Slotted Random-Access Wireless Network

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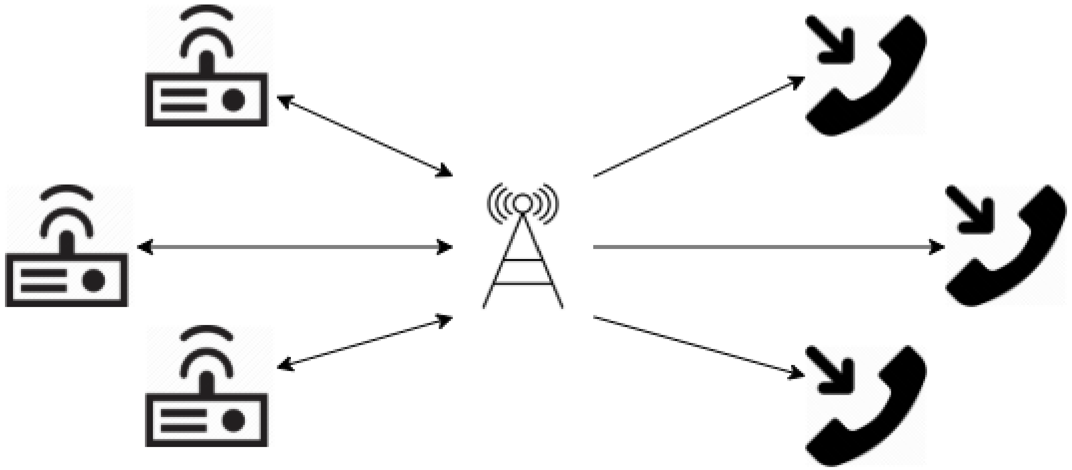
Modelling



General Assumptions

- Transmission at the beginning
- Constant Packet Size
- No Propagation Error
- Unbounded Queues
- Tx/Rx Synchronization
- Collisions and Channel Choice

Factors

- N: Transmitter/Receiver Couples
- C: Number of Channels
- p: Sending Probability
- $1/\lambda$: Mean Inter-Arrival Time
- T_{slot}: Time Slot Duration

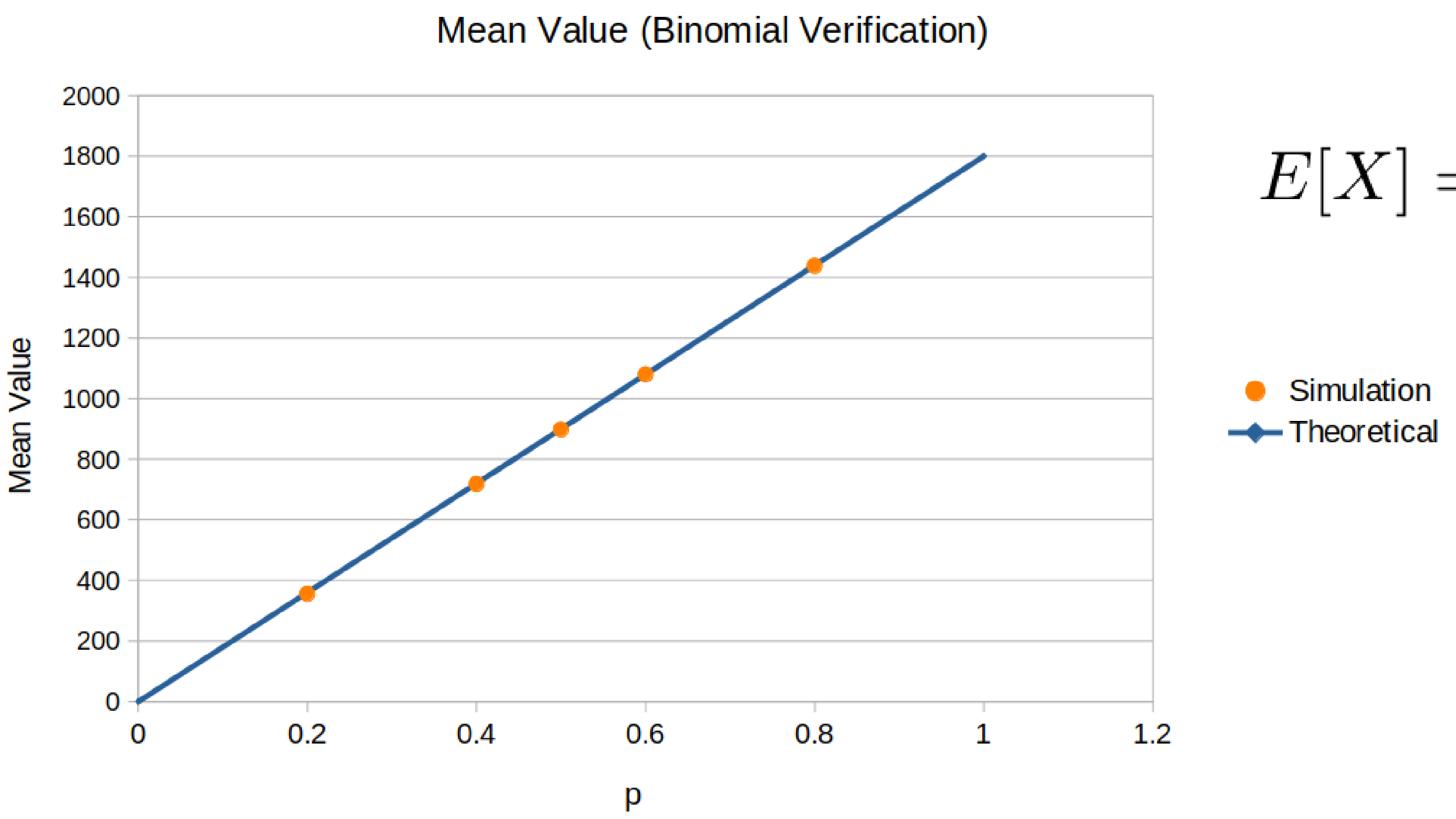
Verification (1)

Tests Performed

- Continuity Test
- Consistency Test
- Degeneracy Test
- Binomial Model
- Collision Model

Binomial Model

N=1; C=1; $1/\lambda = 1s$; p = {0.05, 0.1, 0.15, 0.2, 0.4, 0.5, 0.6, 0.8}



$$E[X] = np$$

Verification (2)

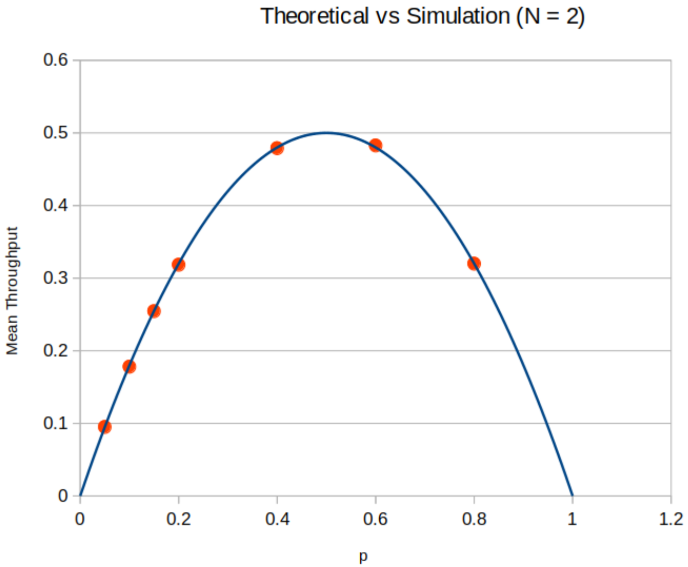
Collision Model

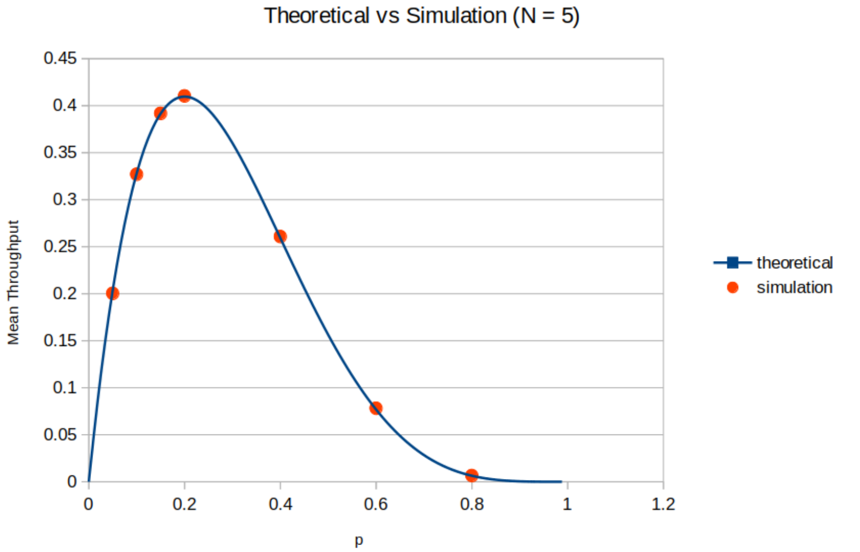
The probability of a successfull transmission is equal to the probability that only one tx transmit, i.e.:

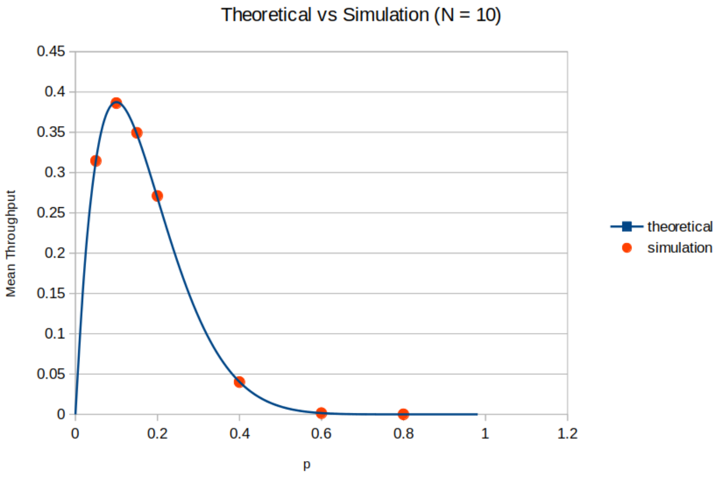
$$P\{\text{"}only\ one\ tx\ transmit\text{"}\} = N \cdot p \cdot (1-p)^{N-1}$$

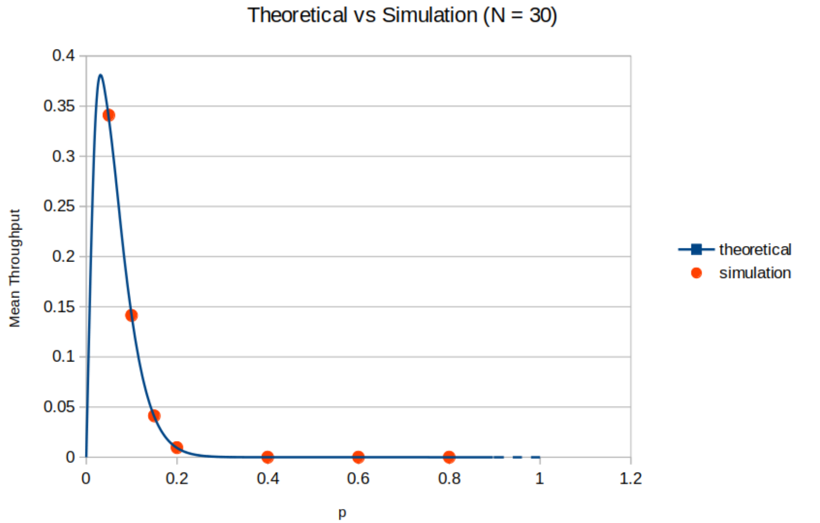
The latter can be seen as the mean throughput of the system in the single channel case:

$$Tp\ (slot) = \frac{N_p}{N_t} = \frac{N_t \cdot P\{\text{"}successful\ transmission\text{"}\}}{N_t}$$

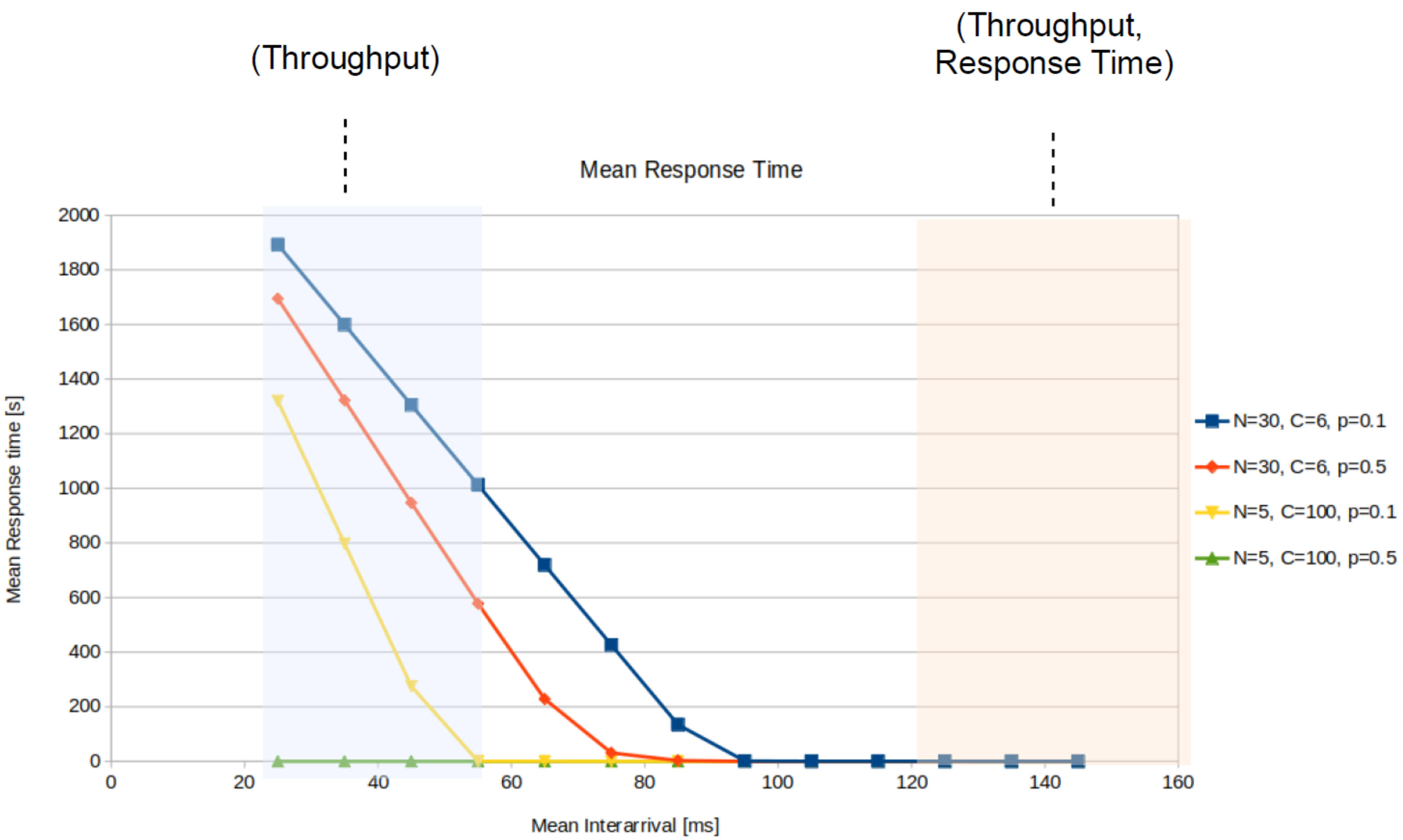




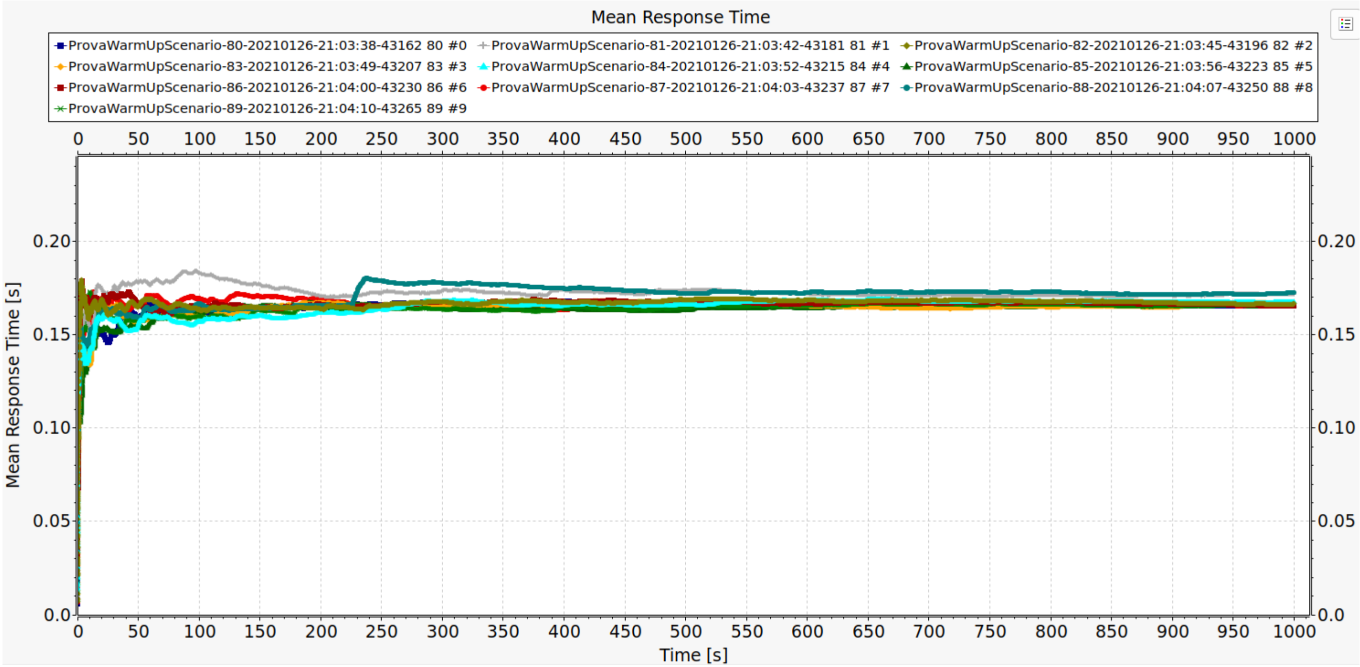




Response Time Limits



Scenario Calibration



WARMUP:

250s

SIMULATION DURATION:

5000s

Standard Scenario:

N = [5, 30]; C = [6, 100]; 1/λ = [125ms, 500ms]; p = [0.1, 0.5]; T_{slot}= 5ms;

Response Time Explosion Scenario:

N = [5, 30]; C = [6, 100]; 1/λ = [25ms, 55ms]; p = [0.1, 1]; T_{slot}= 5ms;

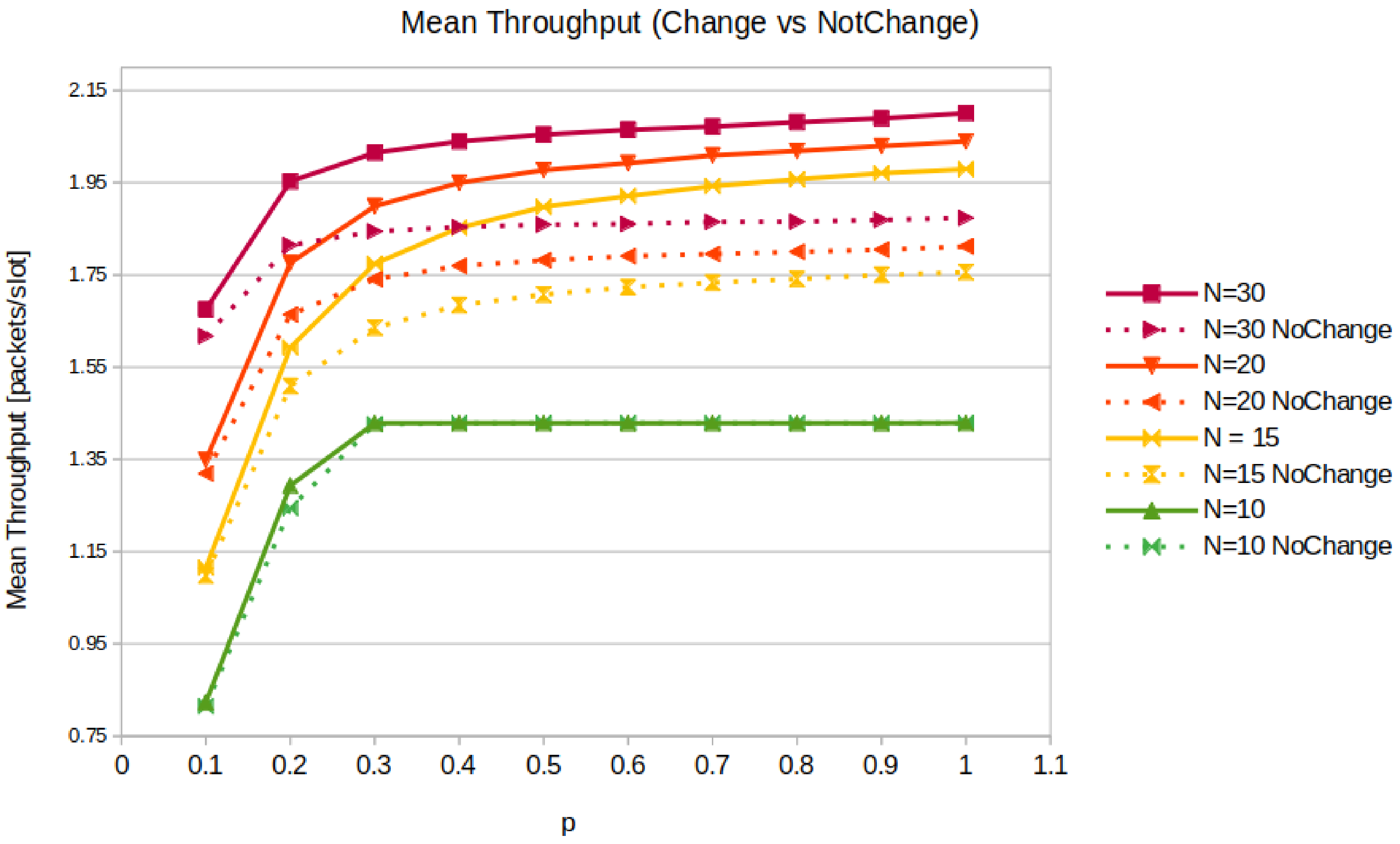
Response Time Explosion Scenario

Most Relevant Factors for Throughput

(Change Channel if Collision vs NoChange)

- Number Of Couples **N**
  - 55.93% vs 53%
  - $q_A = 1.064$ vs $q_A = 1.032$
- Send Probability **p** (simple to tune)
  - 4.684% vs 4.207%
  - $q_C = 0.308$ vs $q_C = 0.290$

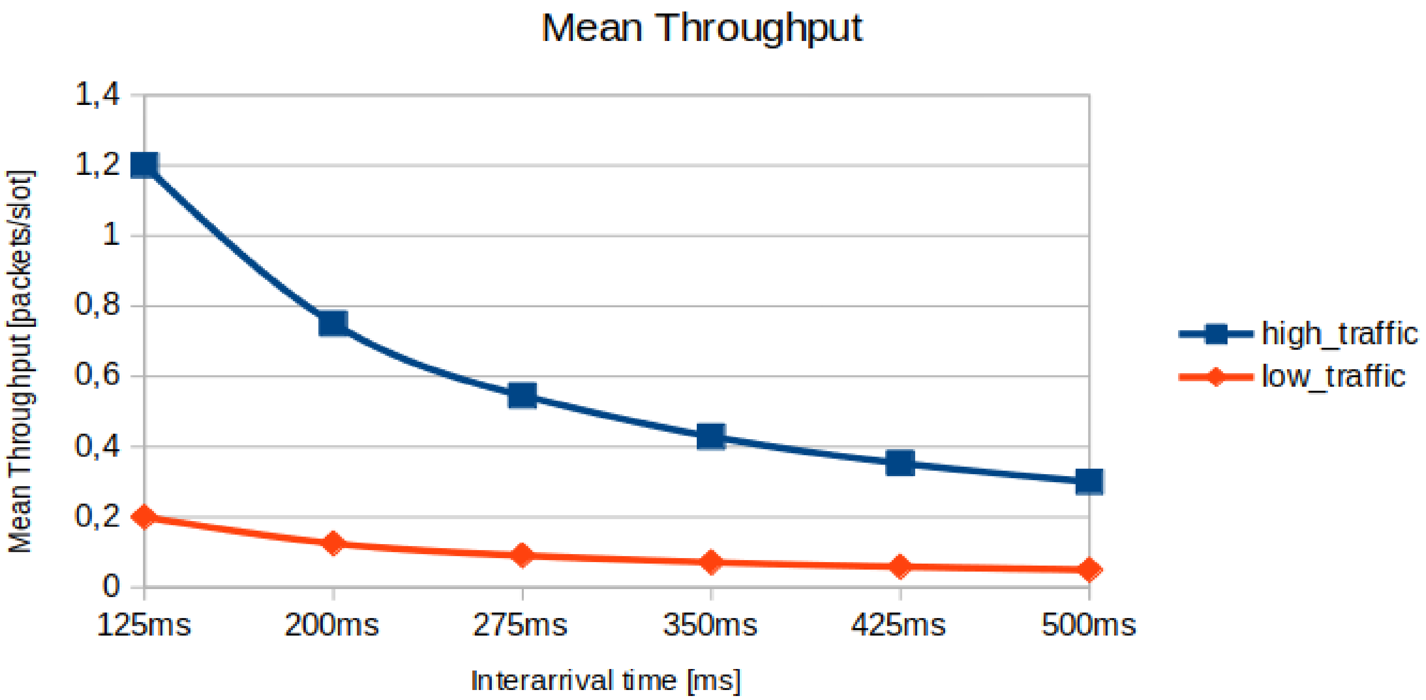
(C=6, 1/λ = 35ms)



Standard Scenario - Throughput

Most Relevant Factors for Throughput

- Number of Couples
  - 48.44% of variability
  - $q_A = 0.3125$
- Mean Inter-Arrival Time
  - 34.15% of variability
  - $q_D = -0.2624$
- Jointly effect of Couples and $\frac{1}{\lambda}$
  - 17.39% of variability
  - $q_{AD} = -0.1872$



High Traffic Scenario

N = 30; C = 6; p = 0.1

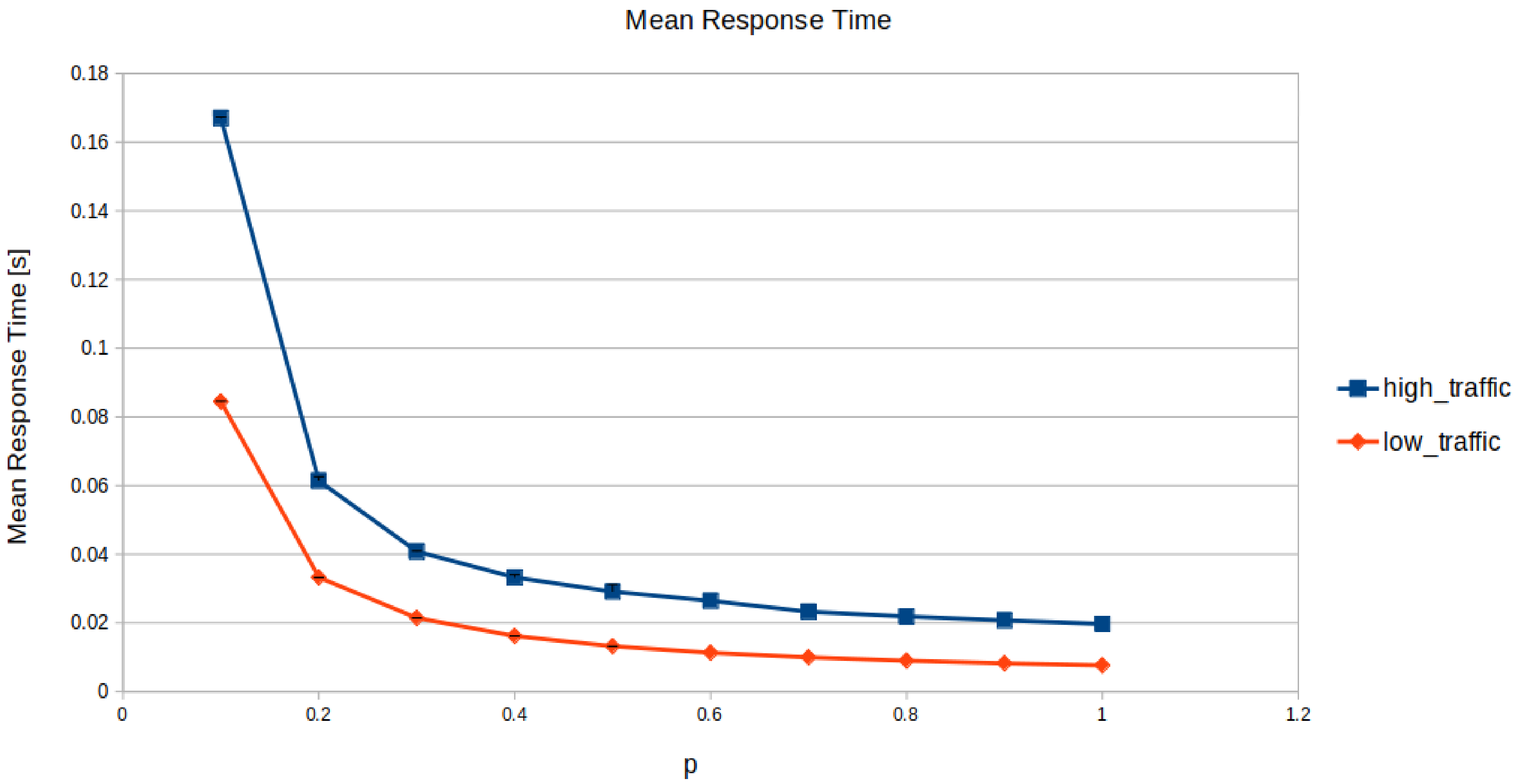
Low Traffic Scenario

N = 5; C = 100; p=0.1

Standard Scenario – Response Time

Most Relevant Factors for Response Time

- Send Probability
  - 65.67% of variability
  - $q_C = -0.0339$
- Mean Inter-Arrival Time
  - 9.57% of variability
  - $q_D = -0.0129$



High Traffic Scenario: N = 30; C = 6; 1/λ = 125ms

Low Traffic Scenario: N = 5; C = 100; 1/λ = 125ms

Conclusions

1. General: an high **Send Probability** is better in both scenarios

2. Response Time Explosion Scenario: **No-Change of Channel** has **worst throughput**

3. Limited Response Time Scenario: the **Throughput** increases with the increasing of **N** and the decreasing of $\frac{1}{\lambda}$

4. Limited Response Time Scenario: the **Response Time** decreases with the decreasing of **N**