Last class

- Metrics
  - App Centric
    - Turnaround Time
    - Output Time
  - System Centric
    - Ptot
  - Fairness
  - Utilization

- Pre-emptive & Cooperative Scheduling

- Policies
  - FCFS/FIFO
  - SJF/SCTF
  - Round Robin

Where we left off

A: CPU Bound
B: CPU Bound
C: 1ms CPU \xrightarrow{\text{Blocking}} 10ms Disk

RR, 100ms Quanta
Disk Utilization: \( \frac{10\text{ms}}{\sim 201\text{ms}} \)

RR: 1ms

CPU

Disk

Disk Utilization \( \frac{10\text{ms}}{\sim 100\%} \)
\( 10 \leq t \leq 12\text{ms} \)

Observation: Small quanta better for disk

Worse in terms of \# of context switches.

SCTF, except:

\[ \rightarrow \] Use CPU time as completion time

\[ \rightarrow \] Invoke scheduler whenever

- New process arrives
- Process unblocks
- Quanta expires (100ms)

<table>
<thead>
<tr>
<th>Process</th>
<th>Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running A</td>
<td>( \infty ) - 10ms</td>
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Observation

- SCTF does better than RR w/ 100 ms quanta for disk utilization

- SCTF does better than RR w/ 1ms quanta for context switches

- But needs to know completion time?

Use past observation to estimate exponential weighted moving average

$$\sum_{i=0}^{T} x_i X_i$$
PRIORITIES

THIS IS IMPORTANT/COMMONLY USED

Strict Priority (Higher # Better)

5

A B C ← RR

ABC

A B C

4

D ← RR

ABC D

1

F ← RR

Problem: When does F (Priority = 1) run?

Starvation

Multi-Level Feedback Queue

ABC A B C D A B C

Goal: Avoid starvation.

How: Feedback?
Lotto: ABCDE

A 5+5x
B 5+5x
C 5+5x
D 4+6x
E 1+6x

Total tf = 20

E: 30s
D: 15s
C: 15s
B: 15s
A: 15s

Priority for processes that have not run.

Temporarily boost 20ms

10ms
10ms
5ms
5ms
5ms

THERAC-25

PRODUCE 0 - 25 MeV q Energy

Ion Chamber 25 MeV → X-ray

Electromagnet

0-25 MeV → "SHAPES Beam"

Light for Targeting
0eV → Light

Energy Level +

ON OR NOT

Sensor to detect state

Problem?
TERMINAL TO SETUP TREATMENT

WAIT
READ
SETUP 280 CCS
IF COMPLETE:
START

UP< CURSOR UP
DN< CURSOR DN

IF INPUT VALIDATES
COMPLETE=
(CURSOR == LAST LINE)
Why did it take so long to figure it out?

QA difficult & exp.

Concurrence

Inputs needed

Societal expectation

Error code abstract

No documentation

Interlocks???