Introduction to Distributed Systems

- Distributed Systems
- Network OSs vs. distributed OSs
- Research and design issues
- *Reading: Coulouris, chapters 1, 2, and 3*

Distributed *vs.* Centralized Systems

- Advantages of Distributed Systems:
  - Reliability.
  - Sharing of resources.
  - Aggregate computing power.
  - Openness/Scalability
- Disadvantages of distributed systems:
  - Security.
  - Physical distribution of resources *vs.* demand.
  - Computing power per node is limited.

Distributed Operating Systems

- Requirements:
  - Provide user with convenient virtual computer.
  - Hide distribution of resources.
  - Mechanisms for protecting resources.
  - Secure communication.

- Definition

Distributed OS looks to user like ordinary centralized OS, but runs on multiple, independent CPUs.

- Use of multiple processors is invisible.
- User views system as virtual uniprocessor.

Distributed *vs.* Networked OS

- Transparency:
  - How aware are users of the fact that multiple computers are being used?
- Network OS:
  - Users are aware where resources are located
  - Network OS is built on top of centralized OS.
  - Handles interfacing and coordination between local OSs.
- Distributed OS:
  - Designed to control and optimize operations and resources in distributed system.

Network OSs

- Definition:

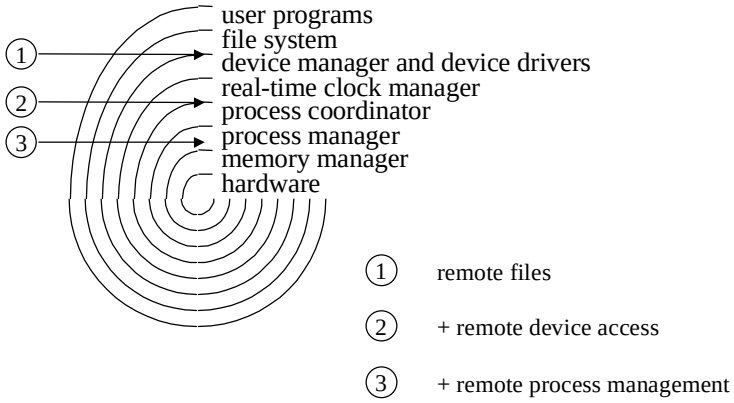
  A network OS is a collection of OSs of computers connected through a network incorporating modules to provide access to remote resources.

- Characteristics:
  - Each computer has private OS.
  - User works on his own machine and remotely logs in to other computers.
  - Users are aware of location of files.
  - Limited fault tolerance.

IPC and Transparency

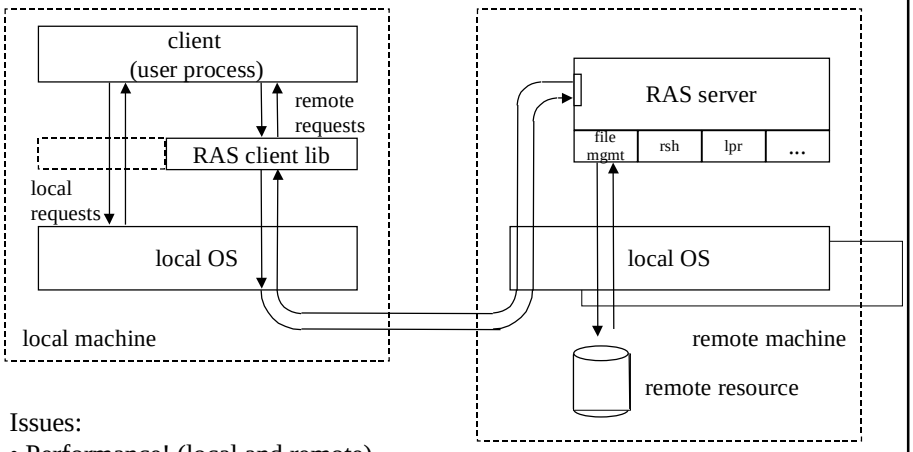
The insider's view of a centralized OS.

(Roughly patterned after XINU [Comer 1984])



A Vanilla Network OS

(Remote Access System [Goscinsky '83])



Issues:
- Performance! (local and remote)
- Where is the state?
- Serialization of operations.
- Blocking operations

Research and Design Issues

- Communication model
- Paradigms for process interaction
- Transparency
- Heterogeneity
- Autonomy and/or interdependence
- Reliable distributed computing
- Replication

Communication Model

- ISO/OSI Model
  - Physical
  - Datalink
  - Network
  - Transport
  - Session
  - Presentation
  - Application
- An alternative, e.g. *Functional*, Model
  - Physical
    - same as ISO/OSI
  - Datagram
    - connectionless service between source and destination process
    - location of services
  - Transport
    - reliable transport between client and server
    - "transaction level"
  - Binding
    - location of resources within the server
    - logical connection between client and server
  - User
    - request semantics

Process Interaction: Client/Server

Server: A subsystem that provides a particular type of service to *a priori* unknown clients.

- Control functionally distributed among the various servers in the system.
- Control of *individual* resources is centralized in a server. (localized?)
- Problems:
  - Reliability/Availability
  - Scalability
  - Replication?

Process Interaction: Pipe Model

Pipe: Communication facility to transfer data between processes in FIFO order. Can be used for synchronization purposes.

- Named/unnamed pipes
- Pipes for secure IPC
- Pipes across network?
- Multicast pipes?

Process Interaction: RPC Model

- Allows a process to call a procedure on a remote computer.
- Looks like a local procedure.
- Blocking characteristics?
- *More about this later.*

Transparency

Transparency: Make the network invisible to user/applications.

Various degrees of transparency:

- Access Transparency
- Location Transparency
- Name Transparency
- Data Transparency
- Execution Transparency
- Performance Transparency

Autonomy and Interdependence

- Disadvantage generated by interdependence:
  - cannot work stand-alone
  - globally controlled
  - difficult to identify source of authority and responsability
  - what about mutual suspicion?
- Reasons for autonomy:
  - policy freedom
  - robustness
  - cooperation between mutually suspicious users