Categories of Computer Systems, Flynn's Taxonomy

- Single Instruction Single Data (SISD) stream
  - Single processor executes a single instruction stream to operate on data stored in a single memory
- Single Instruction Multiple Data (SIMD) stream
  - Each instruction is executed on a different set of data by the different processors

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Flynn's Taxonomy (cont.)

- Multiple Instruction Single Data (MISD) stream
  - A sequence of data is transmitted to a set of processors, each of which executes a different instruction sequence. Never implemented
- Multiple Instruction Multiple Data (MIMD)
  - A set of processors simultaneously execute different instruction sequences on different data sets
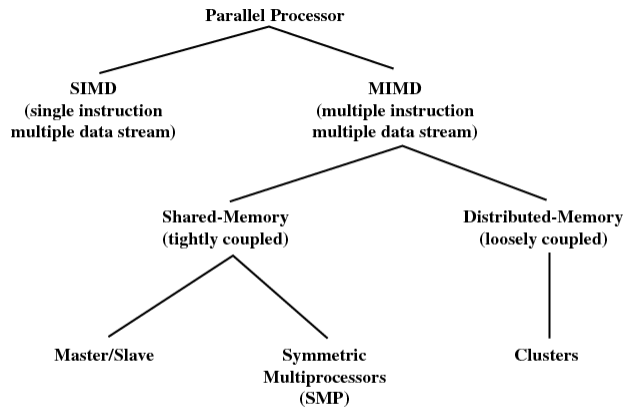
2

Figure 4.8 Parallel Processor Architectures

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Multi-core Processors

- Where do they fit in?

4

2

Symmetric Multiprocessing

- Kernel can execute on any processor
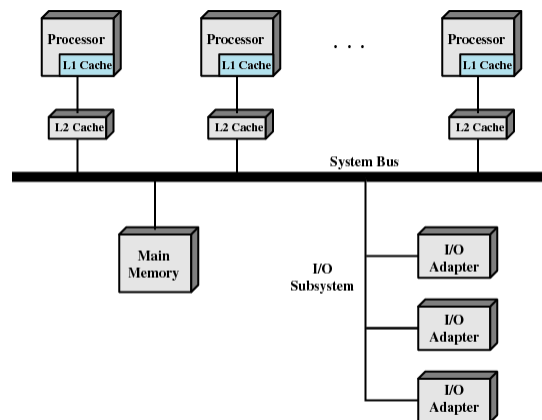- Typically each processor does self-scheduling from the pool of available process or threads

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Figure 4.9 Symmetric Multiprocessor Organization
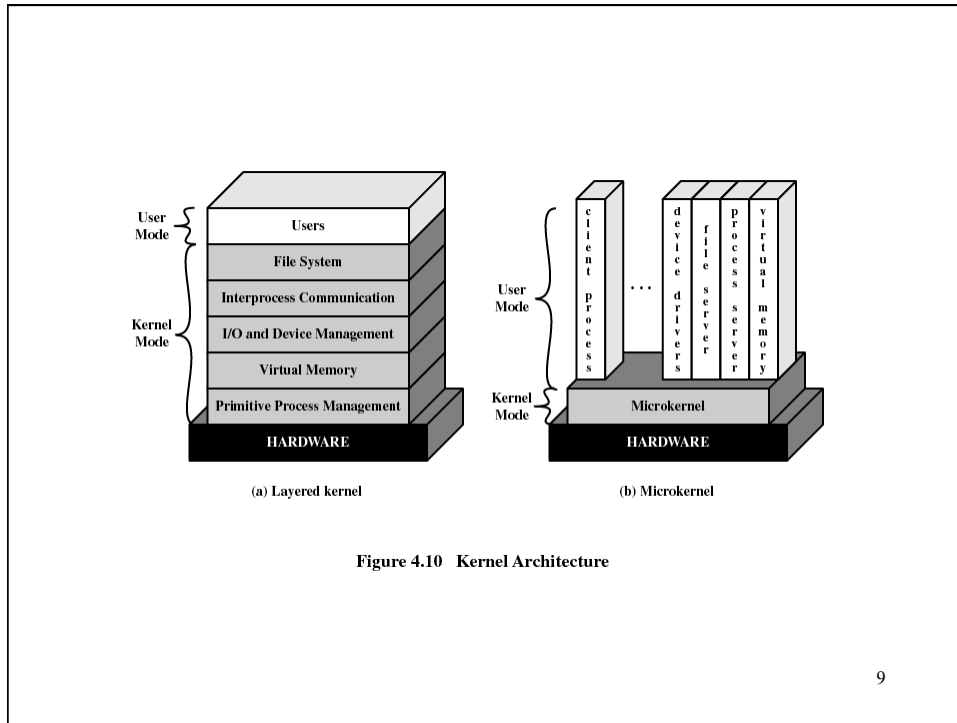
6

Multiprocessor Operating System Design Considerations

- Simultaneous concurrent processes or threads
- Scheduling
- Synchronization
- Memory management
- Reliability and fault tolerance

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Microkernels

- Small operating system core
- Contains only essential core operating systems functions
- Many services traditionally included in the operating system are now external subsystems
  - Device drivers
  - File systems
  - Virtual memory manager
  - Windowing system
  - Security services

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Figure 4.10   Kernel Architecture

Benefits of a Microkernel Organization

- Uniform interface on request made by a process
  - Don't distinguish between kernel-level and user-level services
  - All services are provided by means of message passing
- Extensibility
  - Allows the addition of new services
- Flexibility
  - New features added
  - Existing features can be subtracted

Benefits of a Microkernel Organization

- Portability
  - Changes needed to port the system to a new processor is changed in the microkernel - not in the other services
- Reliability
  - Modular design
  - Small microkernel can be rigorously tested

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Benefits of Microkernel Organization

- Distributed system support
  - Message are sent without knowing what the target machine is
- Object-oriented operating system
  - Components are objects with clearly defined interfaces that can be interconnected to form software

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Microkernel Design

- Low-level memory management
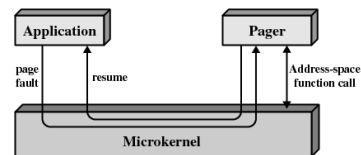 - Mapping each virtual page to a physical page frame

Figure 4.11   Page Fault Processing

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Microkernel Design

- Interprocess communication
- I/O and interrupt management

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