CS201 Fall 2019

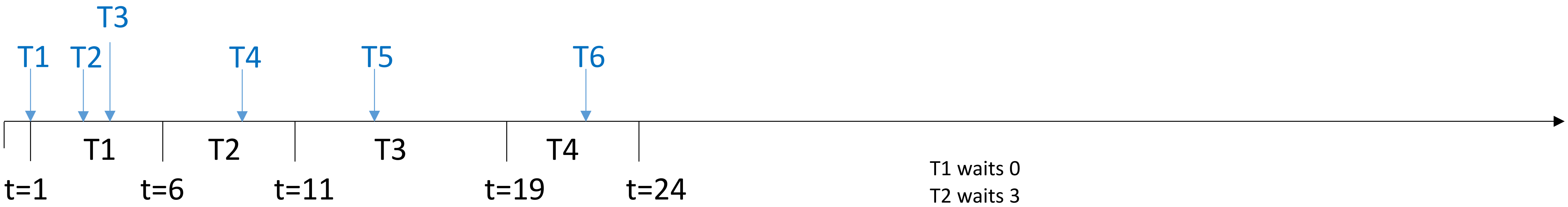
Assignment #4: CPU Scheduler

diagrams showing behavior of the queues

DESexample:

FCFS scheduling of Things

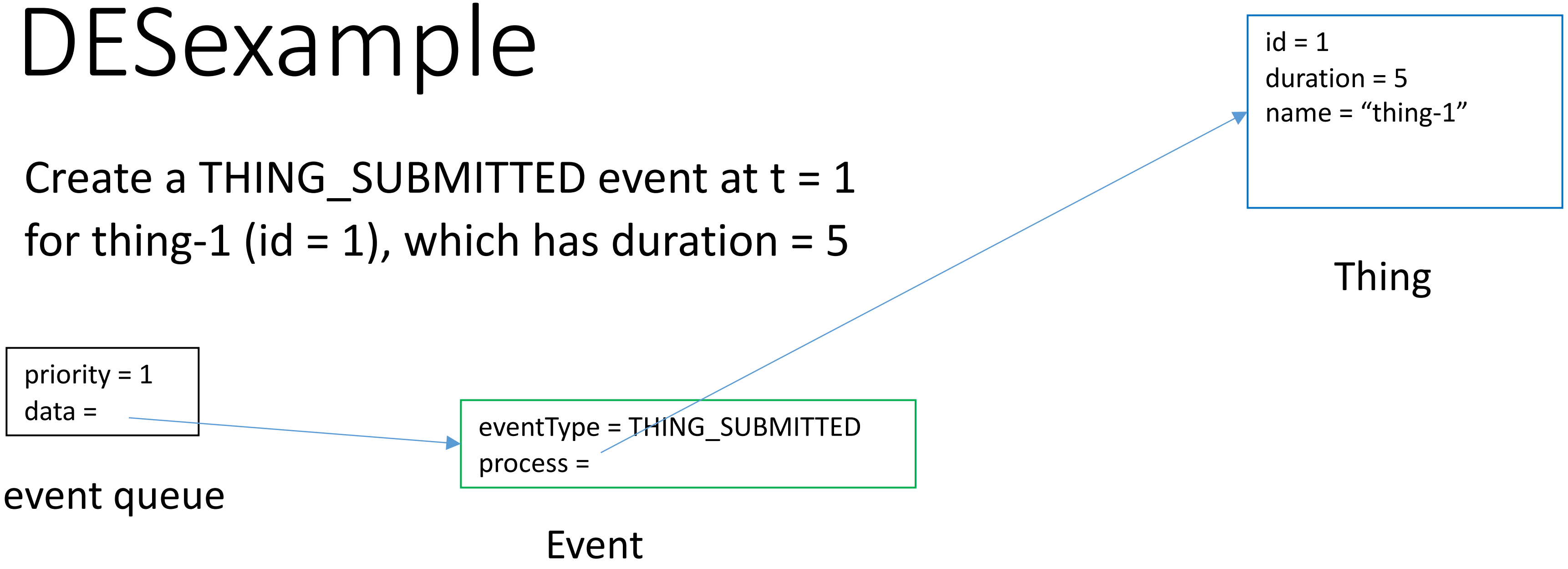
Thing	Submitted at	Duration
thing-1	t=1	5
thing-2	t=3	5
thing-3	t=4	8
thing-4	t=9	5
thing-5	t=14	10
thing-6	t=22	7
thing-7	t=28	14
thing-8	t=29	10
thing-9	t=30	12
thing-10	t=33	7



T1 waits 0
T2 waits 3
T3 waits 7
T4 waits 10

DESexample

Create a THING_SUBMITTED event at t = 1 for thing-1 (id = 1), which has duration = 5



priority = 1
data =

event queue

eventType = THING_SUBMITTED
process =

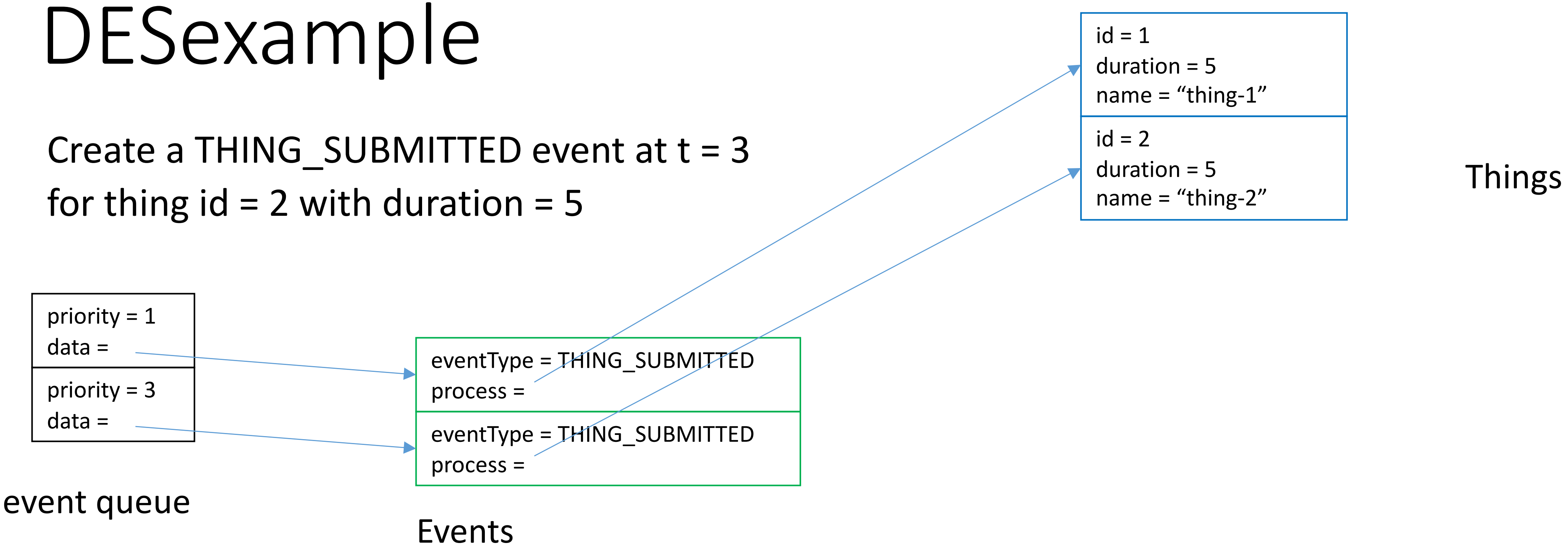
Event

id = 1
duration = 5
name = “thing-1”

Thing

DESexample

Create a THING_SUBMITTED event at t = 3
for thing id = 2 with duration = 5



priority = 1
data =

priority = 3
data =

event queue

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = “thing-1”

id = 2
duration = 5
name = “thing-2”

Things

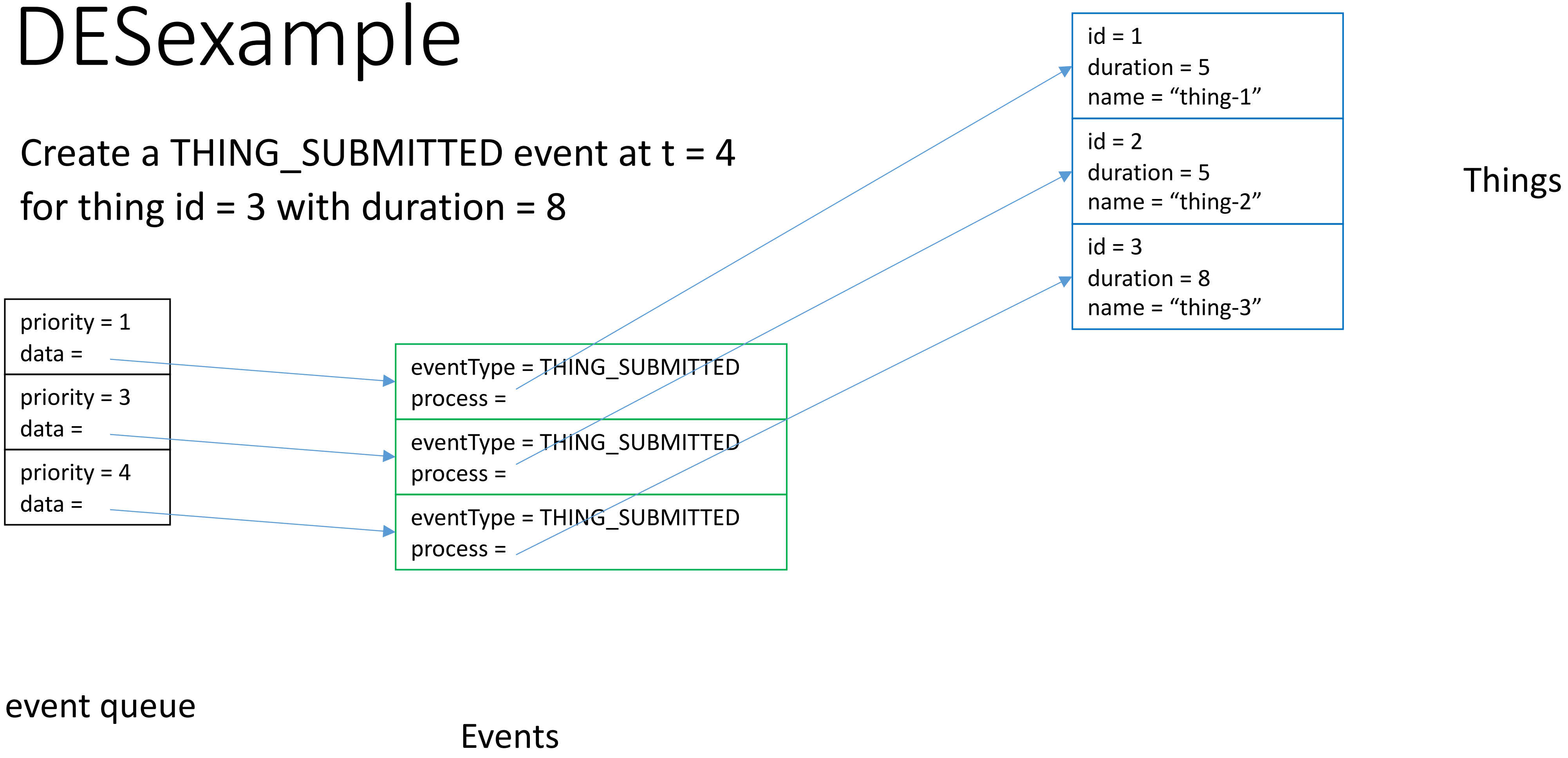
You don’t need a data structure to hold the Things in the system—each Event in the event queue will have a pointer to to a Thing

The event queue is FCFS: the priority of each item is the queue is the time that the event occurs

And each entry in the event queue will have a pointer to an Event

DESexample

Create a THING_SUBMITTED event at t = 4
for thing id = 3 with duration = 8



priority = 1
data =

priority = 3
data =

priority = 4
data =

event queue

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = “thing-1”

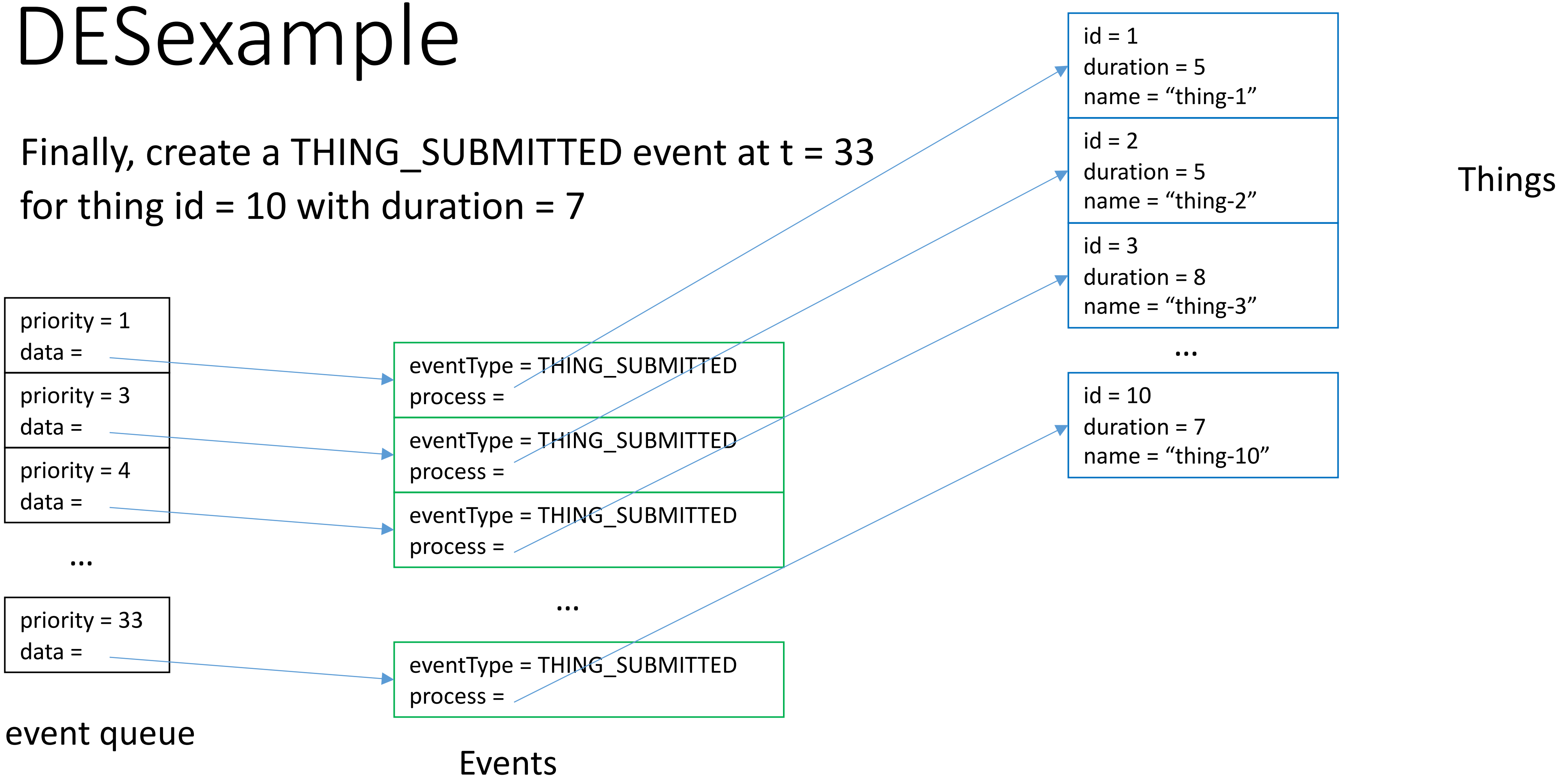
id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

Things

DESexample

Finally, create a THING_SUBMITTED event at t = 33 for thing id = 10 with duration = 7



priority = 1
data =

priority = 3
data =

priority = 4
data =

…

priority = 33
data =

event queue

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

…

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = “thing-1”

id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

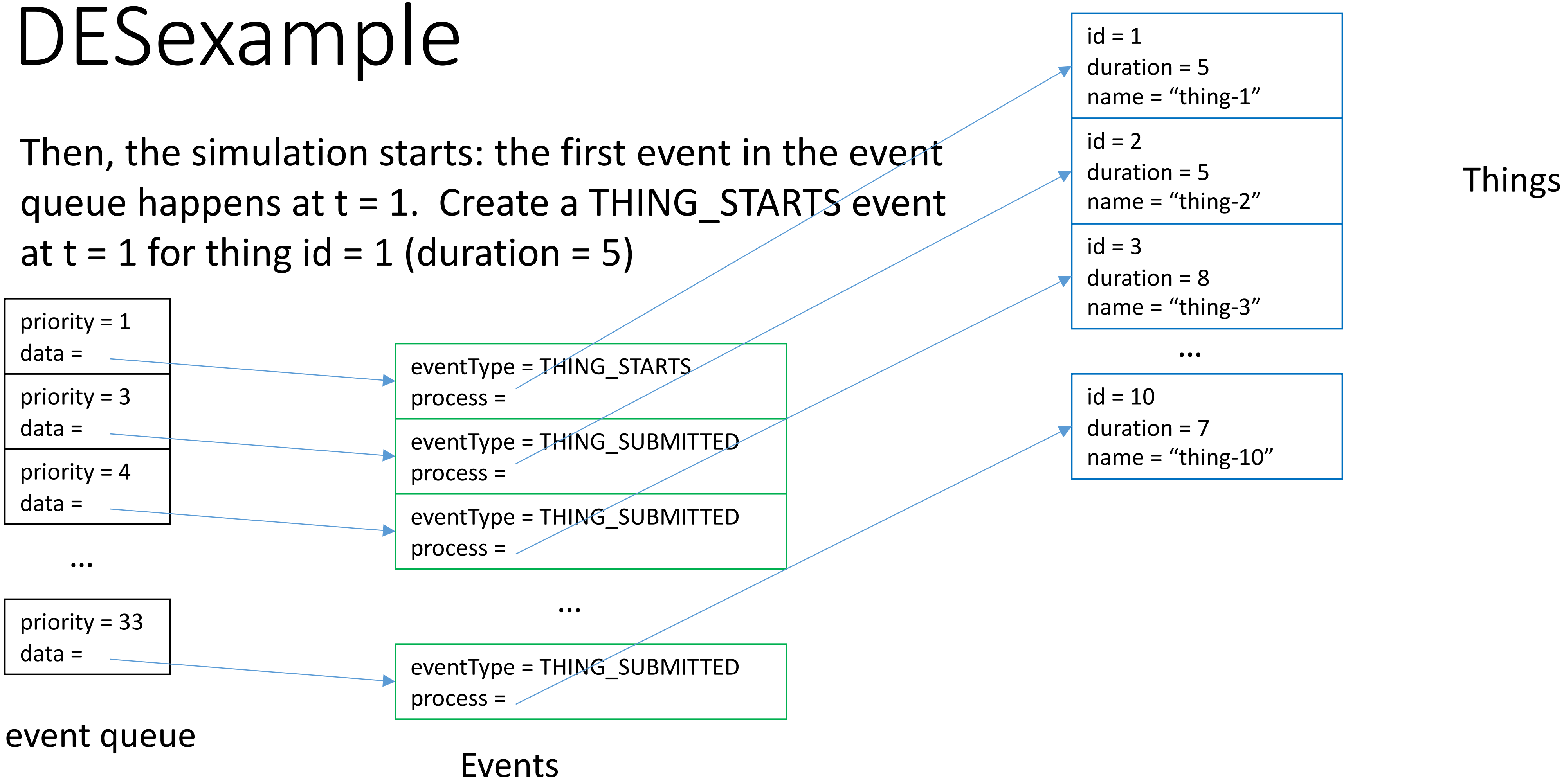
…

id = 10
duration = 7
name = “thing-10”

Things

DESexample

Then, the simulation starts: the first event in the event queue happens at t = 1. Create a THING_STARTS event at t = 1 for thing id = 1 (duration = 5)



priority = 1
data =

priority = 3
data =

priority = 4
data =

…

priority = 33
data =

event queue

eventType = THING_STARTS
process =

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

…

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = “thing-1”

id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

…

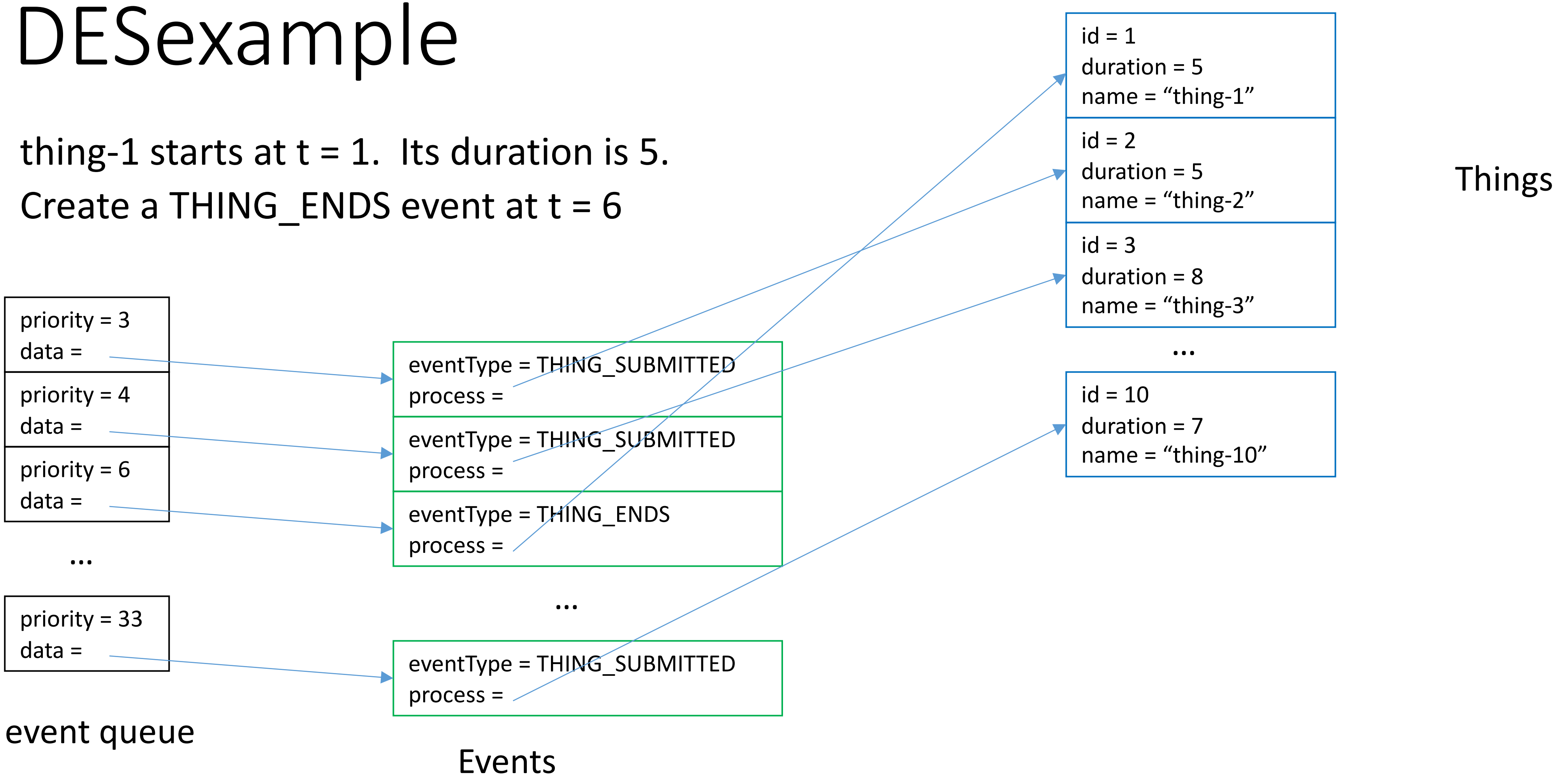
id = 10
duration = 7
name = “thing-10”

Things

DESexample

thing-1 starts at t = 1. Its duration is 5.

Create a THING_ENDS event at t = 6



priority = 3
data =

priority = 4
data =

priority = 6
data =

...

priority = 33
data =

event queue

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

eventType = THING_ENDS
process =

...

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = “thing-1”

id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

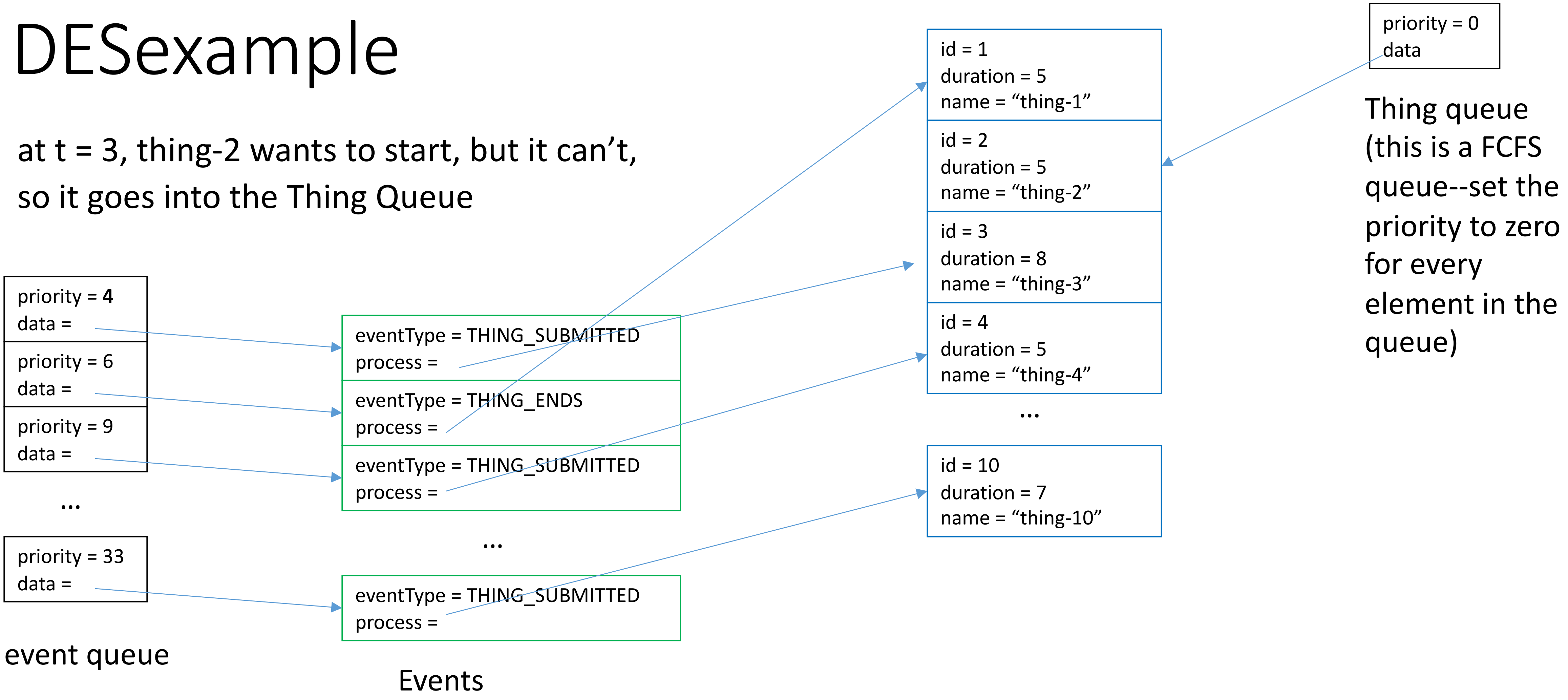
...

id = 10
duration = 7
name = “thing-10”

Things

DESexample

at t = 3, thing-2 wants to start, but it can’t, so it goes into the Thing Queue



priority = **4**
data =

priority = 6
data =

priority = 9
data =

…

priority = 33
data =

event queue

eventType = THING_SUBMITTED
process =

eventType = THING_ENDS
process =

eventType = THING_SUBMITTED
process =

…

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = “thing-1”

id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

id = 4
duration = 5
name = “thing-4”

…

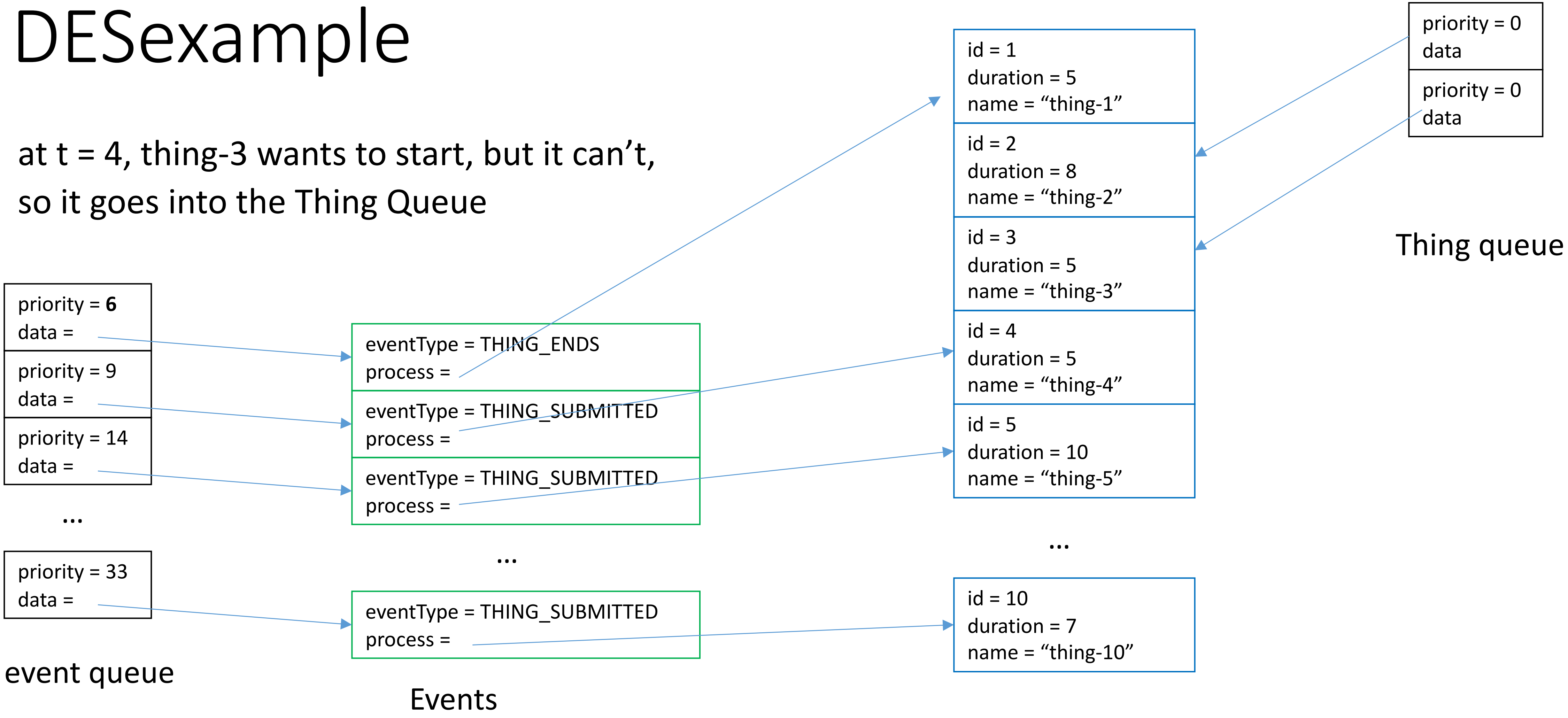
id = 10
duration = 7
name = “thing-10”

priority = 0
data

Thing queue (this is a FCFS queue--set the priority to zero for every element in the queue)

DESexample

at t = 4, thing-3 wants to start, but it can't, so it goes into the Thing Queue



priority = **6**
data =

priority = 9
data =

priority = 14
data =

…

priority = 33
data =

event queue

eventType = THING_ENDS
process =

eventType = THING_SUBMITTED
process =

eventType = THING_SUBMITTED
process =

…

eventType = THING_SUBMITTED
process =

Events

id = 1
duration = 5
name = "thing-1"

id = 2
duration = 8
name = "thing-2"

id = 3
duration = 5
name = "thing-3"

id = 4
duration = 5
name = "thing-4"

id = 5
duration = 10
name = "thing-5"

…

id = 10
duration = 7
name = "thing-10"

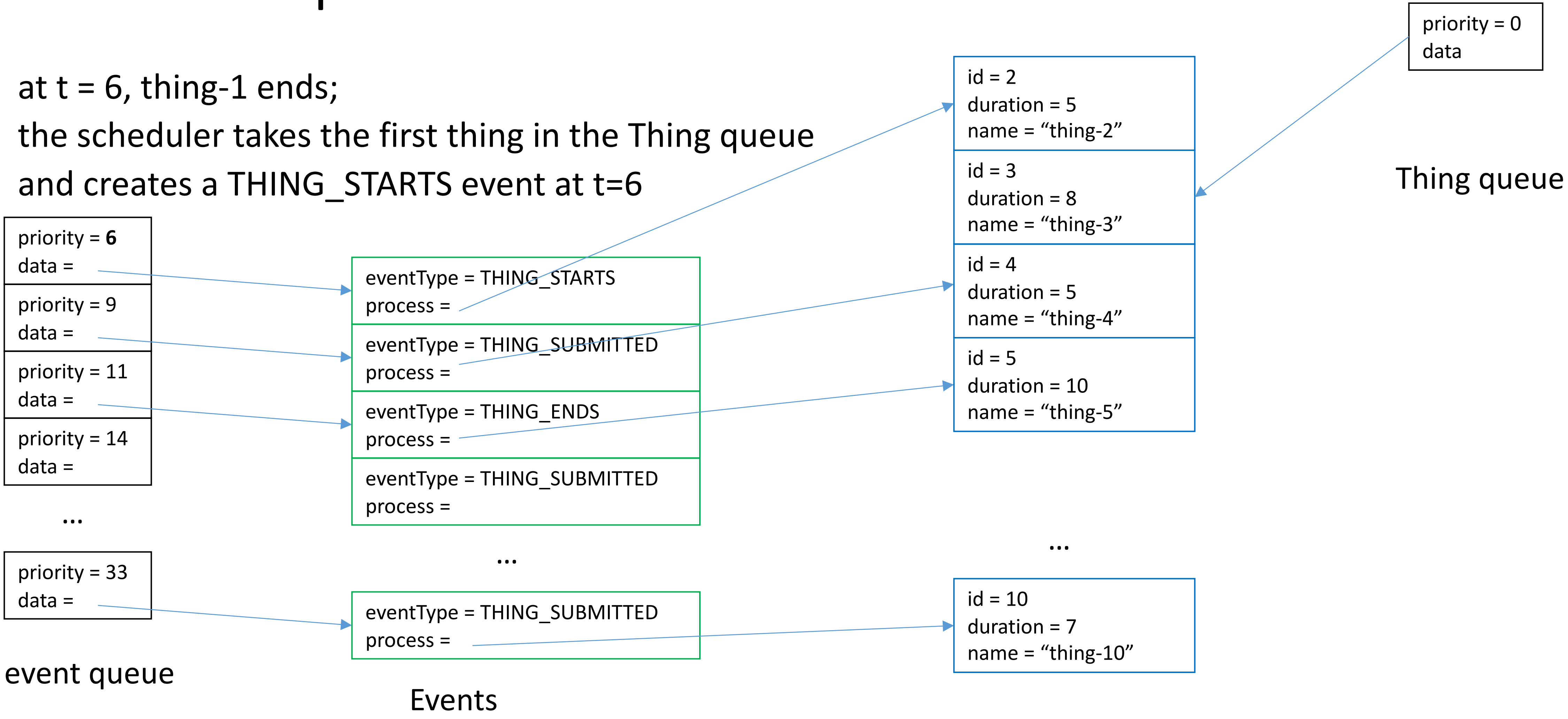
priority = 0
data

priority = 0
data

Thing queue

DESexample

at t = 6, thing-1 ends;
the scheduler takes the first thing in the Thing queue
and creates a THING_STARTS event at t=6



priority = **6**
data =

priority = 9
data =

priority = 11
data =

priority = 14
data =

…

priority = 33
data =

event queue

eventType = THING_STARTS
process =

eventType = THING_SUBMITTED
process =

eventType = THING_ENDS
process =

eventType = THING_SUBMITTED
process =

…

eventType = THING_SUBMITTED
process =

Events

id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

id = 4
duration = 5
name = “thing-4”

id = 5
duration = 10
name = “thing-5”

…

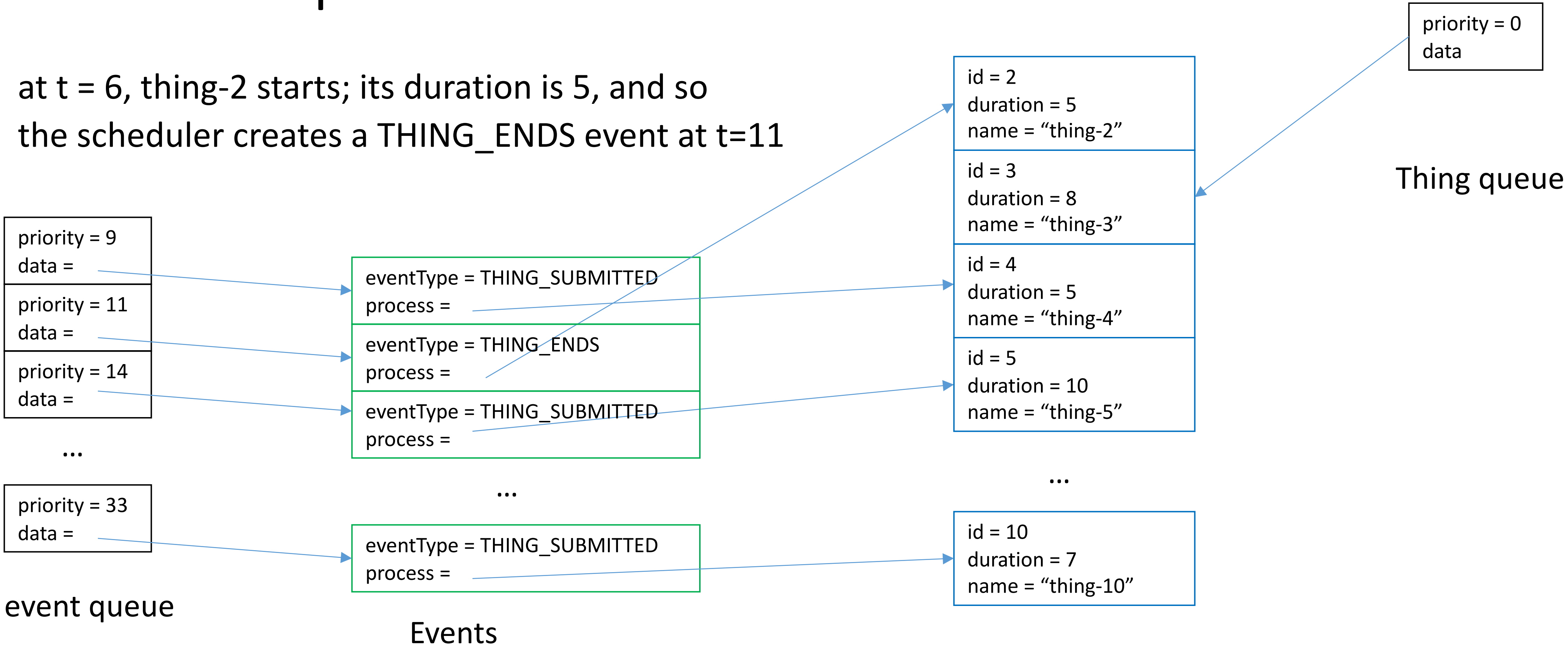
id = 10
duration = 7
name = “thing-10”

priority = 0
data

Thing queue

DESexample

at t = 6, thing-2 starts; its duration is 5, and so
the scheduler creates a THING_ENDS event at t=11



priority = 9
data =

priority = 11
data =

priority = 14
data =

...

priority = 33
data =

event queue

eventType = THING_SUBMITTED
process =

eventType = THING_ENDS
process =

eventType = THING_SUBMITTED
process =

...

eventType = THING_SUBMITTED
process =

Events

id = 2
duration = 5
name = “thing-2”

id = 3
duration = 8
name = “thing-3”

id = 4
duration = 5
name = “thing-4”

id = 5
duration = 10
name = “thing-5”

...

id = 10
duration = 7
name = “thing-10”

priority = 0
data

Thing queue

Diagrams showing the CPU Scheduler

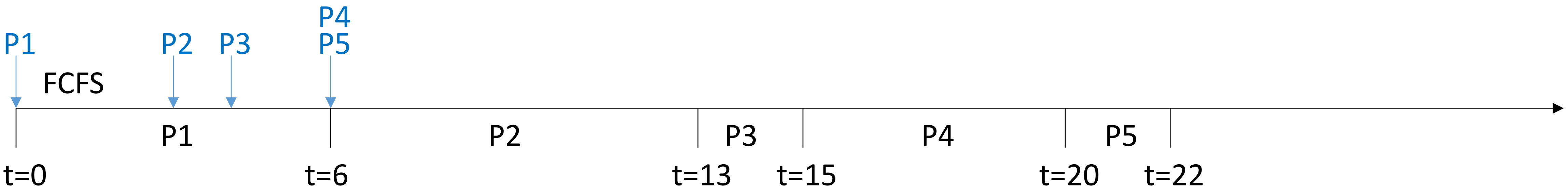
5 Processes

FCFS, SJF, RR simulations

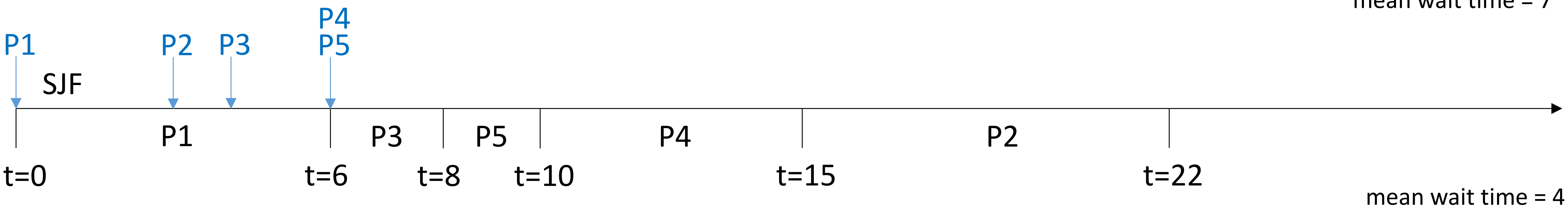
Processes

use these processes as your test case for Part I →

Process	Submitted at	Burst time
pid=1	t=0	6 ms
pid=2	t=3	7 ms
pid=3	t=4	2 ms
pid=4	t=6	5 ms
pid=5	t=6	2 ms



mean wait time = 7

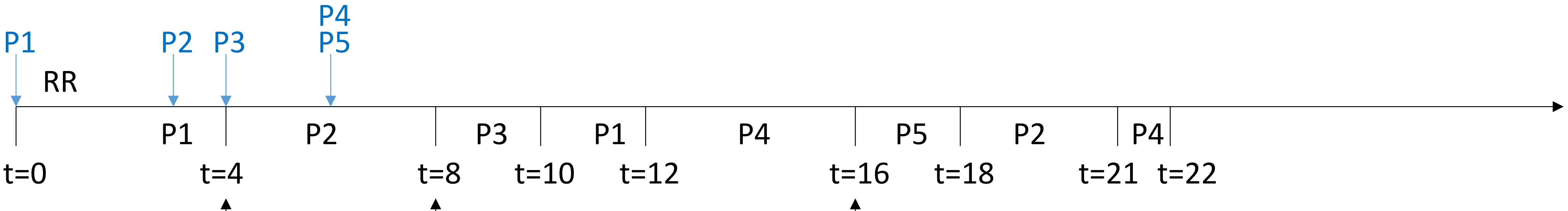


mean wait time = 4

RR, q=4

Here's the behavior of the system with round-robin scheduling, with quantum = 4

Process	Submitted at	Burst time
pid=1	t=0	6 ms
pid=2	t=3	7 ms
pid=3	t=4	2 ms
pid=4	t=6	5 ms
pid=5	t=6	2 ms



at t=4, P2 starts because it's the only process in the ready queue

at t=8, the ready queue is P3, P1, P4, P5, P2

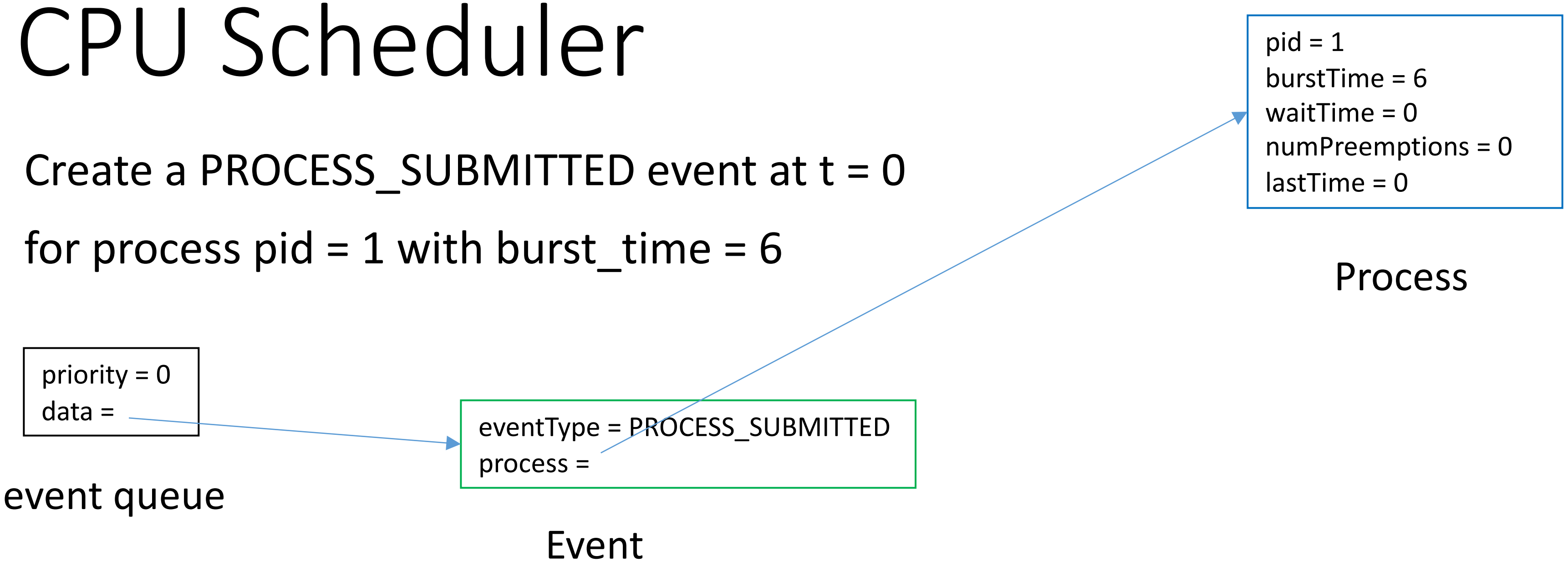
at t=16, the ready queue is P5, P2, P4

P1 wait time = 6
P2 wait time = 1+10=11
P3 wait time = 4
P4 wait time = 6+5=11
P5 wait time = 10
mean wait time = 8.4

CPU Scheduler

Create a PROCESS_SUBMITTED event at t = 0

for process pid = 1 with burst_time = 6



priority = 0
data =

event queue

eventType = PROCESS_SUBMITTED
process =

Event

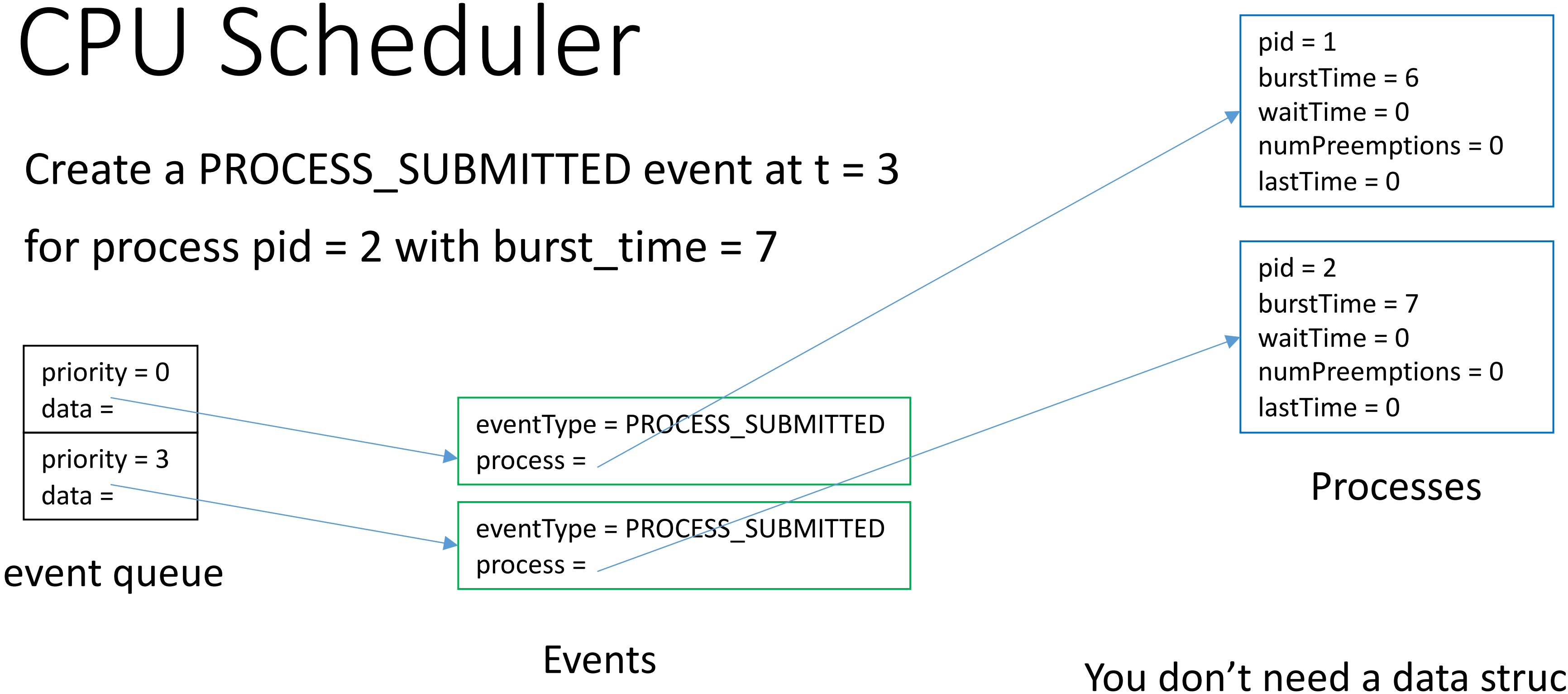
pid = 1
burstTime = 6
waitTime = 0
numPreemptions = 0
lastTime = 0

Process

CPU Scheduler

Create a PROCESS_SUBMITTED event at t = 3

for process pid = 2 with burst_time = 7



priority = 0
data =

priority = 3
data =

event queue

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

Events

pid = 1
burstTime = 6
waitTime = 0
numPreemptions = 0
lastTime = 0

pid = 2
burstTime = 7
waitTime = 0
numPreemptions = 0
lastTime = 0

Processes

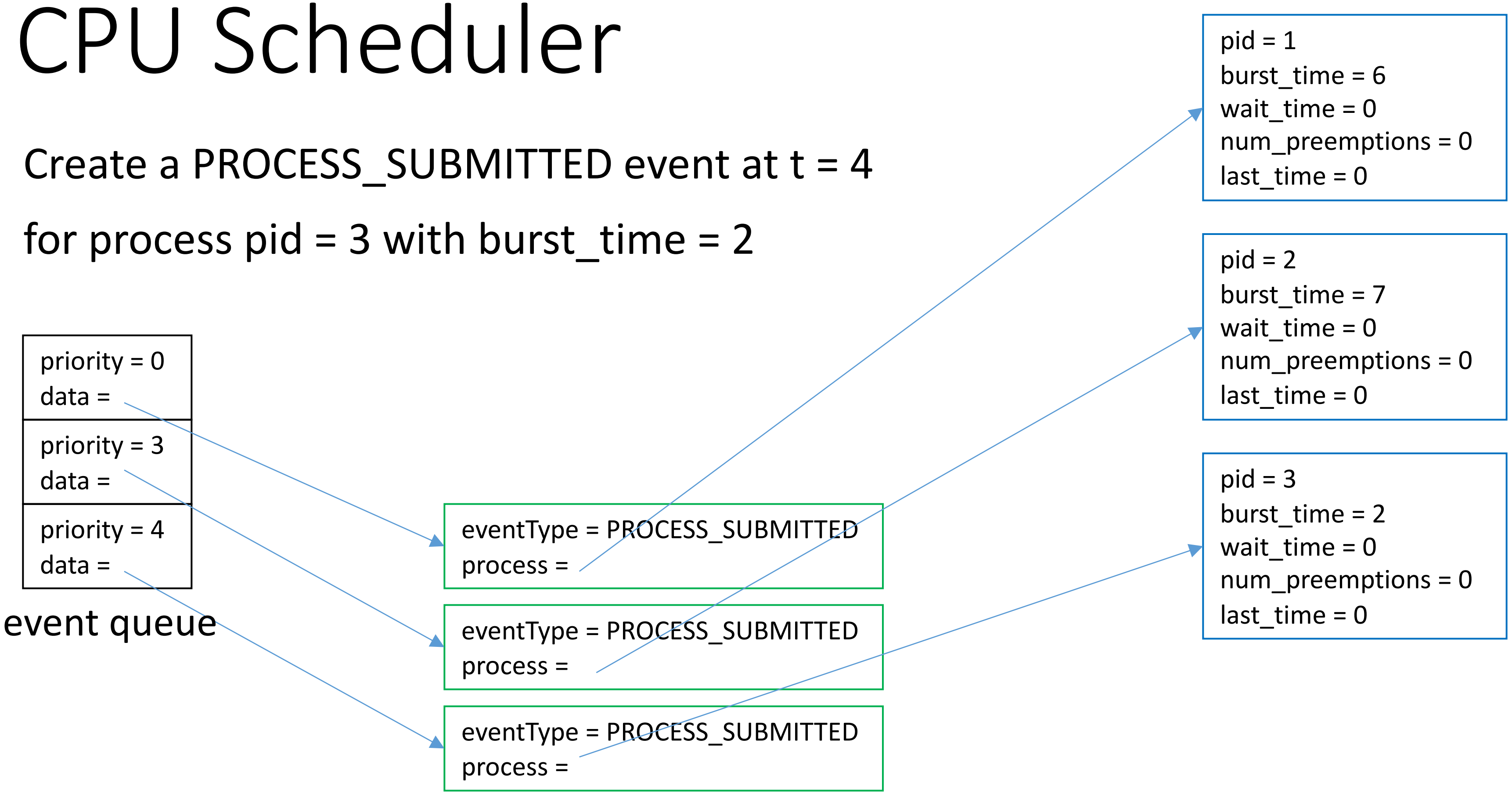
You don’t need a data structure to hold the processes in the system—each Event in the event queue will have a pointer to to a process

And each entry in the event queue will have a pointer to an event

CPU Scheduler

Create a PROCESS_SUBMITTED event at t = 4

for process pid = 3 with burst_time = 2



priority = 0
data =

priority = 3
data =

priority = 4
data =

event queue

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

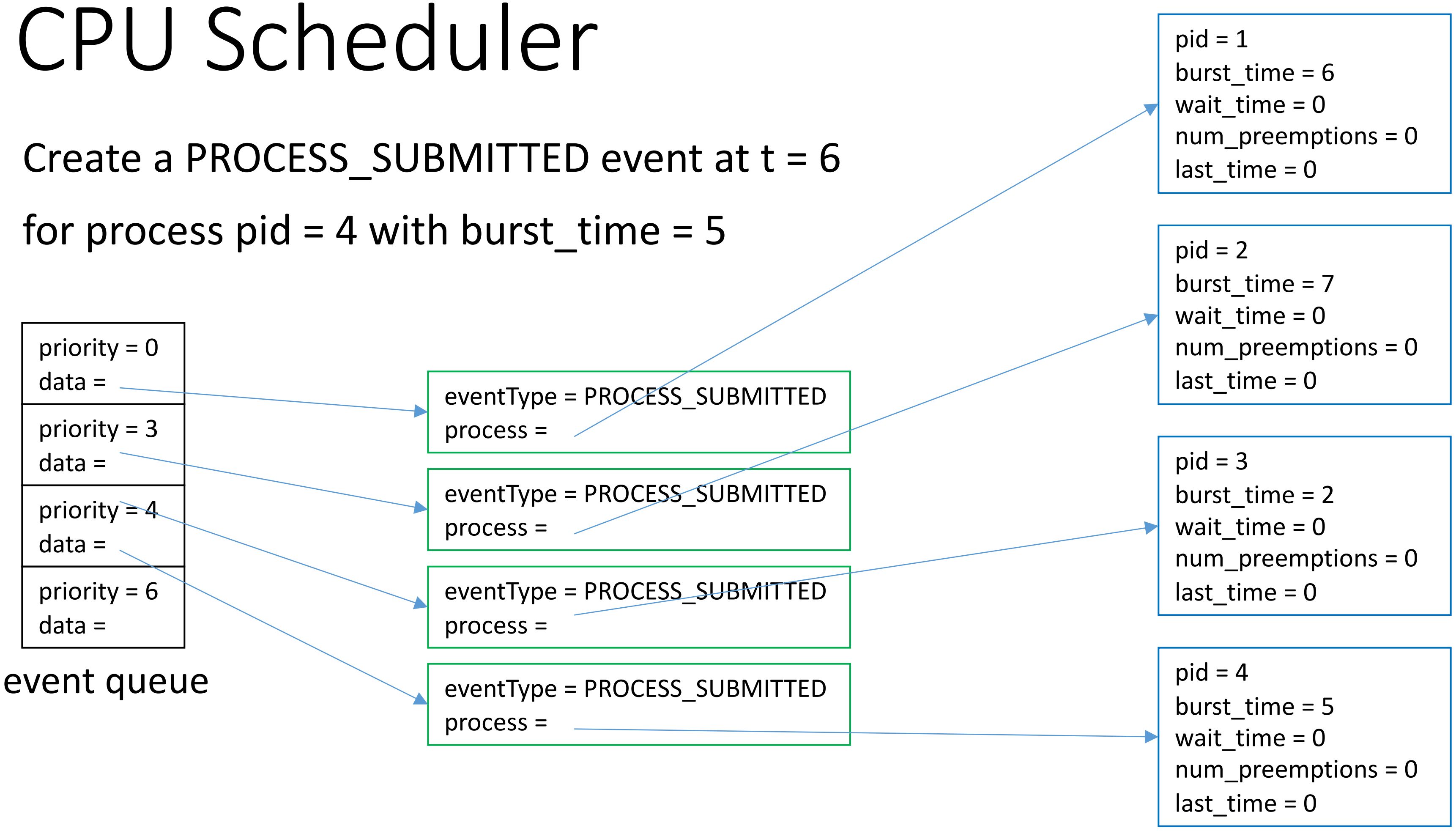
pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

CPU Scheduler

Create a PROCESS_SUBMITTED event at t = 6

for process pid = 4 with burst_time = 5



priority = 0
data =

priority = 3
data =

priority = 4
data =

priority = 6
data =

event queue

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

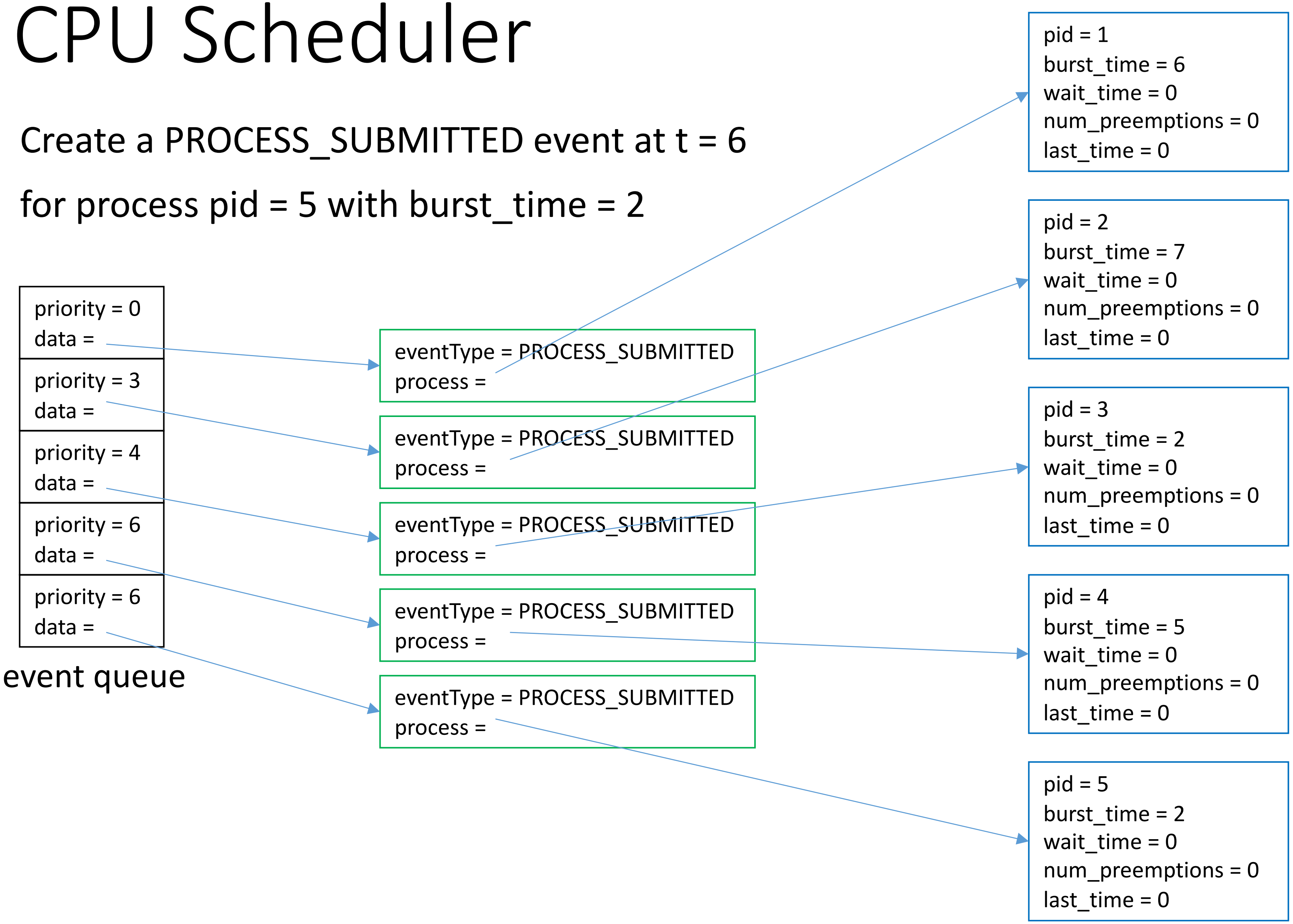
pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

CPU Scheduler

Create a PROCESS_SUBMITTED event at t = 6

for process pid = 5 with burst_time = 2



priority = 0
data =

priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

event queue

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

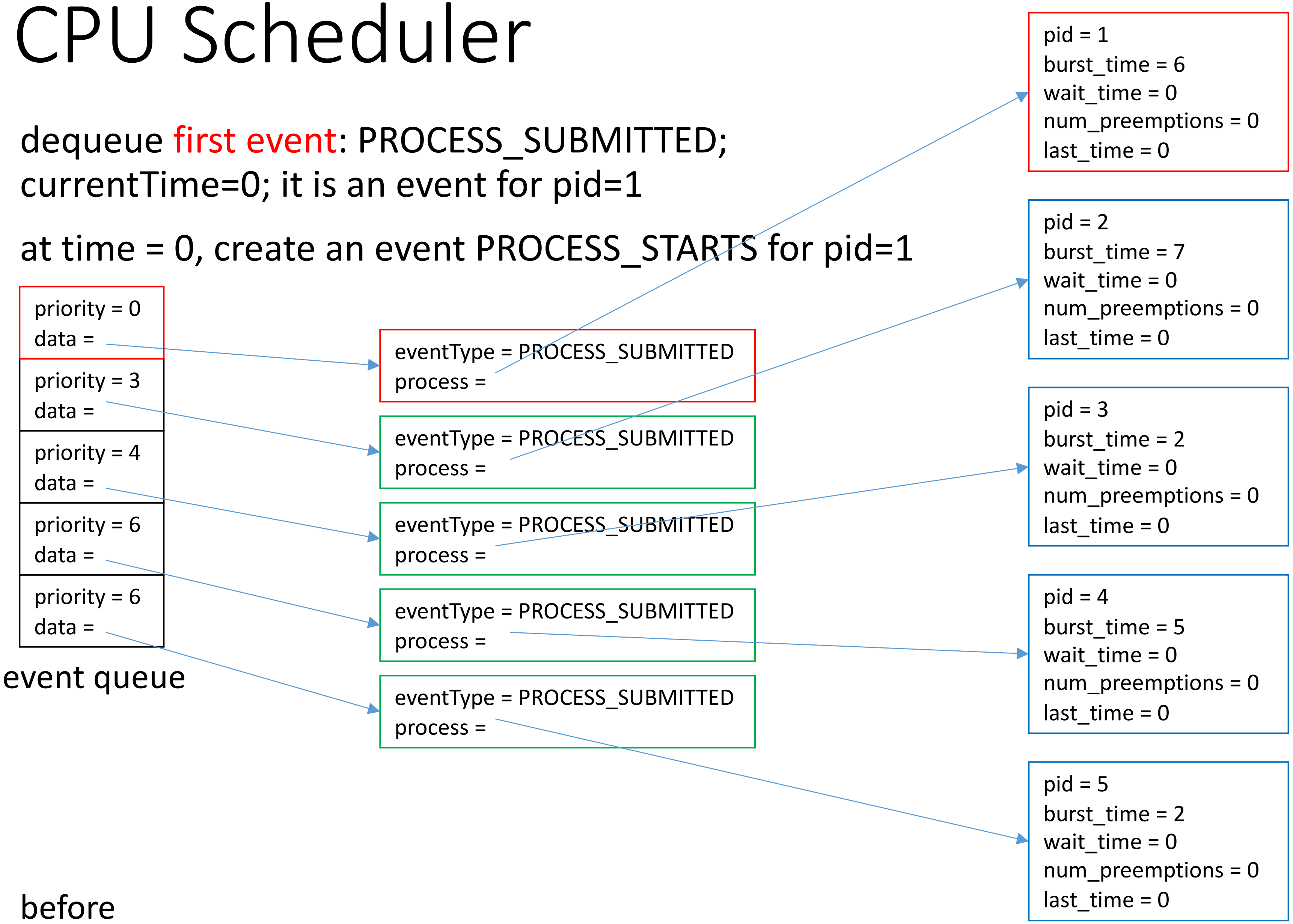
pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

CPU Scheduler

dequeue first event: PROCESS_SUBMITTED; currentTime=0; it is an event for pid=1

at time = 0, create an event PROCESS_STARTS for pid=1



priority = 0
data =

priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

event queue

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

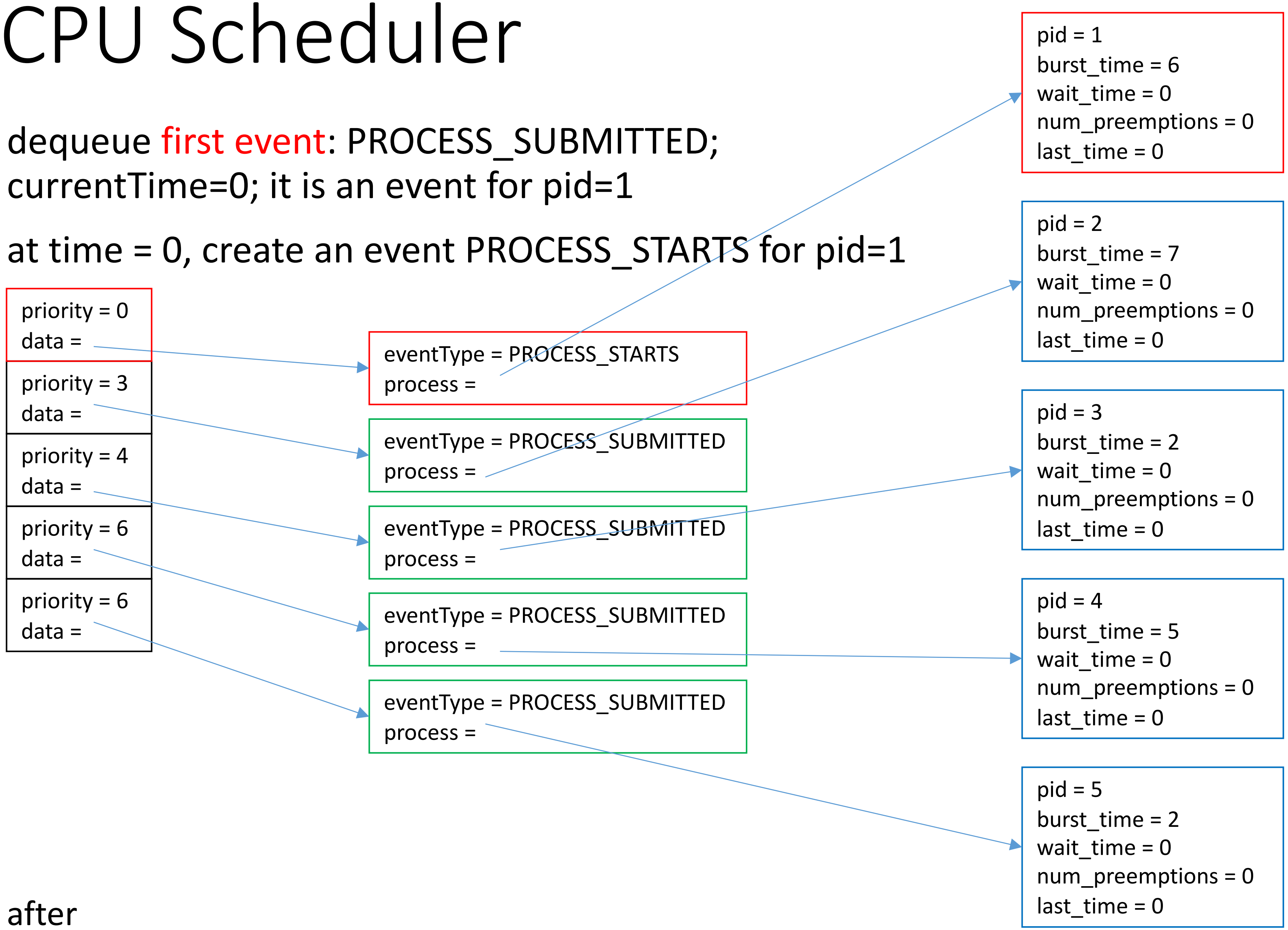
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

before

CPU Scheduler

dequeue first event: PROCESS_SUBMITTED;
currentTime=0; it is an event for pid=1

at time = 0, create an event PROCESS_STARTS for pid=1



priority = 0
data =

priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_STARTS
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

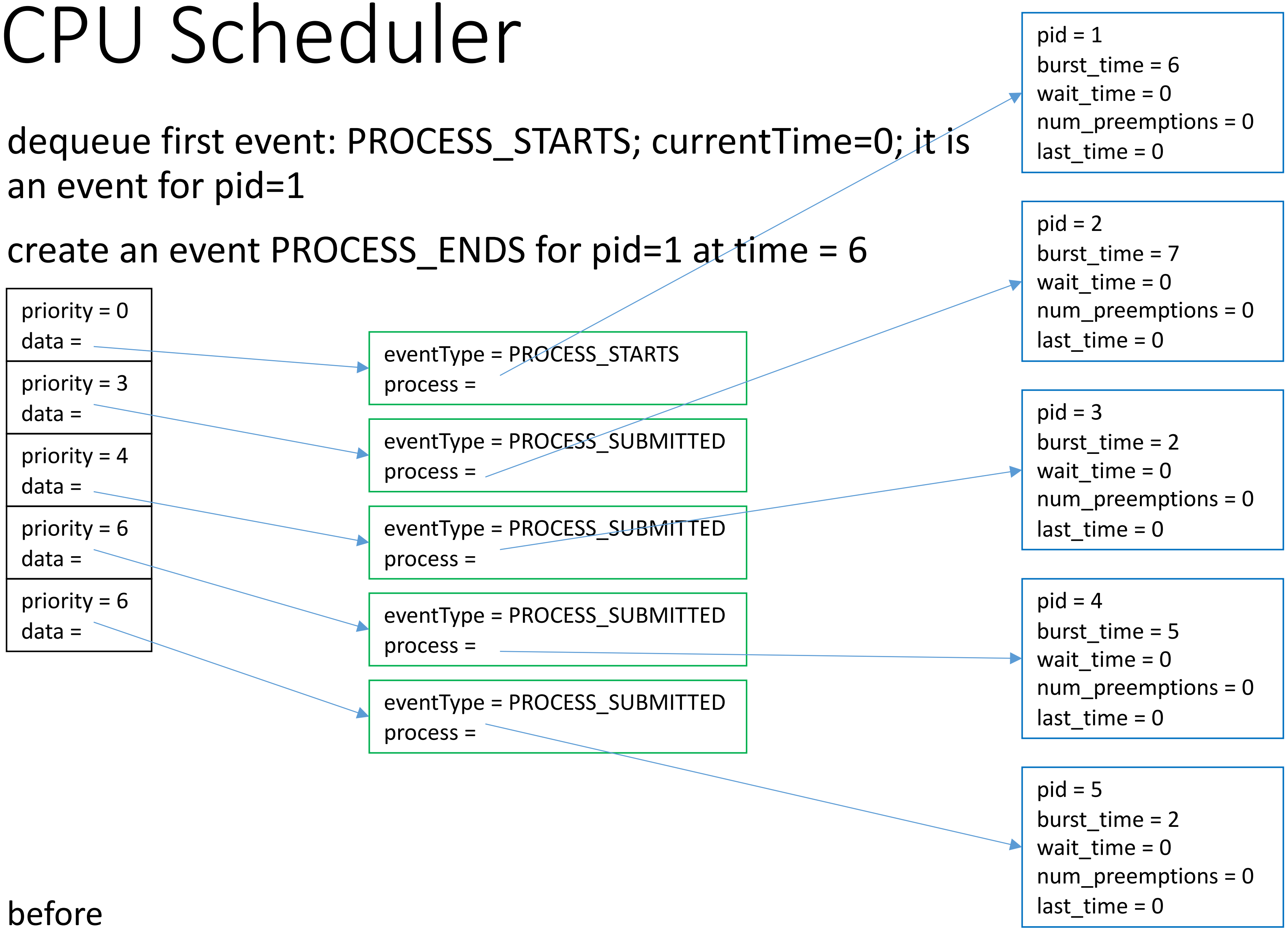
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

after

CPU Scheduler

dequeue first event: PROCESS_STARTS; currentTime=0; it is an event for pid=1

create an event PROCESS_ENDS for pid=1 at time = 6



priority = 0
data =

priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_STARTS
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

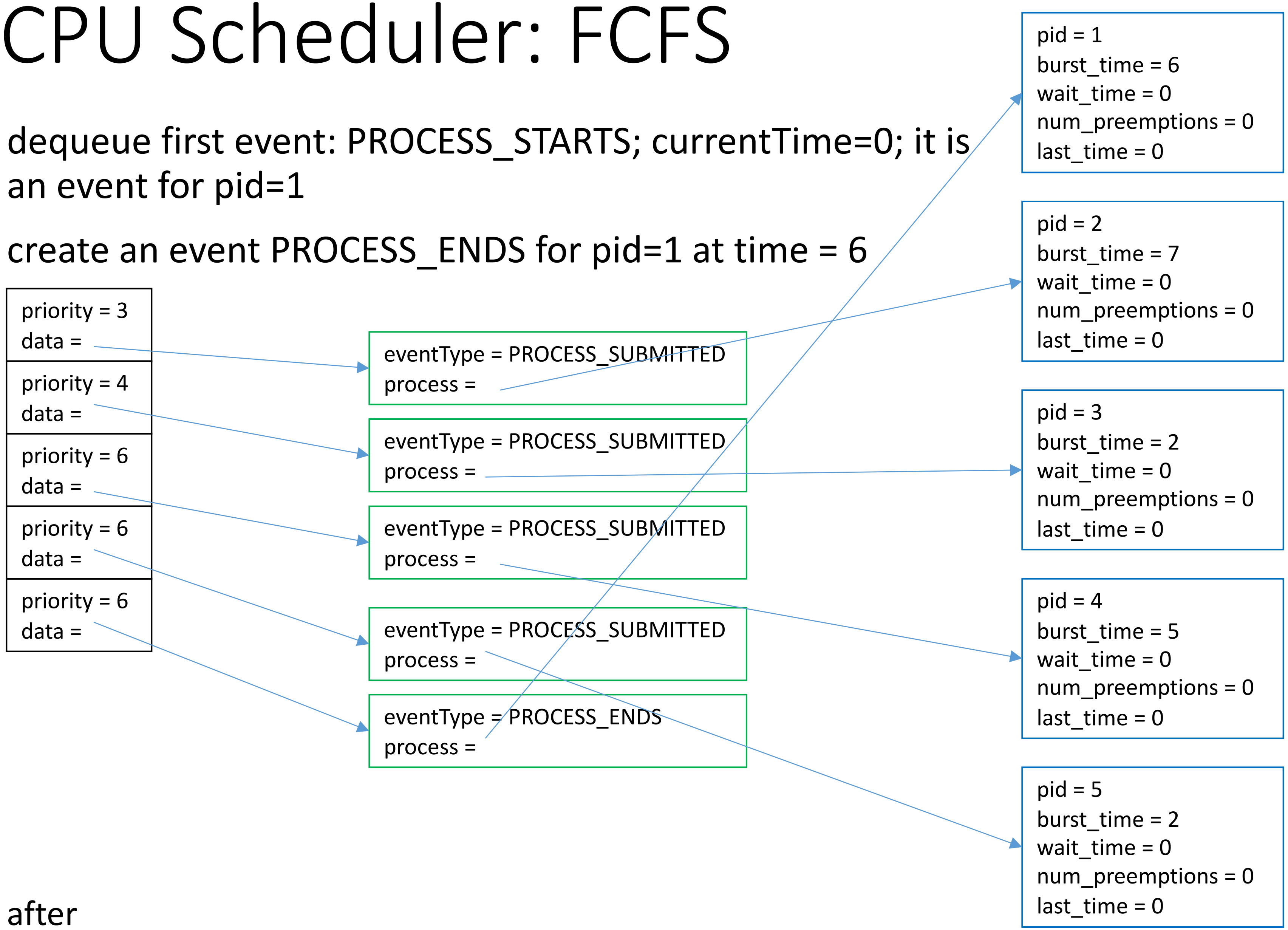
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

before

CPU Scheduler: FCFS

dequeue first event: PROCESS_STARTS; currentTime=0; it is an event for pid=1

create an event PROCESS_ENDS for pid=1 at time = 6



priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

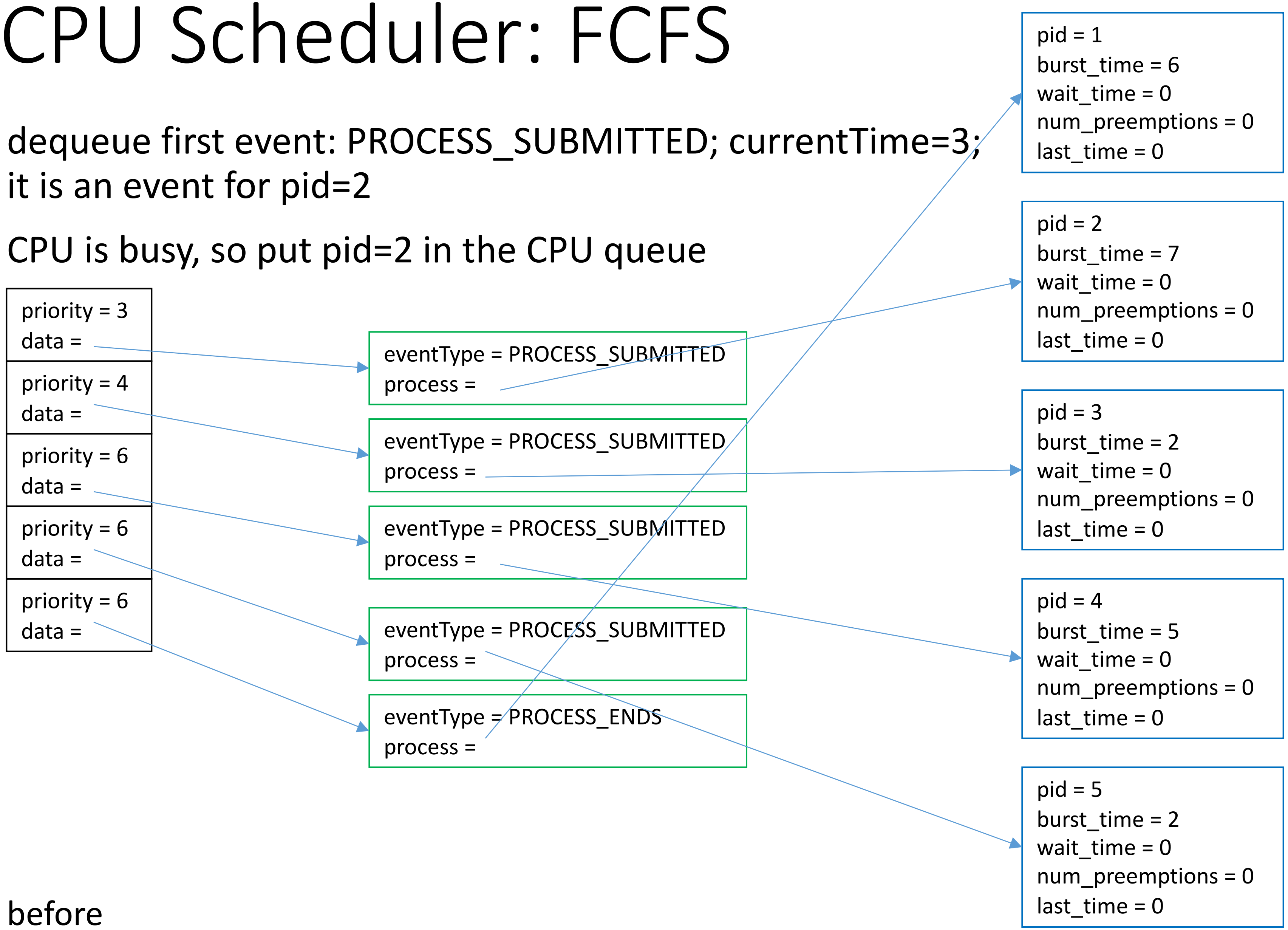
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

after

CPU Scheduler: FCFS

dequeue first event: PROCESS_SUBMITTED; currentTime=3; it is an event for pid=2

CPU is busy, so put pid=2 in the CPU queue



priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

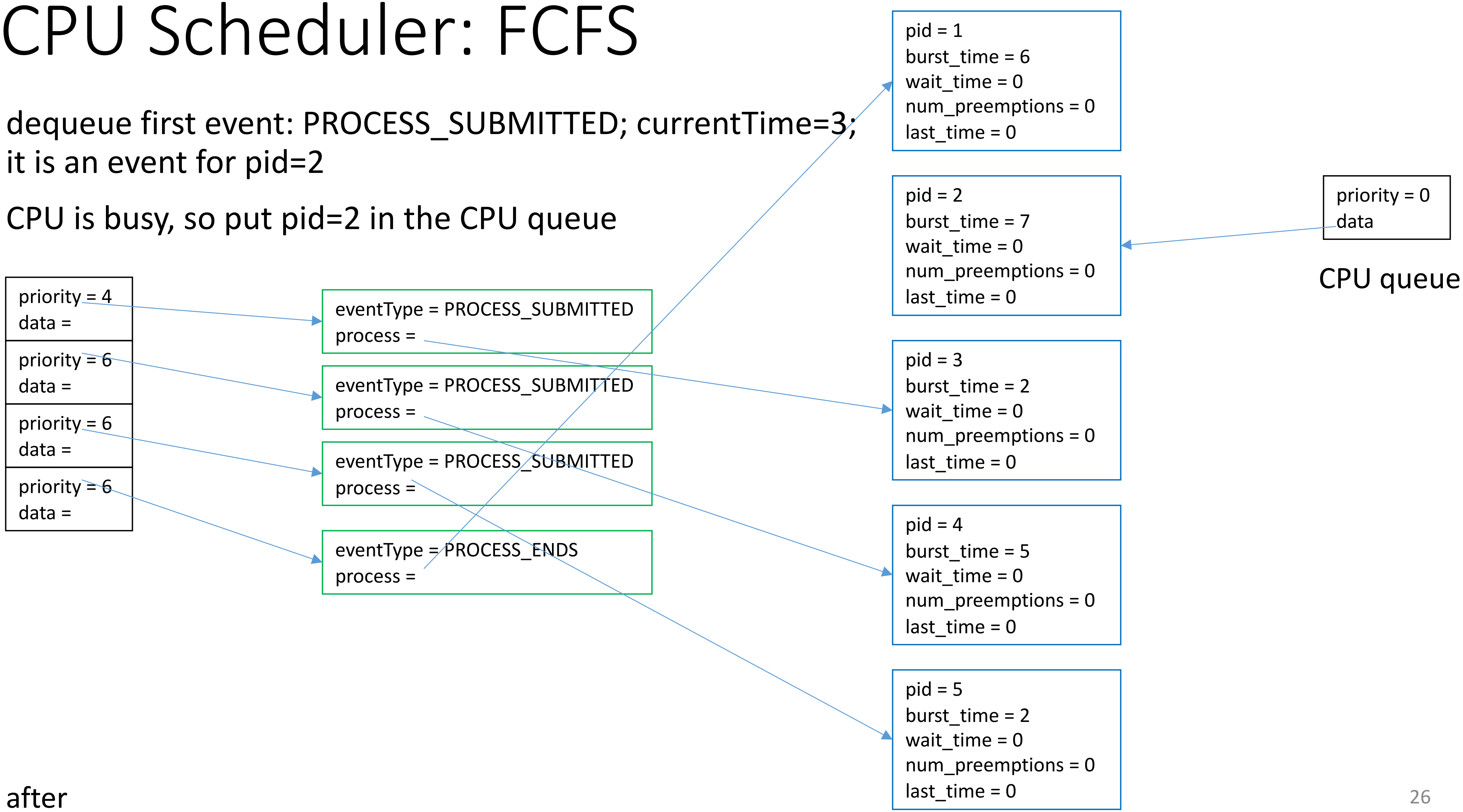
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

before

CPU Scheduler: FCFS

dequeue first event: PROCESS_SUBMITTED; currentTime=3; it is an event for pid=2

CPU is busy, so put pid=2 in the CPU queue



priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data

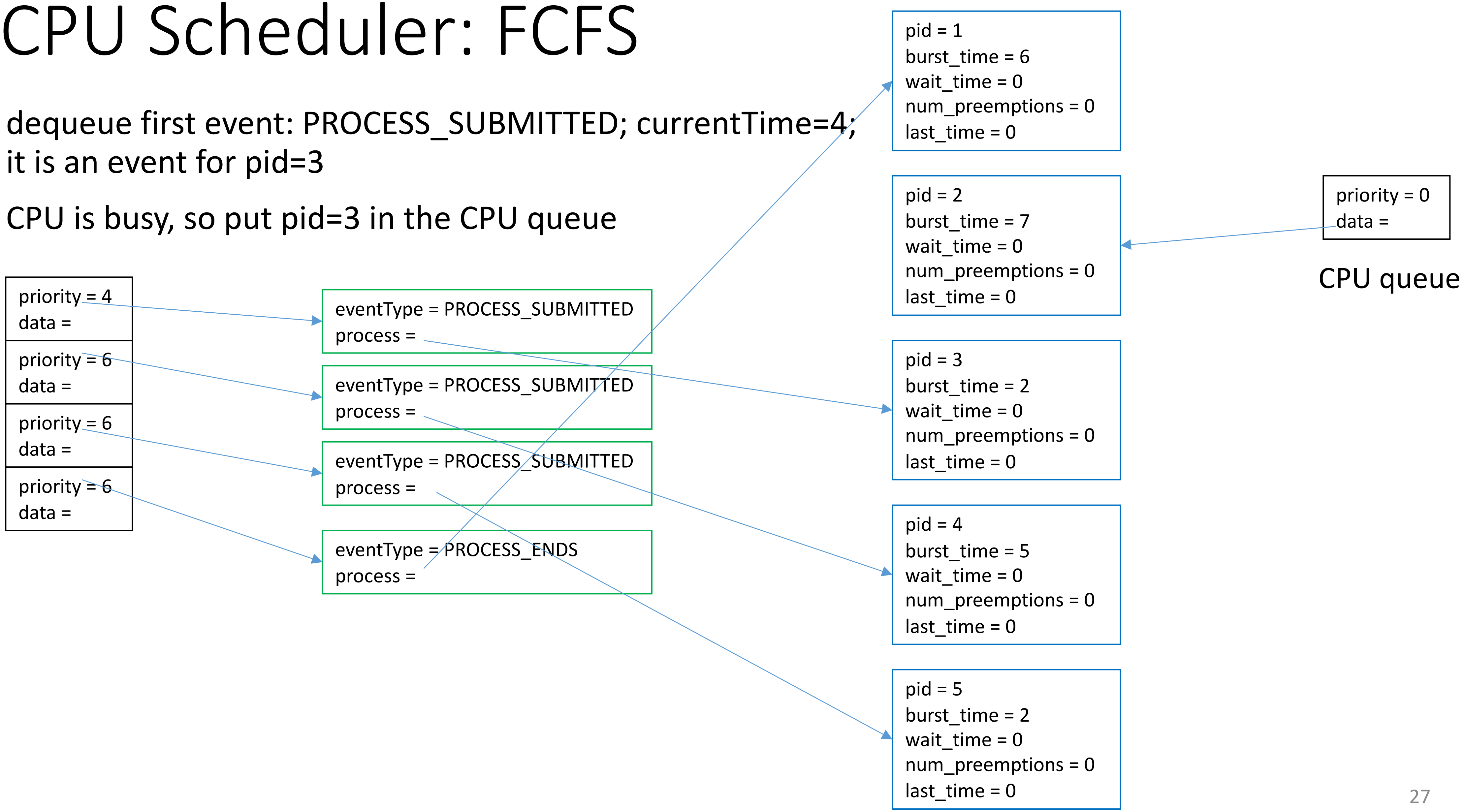
CPU queue

after

CPU Scheduler: FCFS

dequeue first event: PROCESS_SUBMITTED; currentTime=4; it is an event for pid=3

CPU is busy, so put pid=3 in the CPU queue



priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

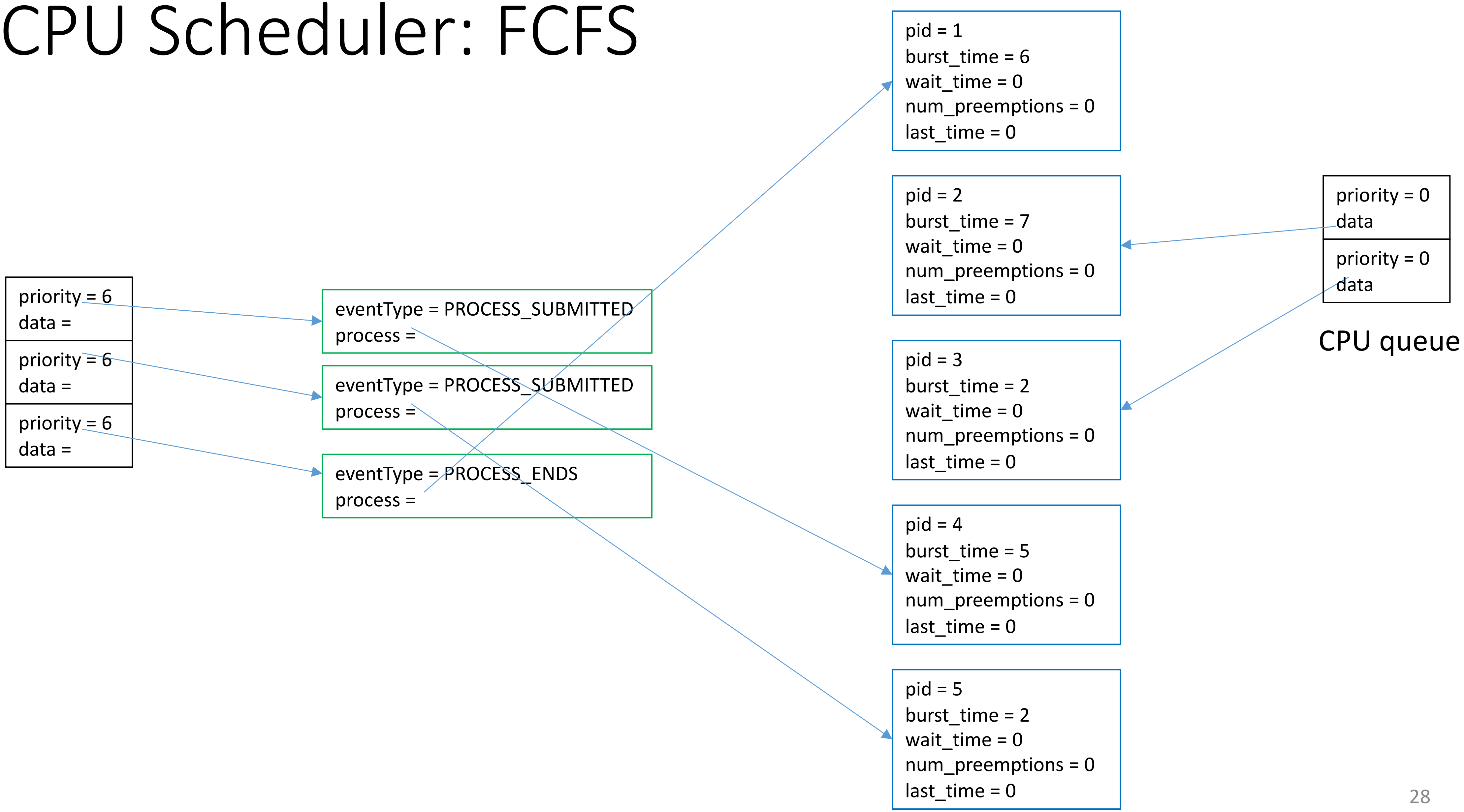
pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data =

CPU queue

CPU Scheduler: FCFS



priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data

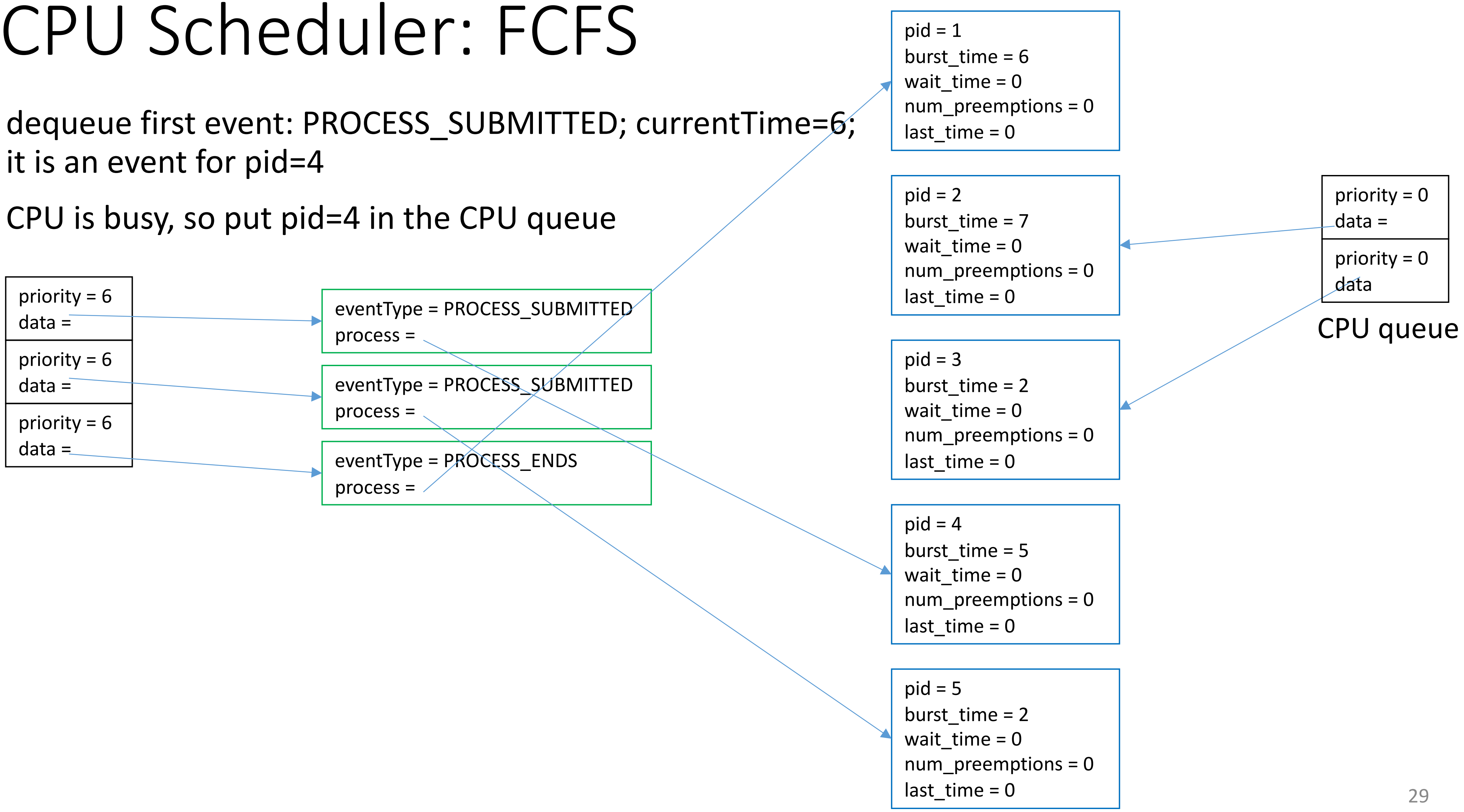
priority = 0
data

CPU queue

CPU Scheduler: FCFS

dequeue first event: PROCESS_SUBMITTED; currentTime=6; it is an event for pid=4

CPU is busy, so put pid=4 in the CPU queue



priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

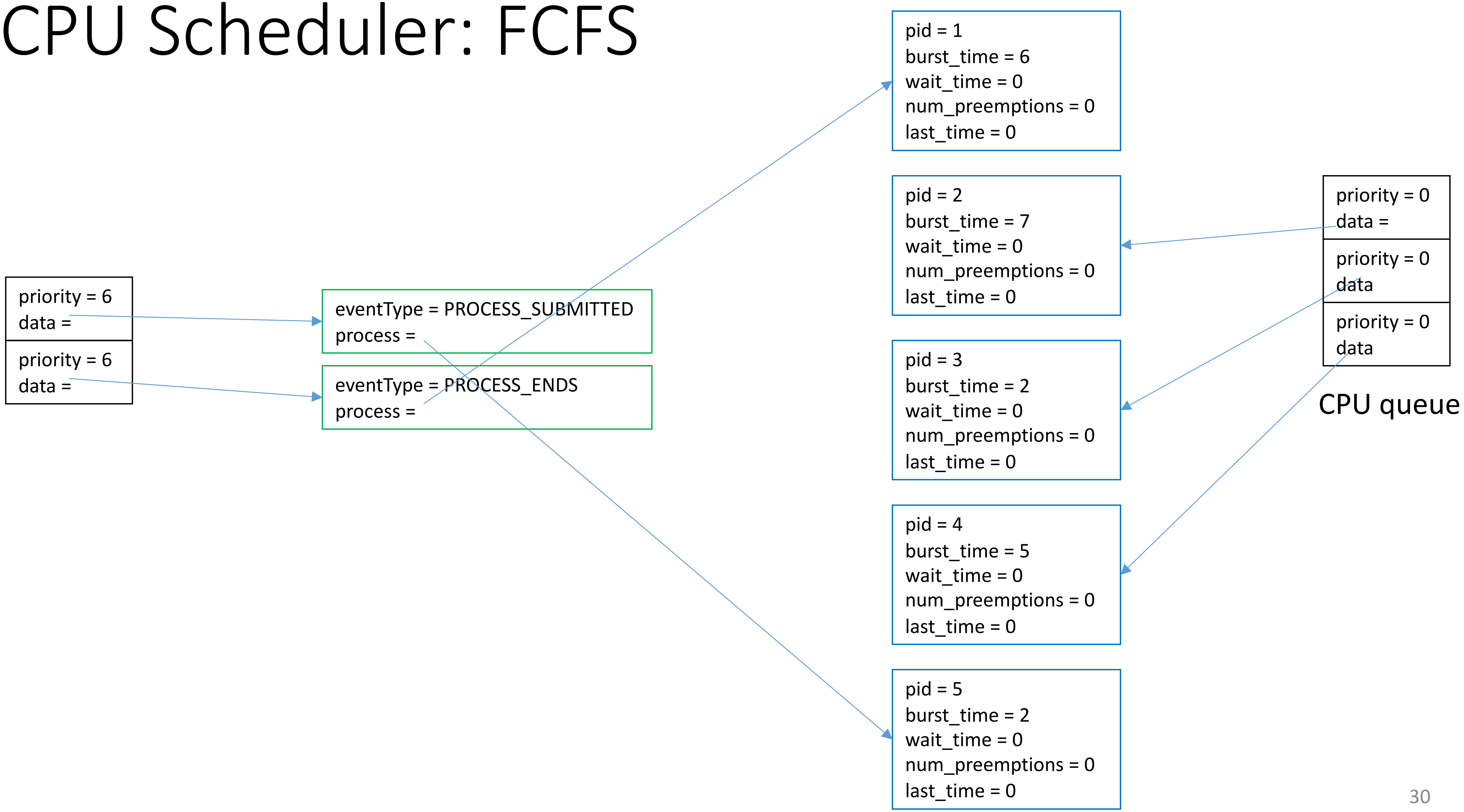
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data =

priority = 0
data

CPU queue

CPU Scheduler: FCFS



priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data =

priority = 0
data

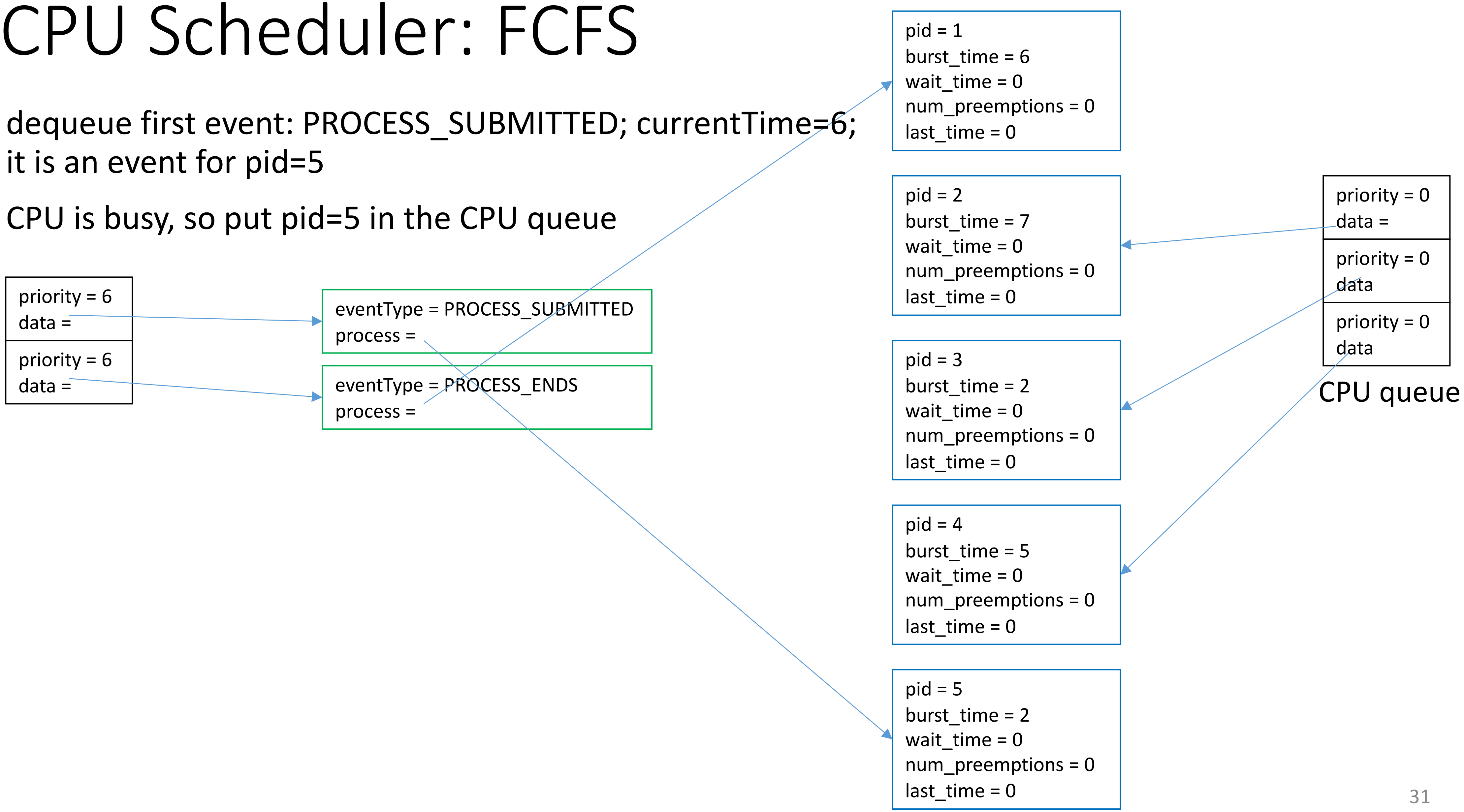
priority = 0
data

CPU queue

CPU Scheduler: FCFS

dequeue first event: PROCESS_SUBMITTED; currentTime=6; it is an event for pid=5

CPU is busy, so put pid=5 in the CPU queue



priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

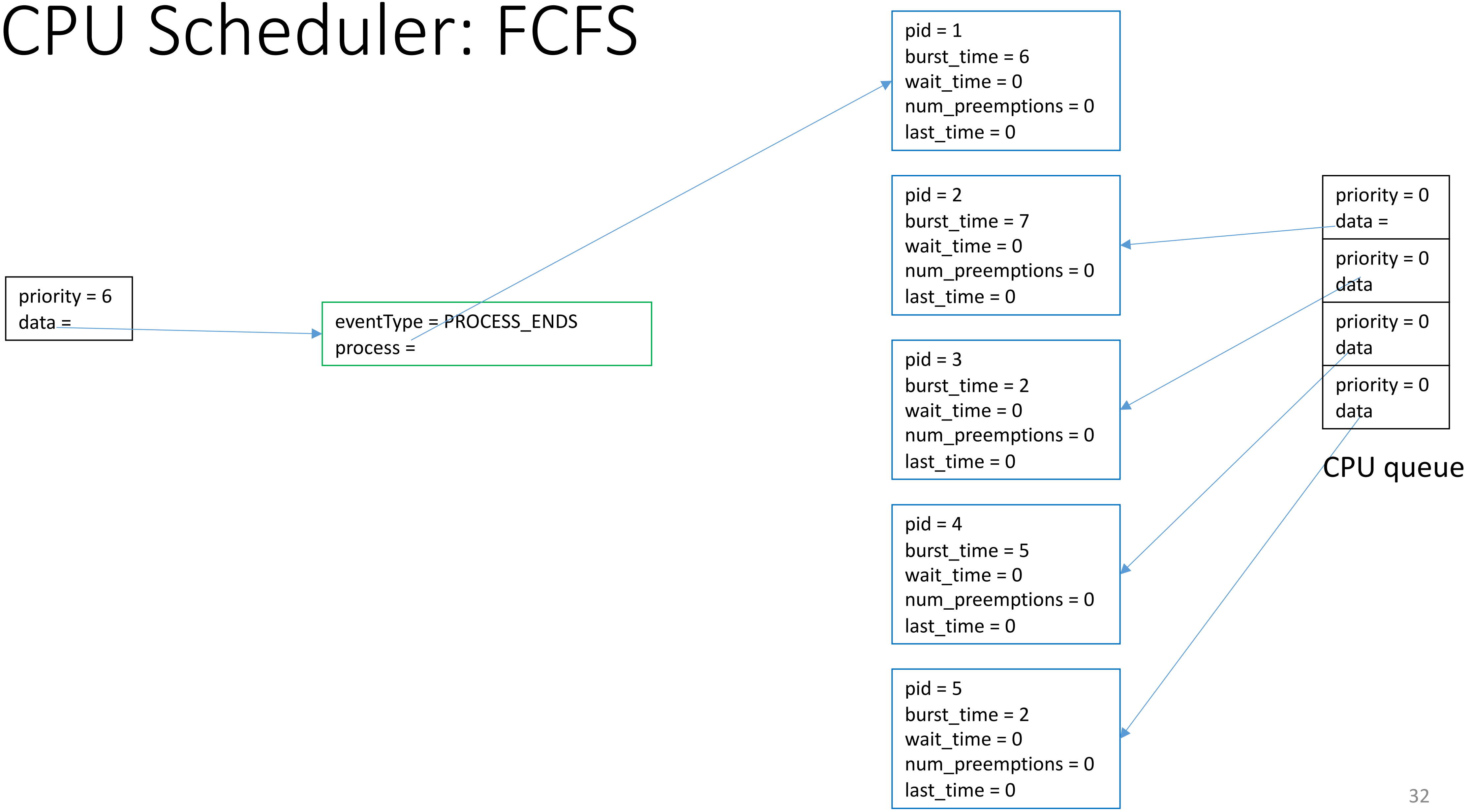
priority = 0
data =

priority = 0
data

priority = 0
data

CPU queue

CPU Scheduler: FCFS



priority = 6
data =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data =

priority = 0
data

priority = 0
data

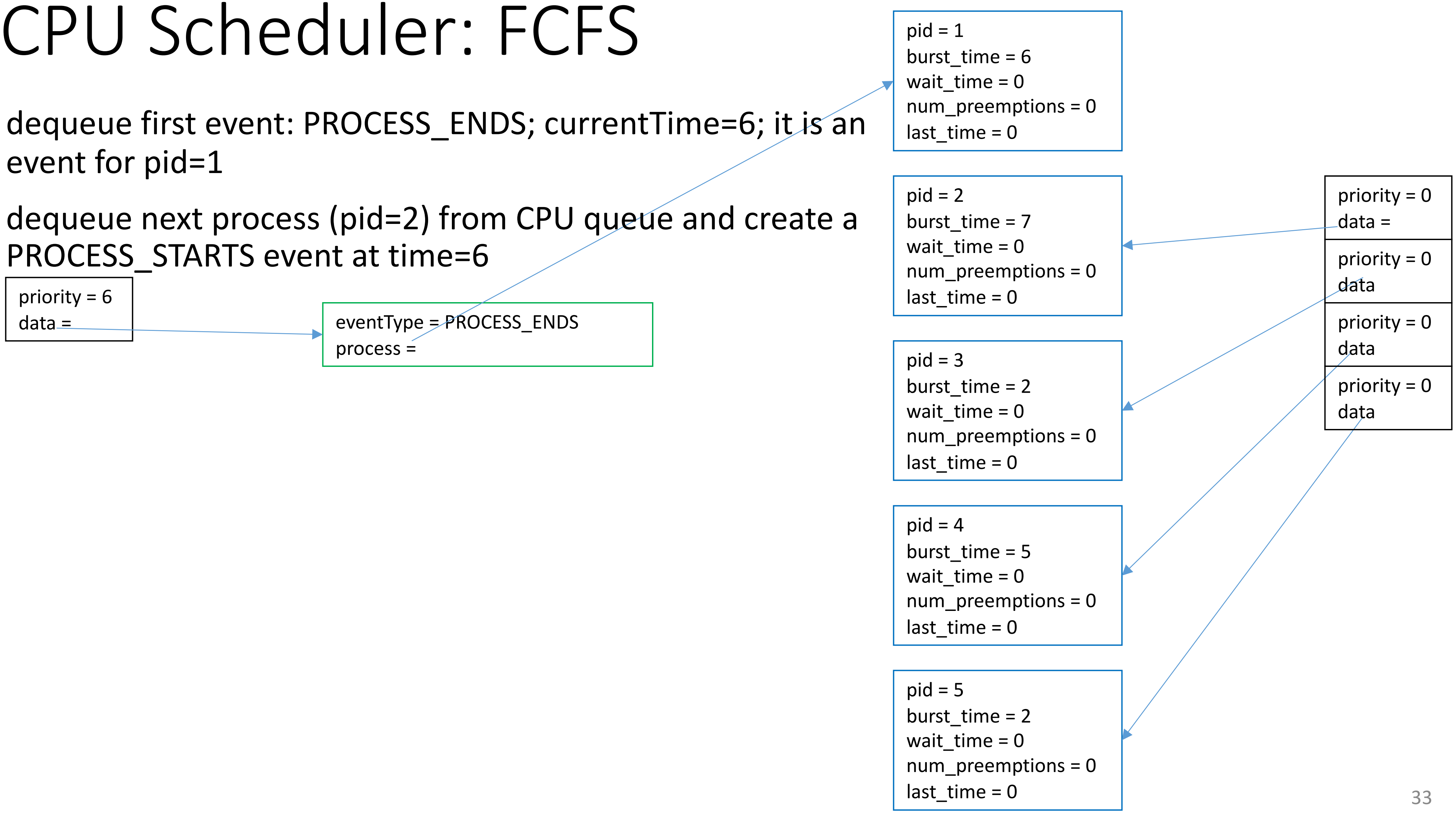
priority = 0
data

CPU queue

CPU Scheduler: FCFS

dequeue first event: PROCESS_ENDS; currentTime=6; it is an event for pid=1

dequeue next process (pid=2) from CPU queue and create a PROCESS_STARTS event at time=6



priority = 6
data =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

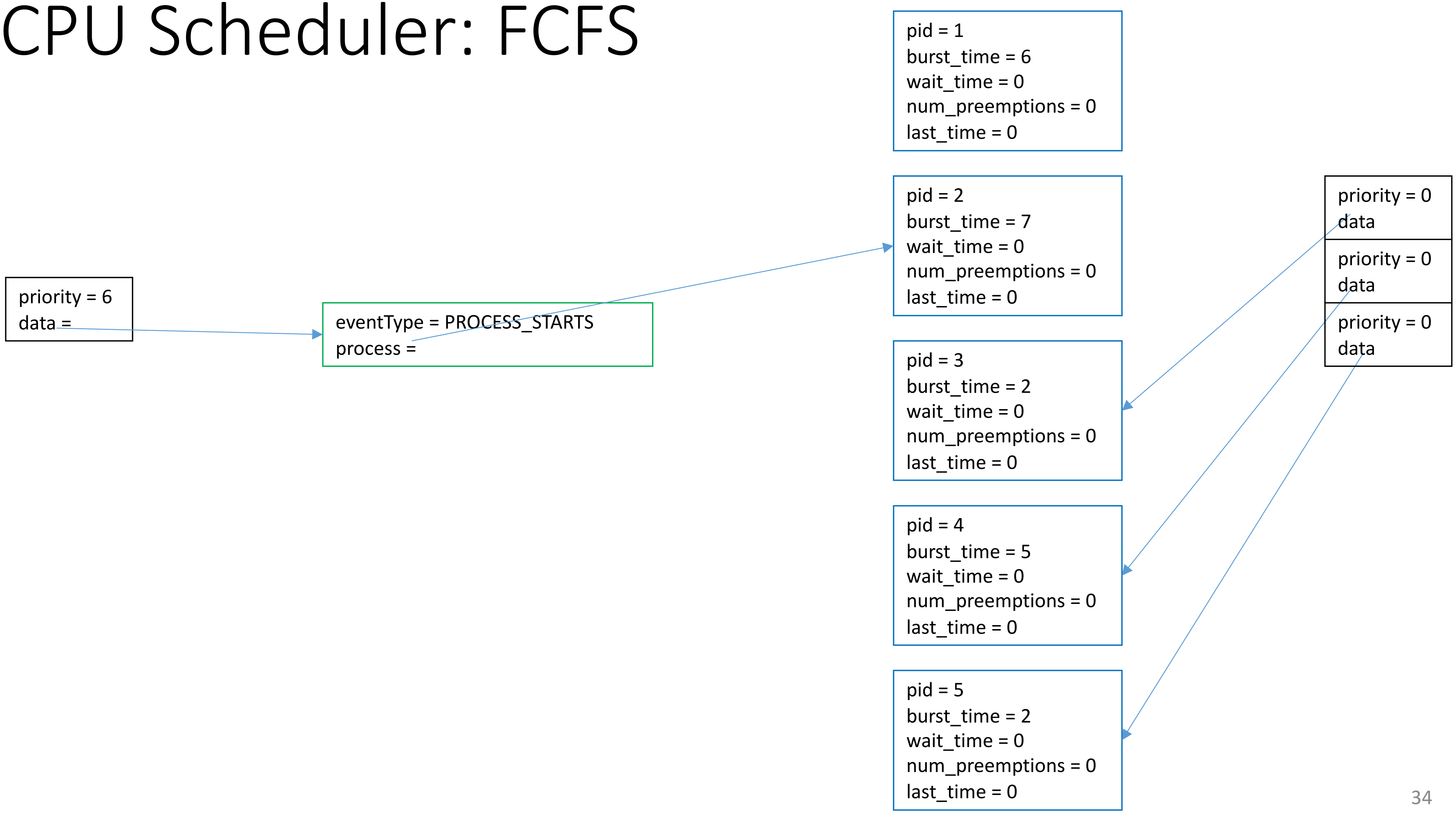
priority = 0
data =

priority = 0
data

priority = 0
data

priority = 0
data

CPU Scheduler: FCFS



priority = 6
data =

eventType = PROCESS_STARTS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data

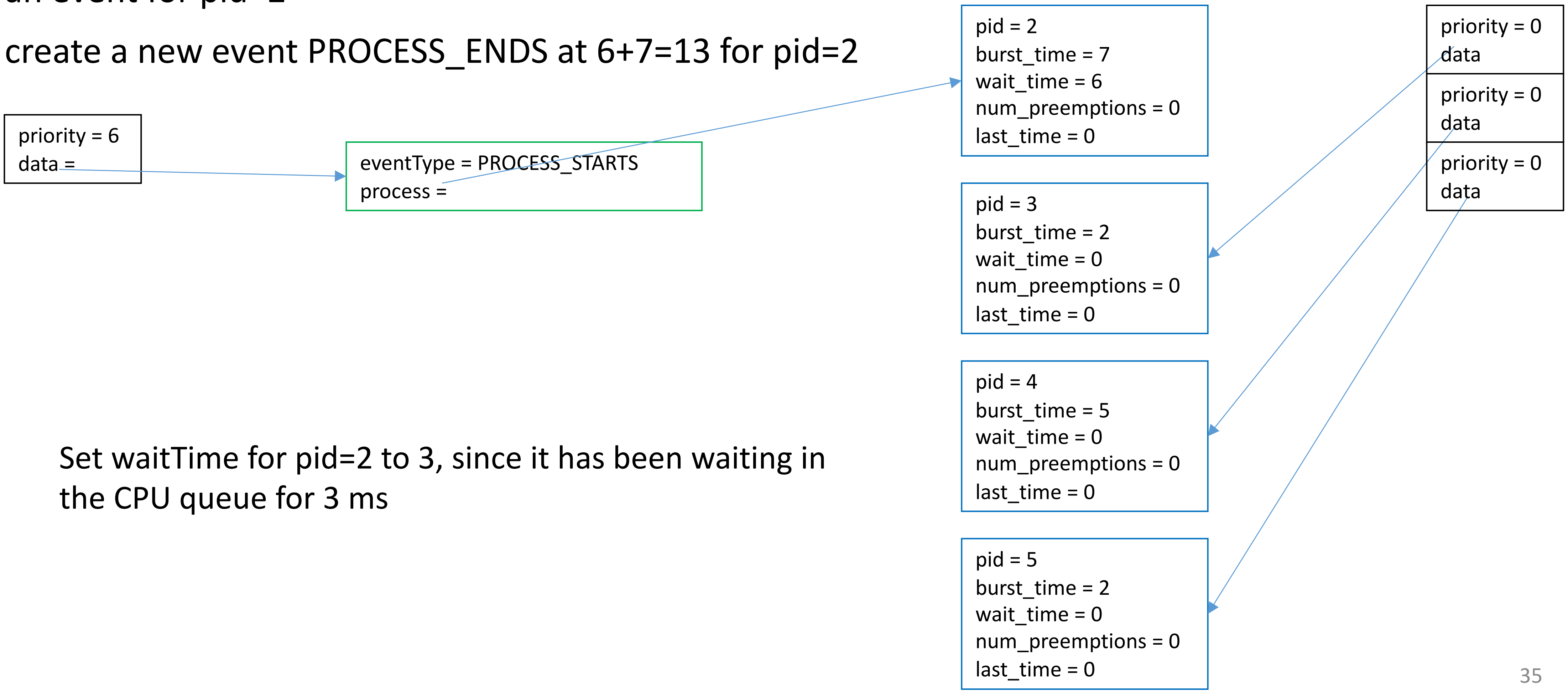
priority = 0
data

priority = 0
data

CPU Scheduler: FCFS

dequeue first event: PROCESS_STARTS; currentTime=6; it is an event for pid=2

create a new event PROCESS_ENDS at 6+7=13 for pid=2



priority = 6
data =

eventType = PROCESS_STARTS
process =

pid = 2
burst_time = 7
wait_time = 6
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

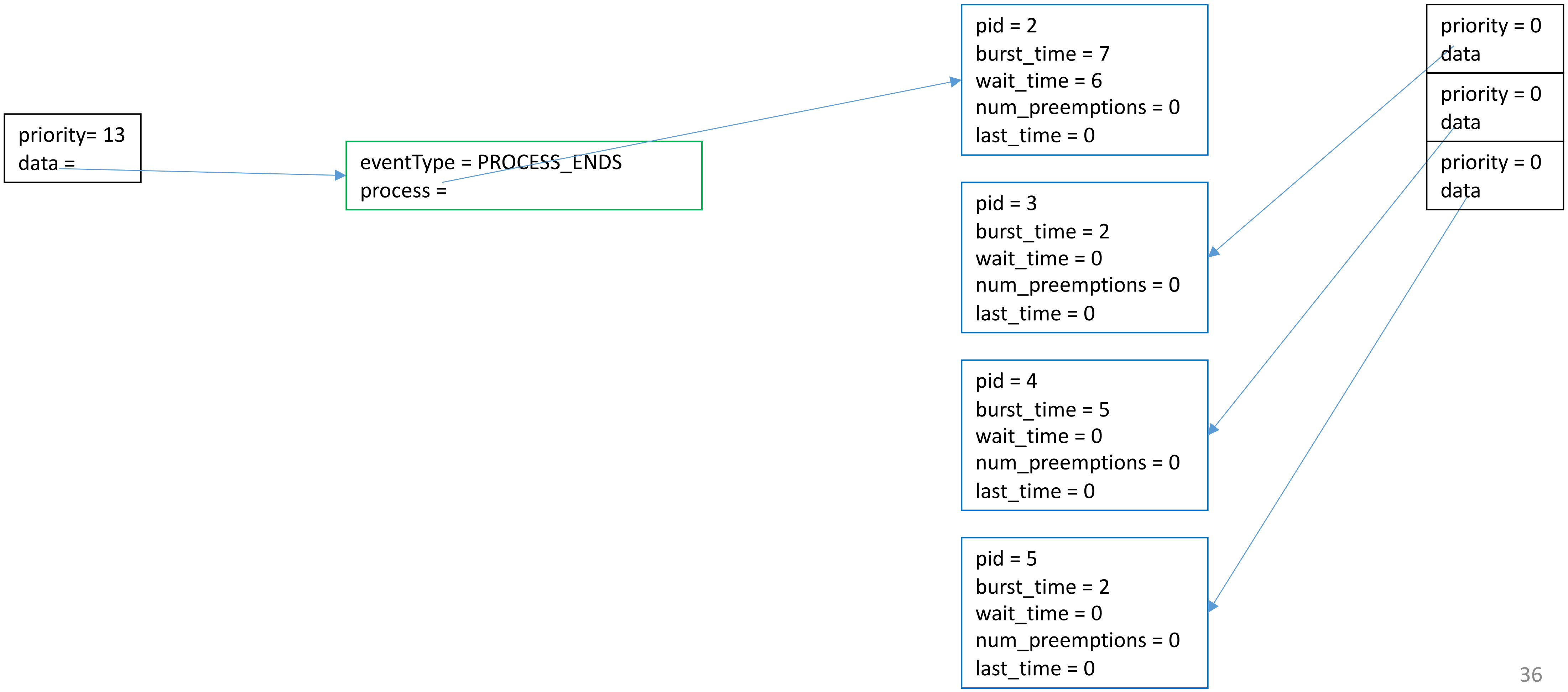
priority = 0
data

priority = 0
data

priority = 0
data

Set waitTime for pid=2 to 3, since it has been waiting in the CPU queue for 3 ms

CPU Scheduler: FCFS



priority= 13
data =

eventType = PROCESS_ENDS
process =

pid = 2
burst_time = 7
wait_time = 6
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data

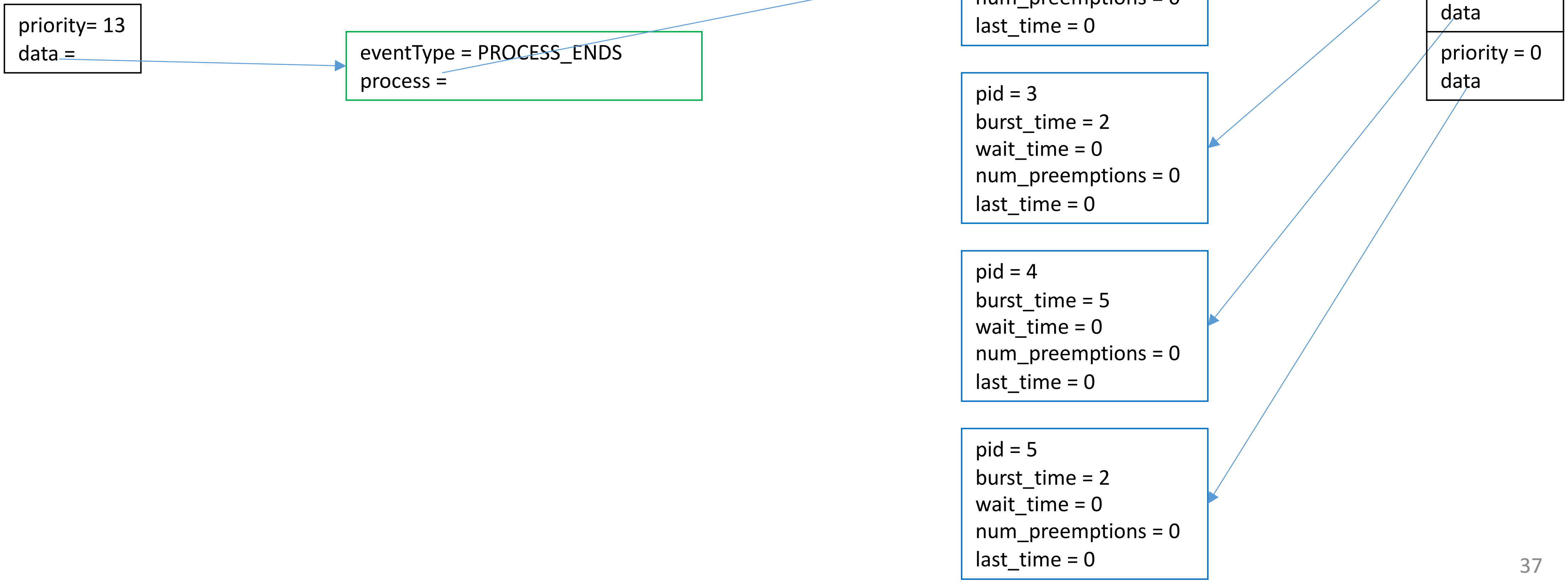
priority = 0
data

priority = 0
data

CPU Scheduler: FCFS

dequeue first event: PROCESS_ENDS; currentTime=13; it is an event for pid=2

dequeue next process (pid=3) in CPU queue and create a PROCESS_STARTS event at time=13



priority= 13
data =

eventType = PROCESS_ENDS
process =

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

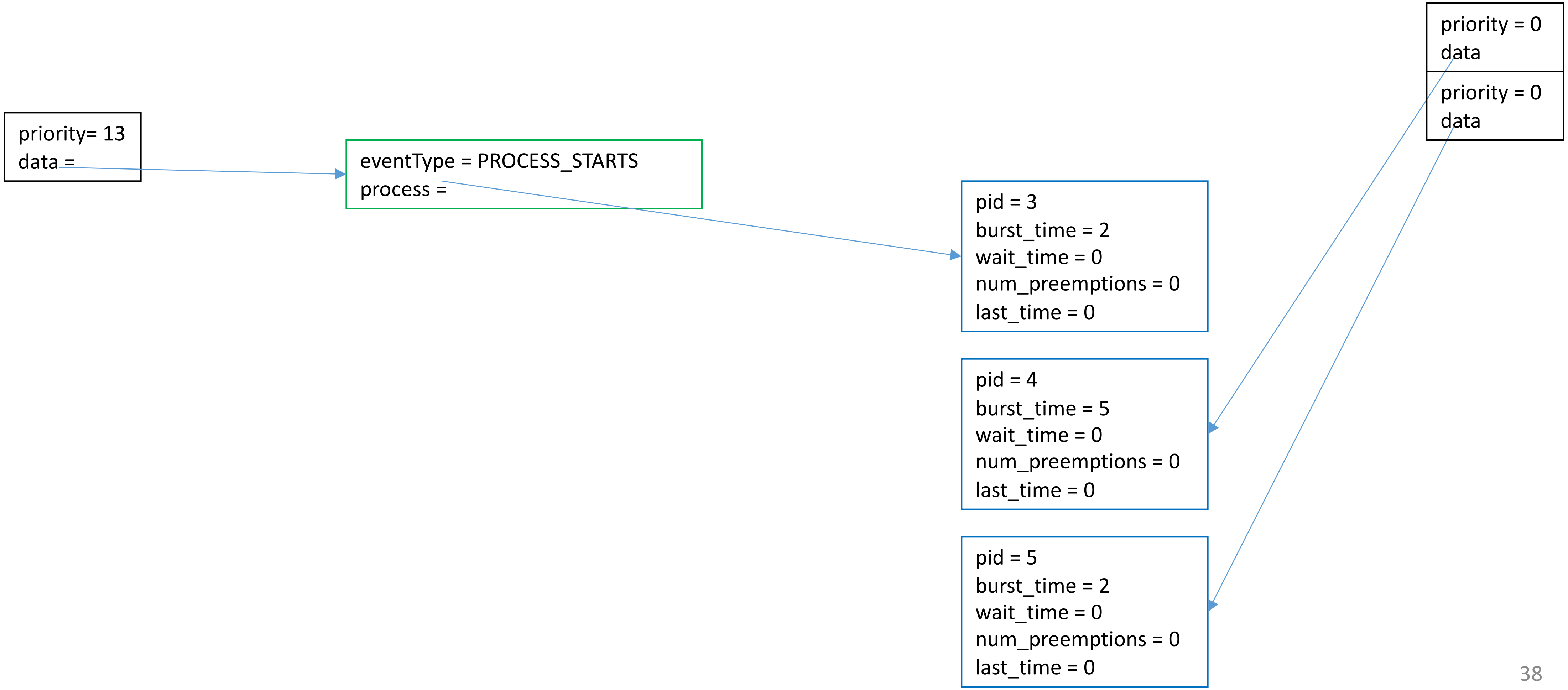
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 0
data

priority = 0
data

priority = 0
data

CPU Scheduler: FCFS



priority= 13
data =

eventType = PROCESS_STARTS
process =

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

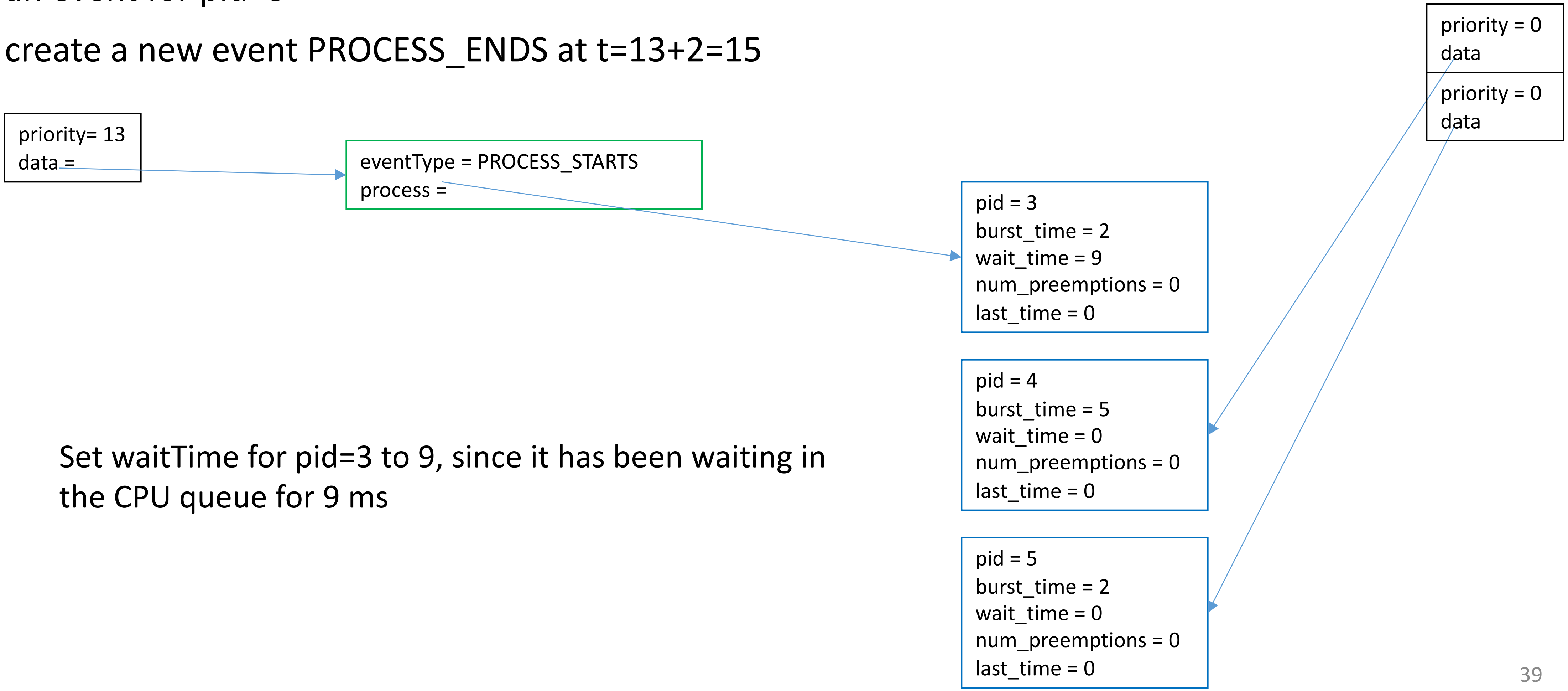
priority = 0
data

priority = 0
data

CPU Scheduler: FCFS

dequeue first event: PROCESS_STARTS; currentTime=13; it is an event for pid=3

create a new event PROCESS_ENDS at t=13+2=15



priority= 13
data =

eventType = PROCESS_STARTS
process =

pid = 3
burst_time = 2
wait_time = 9
num_preemptions = 0
last_time = 0

priority = 0
data

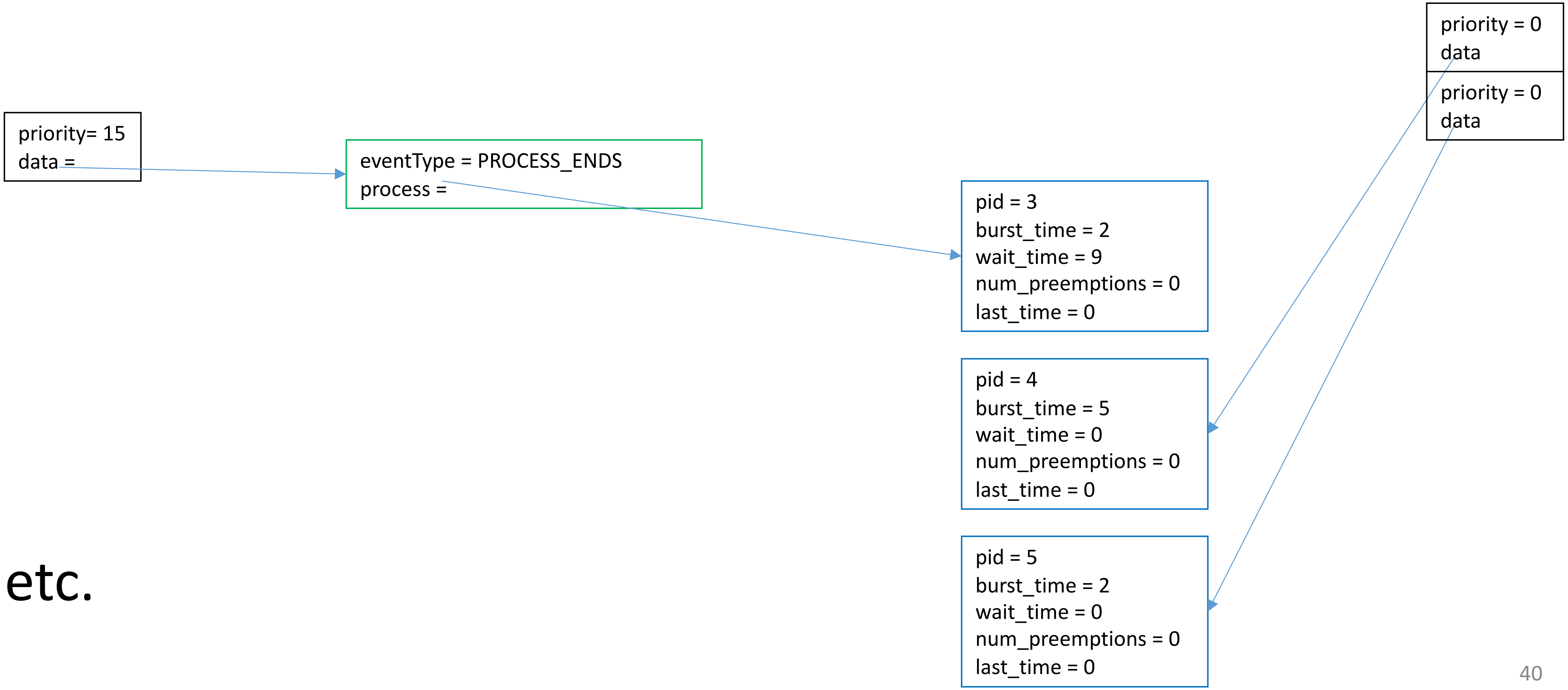
priority = 0
data

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

Set waitTime for pid=3 to 9, since it has been waiting in the CPU queue for 9 ms

CPU Scheduler: FCFS



priority = 0
data

priority = 0
data

priority= 15
data =

eventType = PROCESS_ENDS
process =

pid = 3
burst_time = 2
wait_time = 9
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

etc.

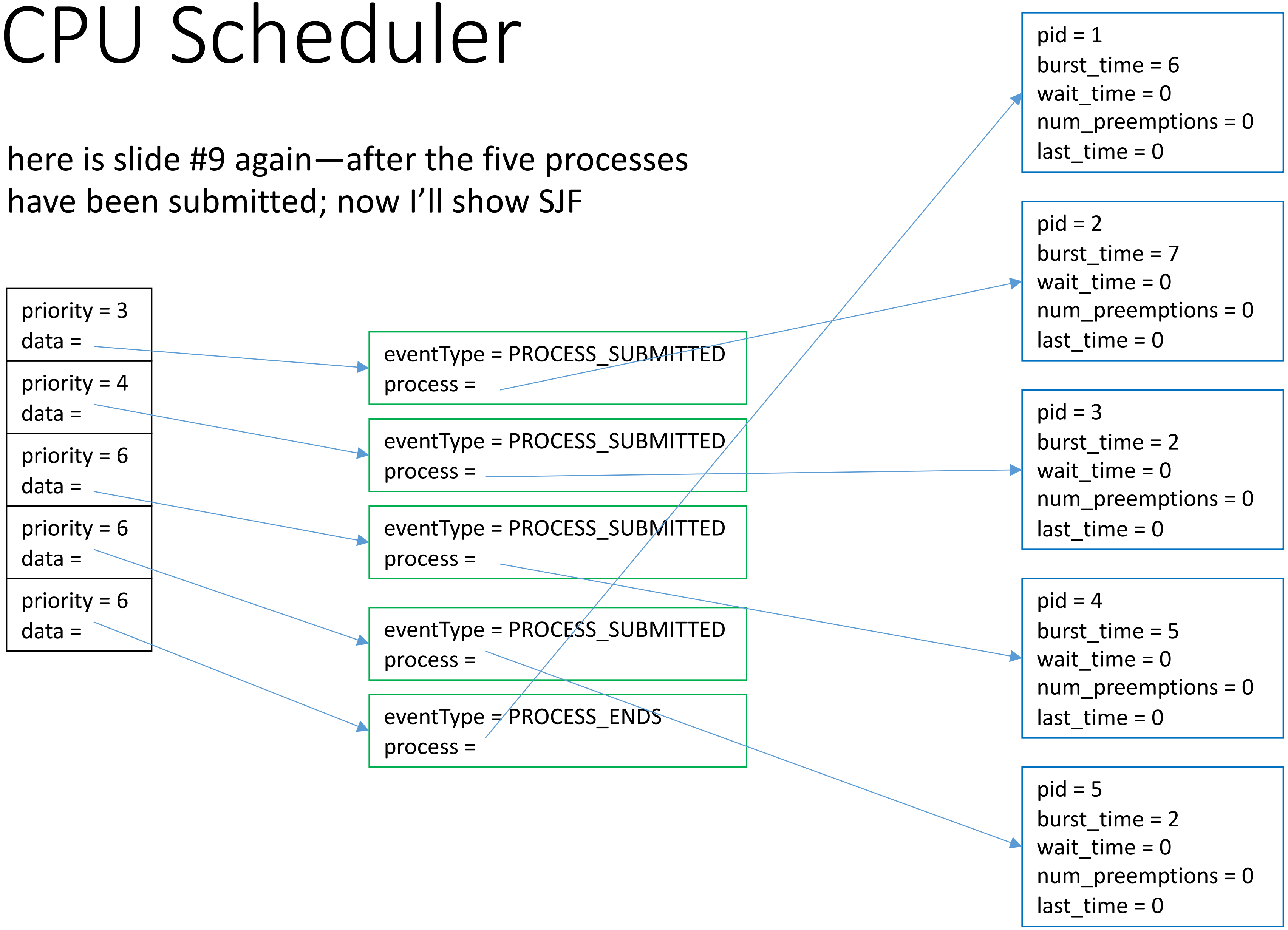
Diagrams showing the CPU Scheduler

5 Processes

SJF simulation

CPU Scheduler

here is slide #9 again—after the five processes have been submitted; now I'll show SJF



priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

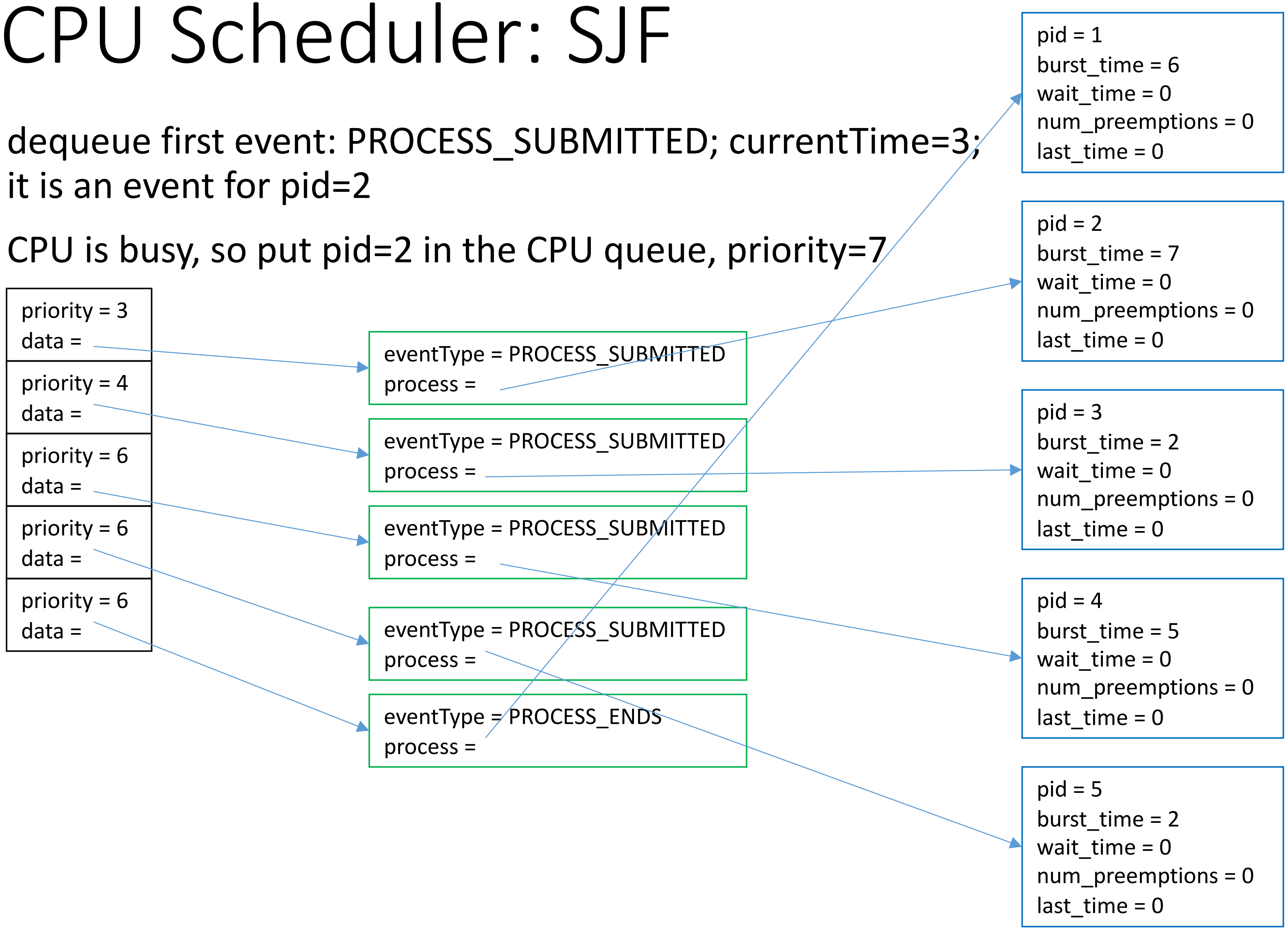
pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=3;
it is an event for pid=2

CPU is busy, so put pid=2 in the CPU queue, priority=7



priority = 3
data =

priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

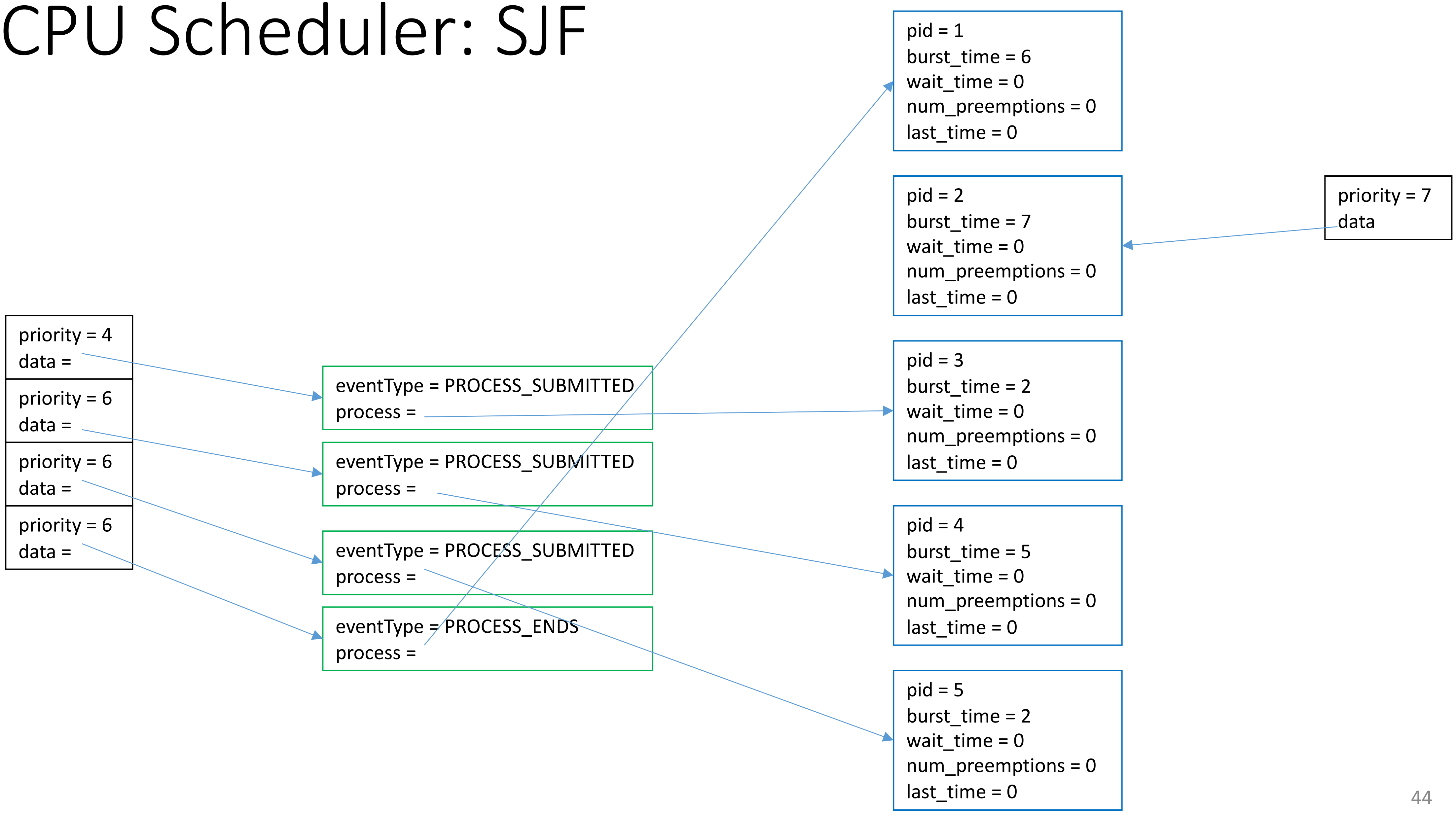
pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

CPU Scheduler: SJF



priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

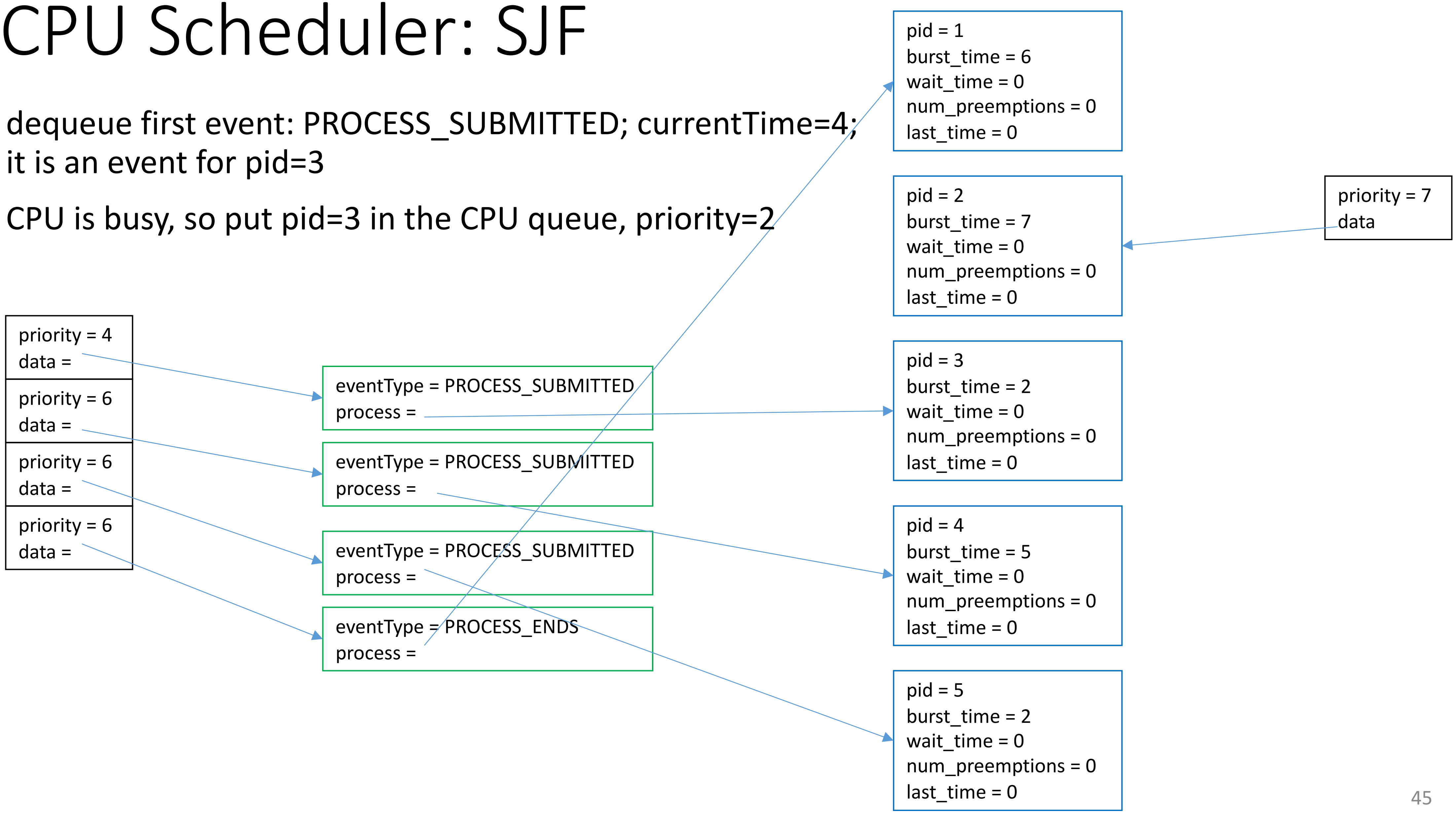
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=4;
it is an event for pid=3

CPU is busy, so put pid=3 in the CPU queue, priority=2



priority = 4
data =

priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

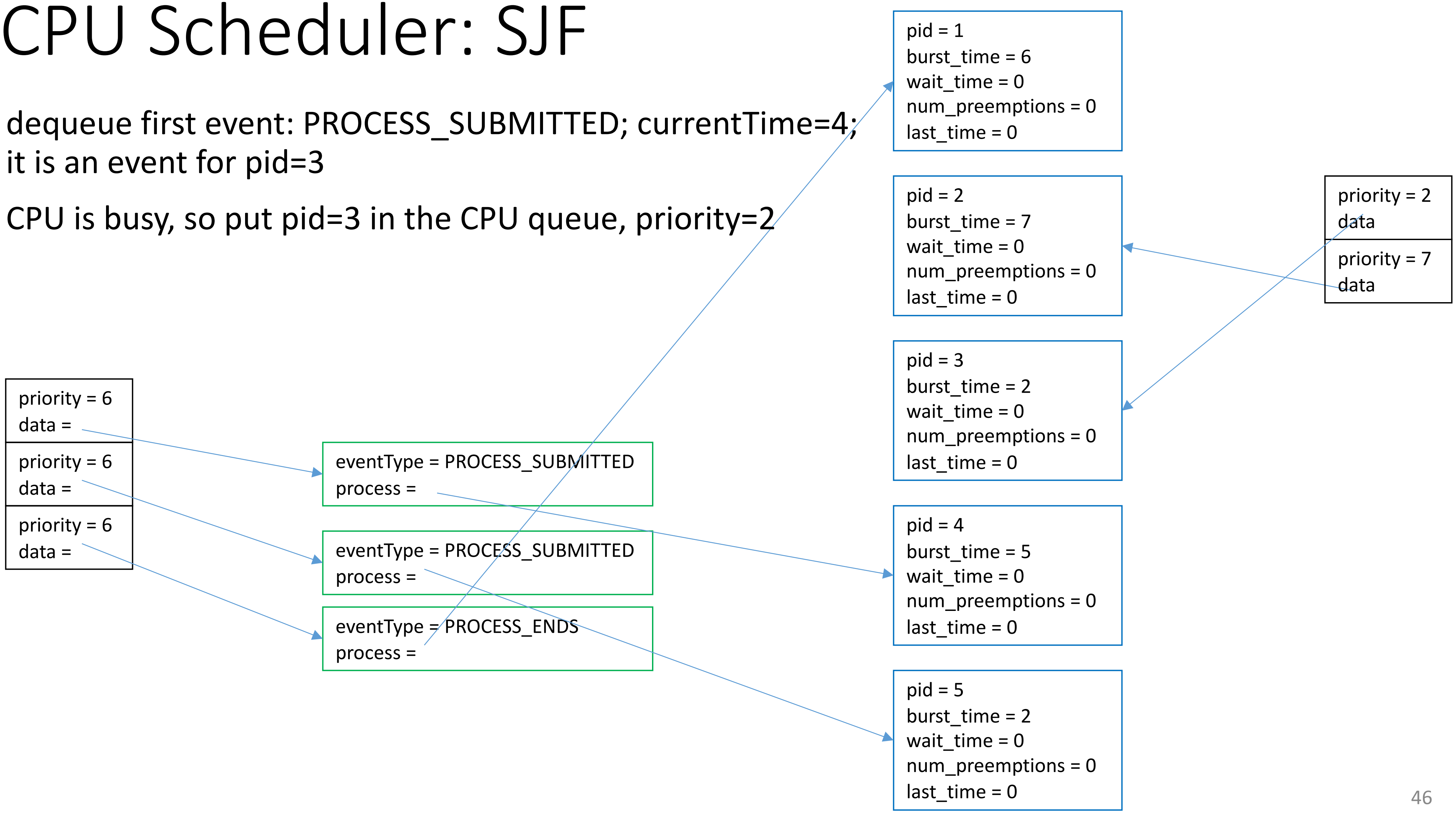
pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=4;
it is an event for pid=3

CPU is busy, so put pid=3 in the CPU queue, priority=2



priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

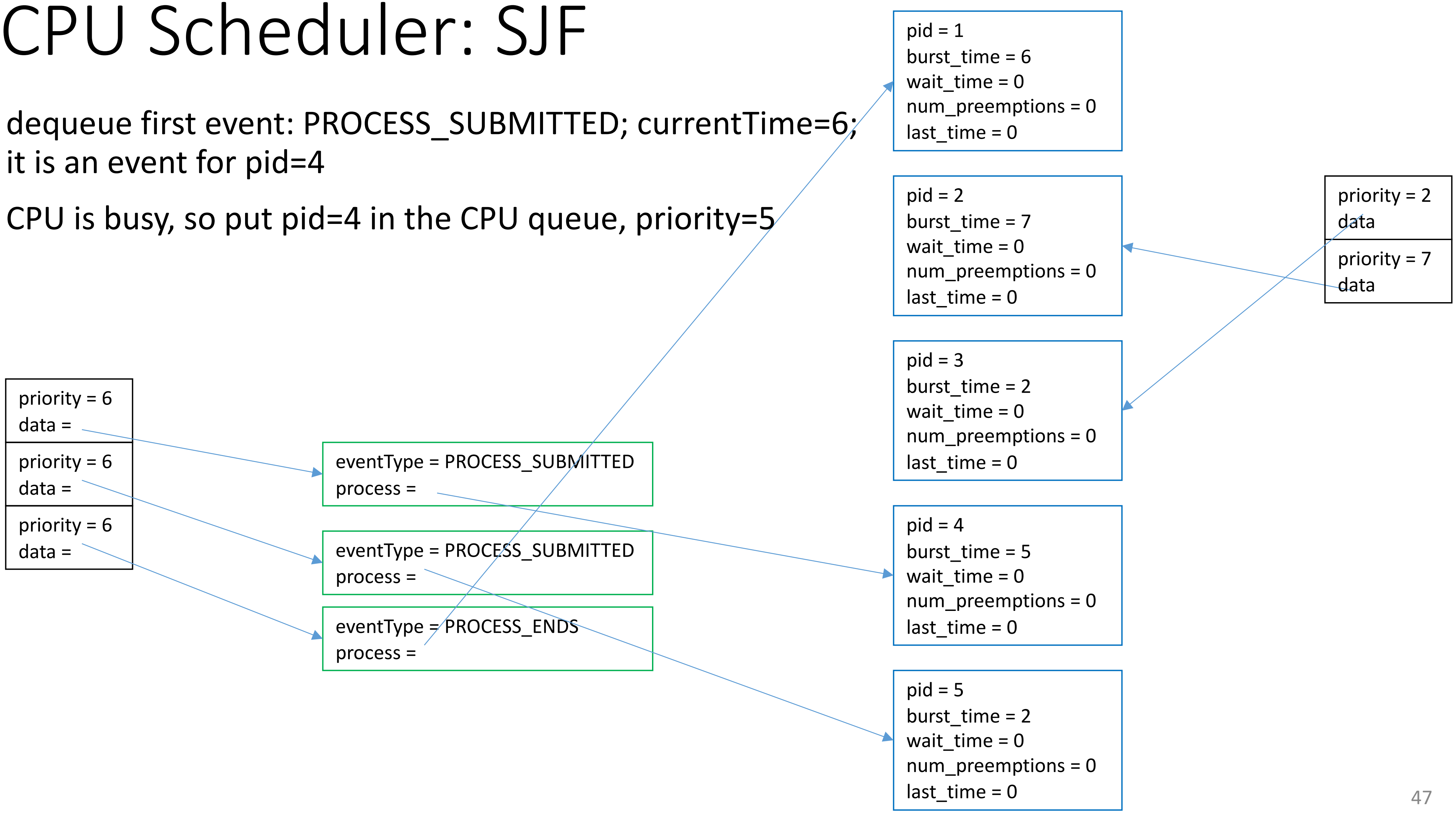
priority = 2
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=6; it is an event for pid=4

CPU is busy, so put pid=4 in the CPU queue, priority=5



priority = 6
data =

priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

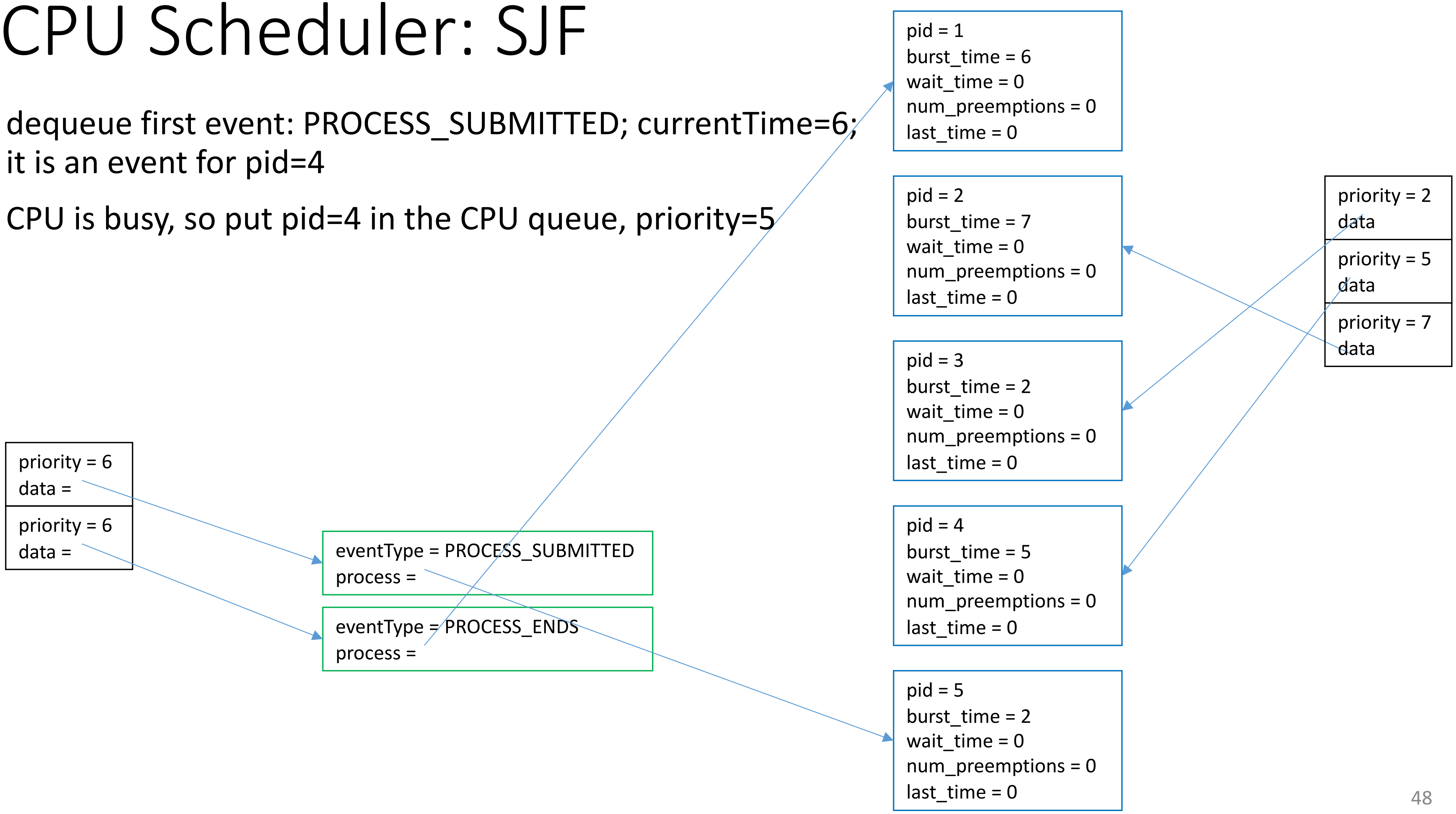
priority = 2
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=6; it is an event for pid=4

CPU is busy, so put pid=4 in the CPU queue, priority=5



priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

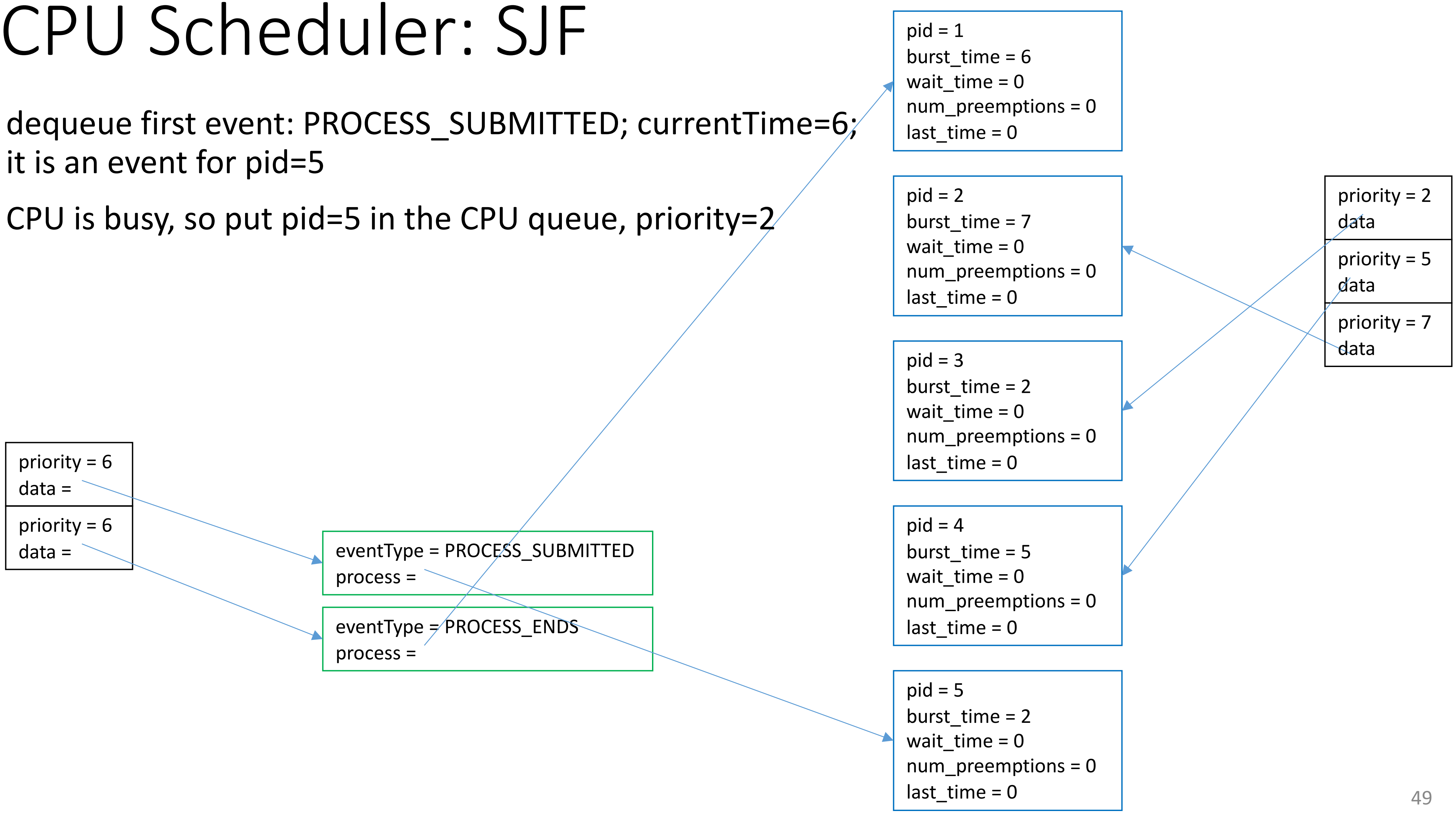
priority = 5
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=6; it is an event for pid=5

CPU is busy, so put pid=5 in the CPU queue, priority=2



priority = 6
data =

priority = 6
data =

eventType = PROCESS_SUBMITTED
process =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

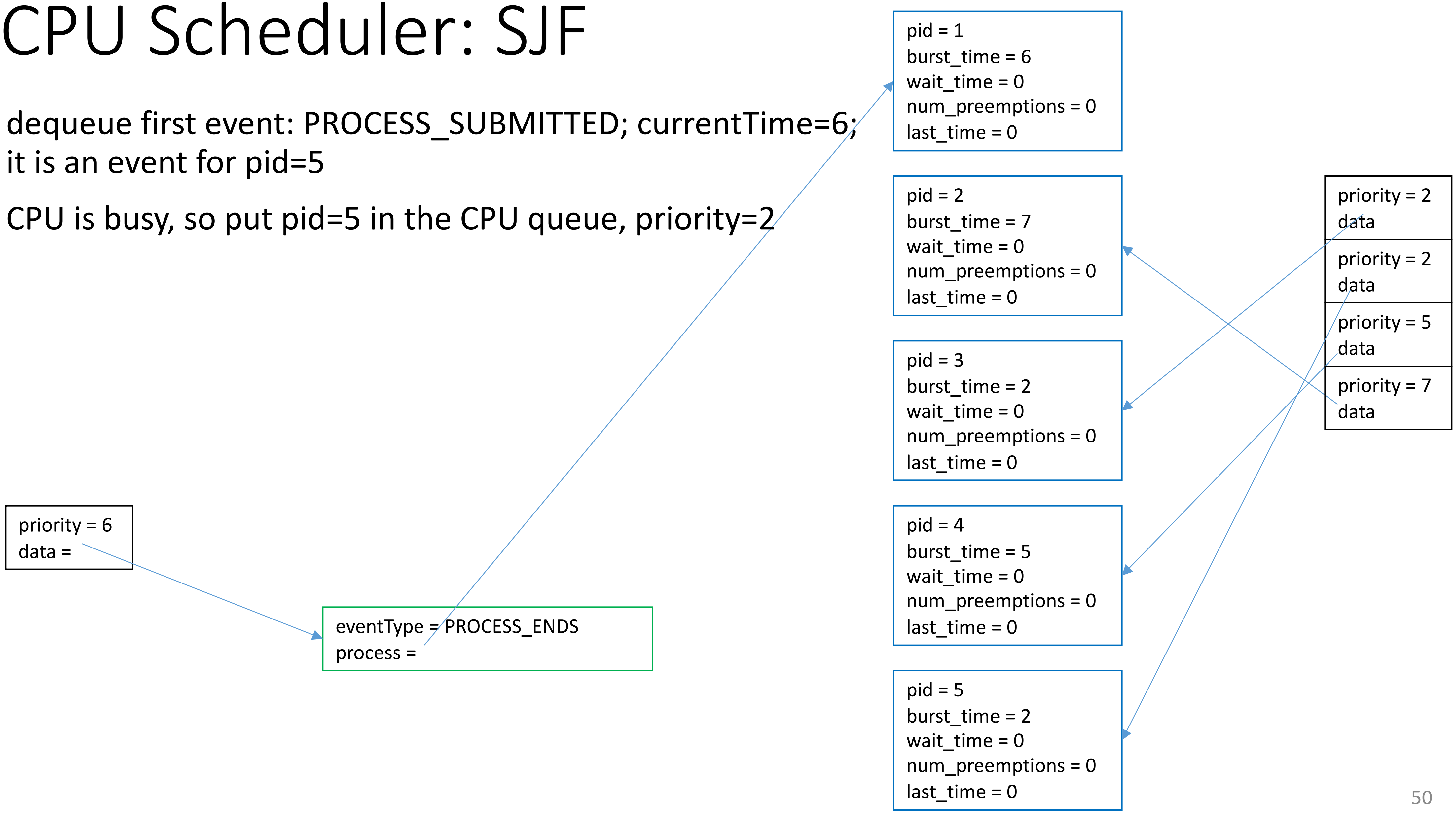
priority = 5
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_SUBMITTED; currentTime=6; it is an event for pid=5

CPU is busy, so put pid=5 in the CPU queue, priority=2



priority = 6
data =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

priority = 2
data

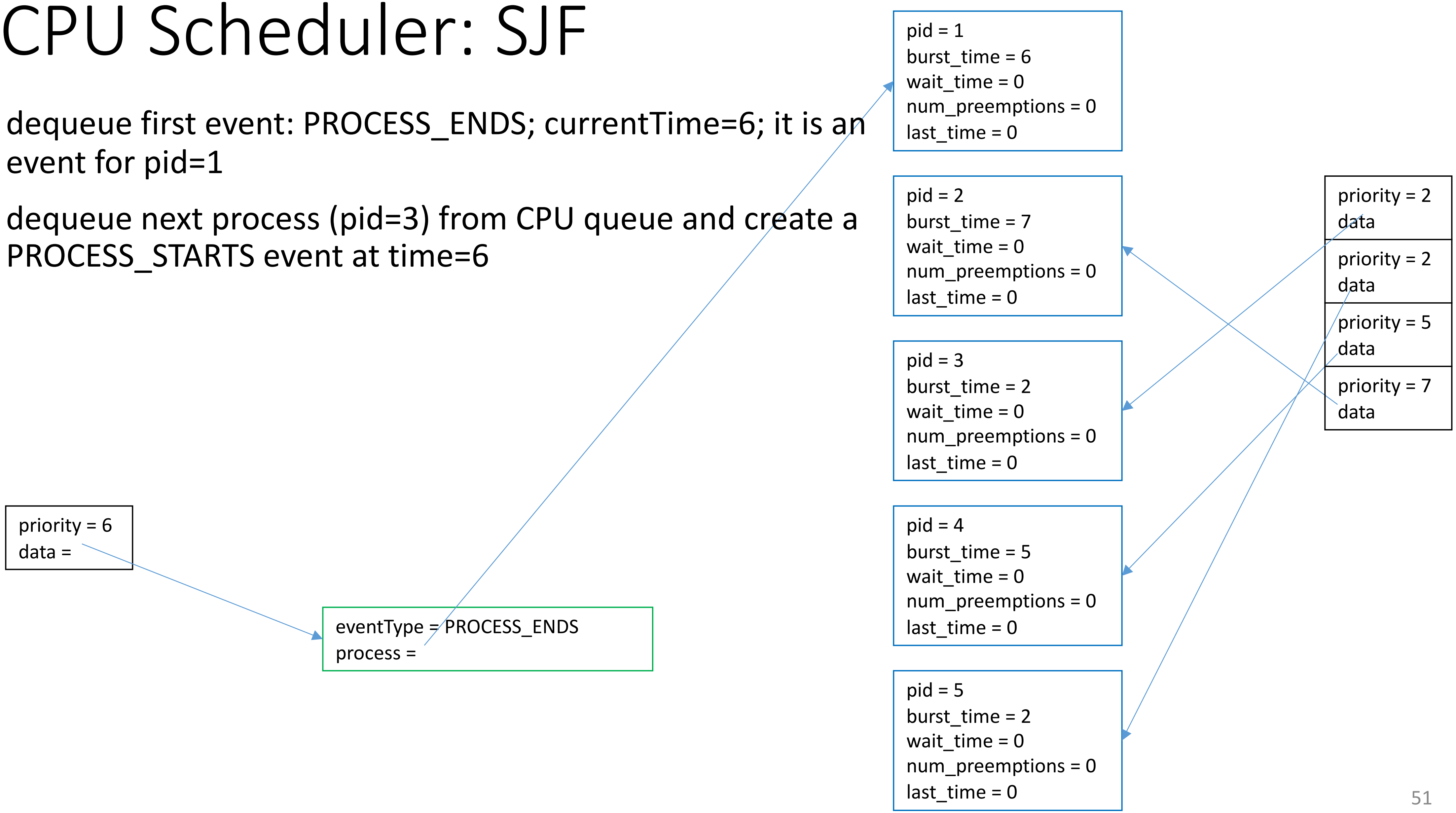
priority = 5
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_ENDS; currentTime=6; it is an event for pid=1

dequeue next process (pid=3) from CPU queue and create a PROCESS_STARTS event at time=6



priority = 6
data =

eventType = PROCESS_ENDS
process =

pid = 1
burst_time = 6
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

priority = 2
data

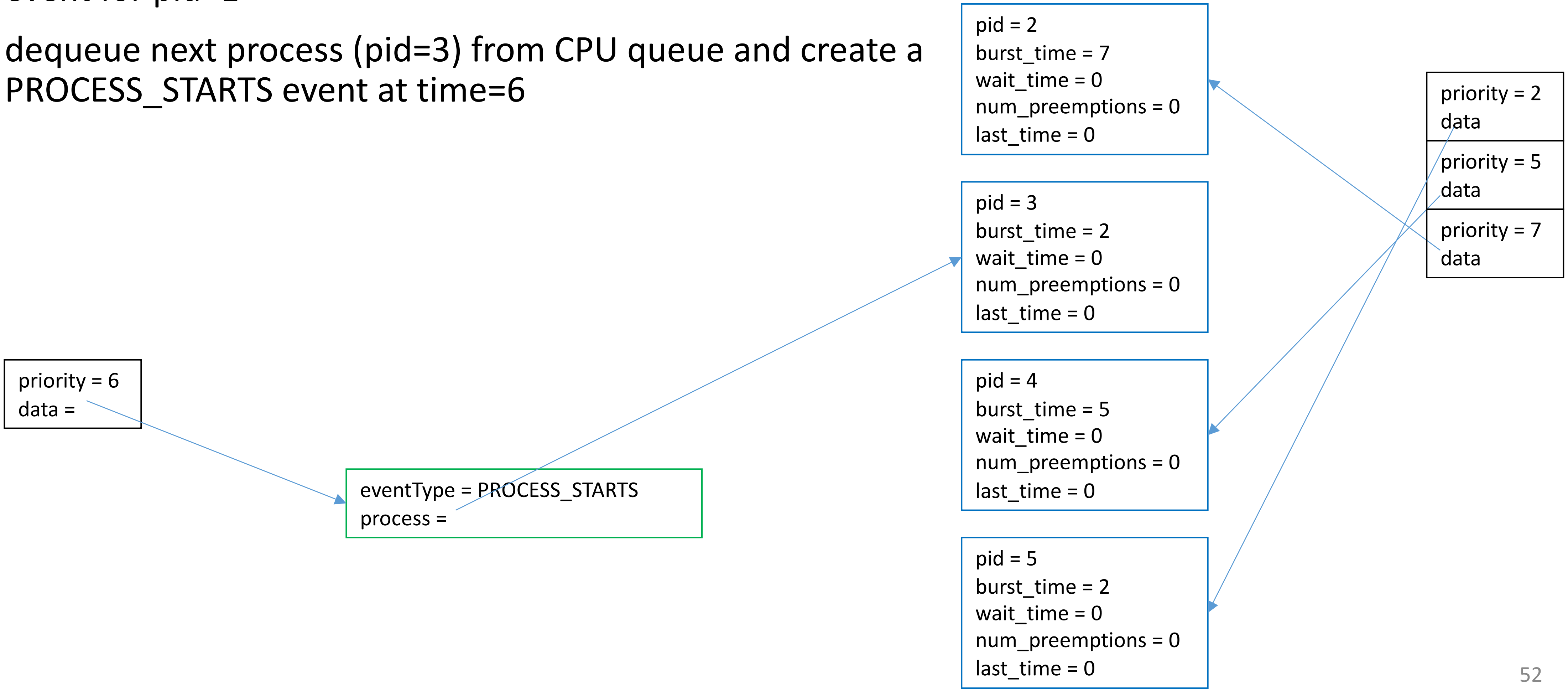
priority = 5
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_ENDS; currentTime=6; it is an event for pid=1

dequeue next process (pid=3) from CPU queue and create a PROCESS_STARTS event at time=6



pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

priority = 5
data

priority = 7
data

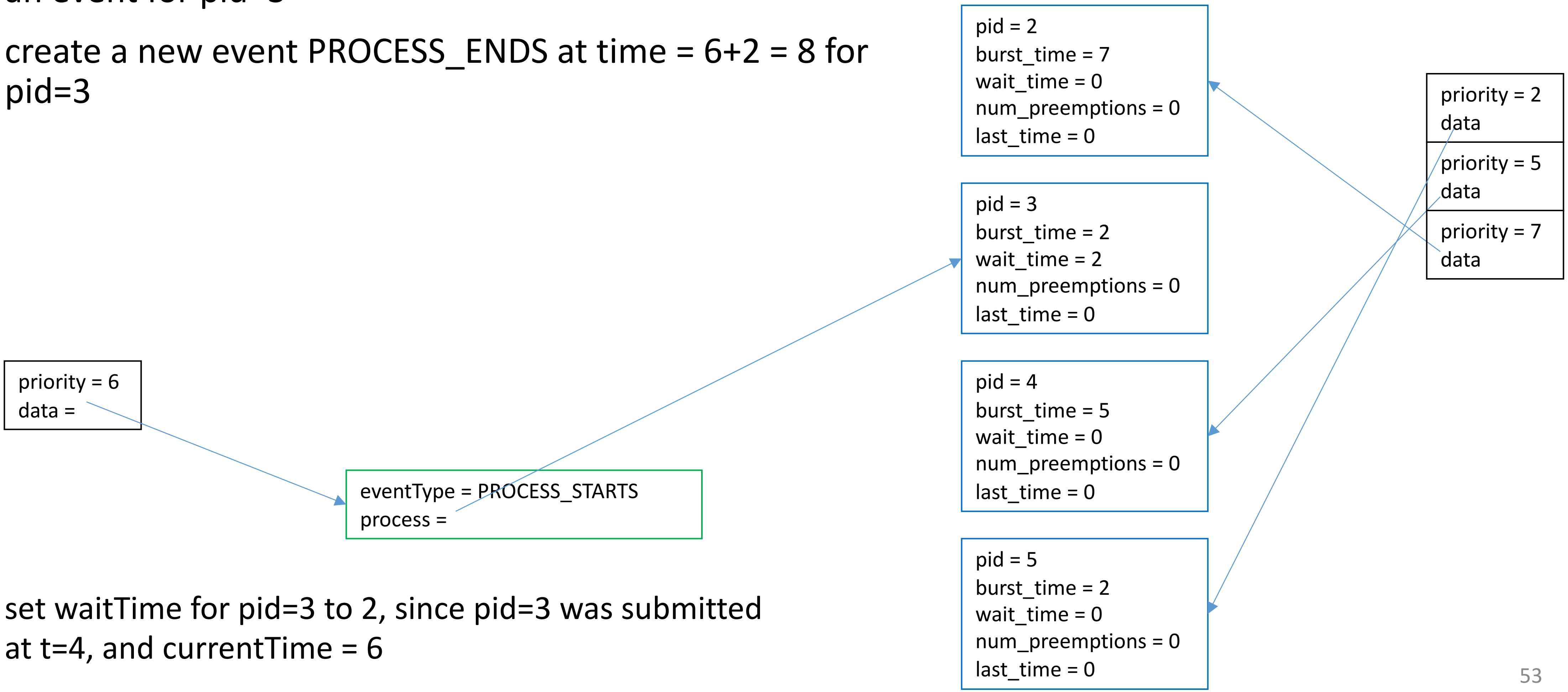
priority = 6
data =

eventType = PROCESS_STARTS
process =

CPU Scheduler: SJF

dequeue first event: PROCESS_STARTS; currentTime=6; it is an event for pid=3

create a new event PROCESS_ENDS at time = 6+2 = 8 for pid=3



priority = 6
data =

eventType = PROCESS_STARTS
process =

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 2
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

priority = 5
data

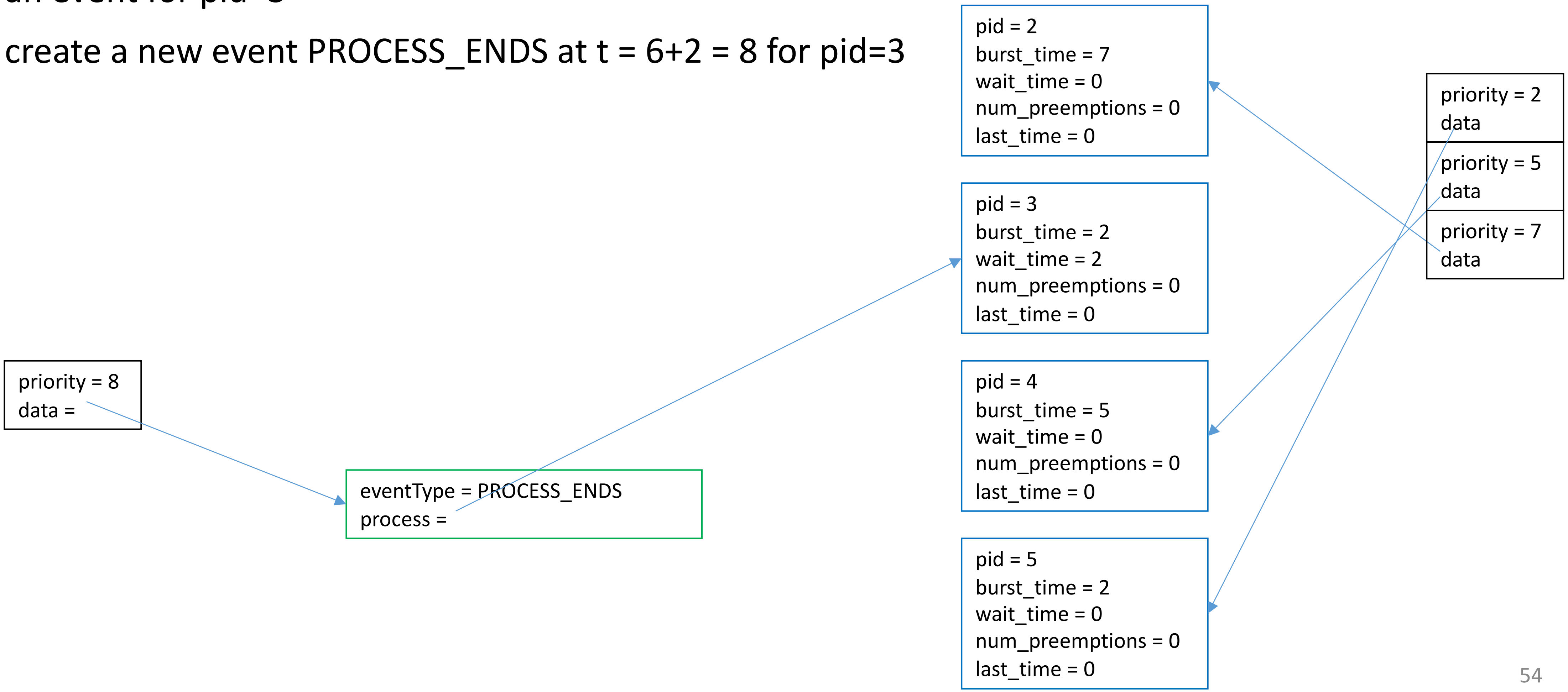
priority = 7
data

set waitTime for pid=3 to 2, since pid=3 was submitted at t=4, and currentTime = 6

CPU Scheduler: SJF

dequeue first event: PROCESS_STARTS; currentTime=6; it is an event for pid=3

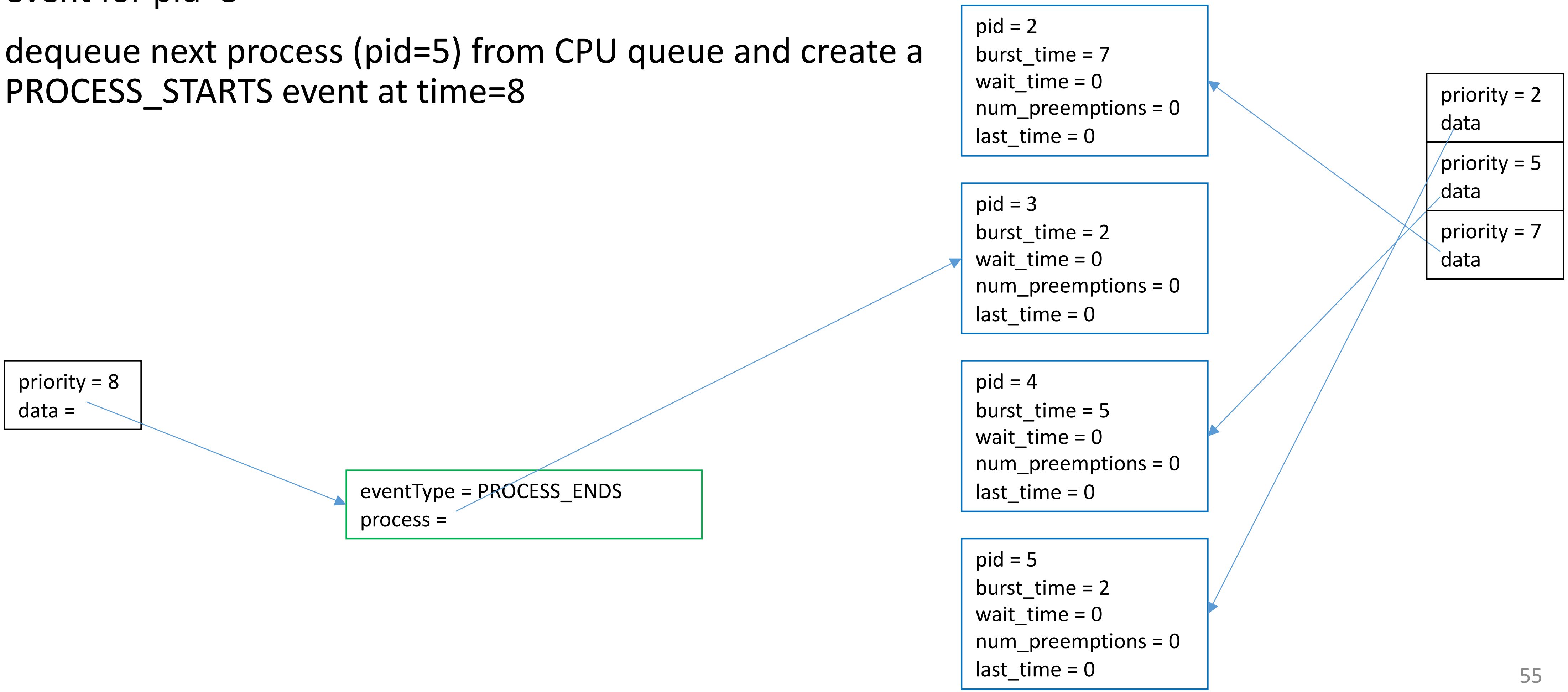
create a new event PROCESS_ENDS at t = 6+2 = 8 for pid=3



CPU Scheduler: SJF

dequeue first event: PROCESS_ENDS; currentTime=8; it is an event for pid=3

dequeue next process (pid=5) from CPU queue and create a PROCESS_STARTS event at time=8



priority = 8
data =

eventType = PROCESS_ENDS
process =

pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 3
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 2
data

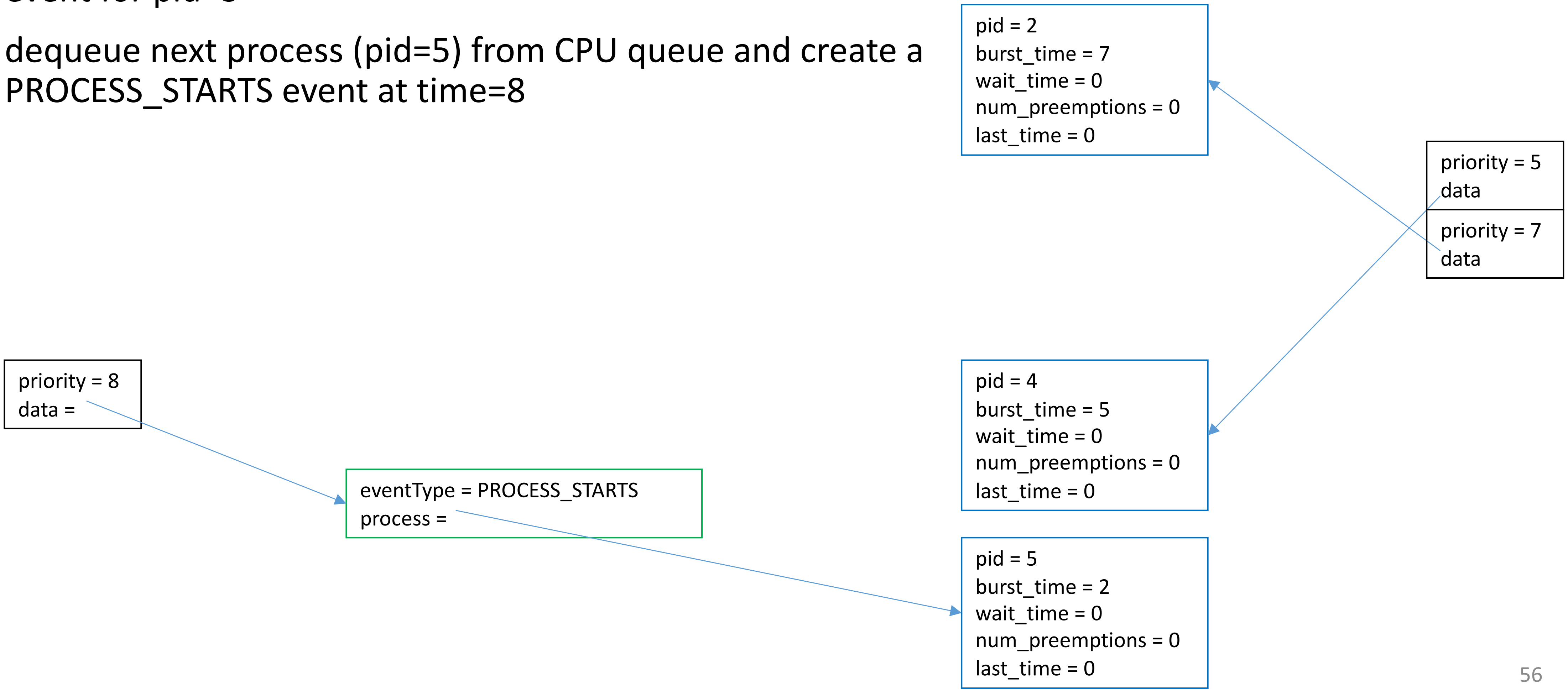
priority = 5
data

priority = 7
data

CPU Scheduler: SJF

dequeue first event: PROCESS_ENDS; currentTime=8; it is an event for pid=3

dequeue next process (pid=5) from CPU queue and create a PROCESS_STARTS event at time=8



pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 5
data

priority = 7
data

priority = 8
data =

eventType = PROCESS_STARTS
process =

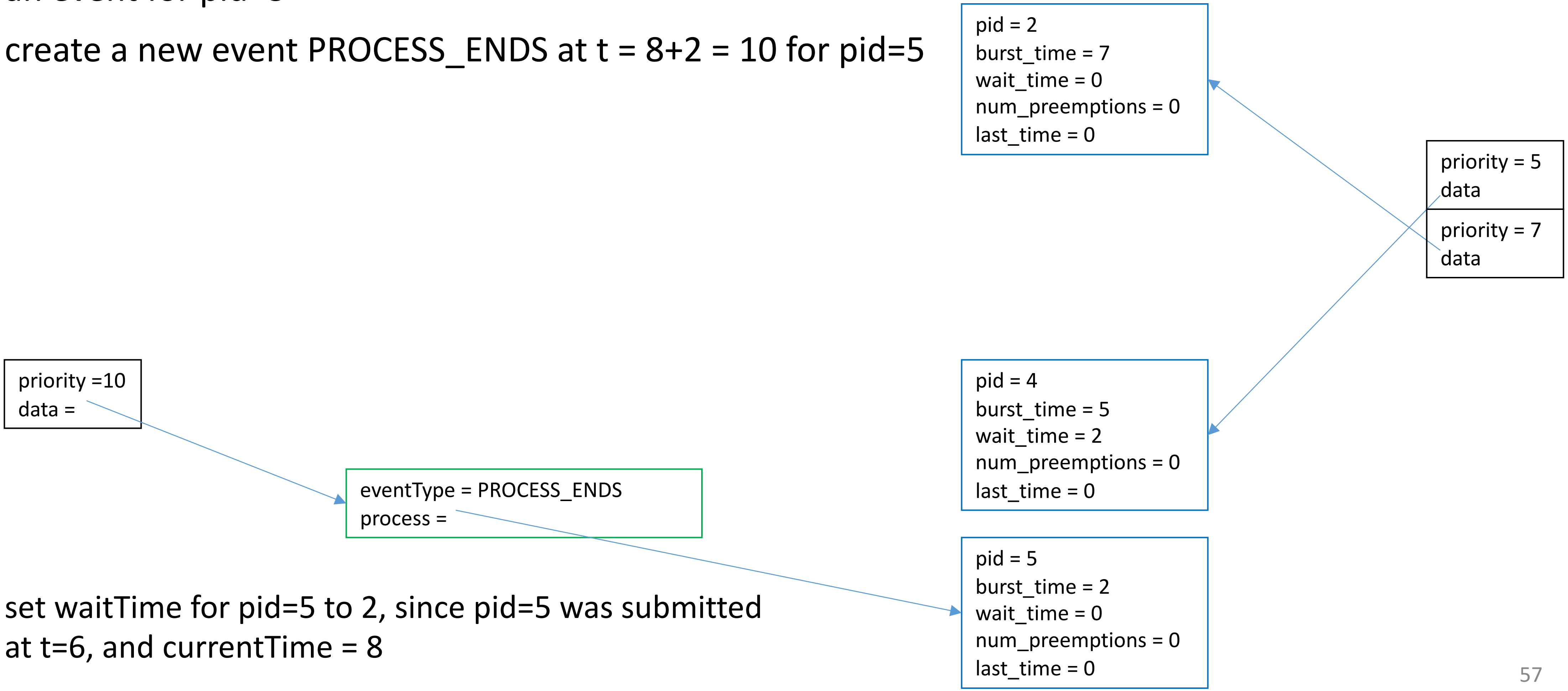
pid = 4
burst_time = 5
wait_time = 0
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

CPU Scheduler: SJF

dequeue first event: PROCESS_STARTS; currentTime=8; it is an event for pid=3

create a new event PROCESS_ENDS at t = 8+2 = 10 for pid=5



pid = 2
burst_time = 7
wait_time = 0
num_preemptions = 0
last_time = 0

priority = 5
data

priority = 7
data

priority =10
data =

eventType = PROCESS_ENDS
process =

pid = 4
burst_time = 5
wait_time = 2
num_preemptions = 0
last_time = 0

pid = 5
burst_time = 2
wait_time = 0
num_preemptions = 0
last_time = 0

set waitTime for pid=5 to 2, since pid=5 was submitted at t=6, and currentTime = 8