SE3910 – REAL TIME SYSTEMS

Scheduling Theory and Networking

ROADMAP

- Friday
  - Communication between processes
- Monday
  - Gstreamer and OpenCV Introduction
    - Image processing / image handling

→ Graphics

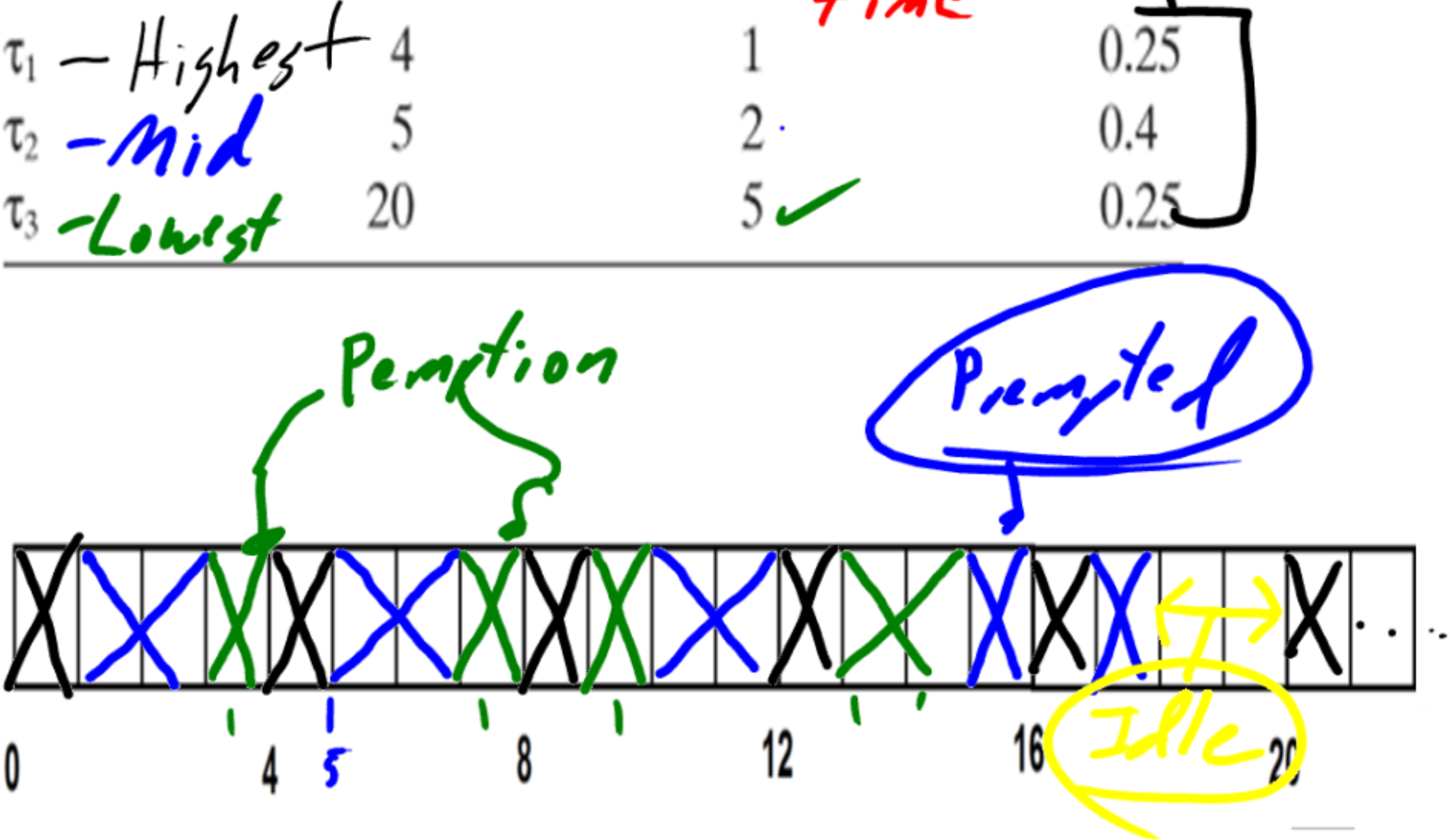
Wednesday
→ Measuring Execution Time.

OBJECTIVES

- Explain rate monatonic analysis and RMA Scheduling
- Explain earliest deadline first scheduling.
- Explain the EDFA Bound scheduling approach
- Explain the concept of a reader, writer, and bounded buffer
- Explain how Time correlated buffering might be used to aid in the design of a system
- Explain the concept of a ring buffer
- Understand how a mailbox works and why a mailbox might be used.

TABLE 3.2. Example Task Set for RM Scheduling

τ_i	p_i	e_i	u_i
τ_1	4	1	0.25
τ_2	5	2	0.4
τ_3	20	5	0.25



- Max Utilization to be schedulable

$$U \leq n * (2^{\frac{1}{n}} - 1)$$

RMA BOUND

$$\lim_{n \to \infty} n * (2^{\frac{1}{n}} - 1) = ln2 \approx 0.69$$

$3 * 2^{\frac{1}{3}} - 1 = 3 * (1.259 - 1)$

2.78

THE CHART FROM LAST WEEK

TABLE 1.3. CPU Utilization (%) Zones

Utilization (%)	Zone Type	Typical Application
<26	Unnecessarily safe	Various
26–50	Very safe	Various
51–68	Safe	Various
69	Theoretical limit	Embedded systems
70–82	Questionable	Embedded systems
83–99	Dangerous	Embedded systems
100	Critical	Marginally stressed systems
>100	Overloaded	Stressed systems

EARLIEST DEADLINE FIRST

- A dynamic scheduling algorithm
  - Priority of the task changes as other tasks are released and completed.

Theorem: The EDFA Bound

A set of n periodic tasks, each of which relative deadline equals its period, can be feasibly scheduled by the EDFA if and only if $U = \sum_{i=1}^{n} e_i / p_i \leq 1$.

$$U = \sum_{i=1}^{n} \frac{e_i}{p_i} \leq 1$$

AN EXAMPLE

TABLE 3.4. Task Pair for the Example of EDF Scheduling

τ_i	p_i	e_i	u_i
τ_1	5	2	0.4
τ_2	7	4	0.57

40%
57%
97%

- Questions:
  - What is total CPU utilization? — 97%
  - Is this within the RMA bound?

$\Rightarrow 2*(2^{\frac{1}{2}}-1)$

$2*(1.4114-1) = .414*2$

.828

TABLE 3.4. Task Pair for the Example of EDF Scheduling

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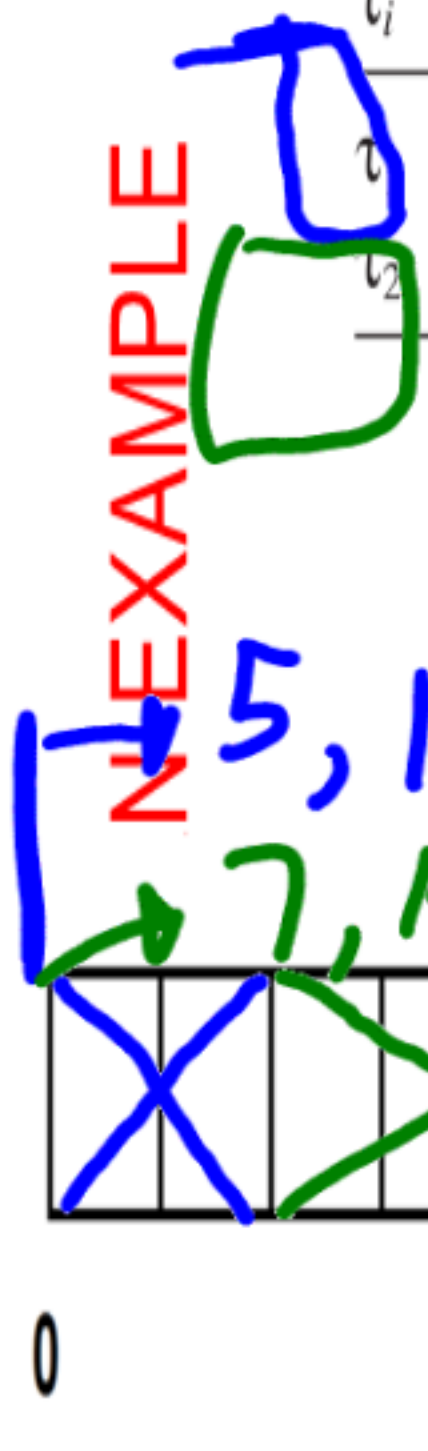

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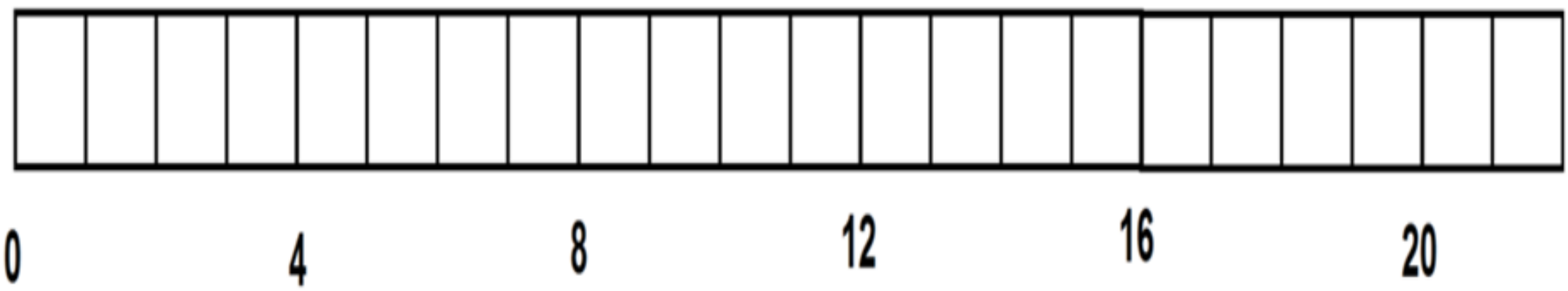


ADVANTAGES / DISADVANTES

- Dynamic Priority
  - More flexible and achieve higher utilization
- Temporal Behavior => Time
  - More constant with a fixed priority algorithm
    - RMA stable in the presence of missed deadlines
      - Same low priority tasks always miss their deadlines
    - EDF can not predict which tasks will miss their deadlines
- RM tends to use more preemption

COMMUNICATING BETWEEN PROCESSES

- Processes must communicate
- How can we do that?

Sending data / info from one process to another.

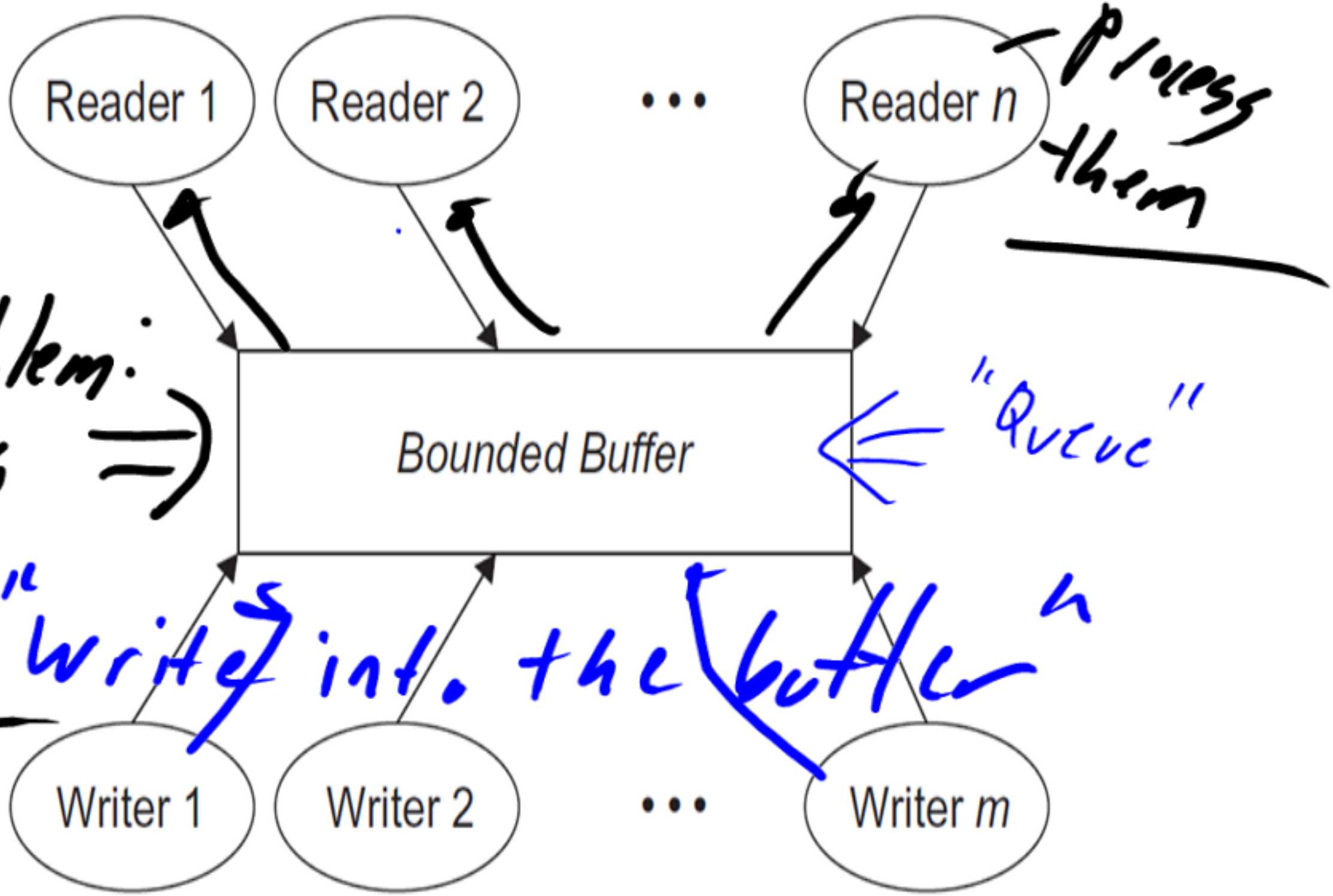
COMMUNICATING BETWEEN PROCESSES

- Processes must communicate
  - How can we do that?

Messages from one process to another.

process

READERS AND WRITERS



DOUBLE BUFFERING

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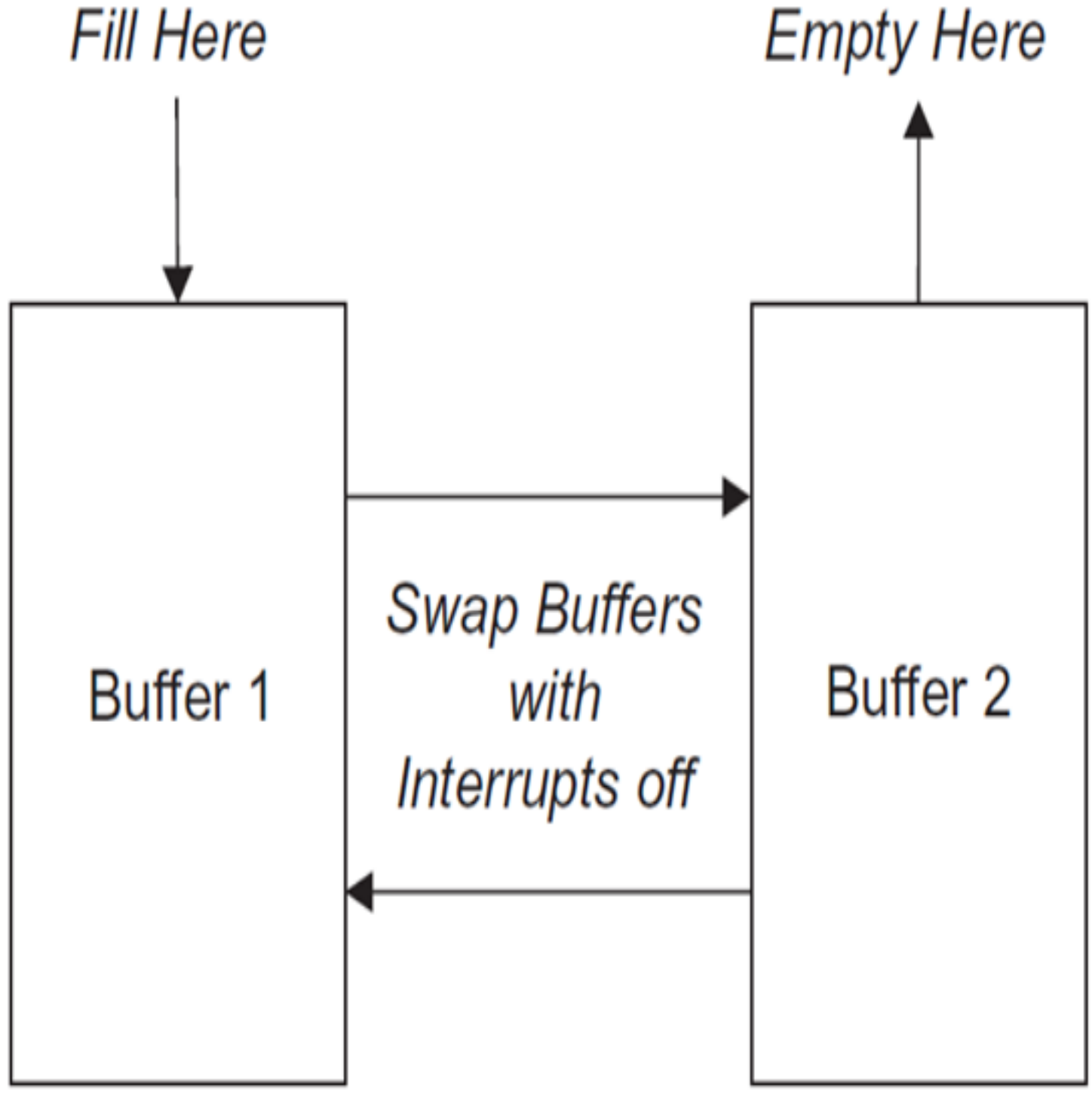
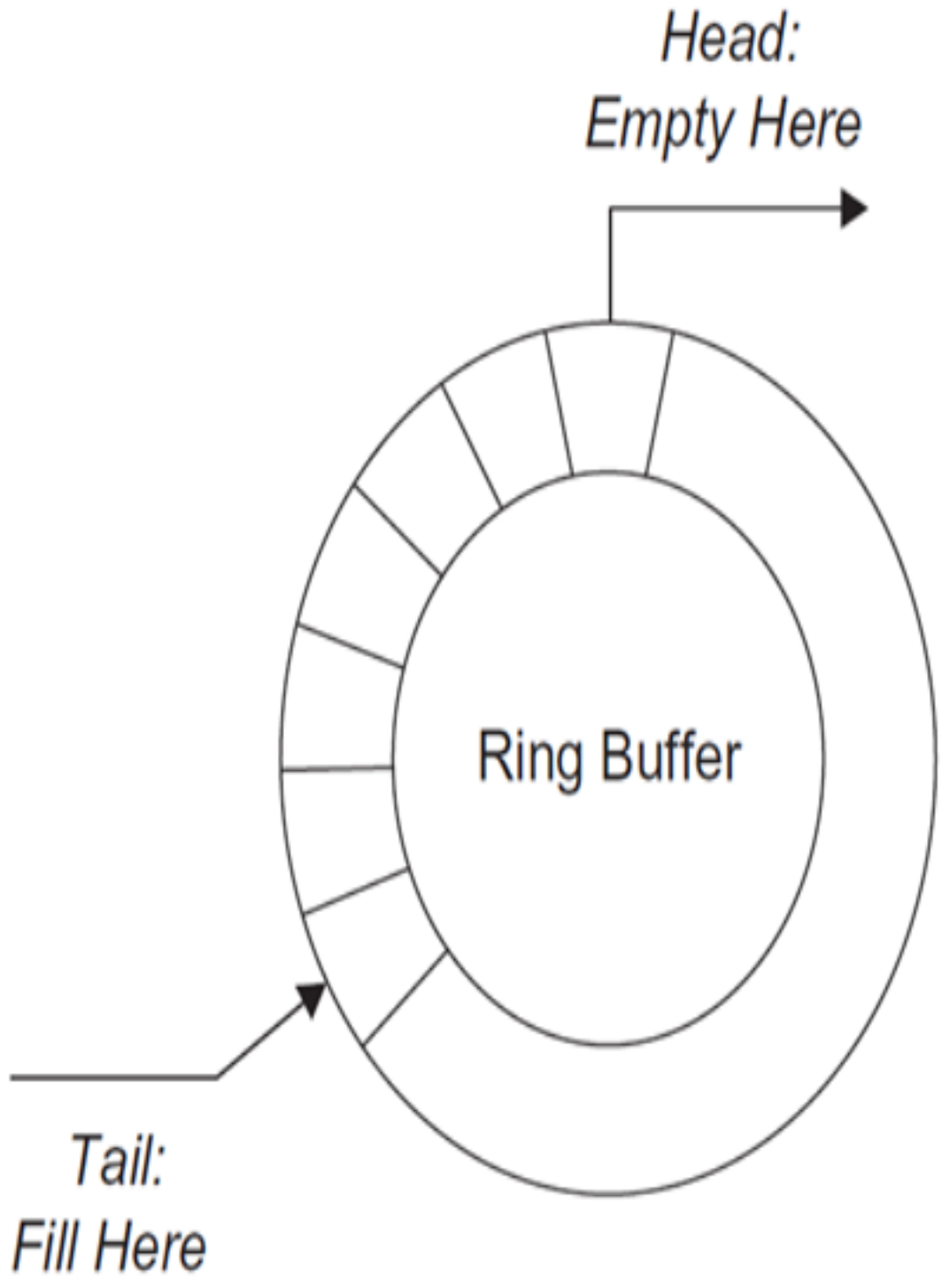
DOUBLE BUFFERING DATA STRUCTURE



EXAMPLE SYSTEM

- We have a GPS System
  - Every 50 ms, we receive a new GPS coordinate
    - 10 ms processing time per coordinate
  - We need to filter the data to remove erroneous readings
    - Filtering requires 5 readings
    - Filtering takes 10 ms
  - After filtering is done, we can refresh the display
    - This takes 100 ms to do.
- How might we do this?

RING BUFFER



MAILBOXES

- Pend(d, &s)
- Post(d &s)
  - D data that is to be sent / received
  - S The mailbox that is to be referenced.

- Pend
  - Allows multiple processes to use the same mailbox, but only one will receive the material
- May be combined with other data structures to be efficient.