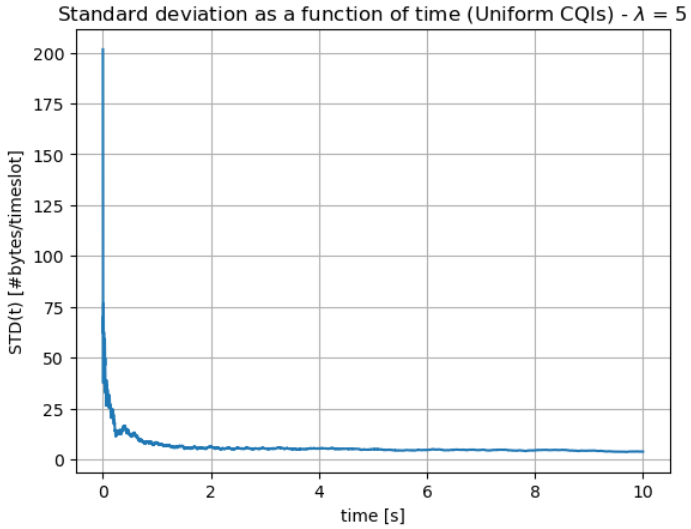
- **Uniform** CQIs
  - CQIs are integer, discrete RVs $\sim U(1, 15)$
- **Binomial** CQIs

  Two different scenarios:
  1. Each user has its own success probability p_i - $\mathrm{CQI_i} \sim Bin(14,\ p_i)$ + 1
  2. Users are splitted in two classes: **high class** ($p = 0.8$) and **low class** ($p = 0.4$)
- In both cases (Uniform and Binomial CQIs) we considered always:
  - **Exponential interarrivals** with rate λ
  - **Uniform Service demand** – packet size $\sim U(3, 75)$

Warmup period and simulation time

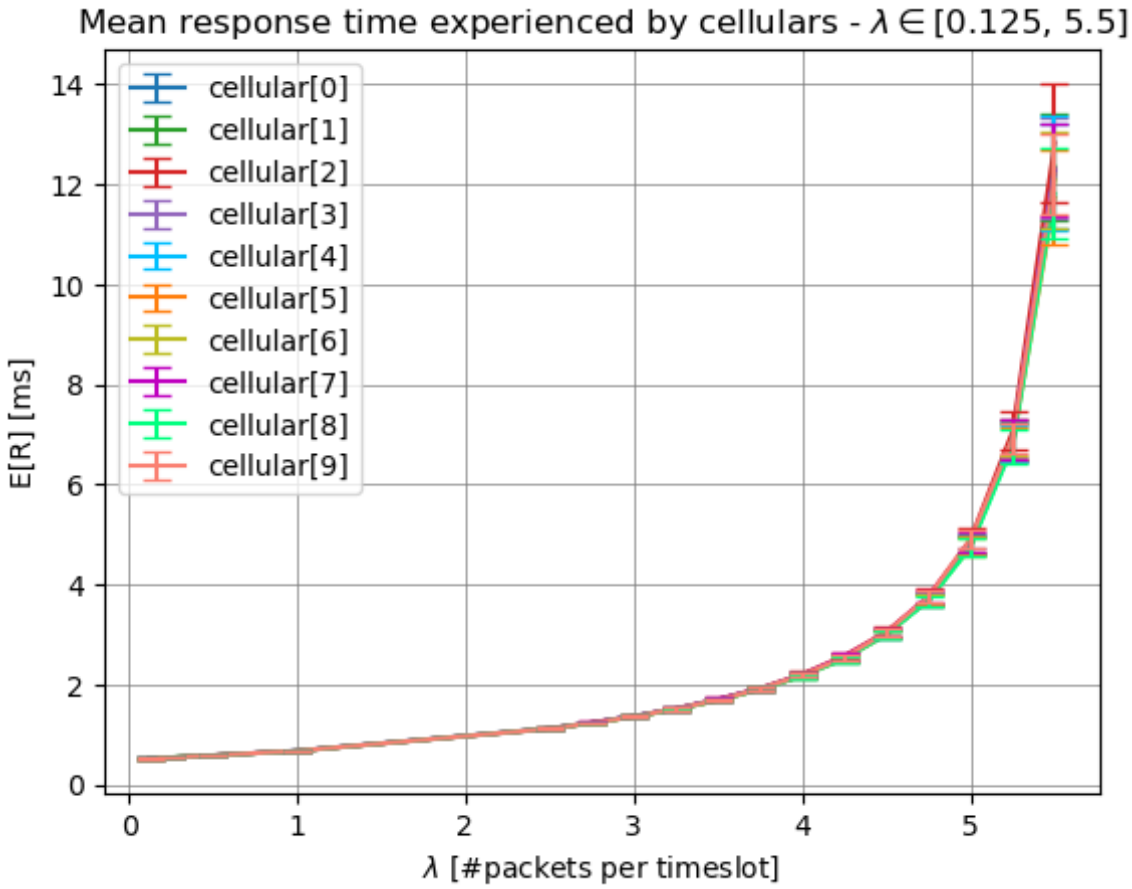
- Reference: **Antenna slotted throughput**
- **Warm-up time**: 2 s
  - We observed the trajectory of the mean throughput, for 10 different repetitions, to see when the transitory has passed.
- **Simulation time**: 10 s
  - We observed the trajectory of the sample standard deviation among different repetitions.
- In both cases we considered the worst-case scenario, and we used them for all simulations.





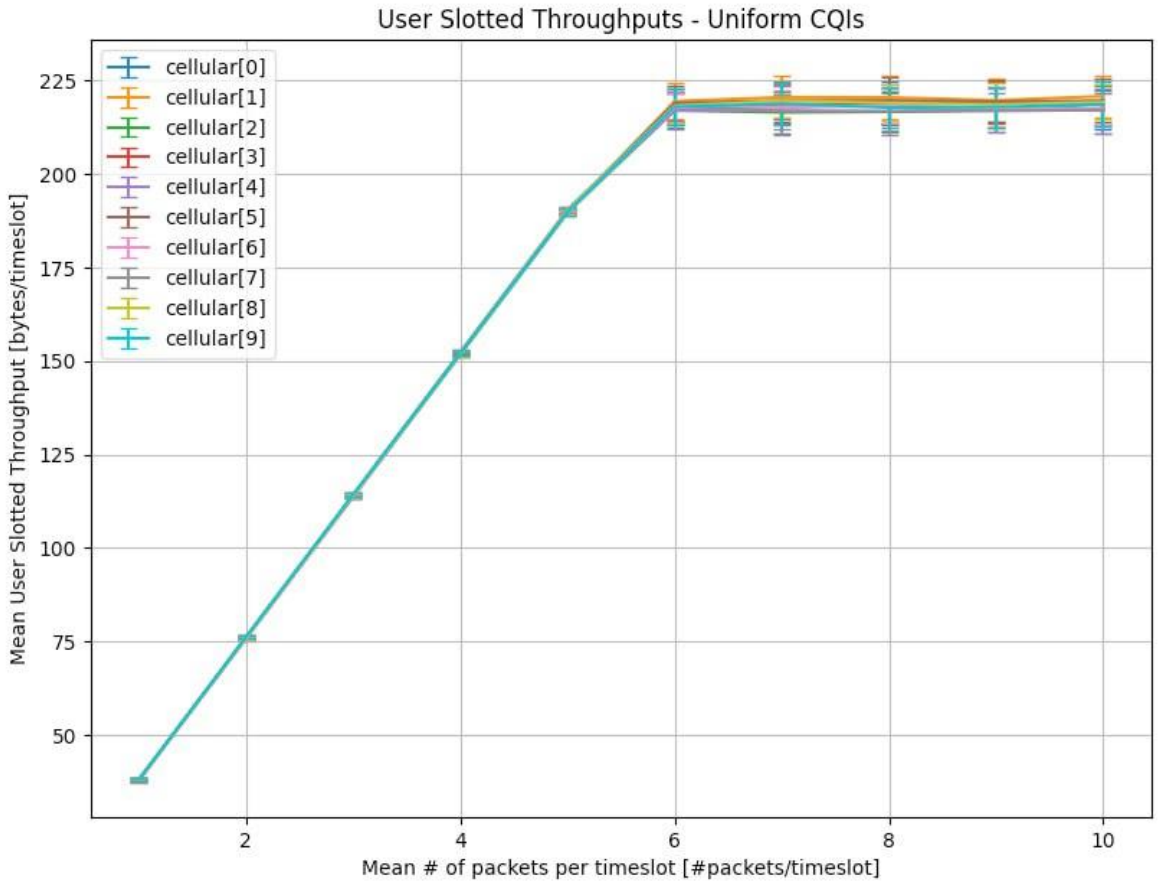
Response time analysis (Uniform)

- The system becomes **unstable** after $\lambda \geq \lambda_{SAT}$ (mean response times shouldn't be considered after λ_{SAT})
- The Antenna fairly serves its users, so users experience very similar mean response times.

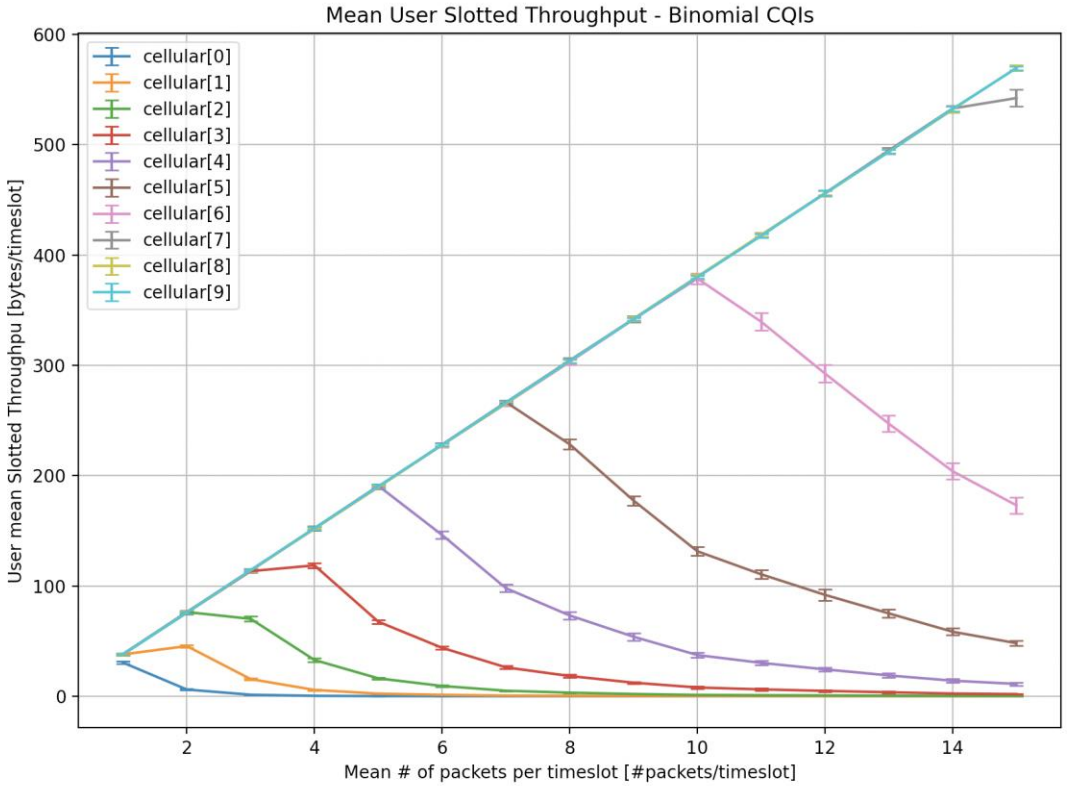


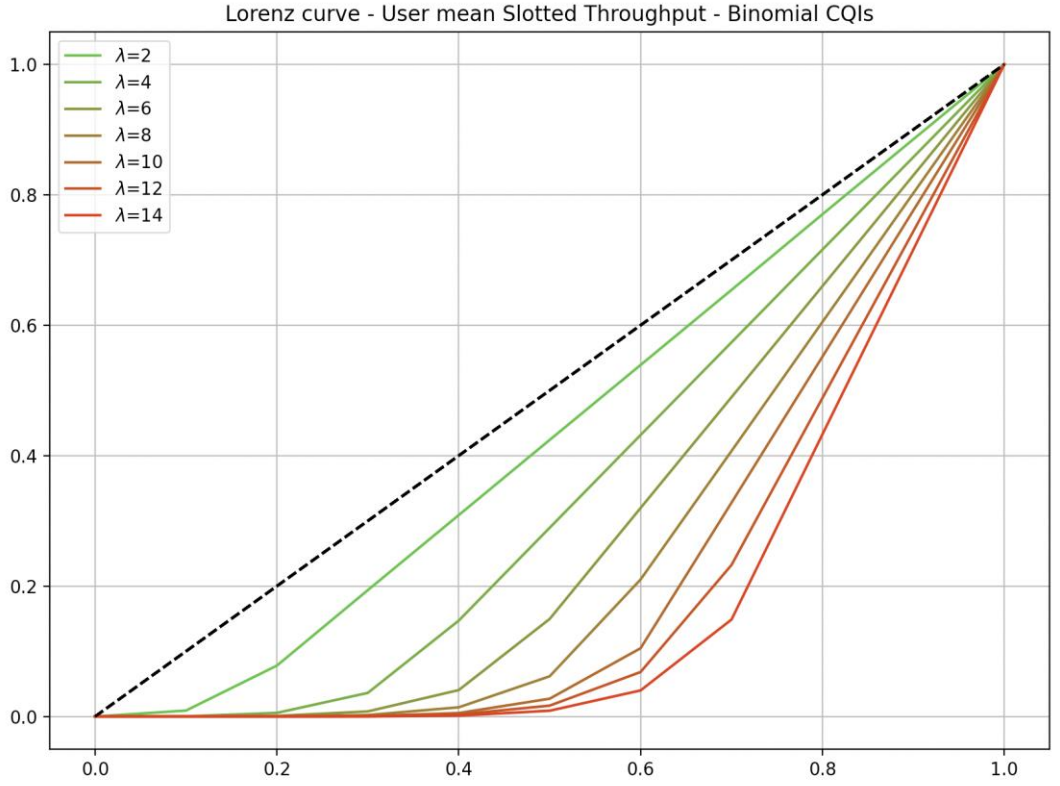
Throughput Analysis (Uniform)

- The mean user throughput E[th] increases as **λ** increases
- E[Th] reaches the maximum value at λ_{SAT} (**Saturation point**)
- λ_{SAT} is the same for each cellular
- The system becomes **unstable** after $\lambda \geq \lambda_{SAT}$



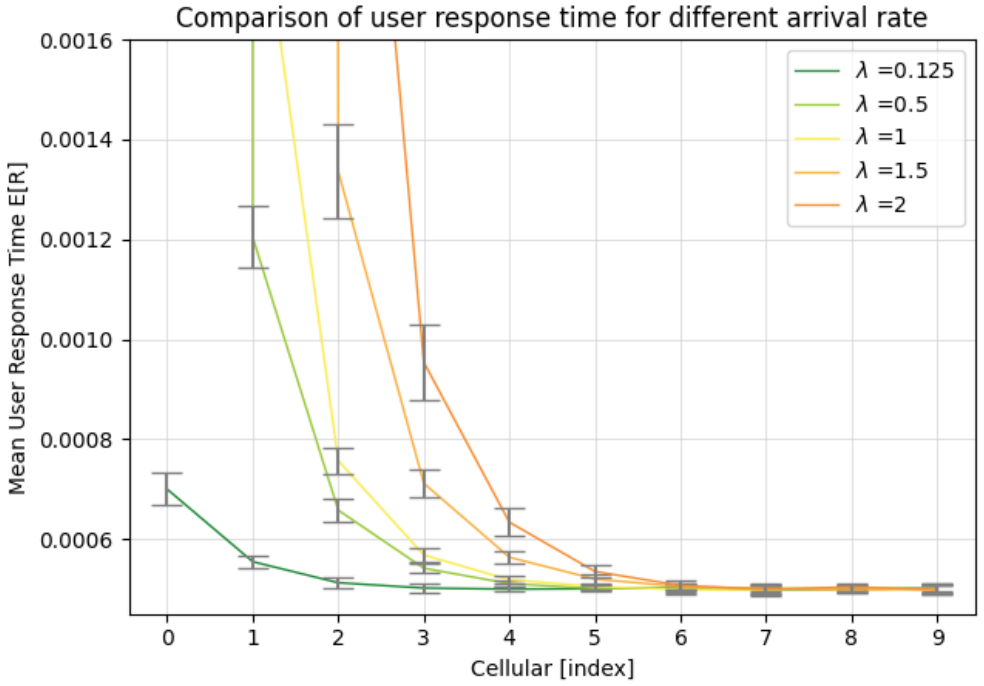
Throughput Analysis (Binomial)

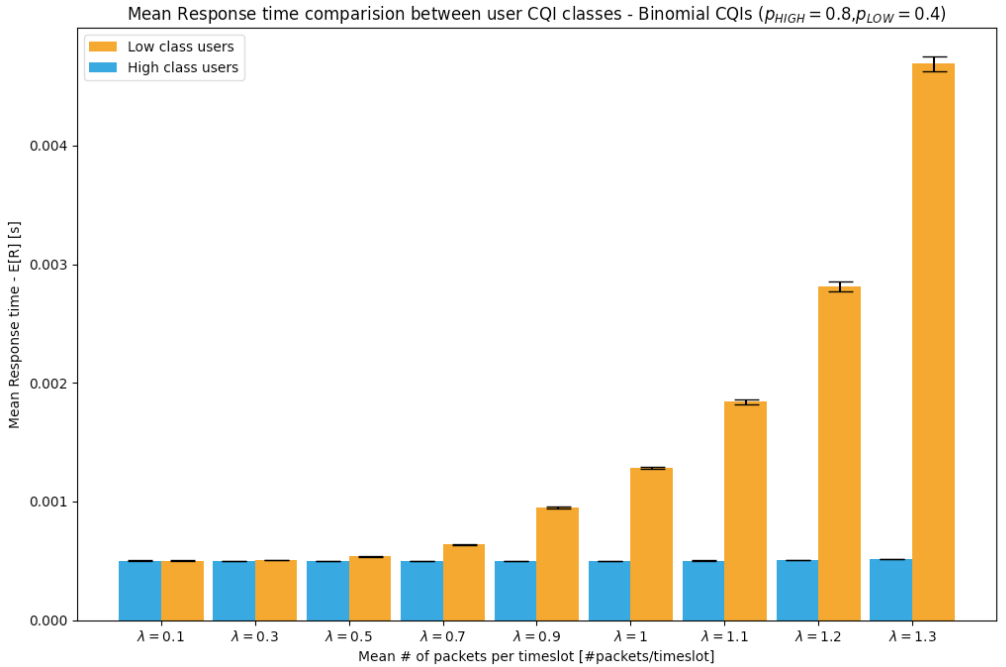




- Low CQI users tend to be excluded as the workload increases (their throughput eventually tends to 0).
- System fairness is heavily affected by workload.

Response time analysis (Binomial)





- Increases of **λ** results in the evident rise of the mean response time E[R]
- The lower CQIs' performance are strongly more affected

Another point of view:

- "*High*" and "*low*" class of users
- The Antenna prioritizes the **high-class** users
- Low CQI class experiences worse response times respect to high CQI class starting from $\lambda \geq 0.3$

Conclusions

- The opportunistic scheduling policy, in general, **prioritize** users which experience a better quality of network.

- The scheduling policy aims to **maximize throughput**.

- What is the **purpose** of having an opportunistic scheduling policy?
  - Building a network which advantages the users depending on their perceived network quality.
  - This type of scheduling policy shouldn’t be used when is required a minimum QoS, if the perceived network quality among all users is heterogeneous.

Questions?