Chapter 10

Management of Network Functions

At a Glance

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Lecture Notes

Overview

When organizations move toward completely decentralized systems, more and more computing devices are linked through complex networks of wireless communications, teleconferencing equipment, host computers, and other digital technologies. However, there are two problems with this expansion. First, a tremendous demand is placed on data communication networks by the staggering number of hardware interconnections. Second, the user community places increasing pressure on these networks to operate with greater reliability, security, and speed.

This chapter explores the differences between network operating systems and distributed operating systems. It also explains process-based and object-based operating system models and uses them to define the roles of the Memory, Processor, Device, File, and Network Managers in distributed operating systems. Finally, the chapter discusses the role of network operating systems.

Learning Objectives

After completing this chapter, the student should be able to describe:

- The complexities introduced to operating systems by network capabilities
- Network operating systems (NOS) compared to distributed operating systems (DO/S)
- How a DO/S performs memory, process, device, and file management
- How a NOS performs memory, process, device, and file management
- Important features of DO/S and NOS

Teaching Tips

History of Networks

1. Provide students with an overview of the history of networks. Point out the two initial motives behind the creation of networks. First, there was a need to share expensive hardware resources such as large mainframes, laser printers, and sizable hard disks. Second, there was the realization that a network's most prized resource was the information stored on it and there was a need for sharing this centralized information resource.

2. Outline the development of two types of operating systems with network capabilities: the network operating systems (NOS) and the more powerful distributed operating systems (DO/S).

3. Briefly discuss distributed processing, which allows even greater access to centralized information to allow users to work together to complete common tasks.

Teaching Tip	Applications collectively known as computer-supported cooperative work use the popular term "groupware." Groupware incorporates distributed processing.

Comparison of Network and Distributed Operating Systems

1. Provide students with an introduction to network operating systems (NOS). Explain how NOS evolved out of a necessity to give users global access to resources, globally manage the network's processes, and make the network almost completely transparent for users and their sites' operating systems, known as local operating systems.

2. Discuss important features of network operating systems including the ability to give local operating systems extended powers. The NOS handles the interfacing details and coordinates the remote processing.

3. Outline the major drawbacks of network operating systems.

4. Use Figure 10.1 on page 321 to illustrate a network operating system.

5. Provide students with an introduction to distributed operating systems (DO/S).

6. Discuss important features of distributed operating systems including:
    a. It provides a unified environment designed to optimize operations for the network as a whole, not just for local sites.
    b. It is typically constructed with a replicated kernel operating system: low-level, hardware-control software (firmware) with system-level software for resource management.
    c. It has a layer that hides the network and its intricacies from users.

7. Use Figure 10.2 on page 322 to illustrate a distributed operating system.

8. Using Table 10.1 on page 322 as a guide, present a comparison of the two types of systems. Be sure to emphasize the major differences between a NOS and a DO/S in terms of how each views and manages the local and global resources.

Teaching Tip	In a network operating system (NOS), the network management functions come into play only when the system needs to use the network.

DO/S Development

1. Provide students with a brief overview of DO/S development. Point out the important advantages of a DO/S, such as its ability to support file copying, electronic mail, and remote printing without requiring the user to install special server software on local machines.

Memory Management

1. Provide students with an overview of memory management in distributed operating systems (DO/S). Discuss the extended role of the Memory Manager in these systems.

2. Discuss the various functions of the Memory Manager.

3. Using Table 10.2 on page 324 as a guide, outline various protection checks that are performed on pages.

Process Management

1. Provide students with an overview of process management in distributed operating systems (DO/S). Discuss the various functions of the Processor Manager including:
    a. It provides the policies and mechanisms to create, delete, abort, name, rename, find, schedule, block, run, and synchronize processes, and provides real-time priority execution if required.
    b. It provides mechanisms for processes to manage states of execution. (READY, RUNNING, WAIT).

2. Discuss the kernel. Point out that each kernel assumes the role of helping the system reach its operational goals and that the kernel's states are dependent on the global system's process scheduler and dispatcher.

3. Use Figure 10.3 on page 325 to illustrate the kernel control of operations.

4. Explain each of the three parts of a systems scheduling function: a decision mode, a priority function, and an arbitration rule. Provide examples for each part.

5. Outline the three theories on which most advances in job scheduling rely (queuing theory, statistical decision theory, or estimation theory). Discuss this topic using an example from estimation theory as provided in the text on page 326.

6. Explain the procedures a Processor Manager uses to create, locate, synchronize, and delete a process.

7. Provide students with an introduction to the two ways to design a distributed operating system: (1) process-based DO/S and (2) object-based DO/S.

Teaching Tip	Each kernel controls each piece of hardware, including the CPU. Each kernel is operated by the DO/S, which in turn, is directed by the application software running on the host computer.

8. Provide students with an overview of a process-based DO/S, which provides for process management using client/server processes, synchronized and linked together through messages and ports (channels or pipes).

9. Discuss how processes and messages provide the basic features essential to process management such as process creation, scheduling, pausing, communication, and identification. Explain the ways these features can be addressed. For example, having a single copy of the operating system, having multiple cooperating peers, or using a combination of the two.

10. Discuss the high level of cooperation and sharing of actions and data required by the sites when determining which process should be loaded and where it should be run. Be sure to mention that synchronization is a key issue in network process management. Note how interrupts are represented as messages that are sent to the proper process for service.

11. Explain to students the concept of process management in an object-based DO/S. Point out that in this type of DO/S, the system is viewed as a collection of objects, where an object can represent hardware (CPUs and memory), software (files, programs, semaphores, and data), or a combination of the two. Make sure students understand the difference between process-based DO/S and object-based DO/S.

12. Using examples, explain that objects have a set of unchanging properties that define them and their behavior within the context of their defined parameters.

13. Using the example provided on page 328, explain that in order to determine an object's state, one must perform an appropriate operation on it.

14. Explain that in an object-based DO/S, process management becomes object management with processes acting as discrete objects. List the two components of process management (kernel level and the Process Manager).

15. Provide students with an overview of the kernel level, which provides the basic mechanisms for building the operating system by creating, managing, scheduling, synchronizing, and deleting objects.

16. Using examples, explain the various responsibilities of the kernel level. Also note that the kernel environment for distributed systems must have a scheduler with a consistent and robust mechanism for scheduling objects within the system according to its operation's goals.

17. Outline various tasks carried out by the Process Manager. Point out that in order to perform these tasks, the Process Manager uses the kernel environment, which provides the primitives it needs to capture the low-level hardware in the system.

Device Management

1. Provide students with an overview of device management in distributed operating systems (DO/S). Discuss the various functions of the Device Manager.

2. Explain the tasks carried out by the Device Manager before allocating or deallocating devices to users. Use the example on page 330 to clarify.

3. Explain, using Figure 10.4 on page 331, that the DO/S Device Manager is a collection of remote device drivers connected to and associated with the devices; however, it is controlled by status data provided by the DO/S Device Manager.

Teaching Tip	All devices are operated by their individual device managers or device drivers using specific status data that is controlled by the DO/S Device Manager.

4. Discuss device management in a process-based DO/S. Note that all resources are controlled by servers called “guardians” or “administrators.” Discuss the responsibilities of these servers and explain how they accept requests for service on the individual devices they control, using Figure 10.5 on page 331 to illustrate this concept.

5. Explain how not all systems have a simple collection of resources and that most process-based systems are configured around complex server processes, which manage multiple resources or divide the work among subordinate processes.

6. Discuss device management in an object-based DO/S. Point out that in this case, each device is managed the same way throughout the network.

7. Explain, using the examples on page 332, that the physical device is manipulated by a set of operations, explicit commands that mobilize the device to perform its designated functions.

8. Discuss the advantages of object-based DO/S. Be sure to point out that for such a system to be successful, the Device Manager object at each site needs to maintain a current directory of device objects at all sites.

Teaching Tip	Refer to the following Web site to access a list of different distributed operating systems: www-vs.informatik.uni-ulm.de:81/DOSinWWW/DOS.html

Quick Quiz 1

1. Which of the following accurately describe NOS? (Choose all that apply.)
   a. Provides a unified environment designed to optimize operations for the network as a whole, not just for local sites
   b. Coordinates communications between the local operating systems
   c. Handles interfacing details and coordinates remote processing
   d. Doesn't take global control over memory management
   Answer: b, c and d

2. (True or False) A DO/S has the ability to support file copying, e-mail, and remote printing without the installation of special server software on local machines.
   Answer: True

3. In a(n) _____ DO/S, network resources are managed as a large heterogeneous collection.
   Answer: process-based

File Management

1. Provide students with an overview of file management in distributed operating systems, which gives users the illusion that the network is a single logical file system that is implemented on an assortment of devices and computers.

2. Explain file management functions and the necessary reactions of the File Manager, using Table 10.3 on page 333 as a guide.

3. Outline various tasks that are required by a DO/S. These include concurrency control, data redundancy, location transparency and distributed directory, deadlock resolution or recovery, and query processing.

4. Explain briefly the concurrency control technique, which gives the system the ability to perform concurrent reads and writes, provided these actions do not jeopardize the database. Use the example on page 334 to clarify if necessary.

5. Explain how data redundancy techniques can make files much faster and easier to read.

6. Discuss the beneficial aspects of data redundancy from a disaster recovery standpoint.

7. Point out the disadvantage of data redundancy: it requires keeping multiple copies of the same file up-to-date at all times.

8. Explain the concepts of location transparency and distributed directory. Point out that location transparency means that users are not concerned with the physical location of their files and that the distributed directory manages transparency of data location and enhances data recovery for users.

9. Remind students of the concepts of deadlock detection and recovery as discussed in Chapter 5. Point out that these are critical issues in a DO/S and that the most important function is to detect and recover from a circular wait.

10. Use Figure 10.6 on page 335 to illustrate a directed graph representing the example provided in the text.

11. Explain why most real-life examples of circular wait are much more complex and difficult to detect.

12. Explain the various tasks performed by distributed systems in detection, prevention, avoidance, and recovery of circular waits.

13. Discuss query processing techniques, which try to increase the effectiveness of global query execution sequences, local site processing sequences, and device processing sequences.

Network Management

1. Provide students with an overview of network management in distributed operating systems.

2. Discuss the responsibilities of the Network Manager. These include:
    a. Locating of processes in the network
    b. Reliably transferring data
    c. Linking processes or objects together through a port when they need to communicate with each other
    d. Providing routing functions
    e. Keeping statistics on network use

3. Briefly discuss network management in process-based distributed operating systems. Outline the responsibilities of the Network Manager in such systems.

4. Point out that the Network Manager routinely acts as the interfacing mechanism for every process in the system and handles message traffic, relieving users of the need to know where their processes are physically located within the network.

5. Discuss network management in an object-based DO/S. Outline the responsibilities of the Network Manager in such systems. Be sure to point out that Network Manager services are usually provided at the kernel level to better accommodate many objects that use them and to offer efficient service.

6. Discuss the communications sent by the Network Manager and their purpose, using Table 10.4 on page 337 as a guide.

NOS Development

1. Provide students with an overview of network operating systems (NOS). Point out that a NOS typically runs on a computer called a server and performs services for network workstations called clients.

2. Using Figure 10.7 on page 338, explain how the network management functions come into play only when the system needs to use the network.

3. Outline the different factors, which determine the best choice of NOS.

Teaching Tip	Refer to the following Web site to learn more about network operating systems: http://compnetworking.about.com/od/softwareapplicationstools/l/bldef_nos.htm

Important NOS Features

1. Discuss the important features of network operating systems, such as:
    a. Support for standard LAN technologies and client desktop operating systems.
    b. Robust architecture that adapts easily to new technologies.
    c. The ability to operate a wide range of third-party software applications and hardware devices.
    d. The ability to support software for multiuser network applications.
    e. Providing an appropriate blend of efficiency and security.

Major NOS Functions

1. Discuss major NOS functions, such as:
    a. It is used to let users transfer files from one computer to another.
    b. It verifies every attempt to log in using login names and passwords.

    Note the need for version control as files are transferred to the local system. Explain the concept of anonymous FTP and its advantages. Use the example of FTP as provided in the text to illustrate these functions and concepts.

Quick Quiz 2

1. Which of the following techniques makes files much faster and easier to read?
    a. Location transparency
    b. Distributed directory
    c. Data redundancy
    d. Query processing

    Answer: c

2. (True or False) In a process-based DO/S, interprocess communication is transparent to users.
   Answer: True

3. (True or False) In a network operating system, the network management functions are applicable all the time, whether the system is using the network or not.
   Answer: False

Class Discussion Topics

1. Have students compare process-based DO/S and object-based DO/S. Ask them to compile a list of advantages and disadvantages for both types.

2. Ask students to discuss their experiences with File Transfer Protocol (FTP) in the past. What do they think are the advantages and disadvantages of using FTP?

Additional Projects

1. Have students research online to determine how to set up virtual private network (VPN) connections in Windows Vista.

2. Have students research online to find five examples of distributed operating systems. Ask them to provide a short description for each including key properties.

Additional Resources

1. Cisco.com:
   www.cisco.com

2. FTP Explorer:
   www.ftpx.com

3. IBM.com:
   www.ibm.com

4. Microsoft.com:
   www.microsoft.com

Key Terms

- **Anonymous FTP:** a use of File Transfer Protocol that allows a user to retrieve documents, files, programs, and other data from anywhere in the Internet without having to establish a user ID and password.
- **Client:** a user node that requests and makes use of various network services.
- **Distributed operating system (DO/S):** an operating system that provides control for a distributed computing system, allowing its resources to be accessed in a unified way.
- **Distributed processing:** a method of data processing in which files are stored at many different locations and in which processing takes place at different sites.
- **File Transfer Protocol (FTP):** a protocol that allows a user on one host to access and transfer files to or from another host over a TCP/IP network.
- **Groupware:** software applications that support cooperative work over a network.
- **Kernel:** the part of the operating system that resides in main memory at all times and performs the most essential tasks, such as managing memory and handling disk input and output.
- **Kernel level:** in an object-based distributed operating system, it provides the basic mechanisms for dynamically building parts of the operating system by creating, managing, scheduling, synchronizing, and deleting objects.
- **Network operating system (NOS):** the software that manages network resources for a node on a network and may provide security and access control.
- **Object:** any one of the many entities that constitute a computer system, such as CPUs, terminals, disk drives, files, or databases.
- **Object-based DO/S:** a view of distributed operating systems where each hardware unit is bundled with its required operational software, forming a discrete object to be handled as an entity.
- **Primitives:** well-defined, predictable, low-level operating system mechanisms that allow higher-level operating system components to perform their functions without considering direct hardware manipulation.
- **Process-based DO/S:** a view of distributed operating systems that encompasses all the system's processes and resources.
- **Server:** a node that provides to clients various network services such as file retrieval, printing, or database access services.
- **Server process:** a logical unit composed of one or more device drivers, a device manager, and a network server module needed to control clusters or similar devices in a process-based, distributed operating system environment.
- **Version control:** the tracking and updating of a specific release of a piece of hardware or software.