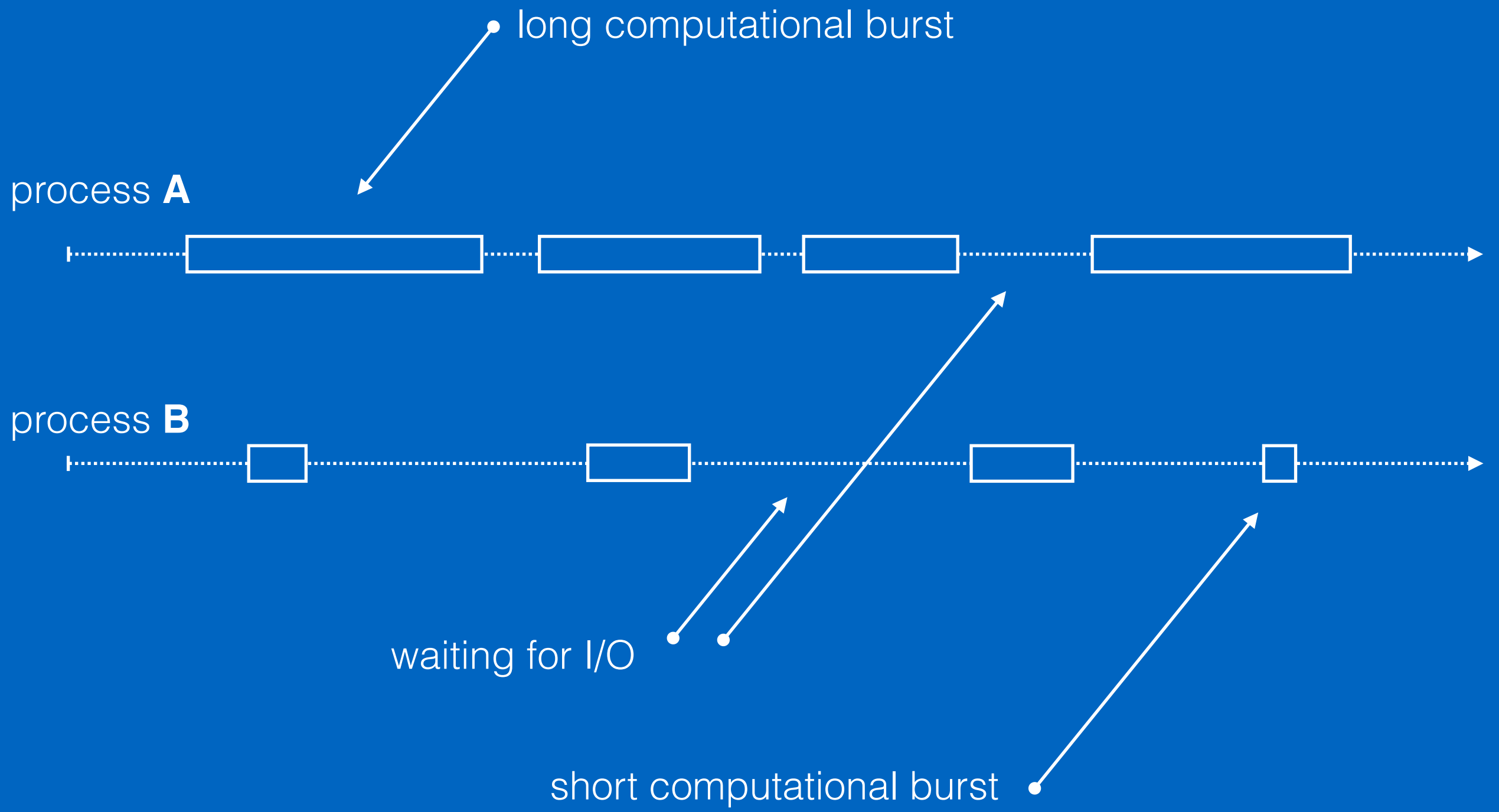


# Scheduling

Operating Systems

process types

compute-bound  
I/O-bound



process **A** is *compute-bound*  
process **B** is *I/O bound*

compute-bound tasks  
have long CPU bursts,  
infrequent I/O stalls.

I/O-bound tasks have  
frequent I/O waits.

when to schedule



a new process is created  
a process exits

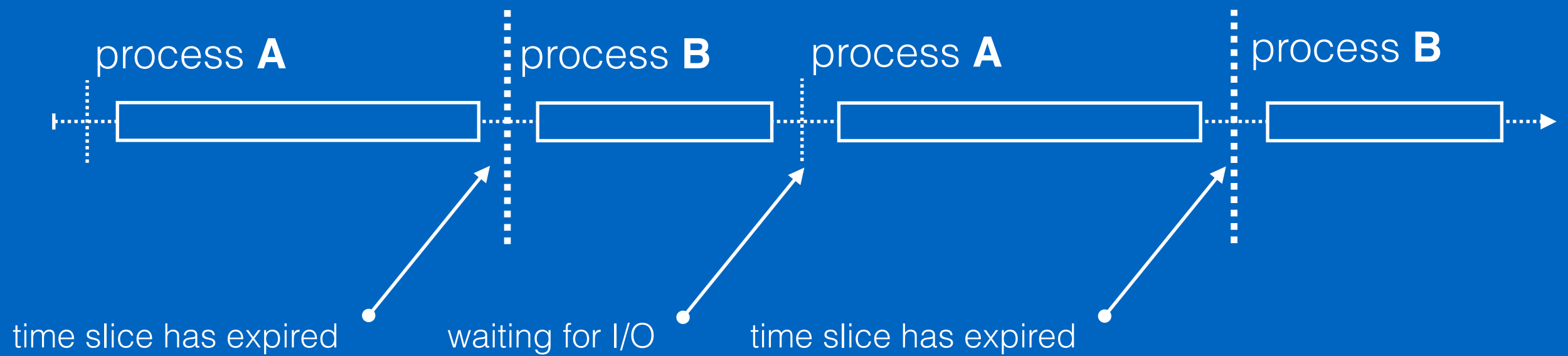
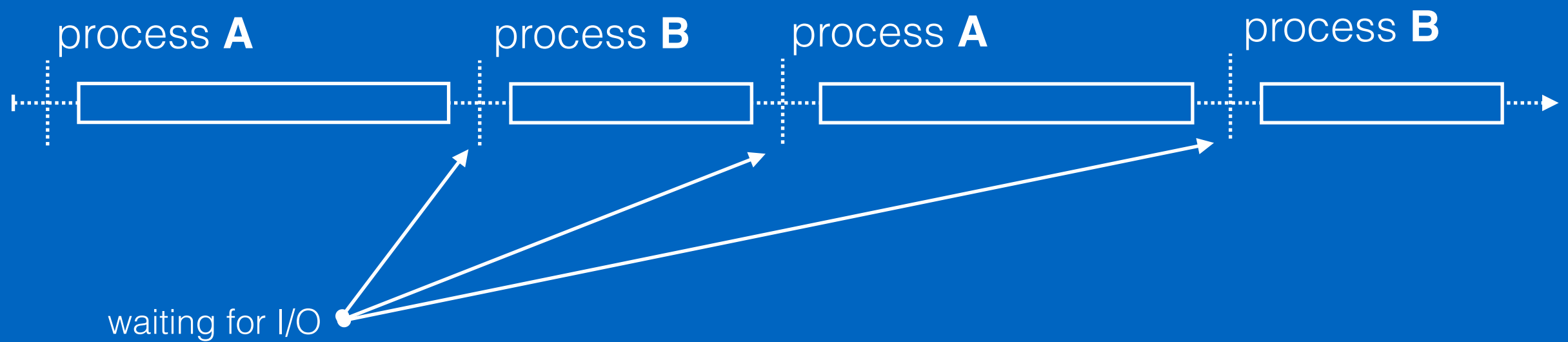
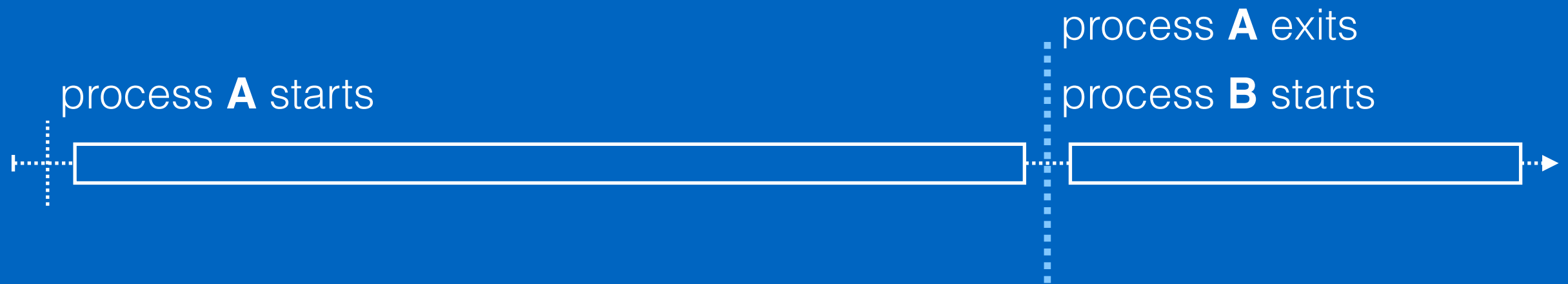
a process blocks  
waits for input/output  
waits to enter a critical section

a hardware interrupt occurs  
input/output device interrupts  
clock interrupts

scheduling algorithm types

preemptive

non-preemptive



scheduling algorithm categories

batch

interactive

real-time



common goals

fairness  
balance

batch schedulers

common goals

- maximize throughput

- minimize turnaround

- maximize CPU utilization

first-come first-served

shortest job first

shortest remaining time next

interactive schedulers

common goals

minimize response time

round-robin scheduling  
priority scheduling  
shortest process next



lottery scheduling  
fair-share scheduling

real-time schedulers

common goals  
meet deadlines

real-time system types

hard real time  
soft real time

hard real time systems  
have absolute deadlines  
that **must** be met.

soft real time systems  
have a level of tolerance  
toward missed deadlines.

missing deadlines in soft  
real-time systems is still  
undesirable.



event types

periodic  
aperiodic

periodic events occur  
at regular intervals.

aperiodic events  
occur unpredictably.

A periodic system with  $n$  events of a period  $T_i$  with  $C_i$  seconds of CPU time to complete is **schedulable** only if...

$$\sum_{i=1}^n \frac{C_i}{T_i} \leq 1$$

real-time OS

FreeRTOS

QNX Neutrino

VxWorks



# Reading

Operating Systems Design and Implementation,  
Third Edition by Andrew S. Tanenbaum

Chapter 2 (2.1, 2.4)

# Supplemental Reading

Understanding the Linux kernel, Third Edition by  
Daniel P. Bovet and Marco Cesati

Chapter 7

# Supplemental Reading

Windows Internals, Part 1 (6th Edition) by Mark E. Russinovich and David A. Solomon

Chapter 5

# Supplemental Reading

Mac OS X and iOS internals : to the apple's core  
by Jonathan Levin

Chapter 11