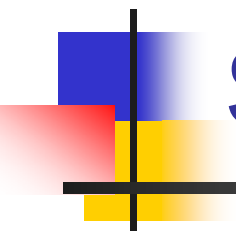

Introduction to Distributed Systems

ENSC 891 – Spring 2003

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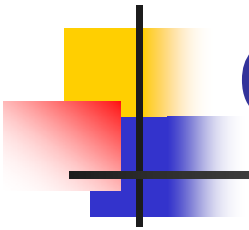
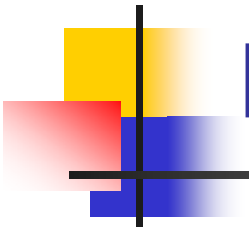


Outline

- Introduction
- Application areas
- Software architecture
- Communications architecture
- Distributed resources

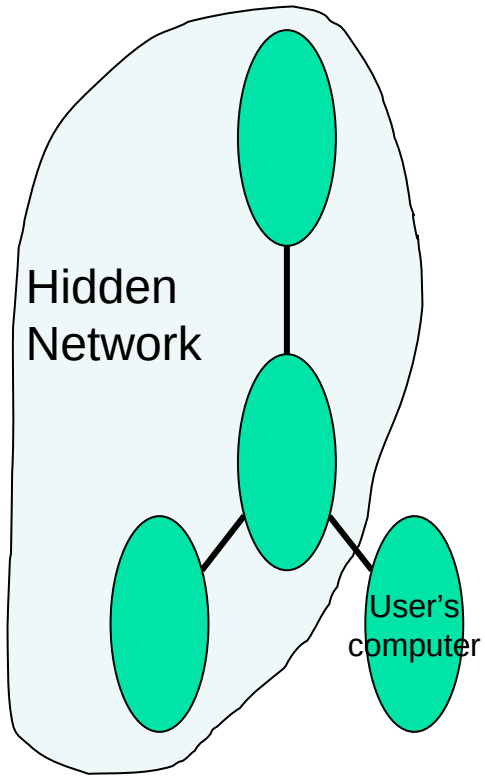


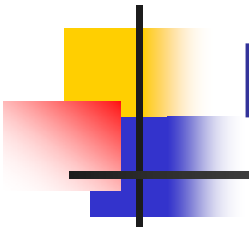
Distributed Systems

- Provides global sharing of computational resources
- Autonomous computers cooperate to solve a large problem or facilitate parallel execution of separate tasks

Attributes of a Distributed System

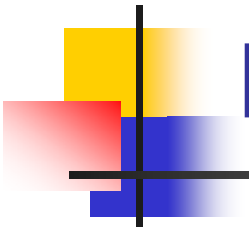
- A network of computers to facilitate communications
- The network is hidden from the user
- The network looks the same wherever the user is working





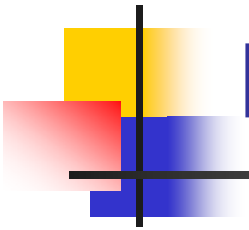
Distributed Systems

- In a distributed system, computers share processing functions
- If the processing is centralized at one computer, the system is not considered distributed
  - Example: remote searching of a centralized database is not a distributed system
- “Partial” distributed systems



Examples of Distributed Systems

- Networks
- E-mail
- Newsgroups and bulletin boards
- FTP, Telnet
- W W W
- Distributed computing
- Electronic payment
- Distributed real-time processing
- Software distributed systems (e.g., multi-threaded OCR software)



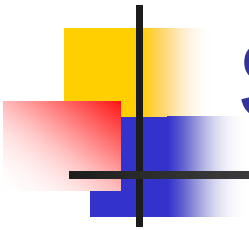
Major Application Areas

1. Distributed file systems
   - Store and retrieve large volumes of data
   - Network-wide file service
   - Users can create, read, write, delete files
2. Distributed database systems
   - Database is divided into separate cooperating databases
   - Users have access to local and remote data

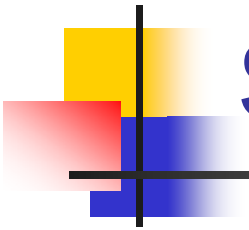
Major Application Areas - cont

3. Distributed real-time systems
   - Examples: real-time transaction processing, e-payments, real-time process control, system monitoring
   - Provide accurate and timely information at all times
4. Distributed multimedia systems
   - Storage and retrieval, network transmission for audio and video files.
   - Signals encoded in a digital form before transmission, and decoded at the receiving sites.
5. Distributed decision support systems
   - Improves human decision-making process
   - Support several decision-makers with access to information from various sources.

Architecture of a Distributed System



- Provides a physical and logical view of the system
- Provides specs for system components and the interrelationships among these components
- Essential for implementation, development and maintenance of the system

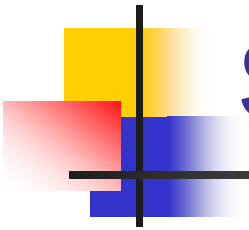


Software Architecture

- Global view:
  - Cooperating processes: exchange messages over a network
    - Peer-to-peer or Master-slave
    - RPC (Remote Procedure Call), PVM (Parallel Virtual Machine) and MPI (Message Passing Interface)
  - Process group: all members are informed about every processing action
    - ISIS toolkit (Cornell University, Ithaca, NY)
  - Client-server: dedicated service-provider and service-consumer processes
    - Three-message and single-shot protocols

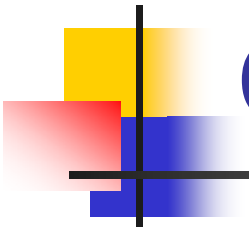
Software Architecture - cont

- Component-based view:
  - Procedure-oriented
    - C language, Pascal
  - Object-oriented
    - C++, Java
  - CORBA (Common Object Request Broker Architecture) and IIOP (Internet Inter-ORB Protocol), IDL (Interface Definition Language)
  - .NET, DCOM (Microsoft)



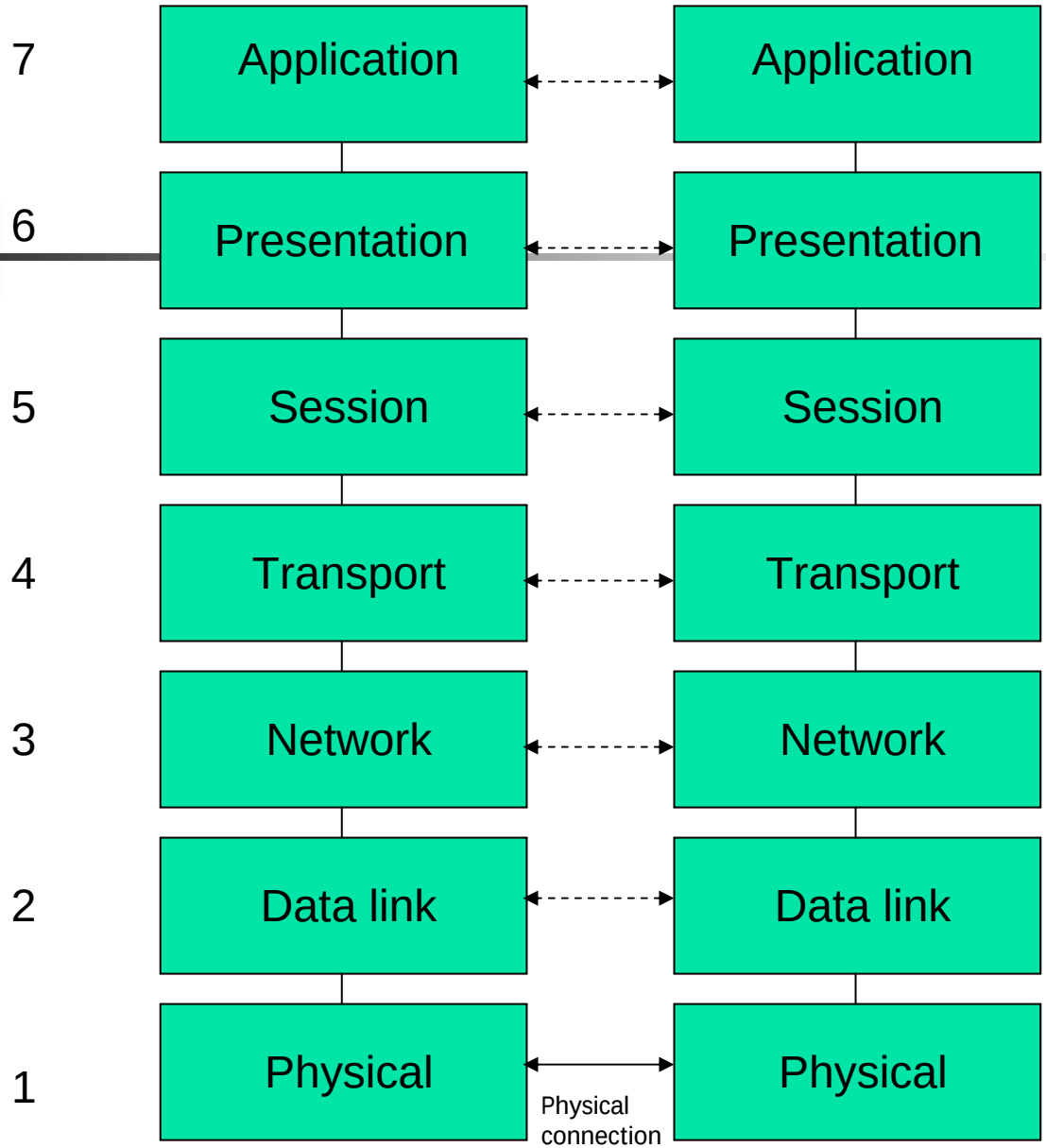
Software Architecture - cont

- Frameworks:
  - Reusable semi-complete application that can be customized for different environments
- Development environments:
  - JADE (Telecom Italia)
  - JINI (Sun)
  - JDPS (Toshiba)



Communications Architecture

- Distributed systems operate over computer networks
- Networks has a layered architecture, for each layer there are communication protocols
- A standard architecture is the ISO-OSI reference model (International Standards Organization-Open Systems Interconnection)



ISO-OSI

Reference model

ISO-OSI model

1. **Physical layer**

   Transmits of raw bits over the communications channel

2. **Data link layer**

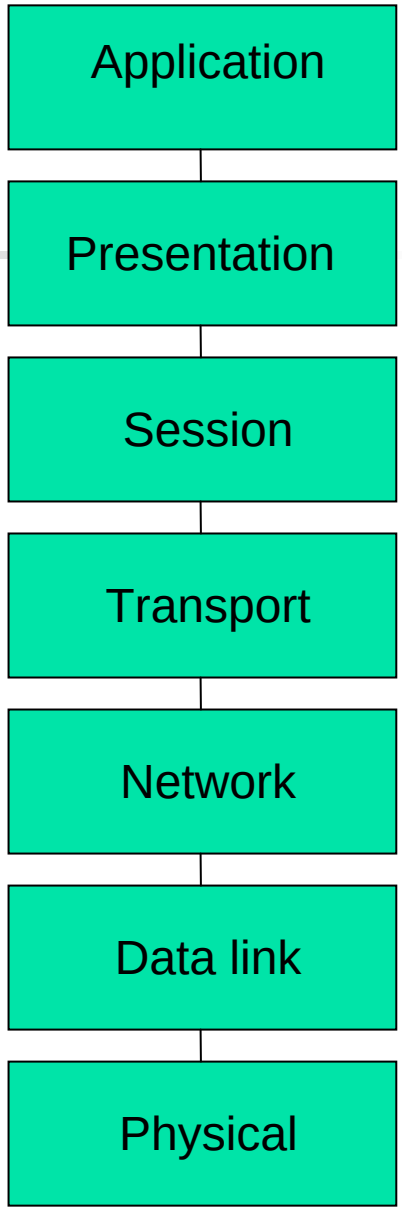
   Transforms the raw bit stream into a string of bits free of errors

3. **Network layer**

   Handles host-to-host communications, routing

4. **Transport layer**

   Transfers messages from one application process to another



ISO-OSI model

5. **Session layer**

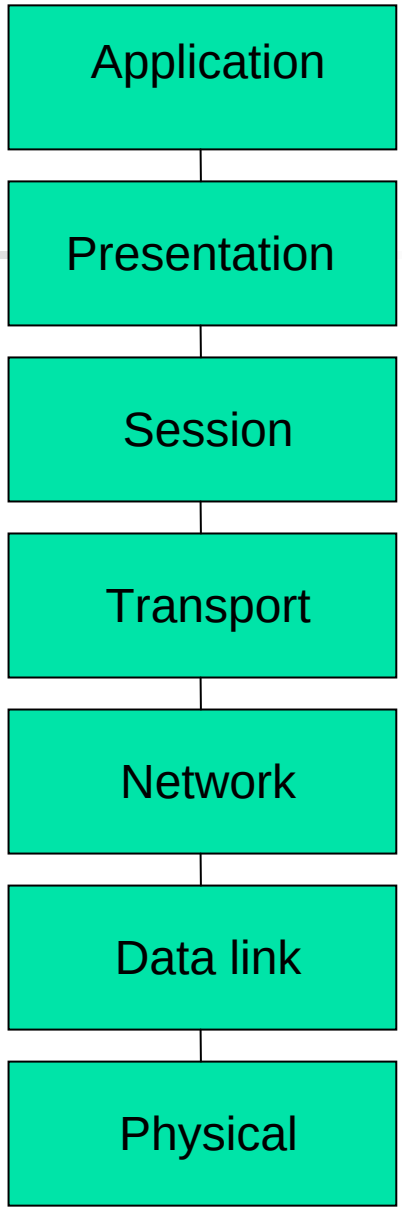
   Initiates connection for communication

6. **Presentation layer**

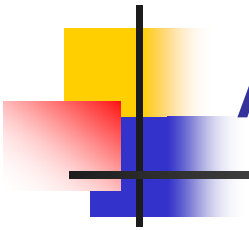
   Resolves differences in formats among various hosts

7. **Application layer**

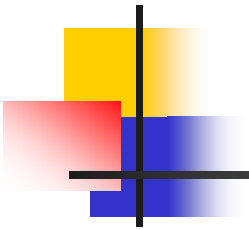
   Where user applications are run and created



Issues with Managing and Accessing Distributed Resources

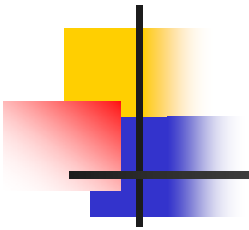


- Naming and addressing
  - Identifying software, hardware, access privileges and ownership
- Sharing
  - Authentication of user for access to system resources
- Availability and reliability
  - System should deliver service correctly whenever there is a demand



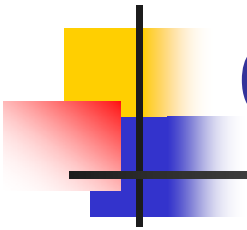
Issues - cont

- Replication
  - Contribute to availability and reliability
  - Processing overhead to maintain consistency
- Privacy and security
  - Passwords, access control lists, firewalls, encryption methods
- Scalability
  - System can accommodate expansion and reduction easily
  - Number of users, computers, locations, etc



Issues - cont

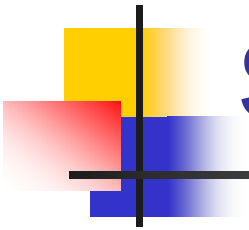
- Communications
  - Following standard communications protocols
- Concurrency
  - Concurrent processes sharing resources can lead to conflicts
- Timing
  - Interrelated activities requires order in processing
  - Time-of-day is required in some applications
- Robustness
  - Redundant elements, logging schemes, backups, retransmission are used to hide system faults from users.



Conclusion

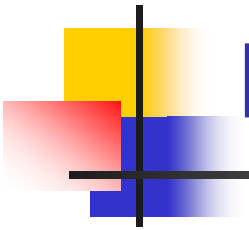
Advantages of distributed systems:

- Scalability
- Reliability
- Robustness to change
- Sharing of resources
- Data integrity
- Decomposing large problems into smaller ones
- Self-configuration



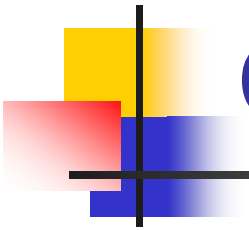
Summary

- Definition and attributes of a distributed system
- Examples of a distributed system
- Software and network architectures
- Managing and accessing distributed resources



Reference

- The essence of distributed systems, Joel M. Crichlow, 1999.



Questions?