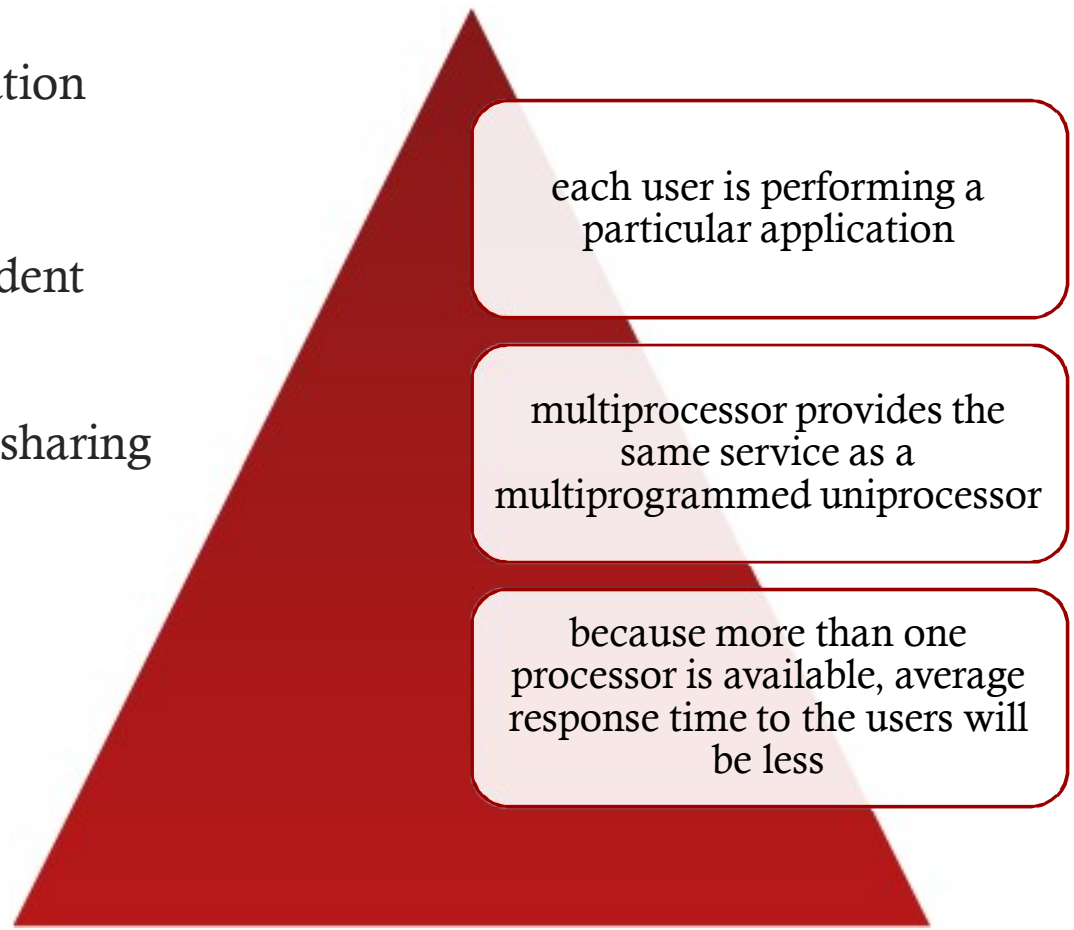
Operating Systems: Internals and Design Principles

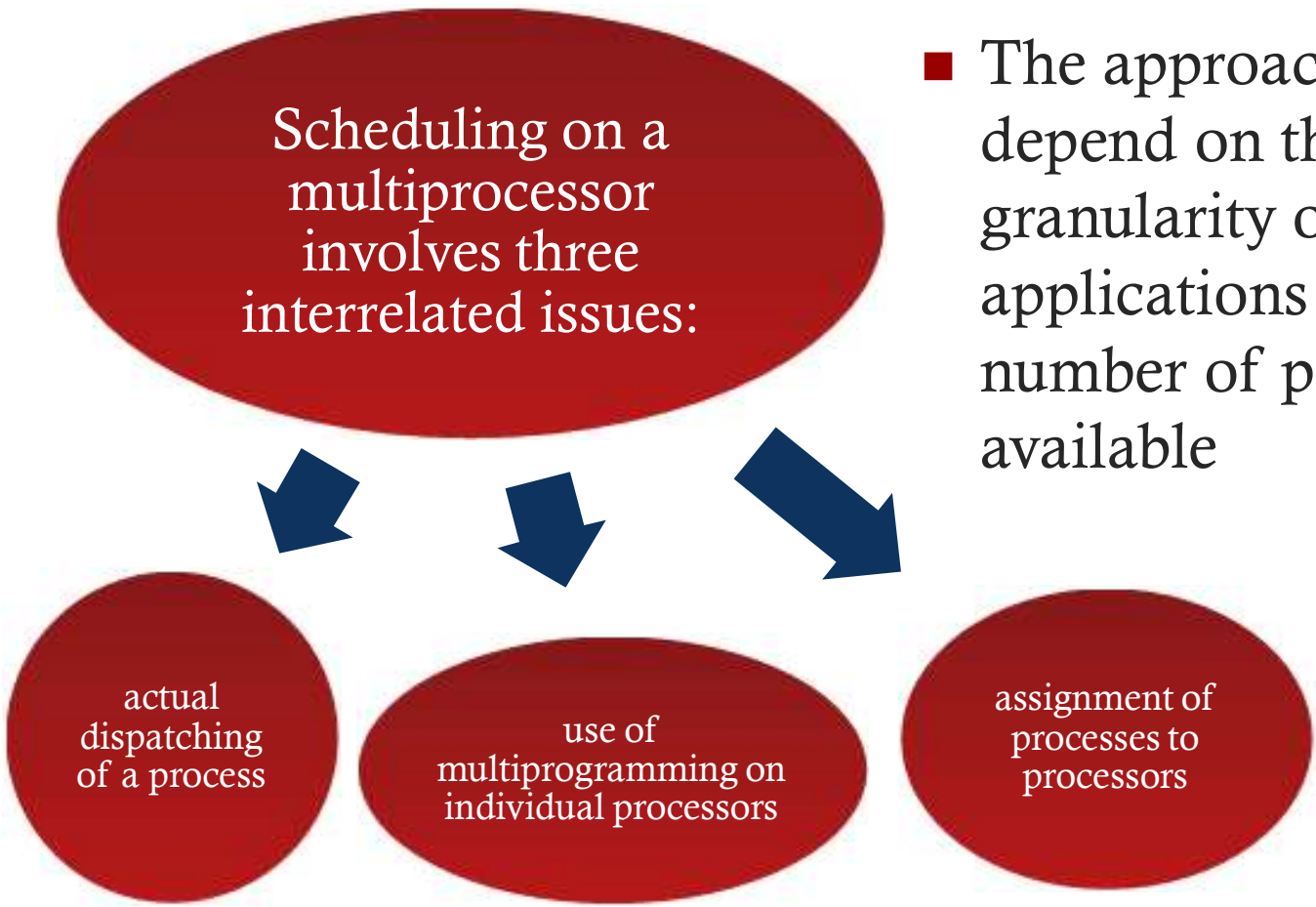
Chapter 10 Multiprocessor, Multicore and Real-Time Scheduling

Independent Parallelism

- No explicit synchronization among processes
  - each represents a separate, independent application or job
- Typical use is in a time-sharing system



Design Issues



- The approach taken will depend on the degree of granularity of applications and the number of processors available

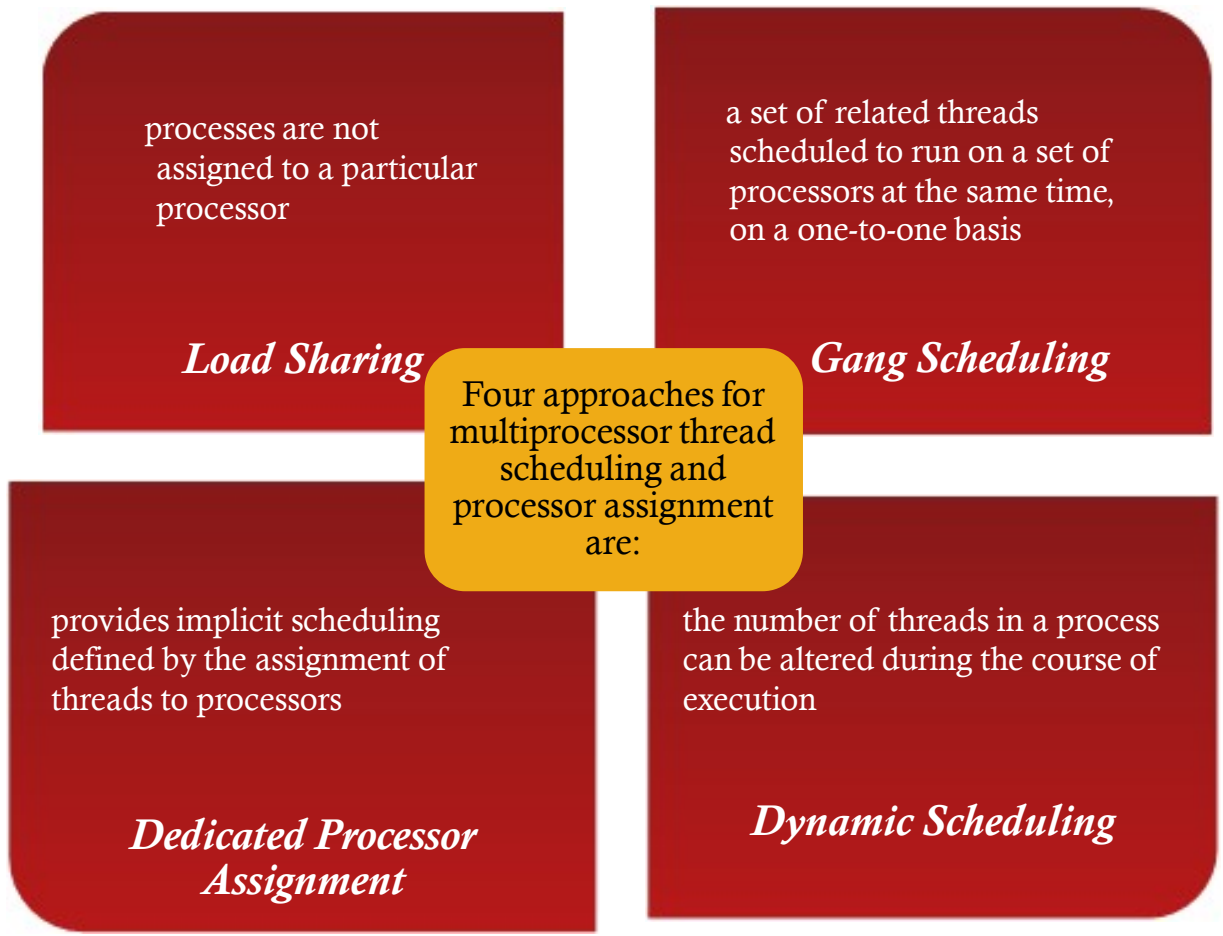
Peer Architecture

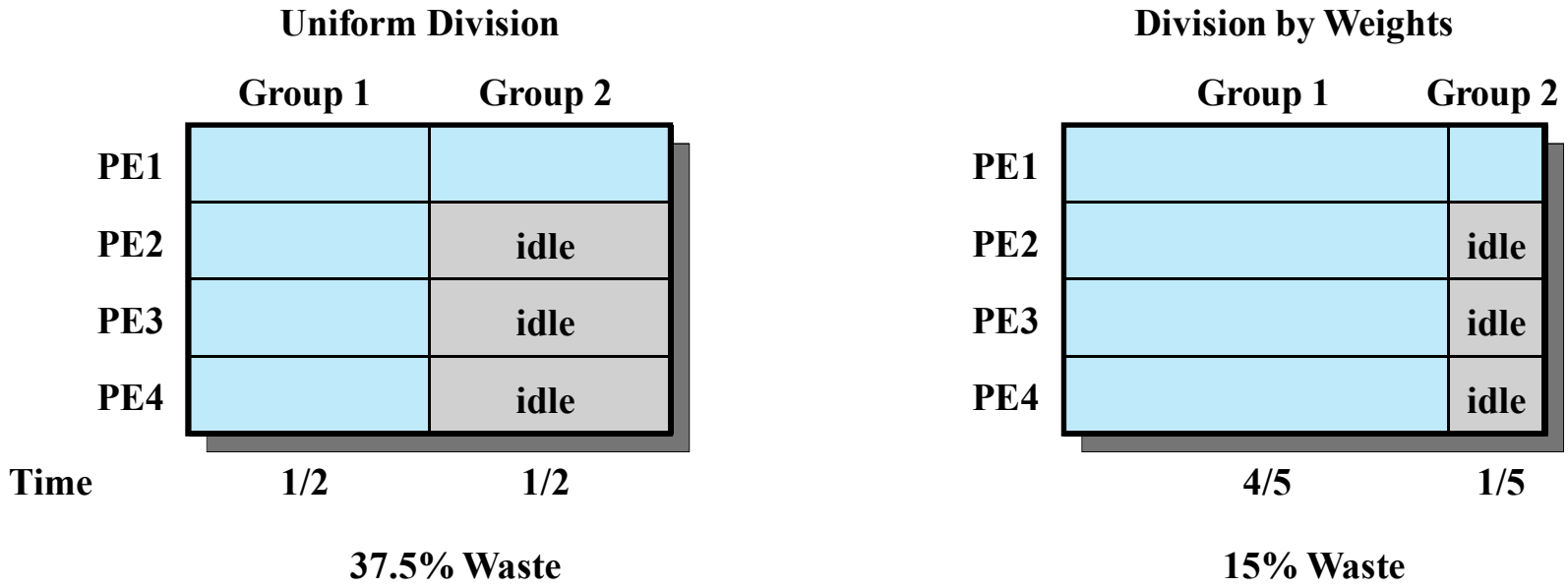
- Kernel can execute on any processor
- Each processor does self-scheduling from the pool of available processes

Complicates the operating system

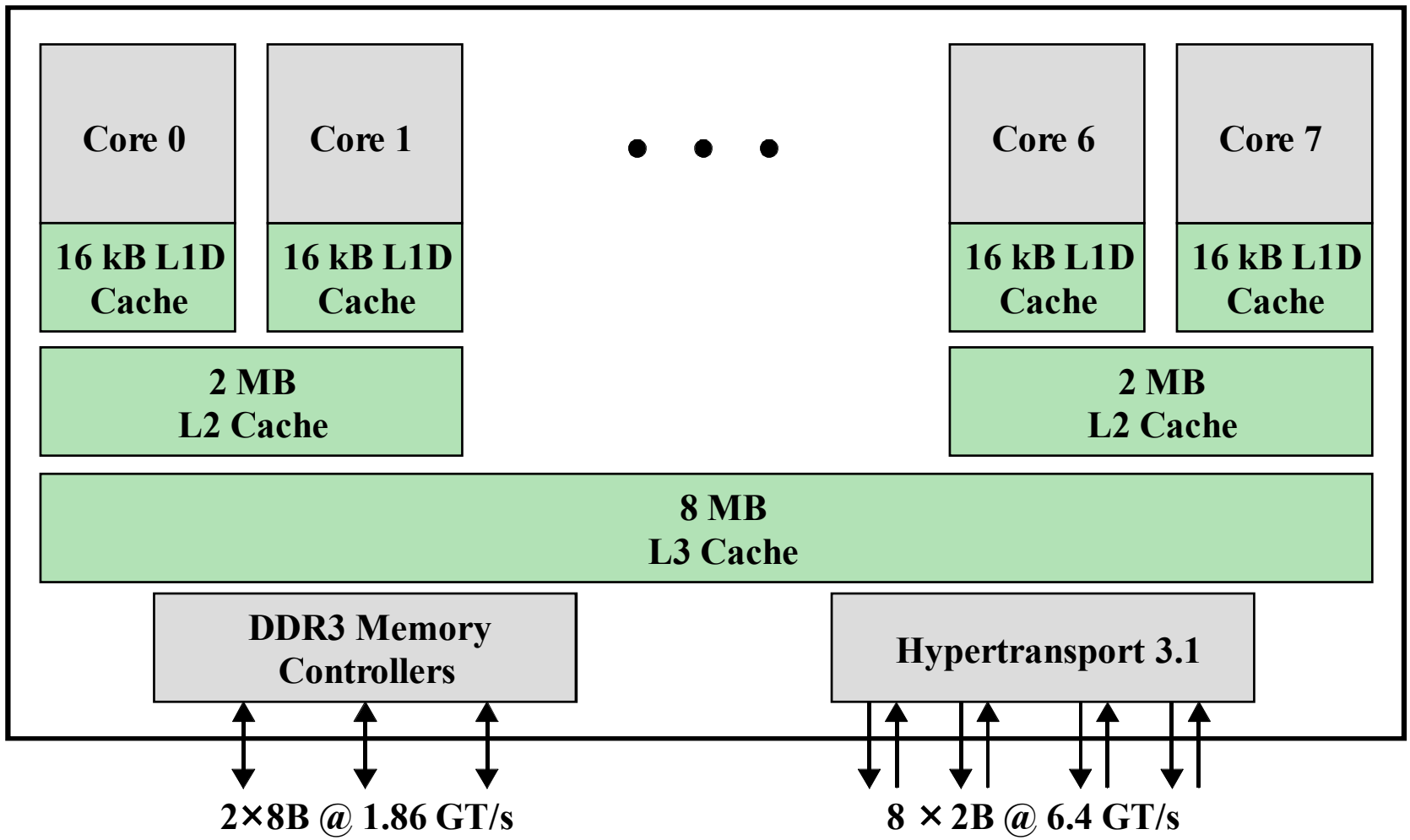
- operating system must ensure that two processors do not choose the same process and that the processes are not somehow lost from the queue

Approaches to Thread Scheduling





Example of Scheduling Groups with Four and One Threads [FEIT90b]



AMD BulldozerArchitecture

Hard and Soft Real-Time Tasks

Hard real-time task

- one that must meet its deadline
- otherwise it will cause unacceptable damage or a fatal error to the system

Soft real-time task

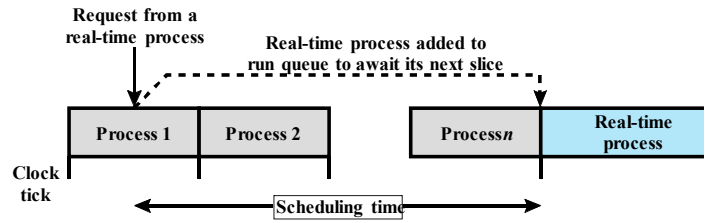
- has an associated deadline that is desirable but not mandatory
- it still makes sense to schedule and complete the task even if it has passed its deadline

Responsiveness

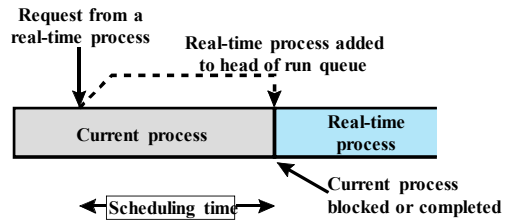
- Together with determinism make up the response time to external events
  - critical for real-time systems that must meet timing requirements imposed by individuals, devices, and data flows external to the system
- Concerned with how long, after acknowledgment, it takes an operating system to service the interrupt

Responsiveness includes:

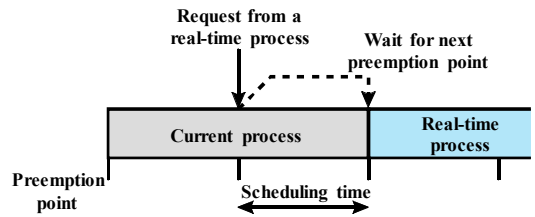
- amount of time required to initially handle the interrupt and begin execution of the interrupt service routine (ISR)
- amount of time required to perform the ISR
- effect of interrupt nesting



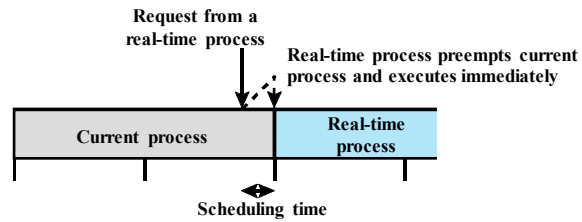
(a) Round-robin Preemptive Scheduler



(b) Priority-Driven Nonpreemptive Scheduler



(c) Priority-Driven Preemptive Scheduler on Preemption Points

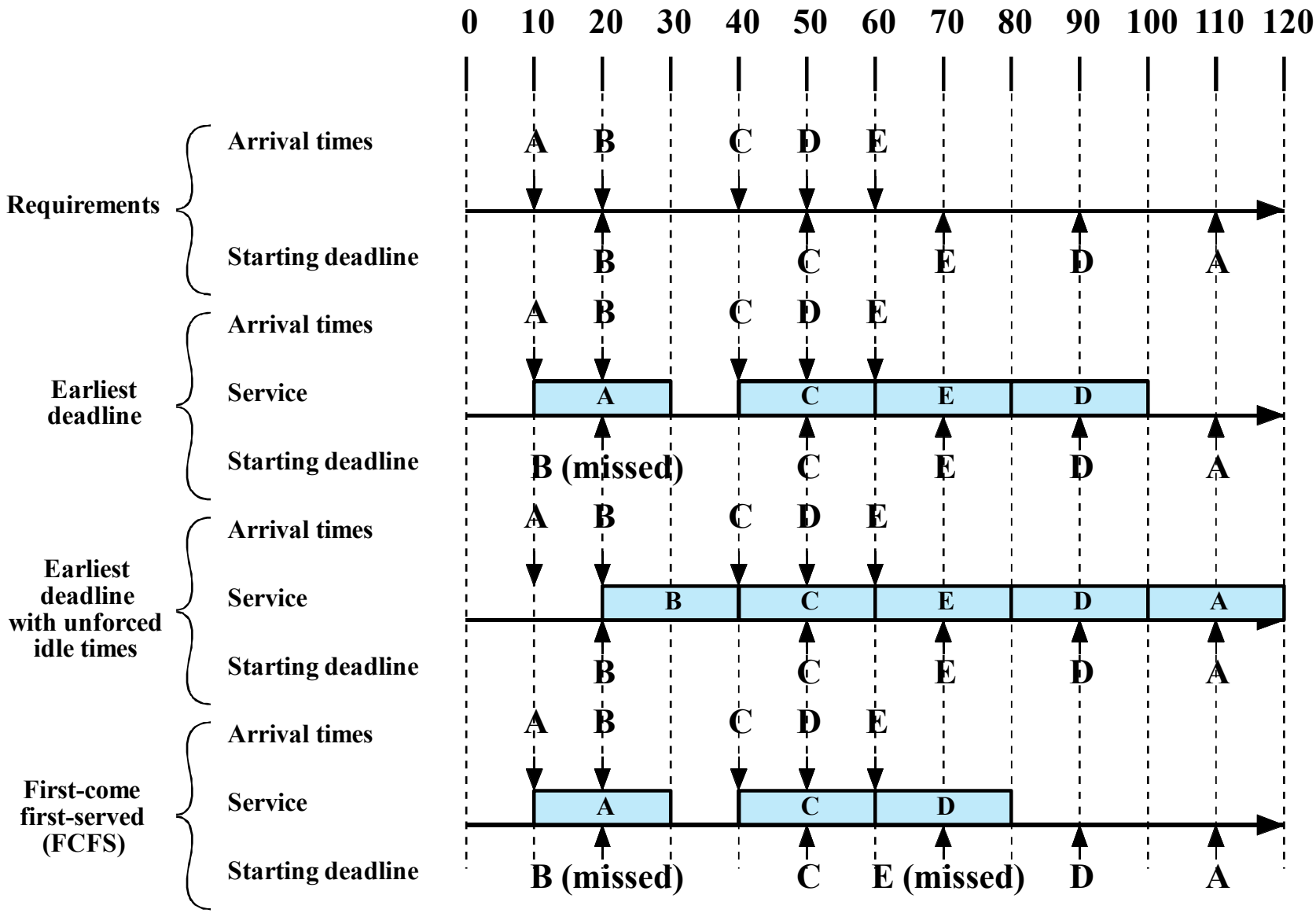


(d) Immediate Preemptive Scheduler

Scheduling of Real-Time Process

Information Used for Deadline Scheduling

Ready time	• time task becomes ready for execution
Starting deadline	• time task must begin
Completion deadline	• time task must be completed
Processing time	• time required to execute the task to completion
Resource requirements	• resources required by the task while it is executing
Priority	• measures relative importance of the task
Subtask scheduler	• a task may be decomposed into a mandatory subtask and an optional subtask



Scheduling of Aperiodic Real-time Tasks with Starting Deadlines

Priority Inversion

- Can occur in any priority-based preemptive scheduling scheme
- Particularly relevant in the context of real-time scheduling
- Best-known instance involved the Mars Pathfinder mission
- Occurs when circumstances within the system force a higher priority task to wait for a lower priority task

Unbounded Priority Inversion

- the duration of a priority inversion depends not only on the time required to handle a shared resource, but also on the unpredictable actions of other unrelated tasks