TP Performance - Introduction

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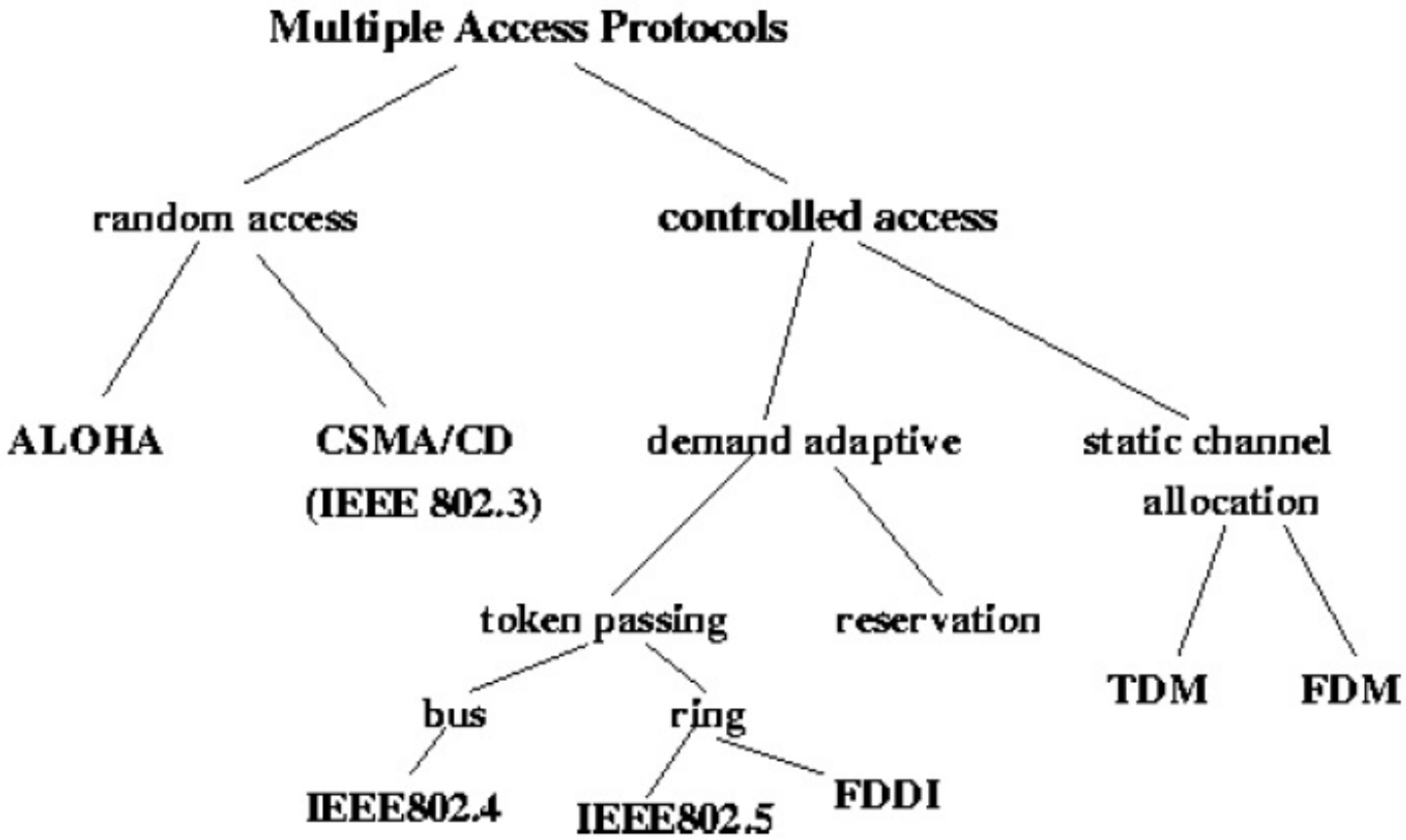
Introduction

Multiple access to the channel

Introduction



Introduction

Performance metrics:

- Spectrum efficiency
- Latency
- Throughput
- ...

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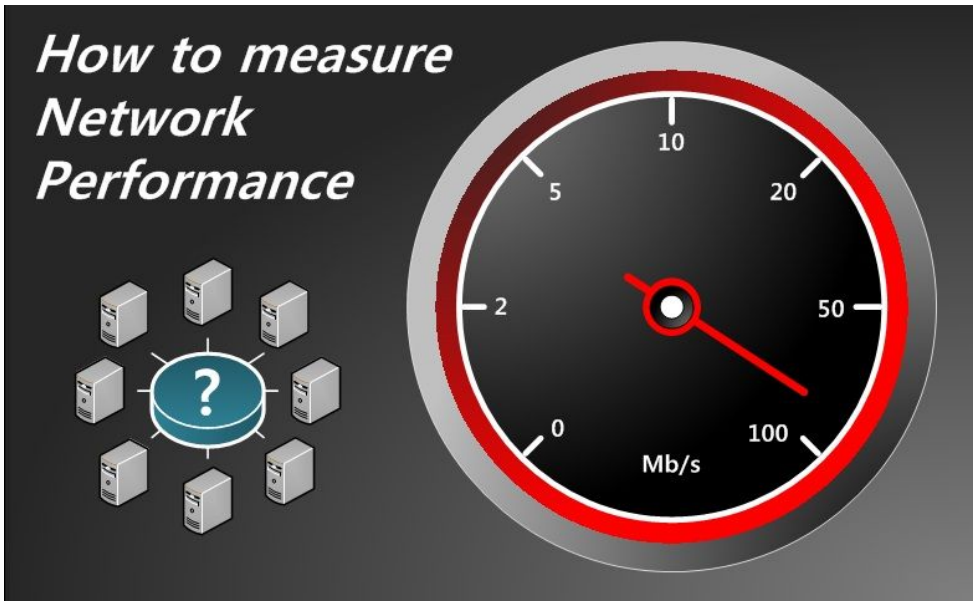

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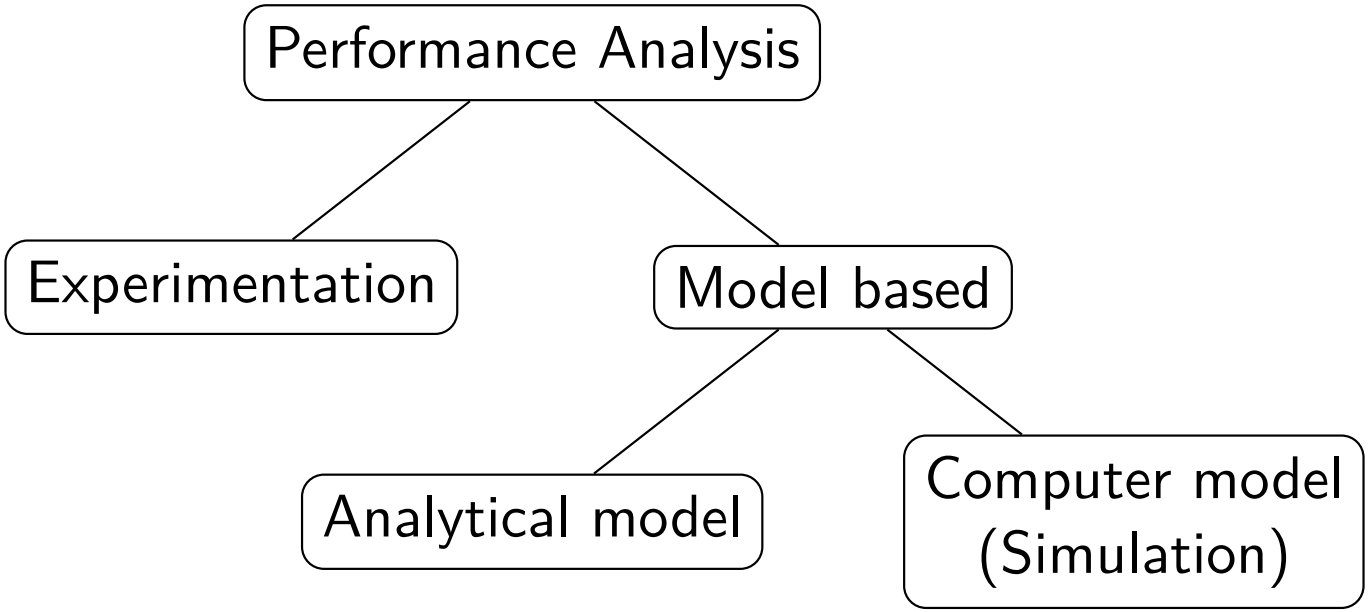
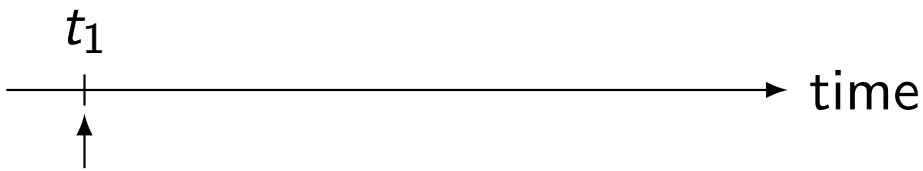


Discrete Event Simulation

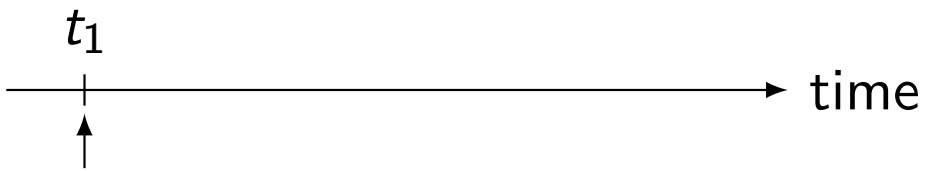


Event A execution (t_1):

1. Update system state
2. Schedule event A' at t_3

Sim Time	Event
t_1	**A**
t_1	B
t_2	C

Discrete Event Simulation

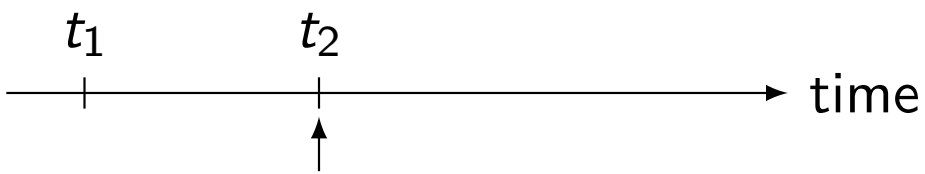


Event B execution (t_1):

1. Update system state
2. Schedule event B' at t_4

Sim Time	Event
$\mathbf{t_1}$	**B**
t_2	C
t_3	A'

Discrete Event Simulation

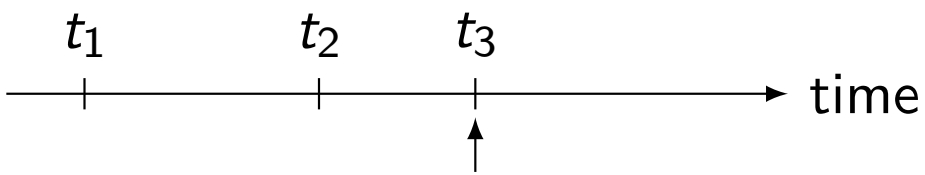


Event C execution (t_2):

1. Update system state
2. No event to schedule

Sim Time	Event
t_2	**C**
t_3	A'
t_4	B'

Discrete Event Simulation



Event A' execution (t_2):

1. Update system state
2. Schedule event A'' at t_5
3. ...

Sim Time	Event
t_3	**A'**
t_4	B'

Simpy

- SimPy (GPL) is a discrete-event simulation library

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import simpy
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env.process(event_generator())
env.run(until=20) # Run simulation until
# the 20th time step
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# the 20th time step
```

- Simpy is event-process based:
  1. Events are wrapped in process functions (or methods)
  2. A process function creates events, yield them to be scheduled, and updates the system state

```
def packet_generator(env):
        while True:
                yield env.timeout(1) # Wait for 1 time step
                packet_count+=1
```

In practice

SimPy implementation requires:

1. A process function (or method) for each event that yields an action and updates the system state
2. An environment (scheduler) that determines the order the event processes should be called

Exercice - Analysis

Problem

A router is sending packets through a 64 kbps link. The length of the packets is an exponential random variable with mean 400 bytes. The interval between arrival of packets is an exponential random variable with mean 15 packets per second. During a packet transmission, the router bufferizes the other arriving packets in a FIFO queue.

1. Formulate the problem as M/M/1 queue.
2. What is the stability condition ?
3. Compute the following in the stationary regime:
   - Average number of packets in the system
   - Average latency of the system

Exercice - Correction

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1. M/M/1 queue: $\mu = 6400/(400 \cdot 8) = 20\text{s}^{-1}$, $\lambda = 15\text{s}^{-1}$

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3. Compute the following in the stationary regime:
   - Average number of packets in the system: $N = \frac{\rho}{1-\rho} (= \frac{\lambda}{\mu-\lambda}) = \frac{0.75}{0.25} = 3$
   - Average latency of the system (Little formula): $T = \frac{N}{\lambda} = \frac{3}{15} = 0.2s$

Exercice - Simulation 1

Problem

A router is sending packets through a 64 kbps link. The length of the packets is an exponential random variable with mean 400 bytes. The interval between arrival of packets is an exponential random variable with mean 15 packets per second. During a packet transmission, the router bufferizes the arriving packets in a FIFO queue.

1. Using SimPy, simulate the corresponding Poisson process packet generator (use random.expovariate)
2. What is the average number of generated packets per time unit (use env.now) ?

Git repo:

- https://gricad-gitlab.univ-grenoble-alpes.fr/mendilm/tp_perf2018.git

SimPy ressources

- Stores are object containers (pair of lists) with a limited or unlimited capacity

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store = simpy.Store(env, capacity=10)
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- Putting elements in a store is an event

```
def producer(env, store, packet):
        """ Put a packet in the store
                each two time steps
        """
        while True:
                yield env.timeout(2)
                # Put a packet in the store
                yield store.put(packet)
```

SimPy ressources

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```
store = simpy.Store(env, capacity=10)
```

- Getting elements from a store is an event

```
def consumer(env, store):
        """ Processes a packet from the store
                each time step
        """
        while True:
                yield env.timeout(1)
                # Get the packet from the store
                packet = yield store.get()
                # ... process packet
```

Exercice - Simulation 2

Problem

A router is sending packets through a 64 kbps link. The length of the packets is an exponential random variable with mean 400 bytes. The interval between arrival of packets is an exponential random variable with mean 15 packets per second. During a packet transmission, the router bufferizes the arriving packets in a FIFO queue.

1. Using SimPy, model the queue/server system corresponding to the router/link
2. Using SimPy, simulate the M/M/1 queue
3. Compute the following in the stationary regime:
   - Average number of packets in the system
   - Average latency of the system

References

1. SimPy official page: https://simpy.readthedocs.io/en/latest/contents.html
2. Git repo: https://gricad-gitlab.univ-grenoble-alpes.fr/mendilm/tp_perf2018.git
3. Introduction to simulation: Sanchez, Paul J. "As simple as possible, but no simpler: a gentle introduction to simulation modeling." In Simulation Conference, 2006. WSC 06. Proceedings of the Winter, pp. 2-10. IEEE, 2006.