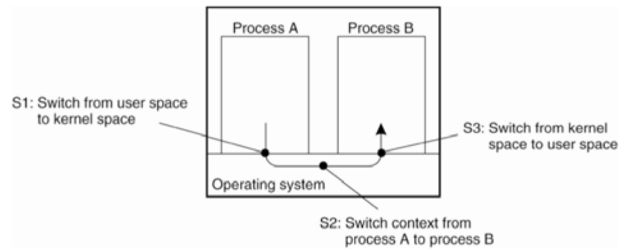
CIS 505: Software Systems
Processes (Chap 3)

Insup Lee
Department of Computer and Information Science
University of Pennsylvania

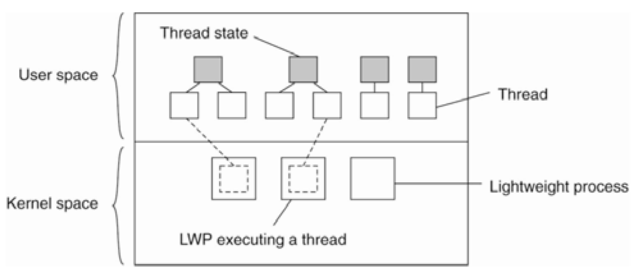
CIS 505, Spring 2007

Thread Usage in Nondistributed Systems



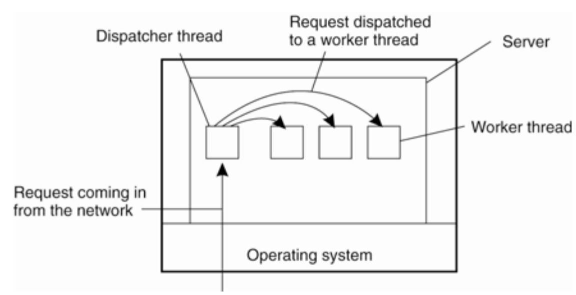
- Figure 3-1. Context switching as the result of IPC.

Thread Implementation



- Figure 3-2. Combining kernel-level lightweight processes and user-level threads.

Multithreaded Servers (1)



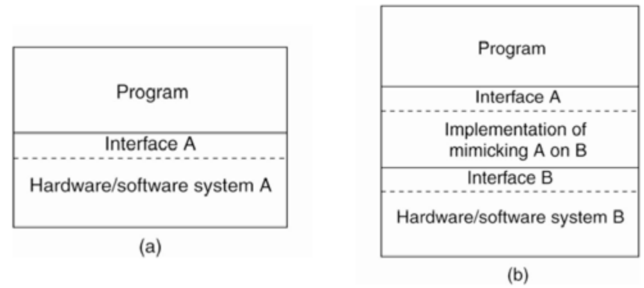
- Figure 3-3. A multithreaded server organized in a dispatcher/worker model.

Multithreaded Servers (2)

- Figure 3-4. Three ways to construct a server.

Model	Characteristics
Threads	Parallelism, blocking system calls
Single-threaded process	No parallelism, blocking system calls
Finite-state machine	Parallelism, nonblocking system calls

The Role of Virtualization in Distributed Systems



- Figure 3-5. (a) General organization between a program, interface, and system. (b) General organization of virtualizing system A on top of system B.

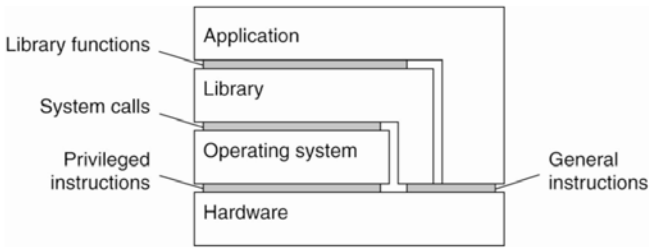
Virtualization

- Virtualization is to extend or replace an existing interface to mimic the behavior of another system.
- IBM 370 mainframe, VMM (Virtual Machine Monitor) - 1970s
  - Support multi users by one VM per user
  - Support different operation systems
- After 1990s,
  - To provide legacy interface on new hardware platforms
  - To provide uniformity over a heterogeneous collection of servers connected by networks
  - To provide a high degree of portability and flexibility

Interfaces of Computer Systems at Different Levels

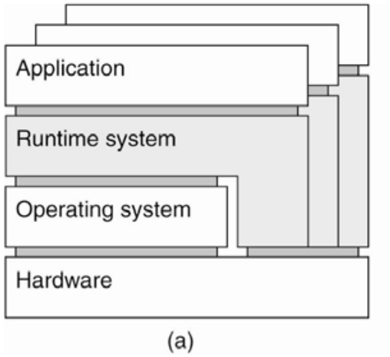
- An interface between the hardware and software consisting of machine instructions
  - that can be invoked by any program.
- An interface between the hardware and software, consisting of machine instructions
  - that can be invoked only by privileged programs, such as an operating system.
- An interface consisting of system calls as offered by an operating system.
- An interface consisting of library calls
  - generally forming what is known as an application programming interface (API).
  - In many cases, the aforementioned system calls are hidden by an API.

Interfaces of Computer Systems



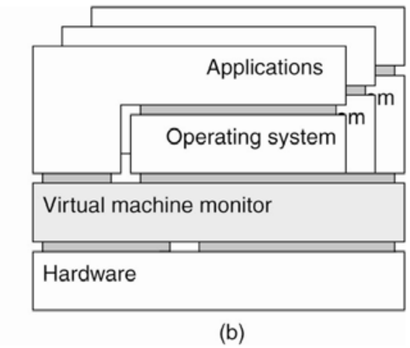
- Figure 3-6. Various interfaces offered by computer systems.

Architectures of Virtual Machines (a)



A process virtual machine, with multiple instances of (application, runtime) combinations.
- JVM
- Cywin

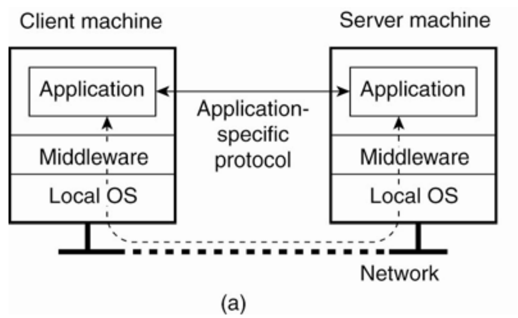
Architectures of Virtual Machines (b)



(b) A virtual machine monitor, with multiple instances of (applications, operating system) combinations.

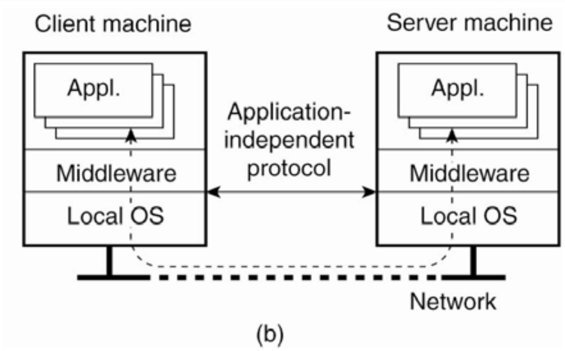
Example: VMware

Networked User Interfaces (1)



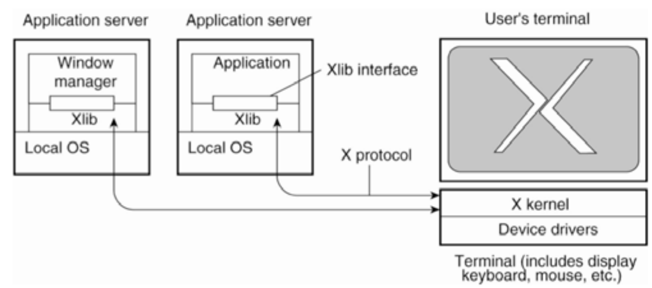
- Figure 3-8. (a) A networked application with its own protocol.

Networked User Interfaces (2)



- Figure 3-8. (b) A general solution to allow access to remote applications.

Example: The XWindow System

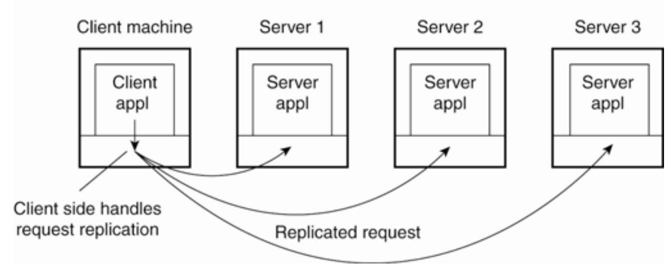


- Figure 3-9. The basic organization of the X Window System.

Client-side transparencies

- Distribute transparency
- Access transparency
  - Use client-side stub from an interface definition of the server
- Location transparency
- Migration transparency
- Relocation transparency
- Replication transparency
- Failure transparency
- Concurrency and persistence transparency handled by servers.

Client-Side Software for Distribution Transparency

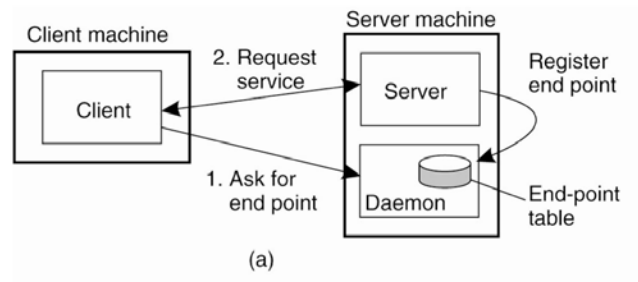


- Figure 3-10. Transparent replication of a server using a client-side solution.

Servers

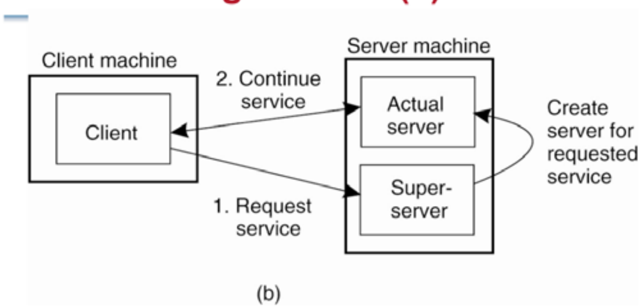
- Binding issues
  - o When, how to bind
- Stateless servers
  - o Soft state
- Stateful servers
  - o Temporary session state vs. permanent state
  - o Where to keep state information
    - Cookies - client side

General Design Issues (1)



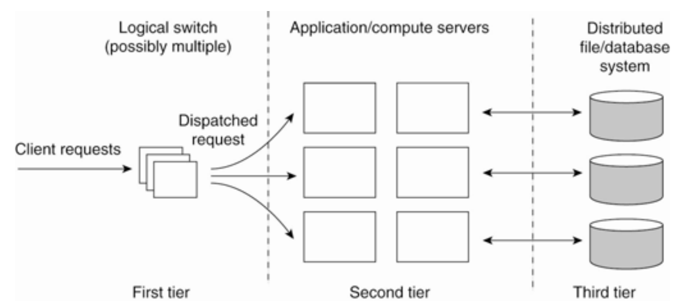
- Figure 3-11. (a) Client-to-server binding using a daemon.

General Design Issues (2)

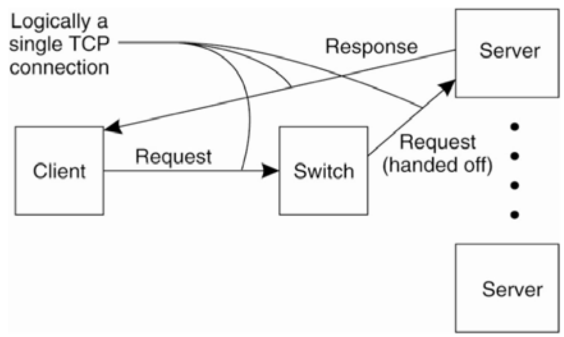


- Figure 3-11. (b) Client-to-server binding using a superserver.

Server Clusters (1)

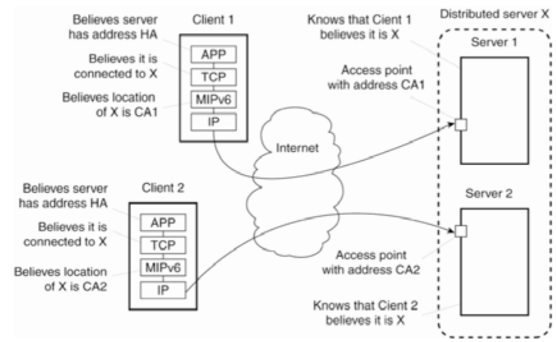


Server Clusters (2)



- Figure 3-13. The principle of TCP handoff.

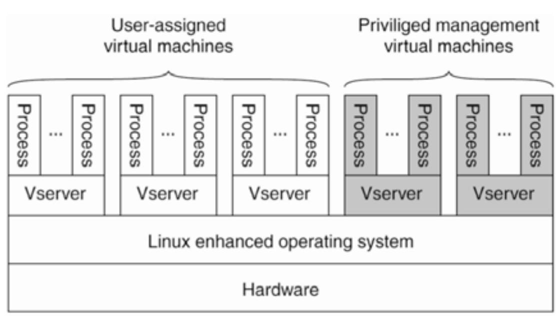
Distributed Servers



- Figure 3-14. Route optimization in a distributed server.

Managing Server Clusters

Example: PlanetLab

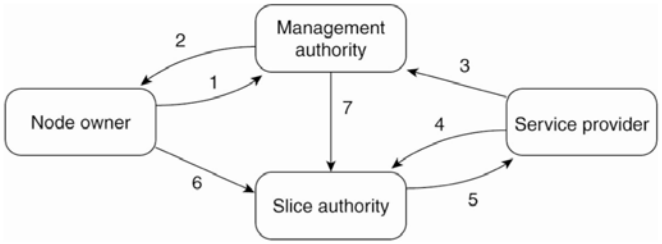


- Figure 3-15. The basic organization of a PlanetLab node.

PlanetLab (1)

- PlanetLab management issues:
- Nodes belong to different organizations.
  - Each organization should be allowed to specify who is allowed to run applications on their nodes,
  - And restrict resource usage appropriately.
- Monitoring tools available assume a very specific combination of hardware and software.
  - All tailored to be used within a single organization.
- Programs from different slices but running on the same node should not interfere with each other.

PlanetLab (2)



- Figure 3-16. The management relationships between various PlanetLab entities.

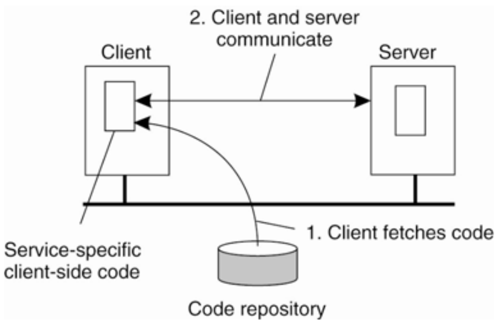
PlanetLab (3)

- Relationships between PlanetLab entities:
- A node owner puts its node under the regime of a management authority, possibly restricting usage where appropriate.
- A management authority provides the necessary software to add a node to PlanetLab.
- A service provider registers itself with a management authority, trusting it to provide well-behaving nodes.

PlanetLab (4)

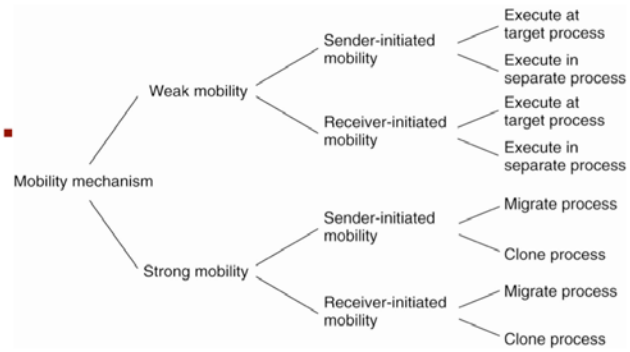
- Relationships between PlanetLab entities:
- A service provider contacts a slice authority to create a slice on a collection of nodes.
- The slice authority needs to authenticate the service provider.
- A node owner provides a slice creation service for a slice authority to create slices. It essentially delegates resource management to the slice authority.
- A management authority delegates the creation of slices to a slice authority.

Reasons for Migrating Code



- Figure 3-17. The principle of dynamically configuring a client to communicate to a server. The client first fetches the necessary software, and then invokes the server.

Models for Code Migration

- 

Migration and Local Resources

		Resource-to-machine binding		
		Unattached	Fastened	Fixed
Process-to-resource binding	By identifier	MV (or GR)	GR (or MV)	GR
	By value	CP (or MV,GR)	GR (or CP)	GR
	By type	RB (or MV,CP)	RB (or GR,CP)	RB (or GR)

GR Establish a global systemwide reference
MV Move the resource
CP Copy the value of the resource
RB Rebind process to locally-available resource

- Figure 3-19. Actions to be taken with respect to the references to local resources when migrating code to another machine.

Migration in Heterogeneous Systems

Three ways to handle migration (which can be combined)

- Pushing memory pages to the new machine and resending the ones that are later modified during the migration process.
- Stopping the current virtual machine; migrate memory, and start the new virtual machine.
- Letting the new virtual machine pull in new pages as needed, that is, let processes start on the new virtual machine immediately and copy memory pages on demand.