Scheduling (Win 2K)

CSE 410, Spring 2004

Computer Systems

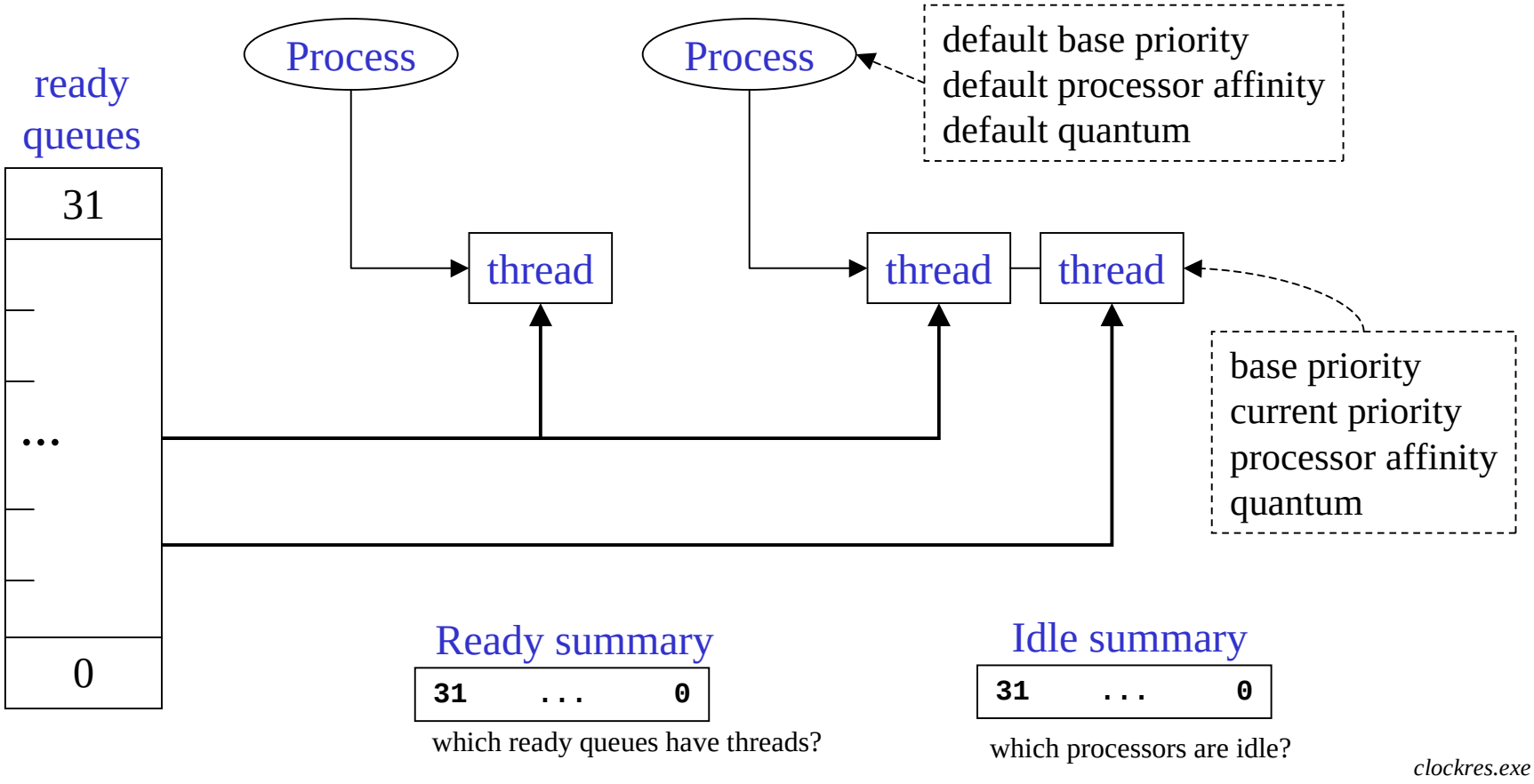
http://www.cs.washington.edu/education/courses/410/04sp/

Readings and References

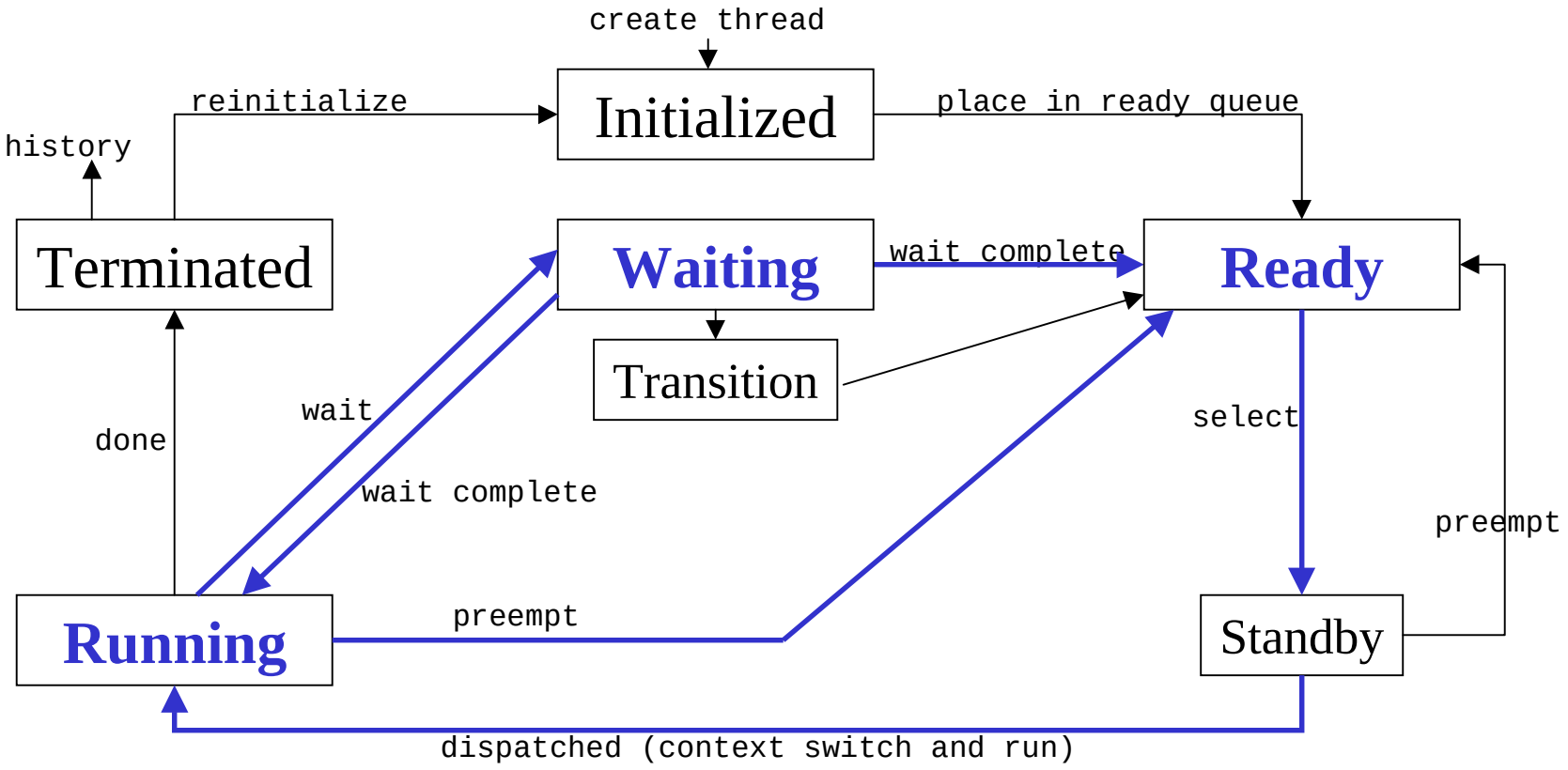
- Reading
  - » Chapter 6, Section 6.7.2, *Operating System Concepts*, Silberschatz, Galvin, and Gagne

- Other References
  - » Chapter 6, Section “Thread Scheduling”, *Inside Microsoft Windows 2000*, Third Edition, Solomon and Russinovich. This book is the source of most of today’s lecture.
  - » Chapter 6, Performance Monitoring, *Windows 2000 Professional Resource Kit*, Microsoft

Dispatcher “database”



Thread State Transitions



Ready, Running, Waiting

- Ready
  - » ready to run if there is a processor available
  - » there is a ready queue for each priority level
- Running
  - » has been switched to and is running
- Waiting
  - » waiting on an event (synchronize, I/O, etc)

Other States

- Initialized
  - » On its way in the door
- Terminated
  - » On its way out the door to history or recycle
- Standby
  - » Ready and selected to run next
- Transition
  - » Ready, but important parts are paged out

Windows 2000 Thread States

7 - Unknown

6 - Transition

5 - Wait (for something to complete)

4 - Terminated

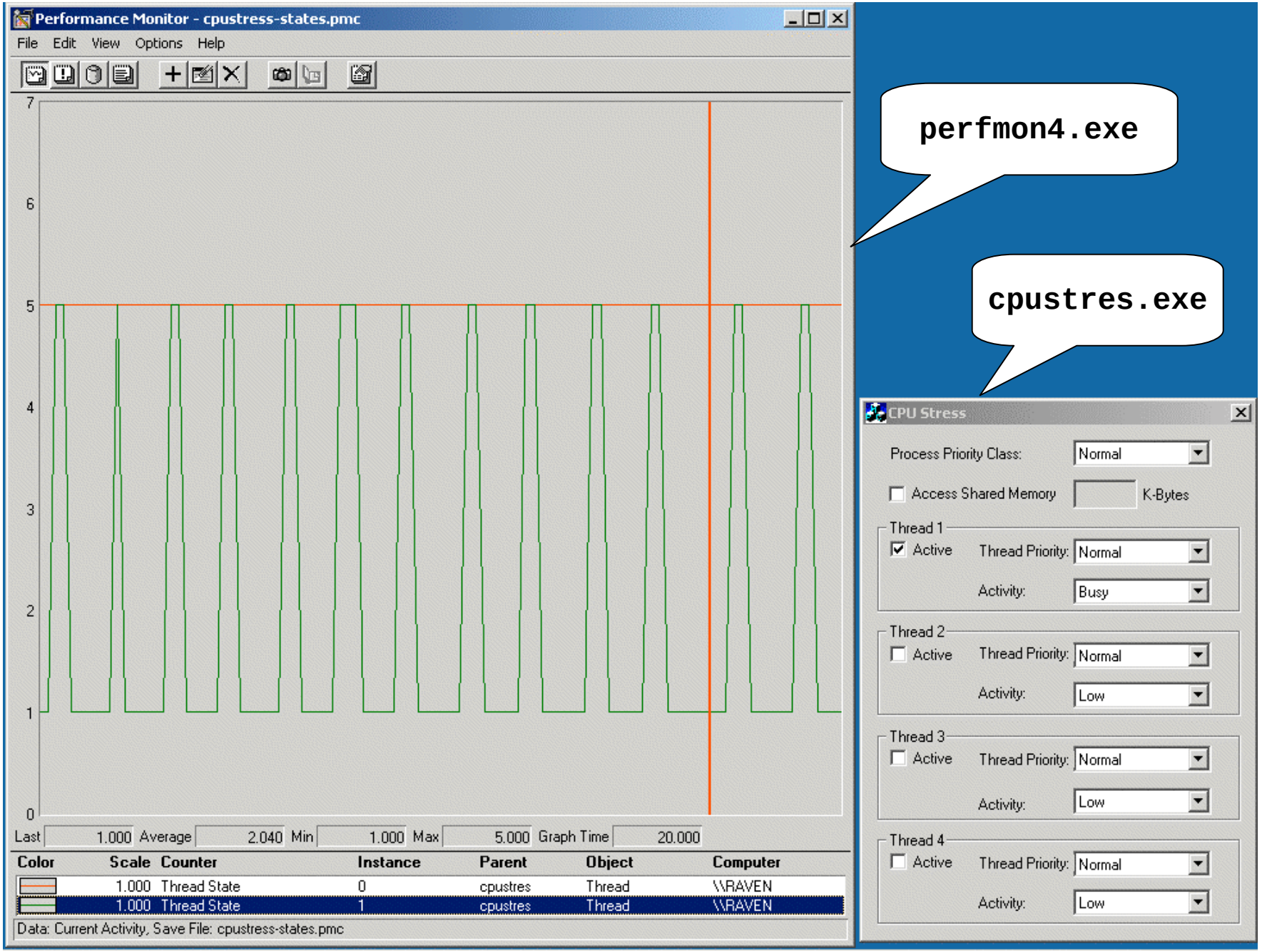
3 - Standby (on-deck circle)

2 - Running (at bat)

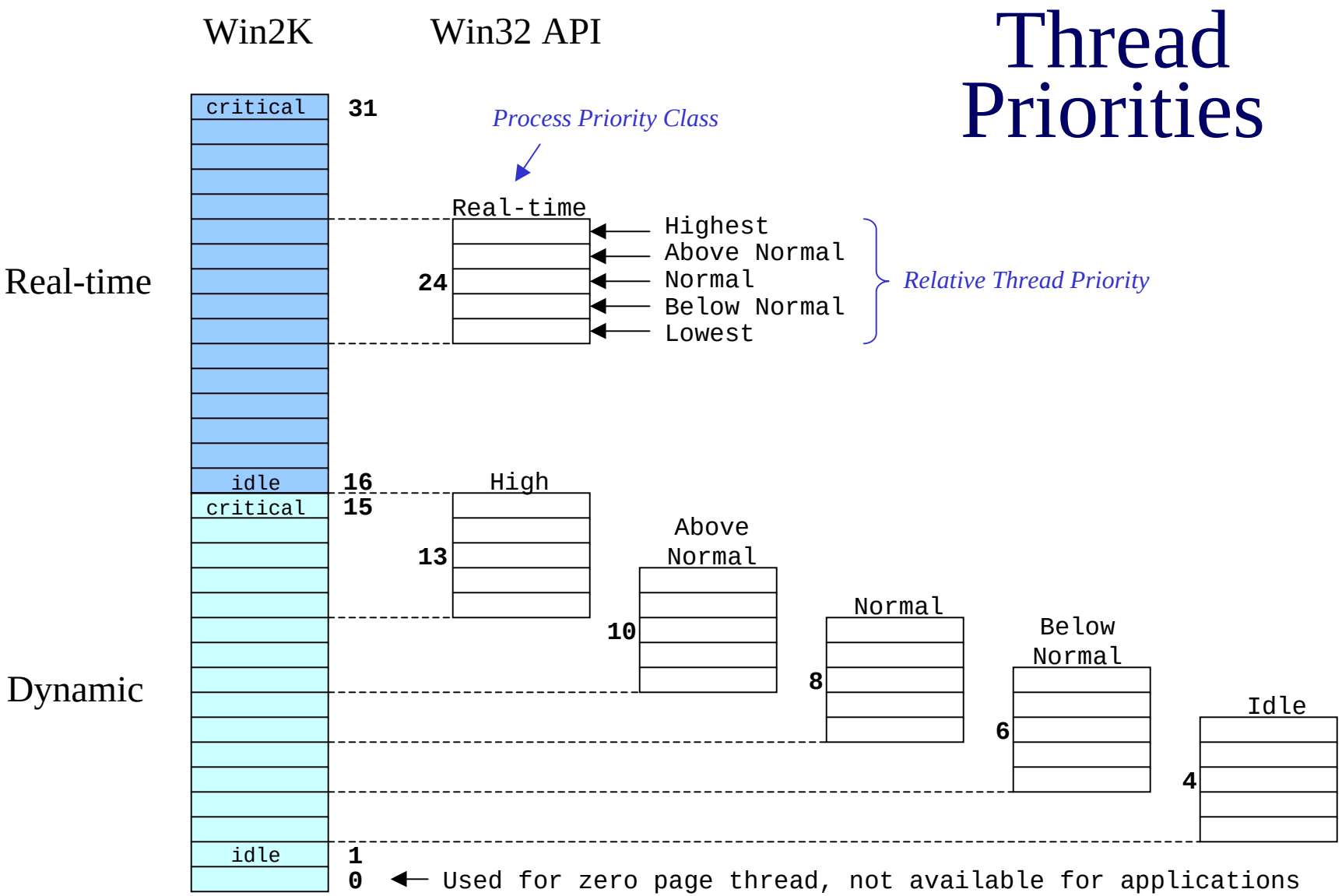
1 - Ready (eligible to be selected)

0 - Initialized

ThreadStatesX1.msc


Performance Monitor - cpustress-states.pmc
File Edit View Options Help
7
6
5
4
3
2
1
0
Last 1.000 Average 2.040 Min 1.000 Max 5.000 Graph Time 20.000
Color Scale Counter Instance Parent Object Computer
1.000 Thread State 0 cpustres Thread \\RAVEN
1.000 Thread State 1 cpustres Thread \\RAVEN
Data: Current Activity, Save File: cpustress-states.pmc
perfmon4.exe
cpustres.exe
CPU Stress
Process Priority Class: Normal
Access Shared Memory K-Bytes
Thread 1
Active
Thread Priority: Normal
Activity: Busy
Thread 2
Active
Thread Priority: Normal
Activity: Low
Thread 3
Active
Thread Priority: Normal
Activity: Low
Thread 4
Active
Thread Priority: Normal
Activity: Low

Thread Priorities

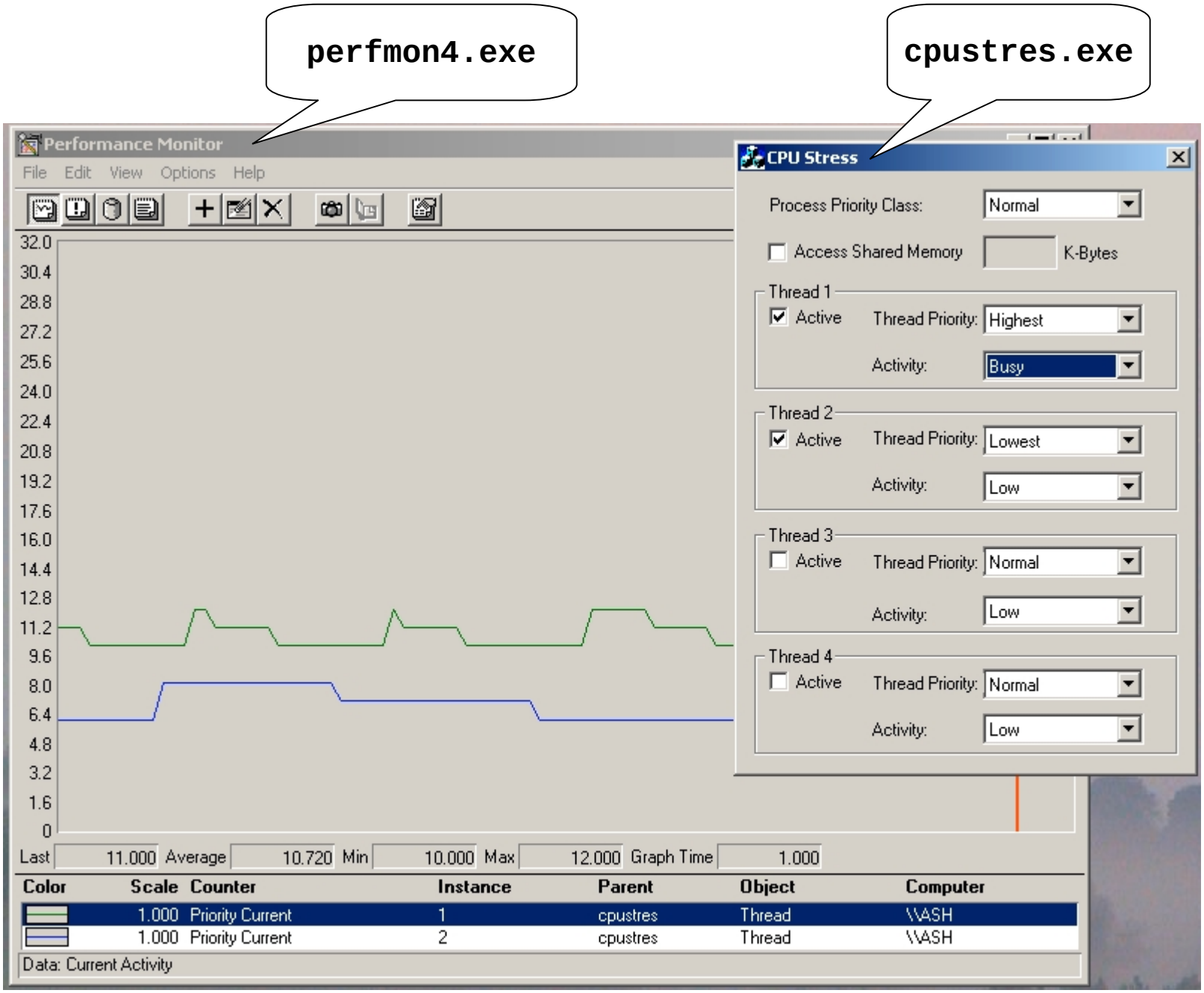


Setting Thread Priorities

- Base priority
  - » normally inherited from process default
  - » can be explicitly set
- Current priority
  - » starts out same as base
  - » real time never changes
  - » dynamic is boosted when appropriate for responsiveness

Priority boosting

- After I/O completion or event wait
  - » you've waited for this data, now use it quick
- User response
  - » Foreground thread after a wait or window thread wakeup for window event
- CPU starvation
  - » found an aging thread on the ready queues
- The boost decays quickly over time


perfmon4.exe
cpustres.exe
Performance Monitor
File Edit View Options Help
32.0
30.4
28.8
27.2
25.6
24.0
22.4
20.8
19.2
17.6
16.0
14.4
12.8
11.2
9.6
8.0
6.4
4.8
3.2
1.6
0
Last 11.000 Average 10.720 Min 10.000 Max 12.000 Graph Time 1.000
Color Scale Counter Instance Parent Object Computer
1.000 Priority Current 1 cpustres Thread \\ASH
1.000 Priority Current 2 cpustres Thread \\ASH
Data: Current Activity
CPU Stress
Process Priority Class: Normal
Access Shared Memory K-Bytes
Thread 1
Active Thread Priority: Highest
Activity: Busy
Thread 2
Active Thread Priority: Lowest
Activity: Low
Thread 3
Active Thread Priority: Normal
Activity: Low
Thread 4
Active Thread Priority: Normal
Activity: Low

Quantum

- Thread Quantum is
  - » indicator of the amount of time a thread can run before W2K checks whether another thread at the same priority should get to run
- Each thread has a current quantum value
  - » a small integer that is decremented under various circumstances
  - » not an actual length of time, just a number

Quantum value

- Thread quantum is initialized when thread is put on the ready queue
  - » initial value of 6 on Windows 2K Professional
  - » initial value of 36 on Windows 2K Server
- Quantum of running thread is decremented by 3 after system clock interrupt
  - » so a W2K Pro thread can run for 2 clock intervals
  - » a W2K Server thread can run for 12 clock intervals

Quantum is reset to initial value

- a thread moves to ready queue after quantum end
  - » in other words, a thread is given another chunk of time to use after it has exhausted the first chunk
- a real-time thread is preempted and moves from running to ready or it moves from running to wait
  - » the presumption is that you are doing a good job of explicitly managing priorities and access to the CPU when you are running real-time threads

Quantum changes

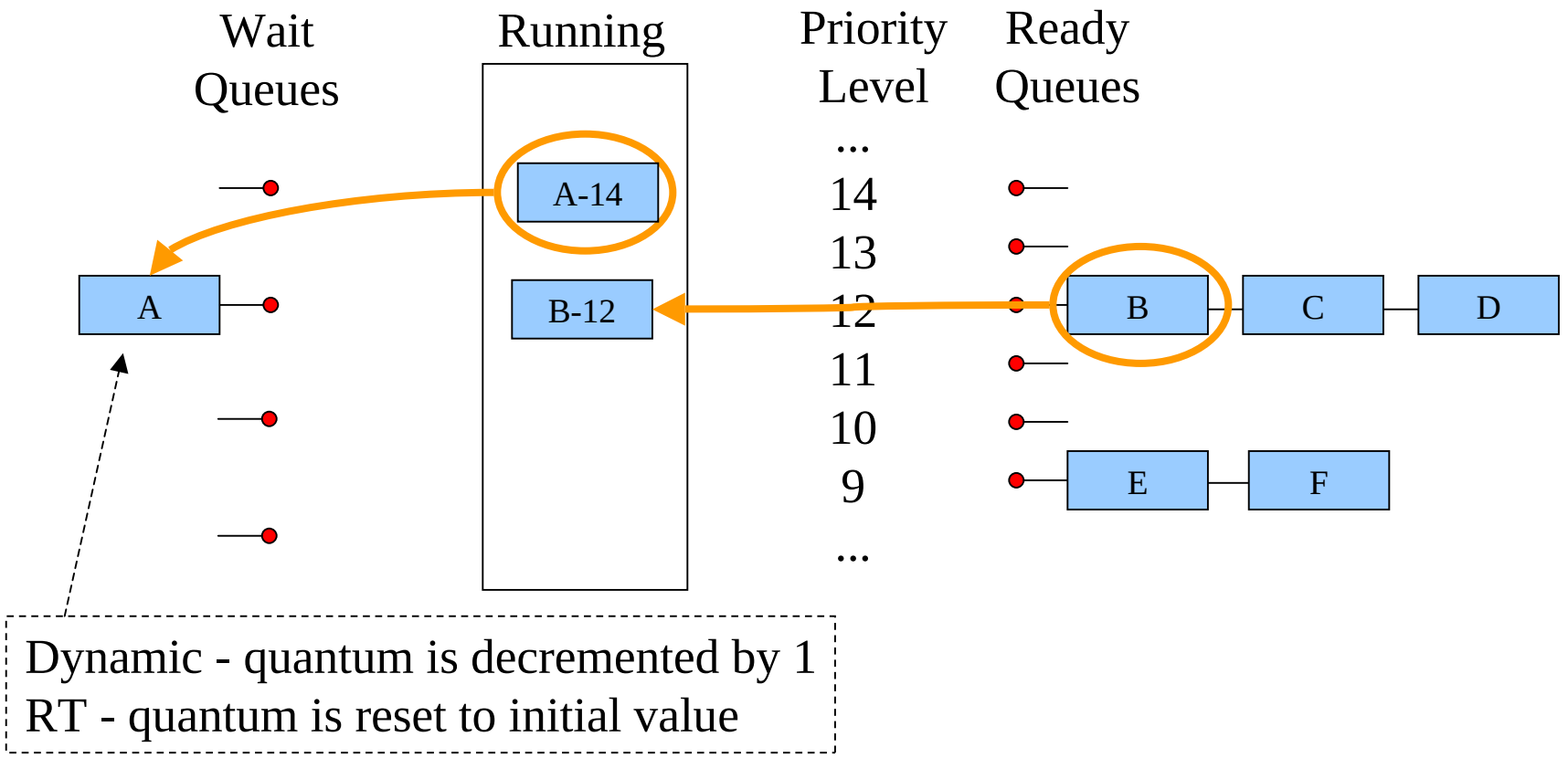
- Quantum is decremented
  - » reduced quantum => less time remaining before thread has exhausted its time slice
  - » reduced by 3 when the clock ticks
  - » by 1 when dynamic thread executes a wait
- Quantum initial value may be boosted
  - » “Optimize performance for applications”

  => boost initial quantum for foreground threads

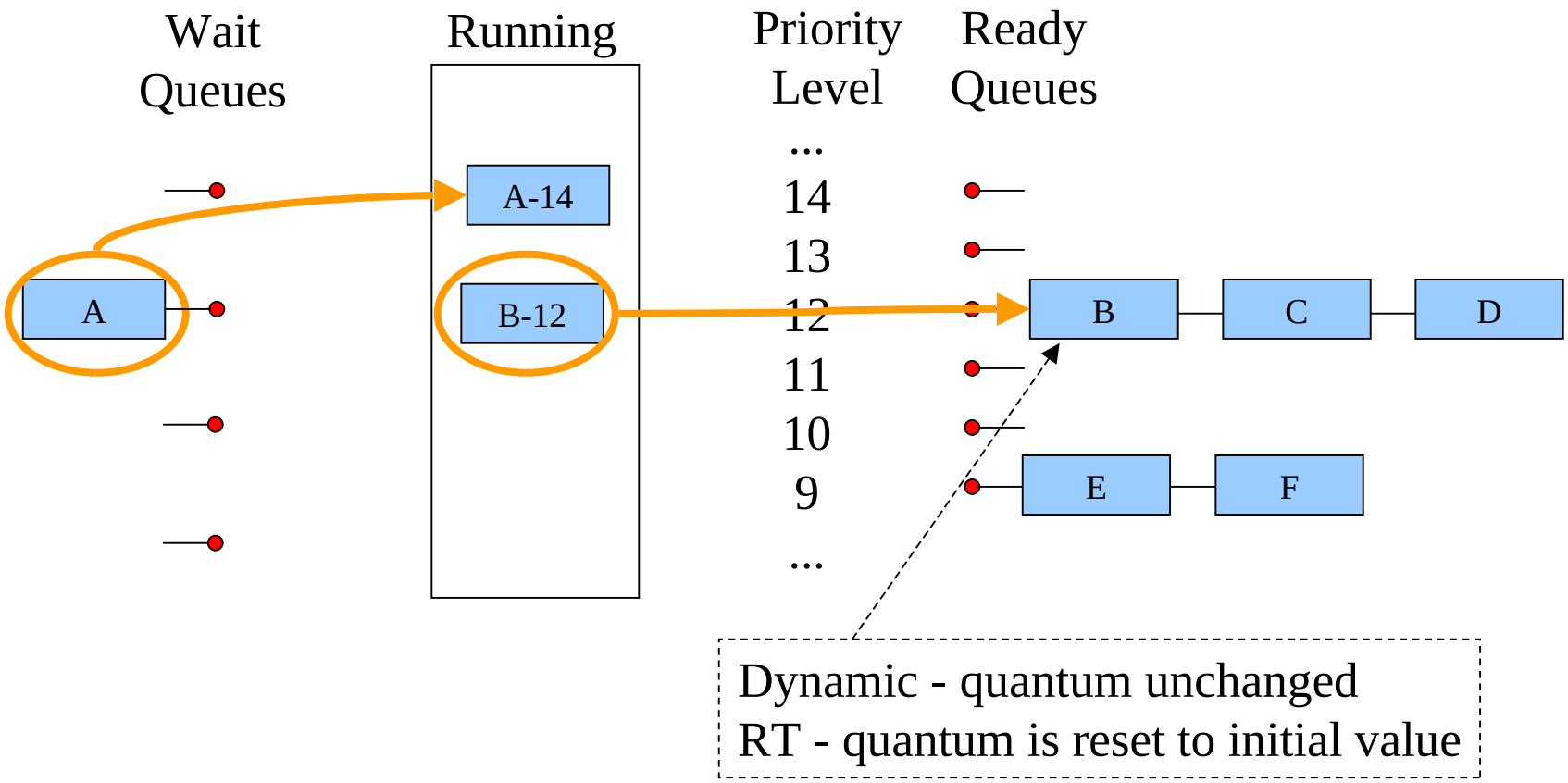
Scheduling Scenarios

- Voluntary switch
  - » thread calls a wait function of some sort
- Preemption
  - » higher priority thread is ready to run
- Quantum end
  - » the running thread exhausts its quantum

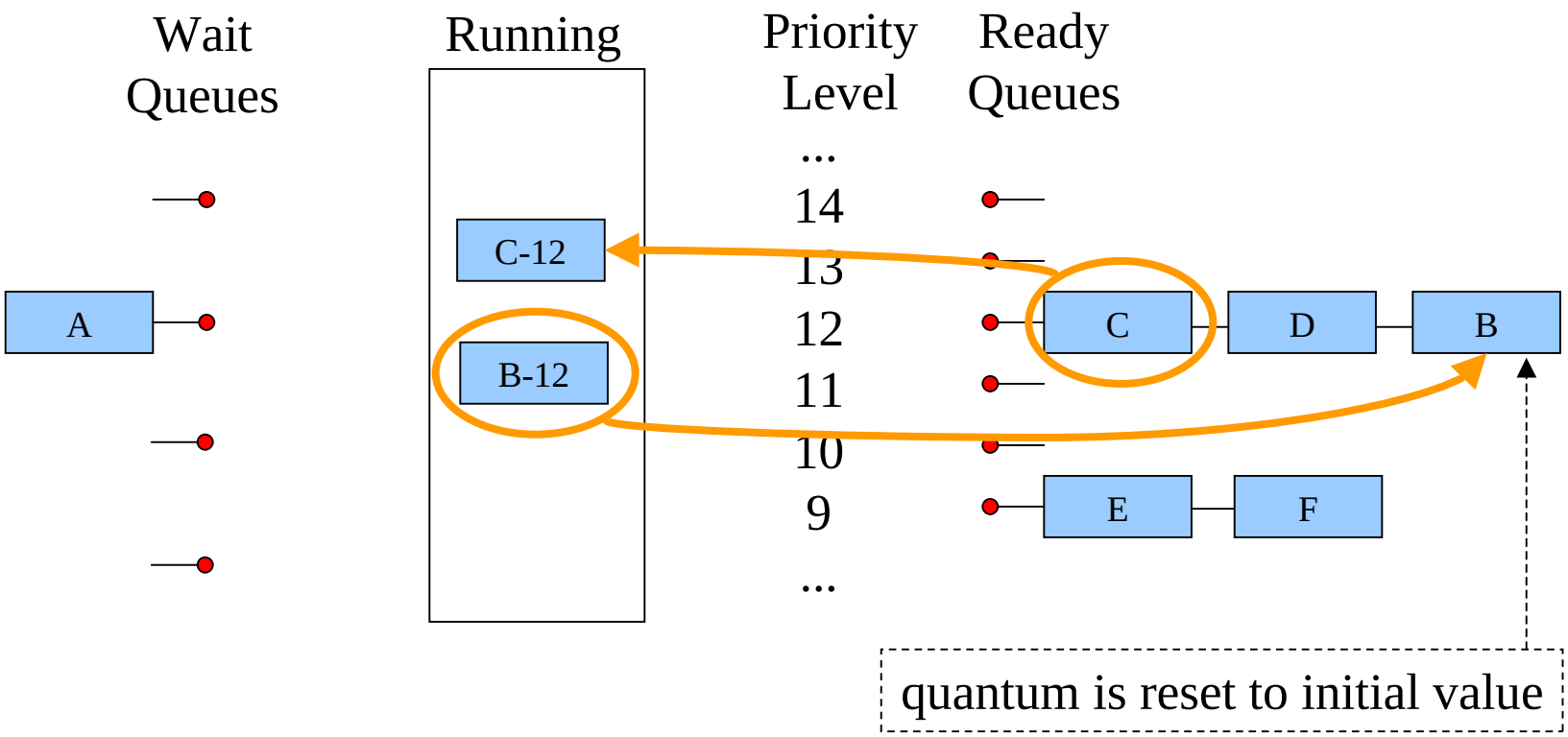
Voluntary Switch



Preemption


Wait Queues
Running
Priority Level
Ready Queues
...
14
13
12
11
10
9
...
A
A-14
B-12
B
C
D
E
F
Dynamic - quantum unchanged
RT - quantum is reset to initial value

Quantum End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quantum is reset to initial value