Tutorial 3

Process Scheduling

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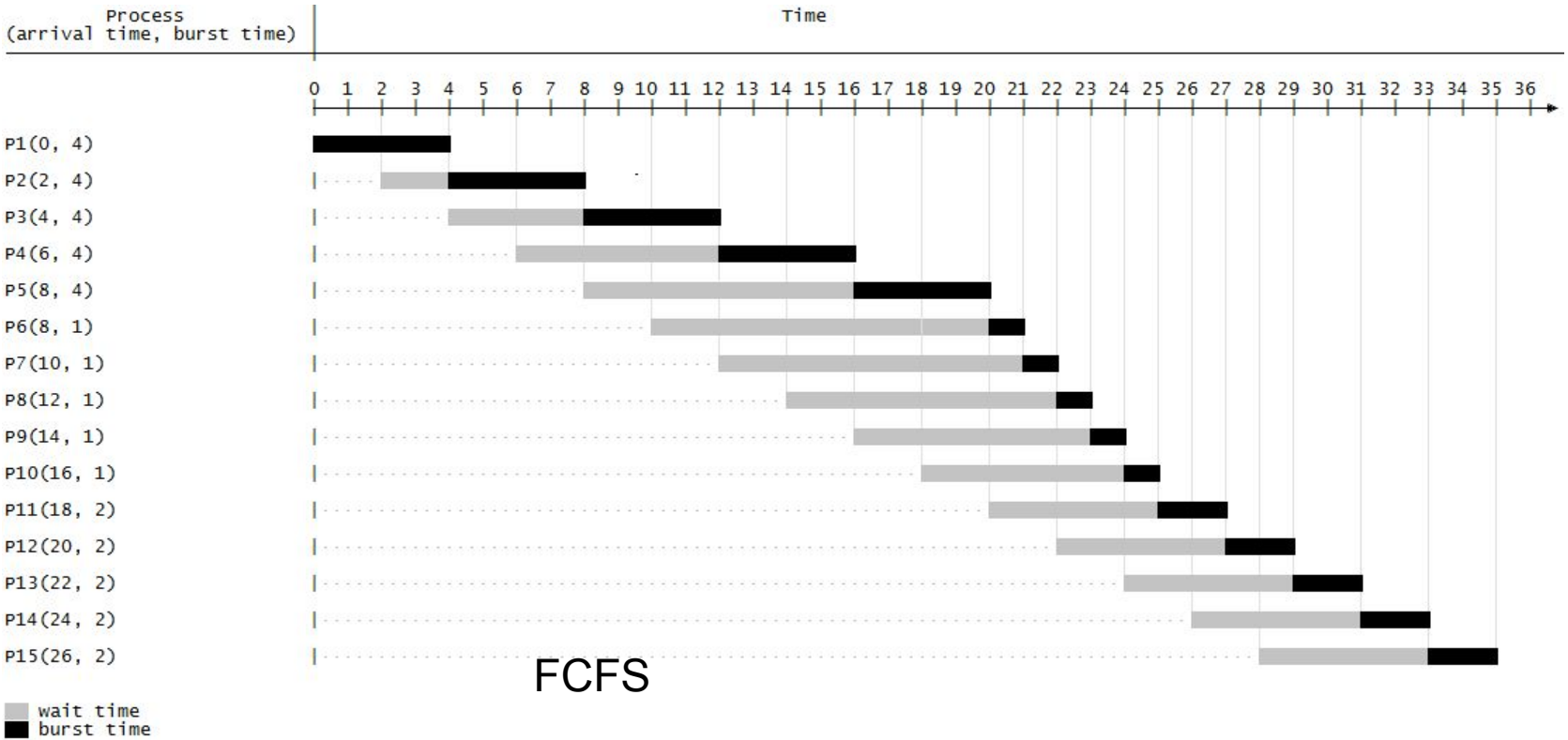
What is Process Scheduling?

- Modern Operating Systems run more than one process ‘at a time’ (more like thousands of processes at a time),
- What do you do if the number of simultaneously running processes on a system exceed the number of physical CPU cores?
- You need a time sharing system which “switches” between processes very rapidly to give the illusion of simultaneity.
- Process Scheduling is all about how this “switching” between processes happens in the OS.

Scheduling Policies?

- First Come First Serve
- Round Robin
- O(n)
- O(1)
- CFS (Current default Linux Scheduler)

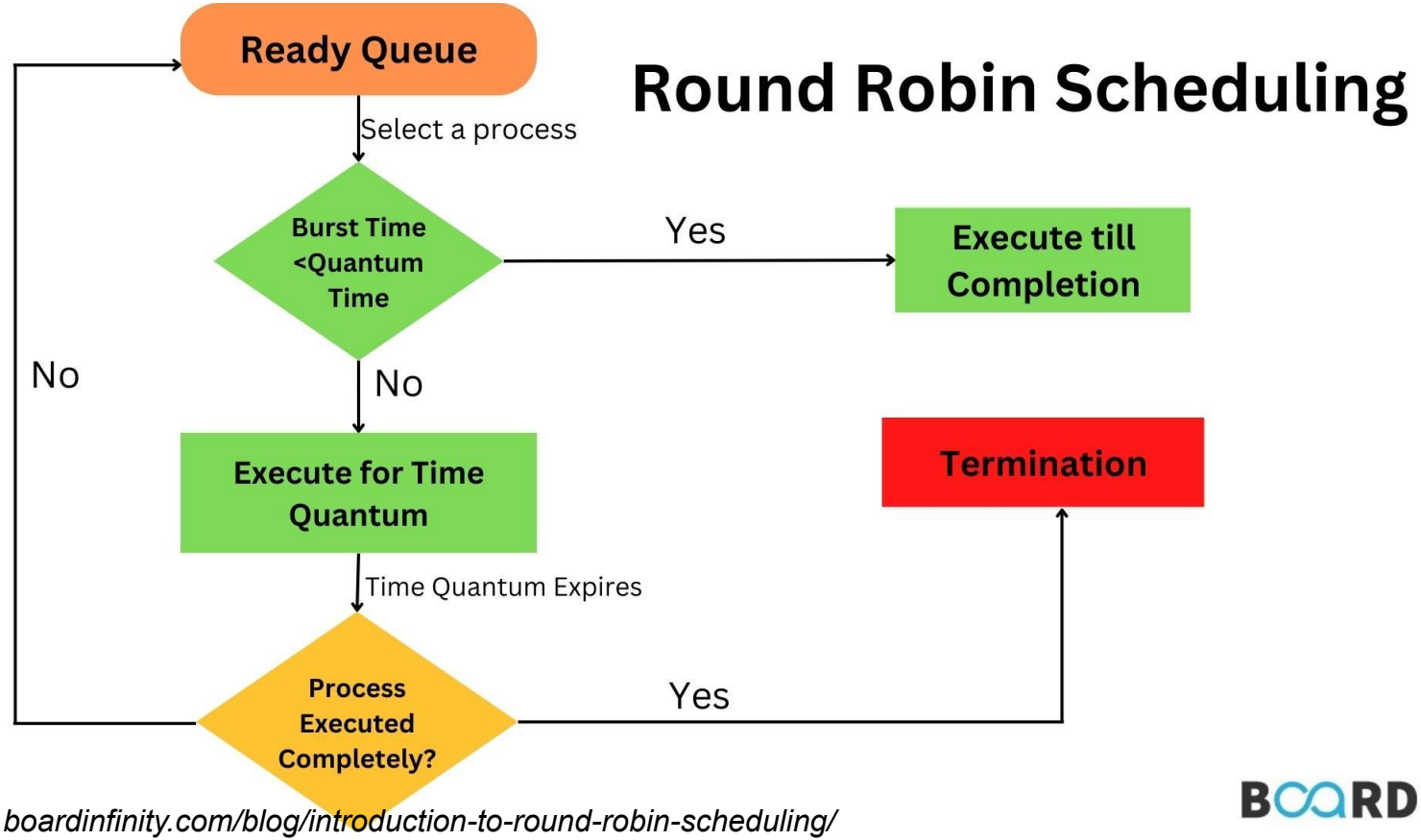
Scheduling Policies



FCFS

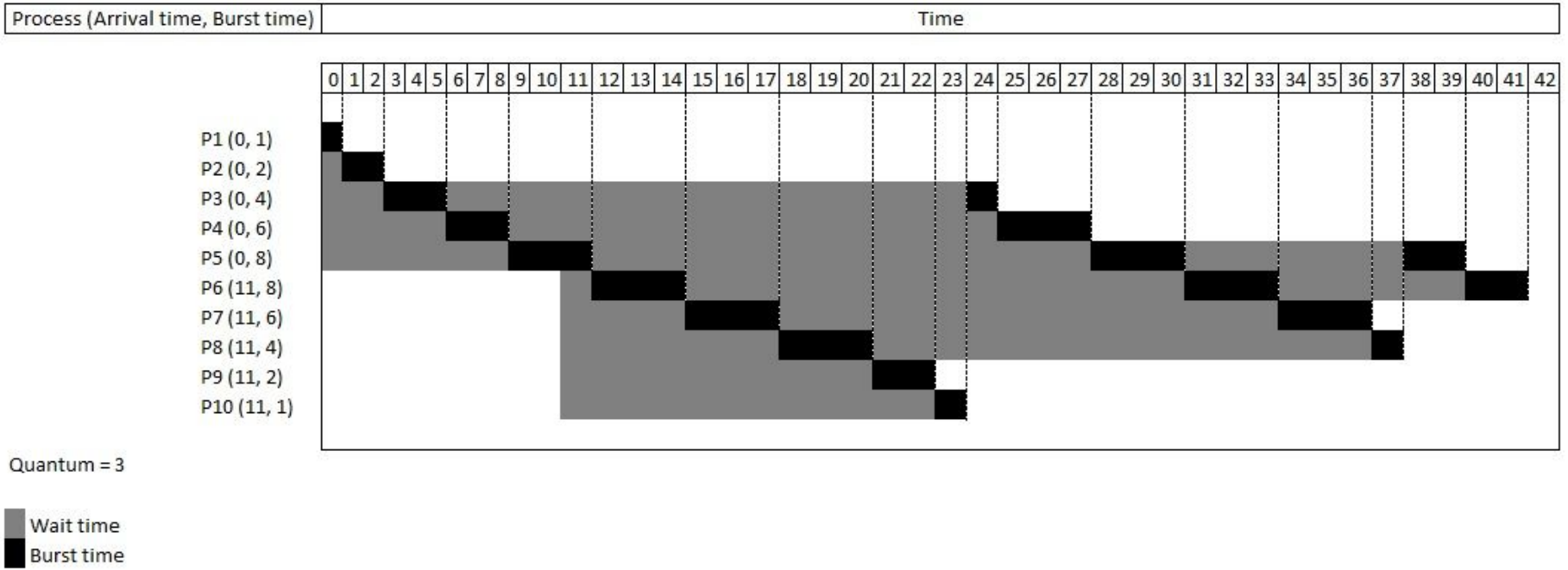
https://upload.wikimedia.org/wikipedia/commons/f/f9/Fifo_schedule.png

Scheduling Policies



https://www.boardinfinity.com/blog/introduction-to-round-robin-scheduling/

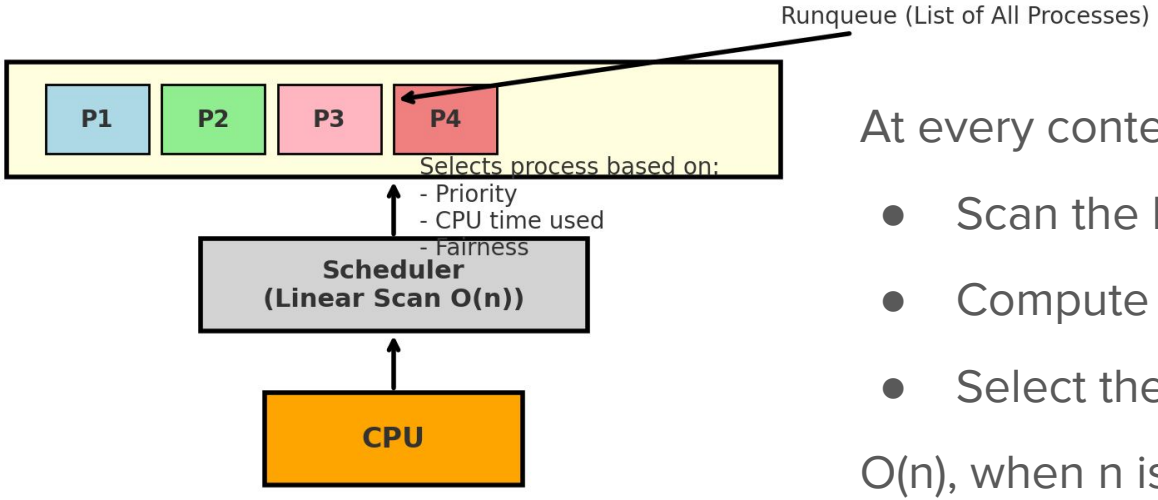
Scheduling Policies



Round Robin

https://commons.wikimedia.org/wiki/File:Round_Robin_Schedule_Example.jpg

Scheduling Policies



O(n) Scheduler

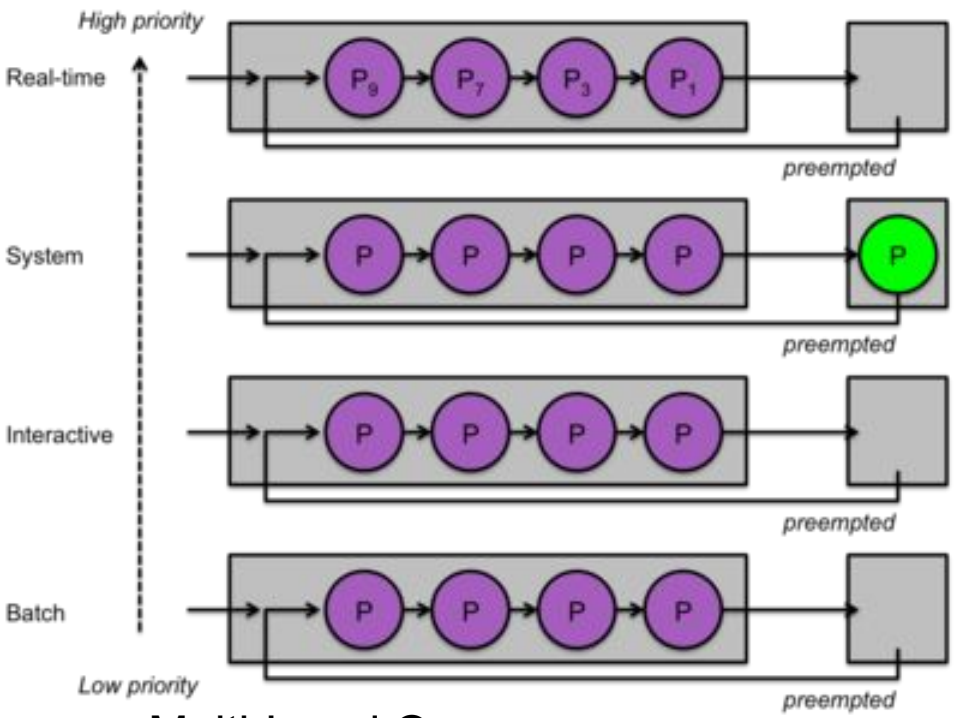
At every context switch

- Scan the list of runnable processes
- Compute priorities
- Select the best process to run

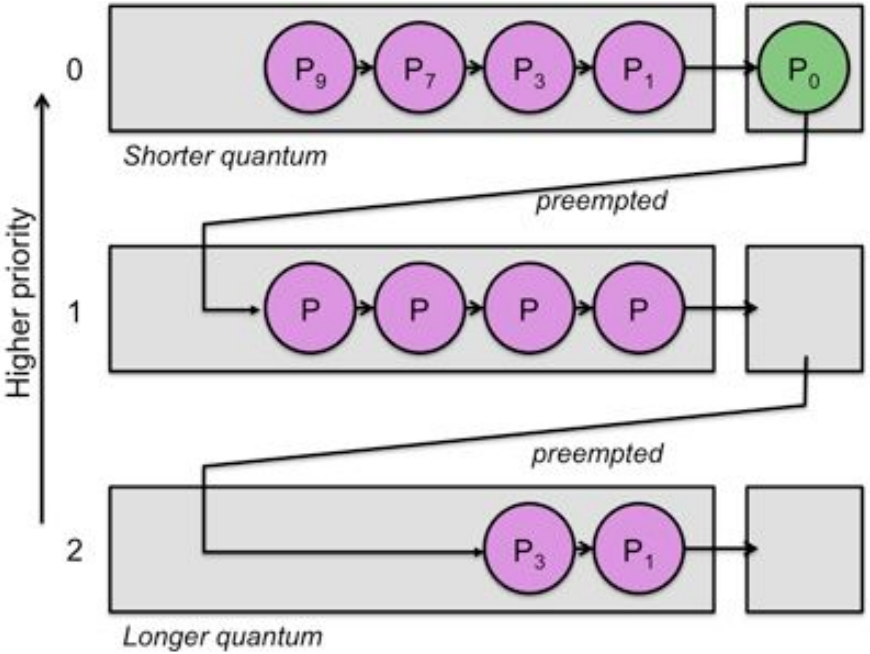
O(n), when n is the number of runnable processes ... Not scalable!!

Used in Linux Kernel 2.4 - 2.6.

Scheduling Policies



Multi-Level Queue

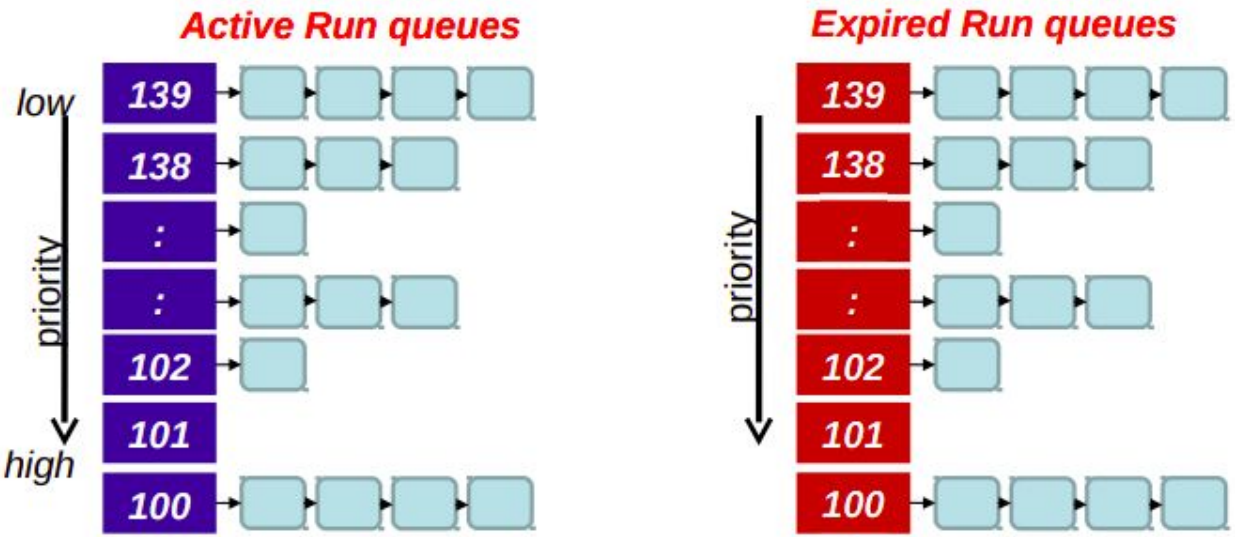


Multi-Level Feedback Queue

https://people.cs.rutgers.edu/~pxk/416/notes/07-scheduling.html

Scheduling Policies

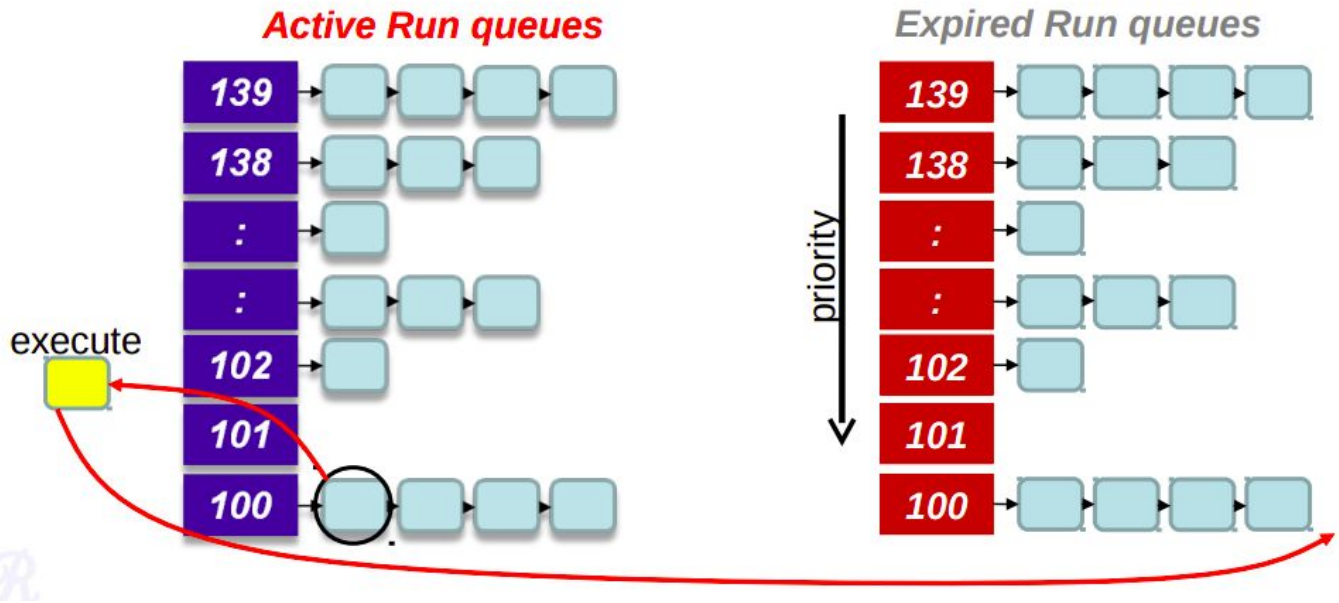
Base Priority = 120



O(1) Scheduler

https://www.cse.iitm.ac.in/~chester/courses/15o_os/slides/8_Scheduling.pdf#page=44

Scheduling Policies



O(1) Scheduler

https://www.cse.iitm.ac.in/~chester/courses/15o_os/slides/8_Scheduling.pdf#page=45

Scheduling Policies

O(1) Scheduler

Used in Linux 2.6-2.6.22

https://www.cse.iitm.ac.in/~chester/courses/15o_os/slides/8_Scheduling.pdf#page=46

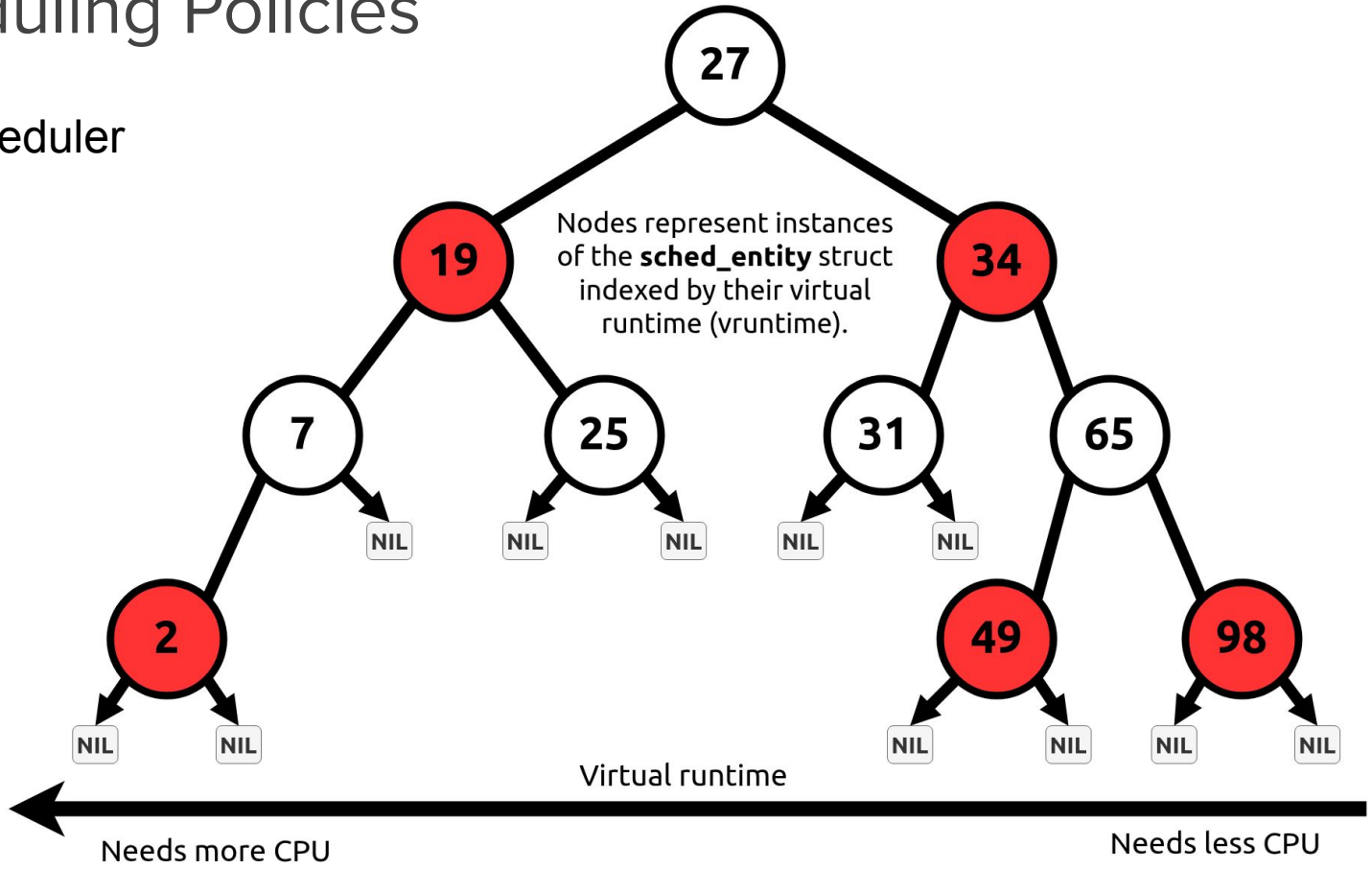
Scheduling Policies - CFS

- Target Scheduler Latency (tl = 6 - 24 ms)

  If there are n runnable processes, then each process will execute for (tl /n) ms.
- With each runnable process is included a virtual runtime (**vruntime**)
  - At every scheduling point, if process has run for t ms, then **vruntime += t**
- When timer interrupt occurs
  - Choose the task with the lowest vruntime (**min_vruntime**)
  - Compute its dynamic timeslice (**tl/n**) and run
- When interrupt occurs again, context switch with another task with a smaller runtime

Scheduling Policies

CFS Scheduler



https://documentation.ubuntu.com/real-time/latest/explanation/schedulers/

Process Priority

- When multiple processes simultaneously require CPU time, the system's scheduling policy and process CPU priorities determine which processes get it.
- High priority processes are scheduled before lower priority processes on the CPU and are given more CPU time.

‘Niceness’ of a process

- At the user level, the priority of processes is defined in terms of their nice value.
- Nice values range from -20 (highest priority) to 19 (lowest priority).
- The nice value can be interpreted as how ‘nice’ a process is towards other processes in terms of giving up CPU time.

Command Line Tools

htop

htop

- htop command in Linux system is a command line utility that allows the user to interactively monitor the system's vital resources or server's processes in real time.
- We can observe all processes running on the system, along with their command line arguments, select multiple processes and act on them all at once.
- htop also prints full command lines for processes and allows one to scroll both vertically and horizontally for processes and command lines respectively.

htop command in Linux with examples - GeeksforGeeks

nice/renice

nice/renice

- nice command helps in execution of a process with modified scheduling priority. If we give a process a higher priority, then Kernel will allocate more CPU time to that process..
- renice command allows you to change and modify the scheduling priority of an already running process. Linux Kernel schedules the process and allocates CPU time accordingly for each of them.
- **nice [OPTION] [COMMAND [ARG]...]**
- **renice [-n] priority [-g|-p|-u] identifier...**

Nice and Renice Command in Linux with Examples - GeeksforGeeks

chrt

chrt

- chrt command in Linux is known for manipulating the real-time attributes of a process.
- It sets or retrieves the real-time scheduling attributes of an existing PID, or runs the command with the given attributes.
- **chrt [options] priority command argument ...**
- **chrt [options] -p [priority] PID**

chrt command in Linux with examples - GeeksforGeeks

Scheduling Policy Options

- SCHED_BATCH : Use Scheduling batch processes algorithm.
- SCHED_FIFO : Uses First In-First Out scheduling algorithm. This scheduling method is used on Batch-Systems, it is NON-PREEMPTIVE. It implements just one queue which holds the tasks in the order they come in.
- SCHED_IDLE: Used for running very low priority background jobs.
- SCHED_OTHER: Uses Default Linux time-sharing scheduling algorithm or simply the standard round-robin time-sharing policy.
- SCHED_RR Uses Round Robin scheduling algorithm and is used as the default algorithm if not specified. It is an algorithm used for PREEMPTIVE scheduling.

chrt command in Linux with examples - GeeksforGeeks

C Library Functions

C Library Functions

- int sched_setscheduler (pid_t pid, int policy, const struct sched_param *param)
- int sched_getscheduler (pid_t pid)
- int sched_setparam (pid_t pid, const struct sched_param *param)
- int sched_getparam (pid_t pid, struct sched_param *param)

https://www.gnu.org/software/libc/manual/html_node/Basic-Scheduling-Functions.html

Questions