

Homework Assignment 1 Solutions

ECE 151 / CMPSC 171 - Spring 2013

1. Discuss the difference between a Distributed Operating System (DOS), a Network Operating System (NOS), and Middleware.

Distributed Operating System is a tightly coupled OS for shared memory multiprocessors and homogenous multi-computers. A Network Operating System is a loosely coupled OS for heterogeneous multi-computers connected using LAN, WAN etc. Middleware is an additional layer on top of NOS that implements general purpose services.

The main difference between DOS and NOS is in how each views and manages local and global resources. DOS views system resources as globally owned and manages them as such. NOS builds on capabilities provided by local OS and extends it to satisfy new needs. The main function of middleware is to provide transparency.

	DOS	NOS	Middleware
Degree of Transparency	High	Low	High
Same OS on all nodes	Yes	No	No
Number of copies of OS	N	N	N
Basis for communication	Messages	Files	Model-specific
Resource management	Global, distributed	Per node	Per node
Scalability	Moderate	Yes	Varies
Openness	Closed	Open	Open

2. (a) Explain the difference between portability and interoperability. (b) How do they together achieve openness in distributed systems?

Portability is an indicator of the ease with which an application designed for system A can be executed on a different system, system B. Interoperability is an indicator of the extent to which two similar systems can operate together using simple communication techniques without needing an additional layer (such as middleware layer). If an application is both portable and interoperable, then it can run on any combination of hardware and software platform without any issues. An open distributed system is a system that offers services according to standard rules. Interoperability is possible because of adherence to these standards. Similarly, for an application to be portable, different systems should follow the standards. Hence, portability and interoperability help achieve openness.

3. (a) Define scalability as it is used in distributed systems. (b) Scalability can be achieved by several different techniques. Describe three different techniques that are used to achieve scalability.

(a) Scalability is a measure of the ease with which a system can be increased in size. There are three metrics to measure the scalability of a system:

- Size- number of users/applications supported.
- Geographical scalability- distance between nodes.

iii) Administrative scalability- number of administrative domains.

(b) There are 3 techniques to achieve scalability:

- i) Distribution- Partition data and processing across multiple machines
- ii) Replication- Making copies of data available on different machines
- iii) Caching- Allowing clients to access local copies

4. Most enterprise computing systems are implemented as three-tier distributed systems, with a user interface in the first tier, processing in the second tier, and databases in the third tier. Why do you think they are designed in this way?

Designing enterprise computing systems as three tier systems has following advantages:

- i) Splitting into three layers makes for simple layers with easy integration.
- ii) Fault detection becomes easy.
- iii) It is convenient to upgrade/replace any of the layers.
- iv) During development, all three layers can be developed in parallel, thus reducing design time.

User Layer: the user only needs to understand this interface to the application. No other knowledge of working of the application is required.

Processing Layer: It separates actual processing from application level.

Data Layer: It separates processing and actual data as data may be accessed at different speeds (eg. data accessed from cache vs. from disk)

If instead of a three tier implementation, there was a two tier implementation (user layer-data layer), then it would not have been easy to provide transparency, openness, scalability.

5. The client-server model and the peer-to-peer model are quite different models of distributed computing. (a) Give an example application where it is more appropriate to use the client-server model than the peer-to-peer model and explain why. (b) Give an example application where it is more appropriate to use the peer-to-peer model than the client-server model and explain why.

An example application for client-server model of distributed system architecture is online banking system. It is more appropriate to use this model for the above mentioned application for the following reasons,

- Data stored in the central servers are confidential and cannot be shared with every machine in the network. Transactions involving critical data are often performed in the banking application and these are to be protected from unauthorized accesses.
- There is always a defined order in processing the requests from the clients by the server (i.e.) consistency is maintained in the system.

Example applications for peer-to-peer model of distributed system architecture are file sharing applications like bit torrent etc. It is more appropriate to use this model for the above mentioned application for the following reasons,

- A peer can request for a piece of data from other peers in the system who could be holding that information (i.e.) decentralized data storage mechanism. This avoids overloading a single machine with too many requests. This scheme will distribute the network traffic throughout the system instead of concentrating it in a fewer number of channels.
- The system is easily scalable as more number of users can be easily added to the system without much additional infrastructure needed. This feature is very essential for the file sharing applications where there could be a sudden spurt in the number of users wanting to use the application.
- Due to decentralized data storage system, there will be no overloading of request queues in any machine in the system and this helps in faster processing of the requests.

6. Sketch a high-level architectural design for a home multimedia center that is capable of connecting various sources (such as Internet, wireless broadcast, cable, or disc), various presentation devices (such as television, radio, or stereo), and various storage devices (such as a hard drive, DVD, or CD). Note that some devices are analog and some devices are digital and, thus, conversion of media streams is necessary. Think about how the end user would control the multimedia center. Think also about how the user would find the material of interest. Strive for minimal latency and jitter.

Home Multimedia System

(a) Devices:

The devices that can be considered in the home multimedia system are HDTV, VCR (Video Cassette Recorder), DVD player, Game Console, Speakers, PCs, modem with cable connection, wired/wireless router, remote controller, mobile phones, some storage devices like disks etc. The list of devices connected in this system can be very long.

(b) Control hub & Security

There is a control hub which takes care of the overall management of the system. The control hub in a way monitors the connections between various devices. For example, it has to check whether the input from the VCR or DVD or set top box is connected to the HDTV depending upon the choice of the user. The control hub is also responsible for providing access to the system for authorized users only. It can maintain a table storing the MAC addresses of the authorized devices. When a new device wants to establish a connection the control hub ensures that the device is in its authorized users list before providing access for the requesting device.

(c) Connectivity

Most of the communication between the devices in the home multimedia system happens over wireless media. Since the devices in the system will be located within a short range bluetooth technology can be considered for data transmission. Since bluetooth technology can support a maximum data rate of 1 Mbps it can be used for transmitting the audio signals/data from the PCs, television to the speakers. Wifi access can be provided for the devices to connect with the router, log onto the internet and upload/download data.

(d) User control

The user can control the system through his mobile phones, remote-controllers etc. The user can wish to view his program of interest on the TV. The control hub can store a list of recommended material for each user. As soon as the user connects to the system the control hub sends the information regarding list of recommended material that could be of interest to that user to the device through which the user connects with the system.

(d) Latency and Jitter

The latency can be considered as the delay in the transmission and reception of the data between the devices in the system. It could be annoying for the user if there is a large latency in receiving the requested data. Increasing the data rate of transmission and minimizing the processing time involved are two key factors in minimizing the latency. In most cases in the wireless transmission of data, jitter is seen in the arrival time of the data packets on the receiver side. To minimize the annoying effect to the user due to the jitter, buffers can be placed on the receiver side to collect the packets received and deliver them to the user at a uniform rate.

