# CSCE 455/855
# Distributed Operating Systems

## Introduction to Distributed Systems

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## What is meant by Distributed Computing?

- Working definition:
  - "... a collection of independent computers that appear to the users of the system as a single system." [p. 2]
- Sometimes referred to as "Client-Server Computing"
- Defining chacteristics
  - individual computers are independent
    - i.e. do not share memory, CPU
  - transparency
    - achieved at user or programmer viewpoint
  - all achieved through a layer of software

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## Distributed System Advantages

- More reliable than time-sharing systems
  - » Another definition by Leslie Lamport: a distributed system is “one in which the failure of a computer you didn't even know existed can render your own computer unusable”
- Resource sharing (printers, cpu’s)
- Cost-effective
- Performance advantage (utilize idle CPUs)
- Incremental growth (network allowing)

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## Distributed System Disadvantages

- Security problems
- Software
  - » load distribution difficult
  - » reliability needs to be built in
  - » control information is distributed
- Communications overhead

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## Centralized and Distributed Systems

- Centralized/Distributed
  - » process management
  - » resource management
  - » memory management
  - » file management
  - » protection
- Distributed system
  - » distributed management of otherwise centralized facilities
  - » communication overhead
  - » distributed control mechanisms
  - » interconnecting heterogeneous systems
- Major problems for distributed systems not faced in centralized systems
  - » lack of global state information
  - » communication & transmission delays

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## Networked Operating Systems

- Transparency not very high
  - » user must know location of services
  - » file servers provide some degree of transparency
- Mounting file systems
  - » mount remote files (directories) on local machine
  - » access accomplished by sending a message
    - ❖ system (transparently) distinguishes between local and remote files
  - » files mounted *onto* individual machines
    - ❖ therefore possible to mount a file at different places on to machines
    - ❖ or one machine may mount files that another doesn't

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## Distributed System Goals

- Control resources on the network
  - » make effective use of disk space, cpu cycles
  - » synchronize events
- Provide a convenient virtual computer
  - » easy way to communicate, access resources
  - » naming, sockets, RPC
- Make access to distributed resources transparent to users
  - » want user to see one machine
  - » OS provides glue that makes a number of machines seem as one

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## Distributed System Goals (cont.)

- Protect system resources
  - » unauthorized and wayward users pose additional problems
  - » provide easy access yet provide enough security
- Provide secure, reliable, fast communication
  - » the basis for all distributed facilities

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## The Continuum From Networked to Distributed Operating Systems

- Transparency (user's perspective)
  - » Networked:
    - ❖ user must know where services are located
    - ❖ calvin:/home/goddard/dissertation/thesis.tex
    - ❖ must log into different machines *(rlogin, telnet)*
    - ❖ explicitly transfer files between machines
  - » Distributed:
    - ❖ users are unaware of where services are located
    - ❖ /home/goddard/dissertation/thesis.tex
    - ❖ different machines accessed without user knowledge
    - ❖ transferring between different machines irrelevant (from user's perspective)

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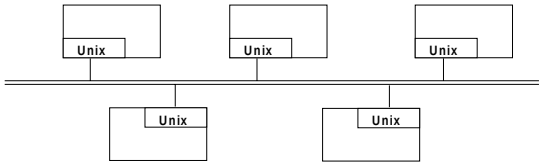
## Distributed System Architecture

- Monolithic kernel
  - » each computer has copy of OS
  - » Unix, etc.

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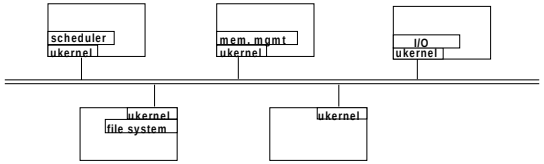
## Distributed System Architecture (con't)

- Microkernel
  - » kernel provides minimal services
    - interprocess communication
    - primary memory management
    - process management
    - I/O
  - » everything else done through server
    - microkernel sends requests to servers

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## Distributed System Architecture (con't)

- Microkernel trade-offs
  - » servers can support heterogeneous systems
  - » flexibility: can interchange servers
  - » performance can suffer
    - communication overhead

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## Transparency

- Location transparency
  - » users don't need to know where resources are located
- Migration transparency
  - » files, processes move without impacting users
  - » mounting files is not transparent
    - ❖ if file moves, mounting system ill not see it
- Replication transparency
  - » system can make multiple copies of files
    - ❖ for increased reliability, availabiltiy

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## Transparency

- Concurrency transparency
  - » resources can be accessed simultaneoulsy
- Parallelism transparency
  - » system uses parallelism without user intervention... some day

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## Achieving Transparency

- Operating system responsible for making distributed system appear as one
  - » request a service
    - ❖ determine where service is located
    - ❖ translate request into appropriate form
    - ❖ send a message
    - ❖ receive results
    - ❖ translate results into form needed by user
  - » receive a request
    - ❖ service set-up (make service available)
    - ❖ receive message
    - ❖ process service
    - ❖ send results

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## Other Design Issues

- Flexibility
  - » accommodating heterogeneous hardware and operating systems
- Reliability
  - » availability, fault tolerance

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## Other Design Issues

- Performance
  - » communication efficiency is key
  - » distributed goals may reduce performance: fault tolerance through replication
- Scalability
  - » depends critically on software
    - ❖ often seductive to use a centralized algorithm to coordinate distributed systems
    - ❖ distributed algorithms harder to understand, more scalable

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