Programming Assignment #8

MAC Performance Analysis: Slotted ALOHA

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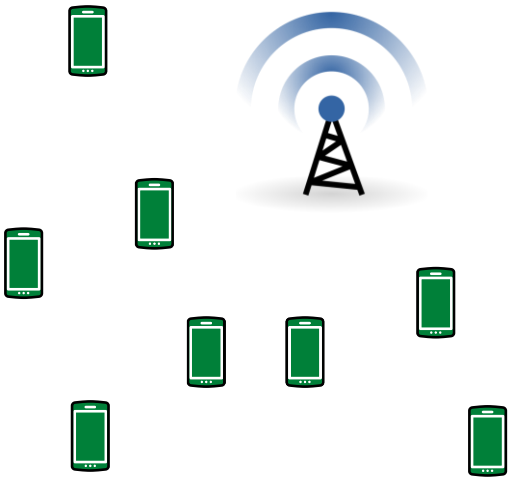
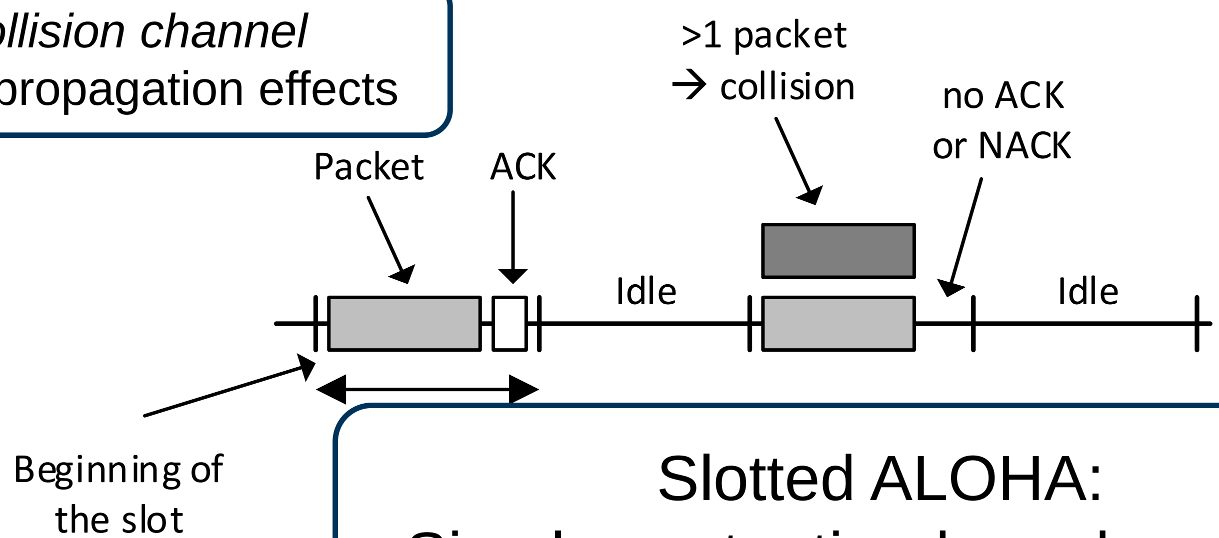
Slotted ALOHA

- **Possible scenario:**
  multiple mobile stations (MSs), uplink to BS
- MSs are synchronized to the ***slot***
  (e.g., via SYNC broadcast from BS)
- All transmissions occur within *a slot*
- **Three states:**
  singleton (1 MS), idle (0 MSs), collision (>1 MS)



collision channel
→ no propagation effects



Slotted ALOHA:
Simple contention-based protocol

Why do we use ALOHA-based MAC?

Contention-based

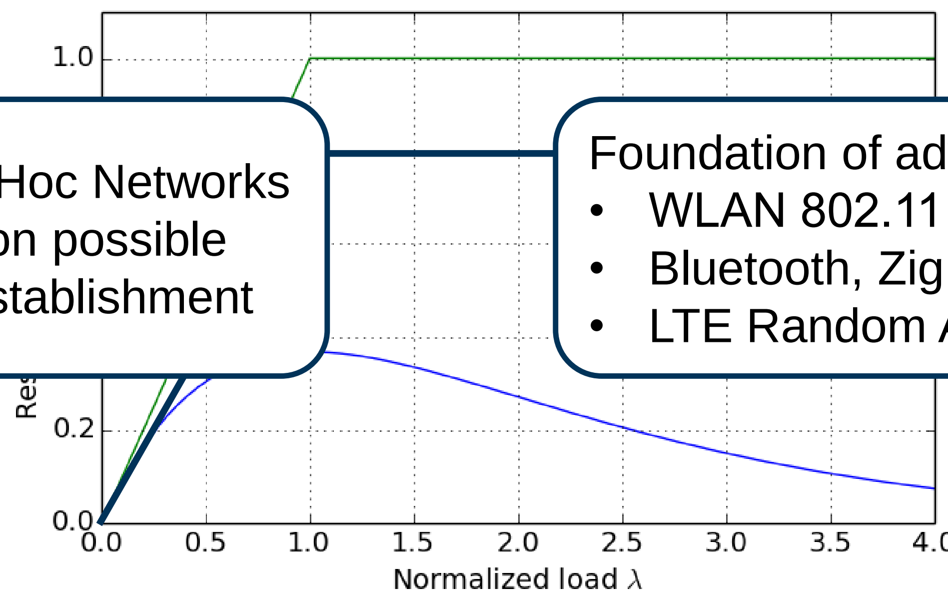
+ Low overhead
  → **No Information Exchange!**
+ Low complexity
+ Lower delay (if under-loaded)

- Low resource utilization: overprovisioning
- Non-linear degradation of the network performance (if over-loaded)

Contention-free

+ Higher resource utilization (high load)
+ Linear scaling of parameters with the load

- High overhead
  → **Information Exchange!**
- High delay (if under-loaded)



- Low load, Ad-Hoc Networks
- No coordination possible
- Connection establishment

Foundation of advanced protocols:

- WLAN 802.11…
- Bluetooth, ZigBee, 6loWPAN,
- LTE Random Access Procedure

Basic analytical model

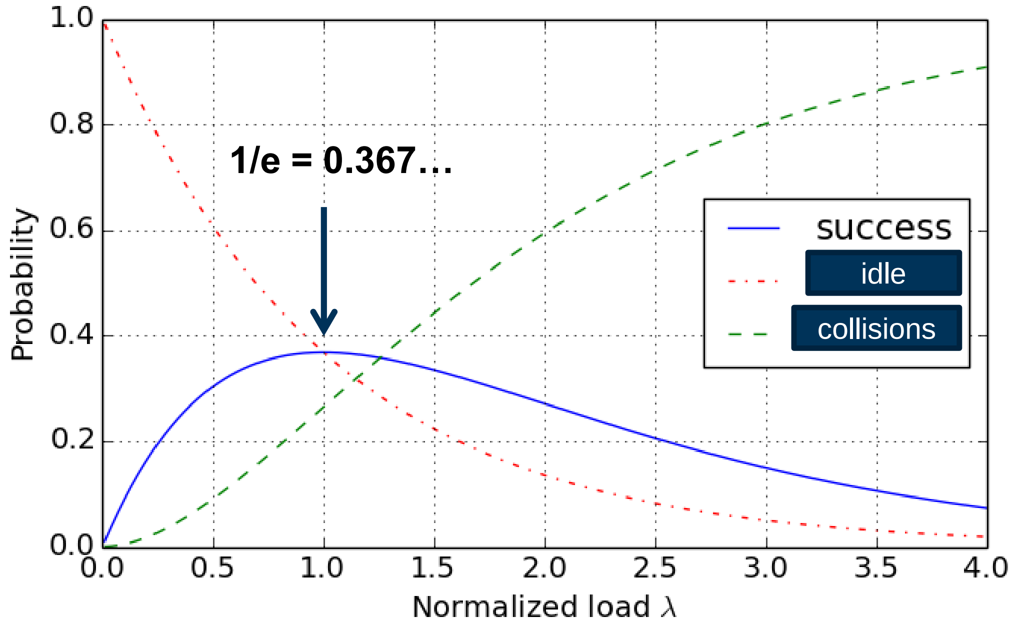
- **Poisson** arrivals with rate **λ (load per slot)**
- **Three states:** Success (1), Idle (0), Collisions (e)
- **Throughput T** – ratio of successful receptions (1) to the total number of slots (1+0+e) **= resource utilization**

Probability of exactly one transmission in a slot is (success probability):

$$P[k=1] = \frac{\lambda^k e^{-\lambda}}{k!} = \boxed{\lambda e^{-\lambda} \quad = T}$$

$$P[k=0] = \frac{\lambda^k e^{-\lambda}}{k!} = e^{-\lambda} \quad = Idle$$

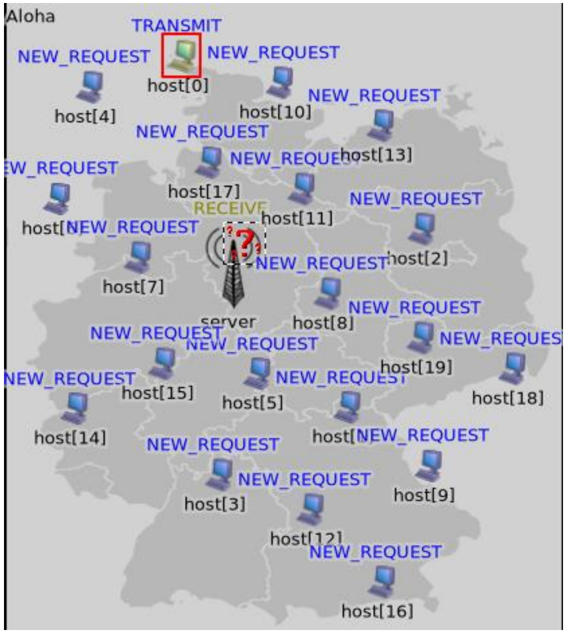
$$P[k>1] = 1 - P[k=0] - P[k=1] \quad = Collision$$



In real applications: retransmissions!

Simulated network

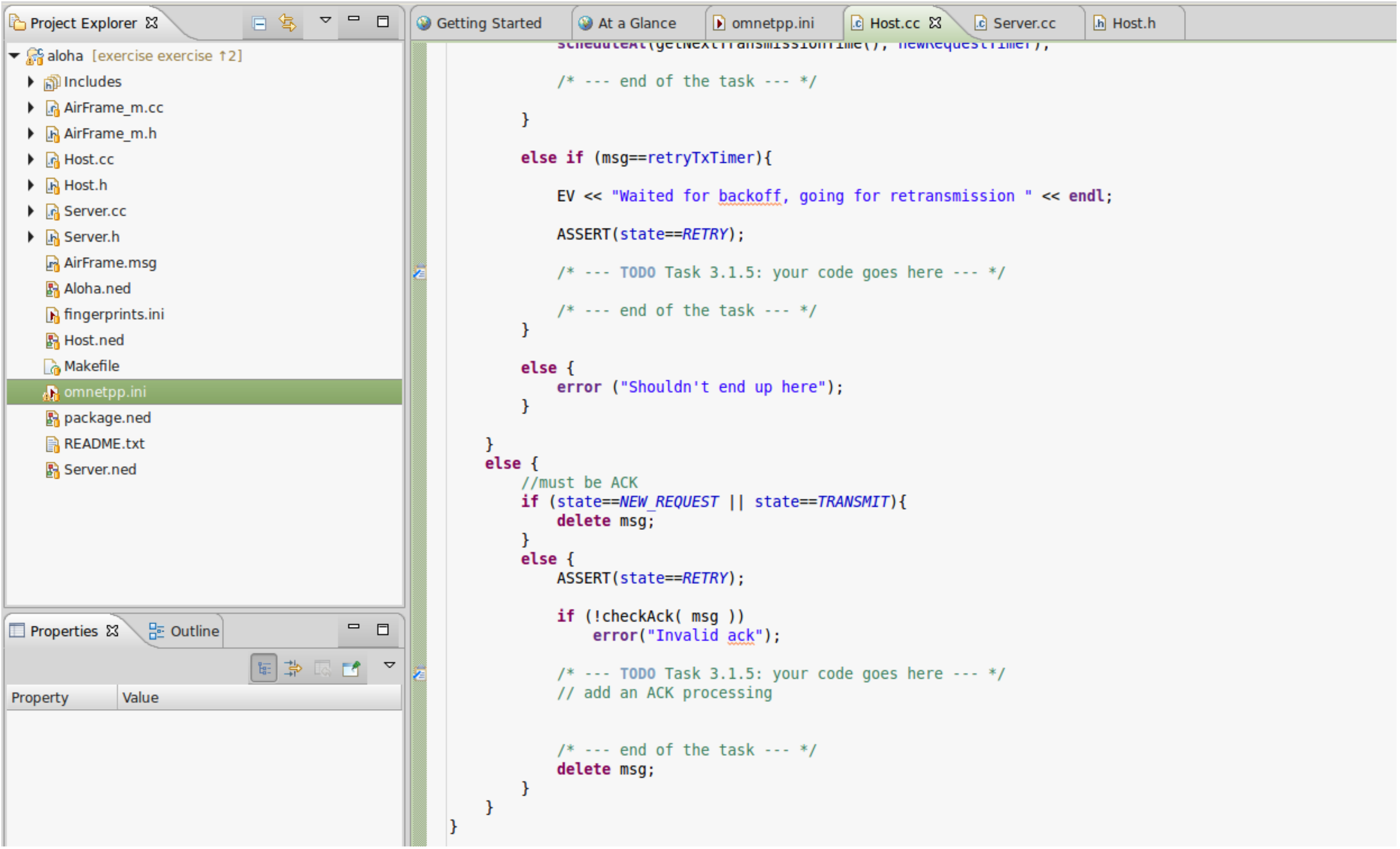
- N MSs (**hosts**)
- One BS (**server**)
- Exponentially distributed ***inter-arrival time***



- **Host behavior:**
  - No retransmission
  - Retransmission until acknowledgement is received
  - Uniform / exponential back-off interval between retransmissions

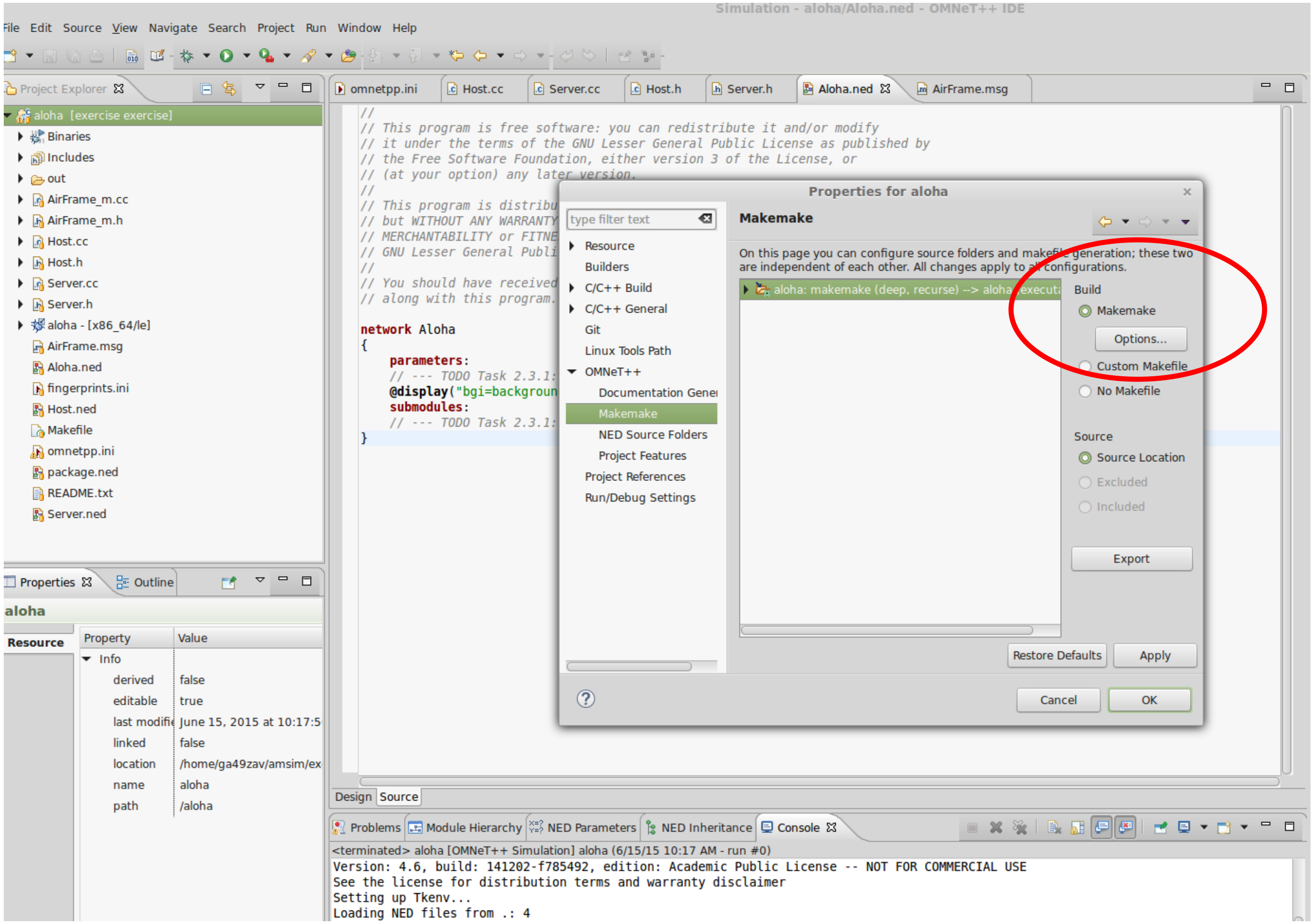
- **Server:**
  - No acknowledgement
  - With acknowledgement

Project structure



Project structure (2)

Project-> Properties -> Omnet++ -> Makemake
Set the Build as Makemake



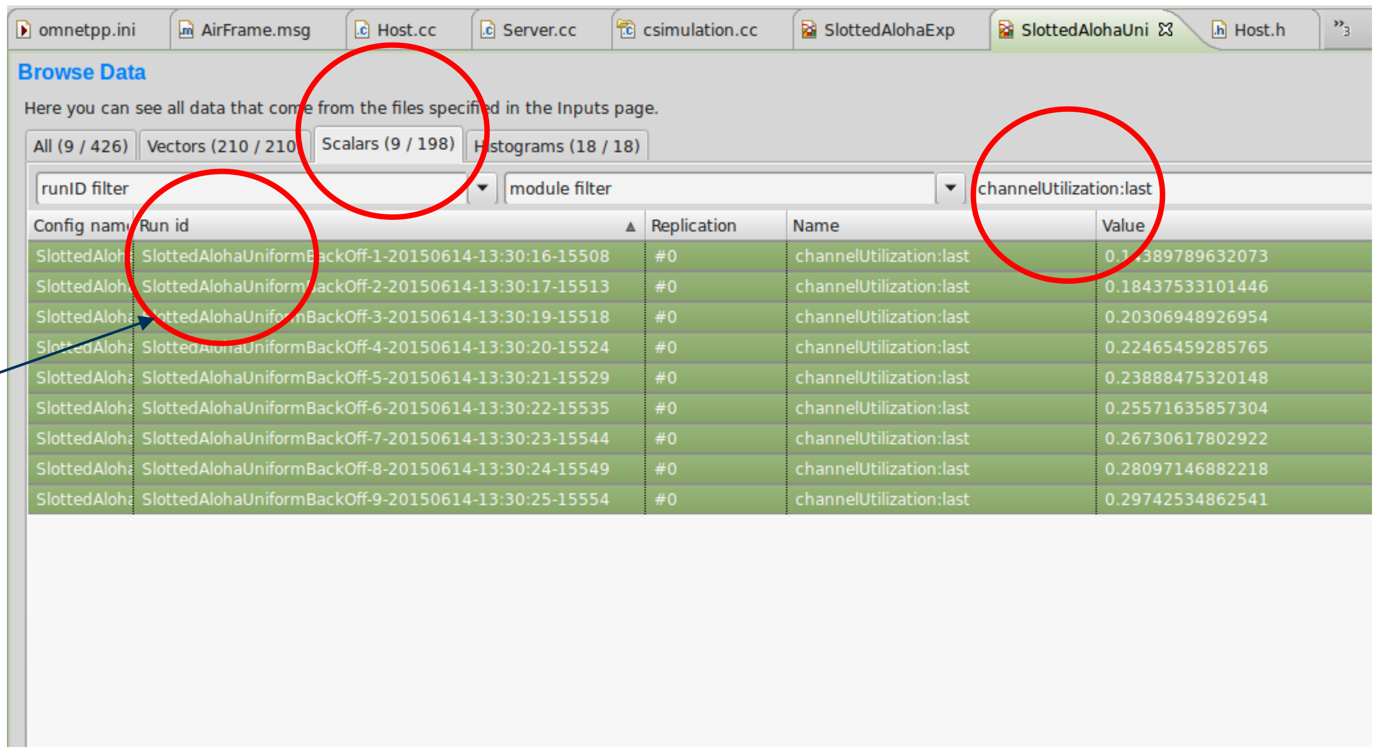
Tasks

- Create a network and run the simulation ~24 Points
- Add retransmissions to the model ~64 Points
- Randomize back-offs ~12 Points

- Bonus:
  - Re-run 30 times and plot with the 0.95 confidence interval ~10 Points
  - Implement the statistic collection for the ratio of dropped packets ~5 Points
  - Implement exponential back-offs ~10 Points
  - Early bird ~5 Points

Questions?

Exporting the results



Ordered by

Right click -> export as .csv
Uncheck “adding headers”
Plot using matplotlib - recomended