DISTRIBUTED SYSTEMS CS3006 – 119CS0102 – Sushree Satarupa

Q1. Answer the following briefly

(a) Differentiate between transparency and concurrency in a distributed system.

transparency	concurrency
Distribution transparency is the property of distributed databases by the virtue of which the internal details of the distribution are hidden from the users.	Distributed concurrency control provides concepts and technologies to synchronize distributed transactions in a way that their interleaved execution does not violate the ACID properties.
The DDBMS designer may choose to fragment tables, replicate the fragments and store them at different sites. However, since users are oblivious of these details, they find the distributed database easy to use like any centralized database.	Distributed transactions are executed in a distributed database environment, where a set of connected data servers host related data.

(b) Diffentiate between Distributed System and Computer Network.

Distributed System	Computer Network
A distributed system is a computing environment in which various components are spread across multiple computers (or other computing devices) on a network.	A computer network is an interconnected collection of autonomous computers able to exchange information.
each node or system have same operating system	each node or system can have its own operating system

(c) Why it is difficult to design a distributed system?

The design of Distributed Systems is tough because they are highly complex. Although using a large number of machines, the system can become scalable but it increases the service's complexity. There will be more messages, more network calls, more machines, and hence it becomes very tedious to manage such systems.

(d) Can the distributed systems be built on the top of a LAN? Justify.

Yes,the distributed systems are built on the top of a LAN.
Justifications:

- Personal workstations and processors are not assigned to specific users
- Single file system with all files accessible from all machines in the same way & using the same path name
- For a certain command the system can look for the best place (workstation) to execute it

(e) Write the role of protocol and standards for communication in a distributed system.

- There can be high levels of heterogeneity that exists in distributed systems.
- So for communication to exist between heterogeneous nodes, Protocols allow different nodes to communicate with each other.

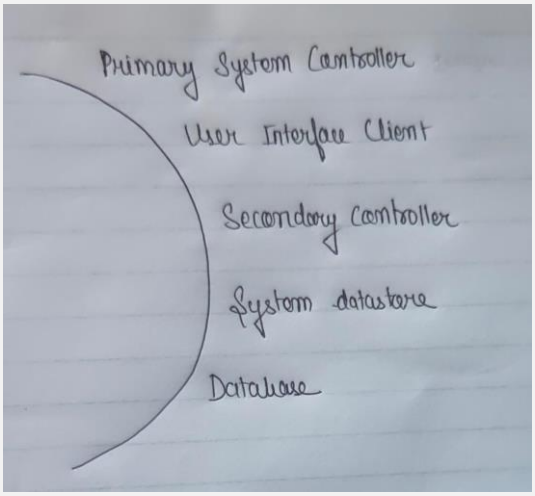
(f) What do you mean by light weight messaging system?

when a messaging system uses very less amount of ram for message passing we call it lightweight message system

(g) What are the components of a distributed system? Show using a diagram.

The components of a distributed system are:

1. Primary System Controller
2. System Data Store
3. Database



(h) How the various events in a distributed system can be ordered in the absence of global clock?

- Distributed systems may have no physically synchronous global clock, so a logical clock allows global ordering on events from different processes in such systems.
- A logical clock is a mechanism for capturing chronological and causal relationships in a distributed system.

(i) What is syndrome decoding? Explain with examples.

- Syndrome decoding is a highly efficient method of decoding a linear code over a noisy channel, i.e. one on which errors are made.
- In essence, syndrome decoding is minimum distance decoding using a reduced lookup table. This is allowed by the linearity of the code.

Example:

Following is an example of syndrome decoding with the Hamming code. First, we need to calculate and create a table of all possible syndromes. This should look very similar to the table we created in the previous section.

Error	Syndrome
0000 000	000
1000 000	110
0100 000	101
0010 000	011
0001 000	111
0000 100	100
0000 010	010
0000 001	001

- Now let's consider the example where we want to transmit the message 1011.
- First, we encode it into the message 1011010.
- Now, during transmission, the third bit experiences an error and flips resulting in the received message 1001010.
- Calculating the syndrome of this message will give us a syndrome of 011.

- Using the table, we can match this syndrome to the error 0010 000. Finally, we can swap this bit resulting in the original encoded message.

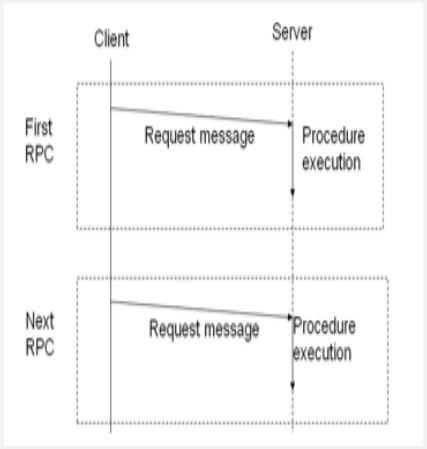
(j) Differentiate between Client-server & Peer to peer protocol.

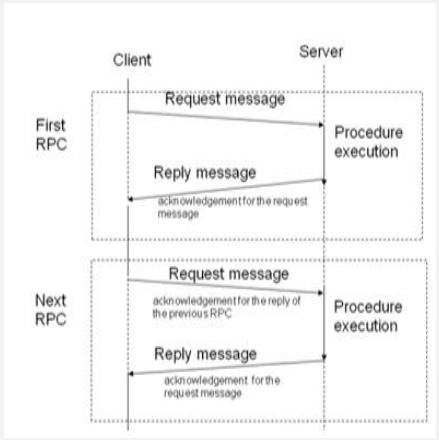
Client-server protocol:	Peer to peer protocol:
A communications protocol that provides a structure for requests between client and server in a network.	In peer-to-peer (P2P) networking, a group of computers are linked together with equal permissions and responsibilities for processing data.
For example, the Web browser in the user's computer (the client) employs the HTTP protocol to request information from a website on a server.	Unlike traditional client-server networking, no devices in a P2P network are designated solely to serve or to receive data.

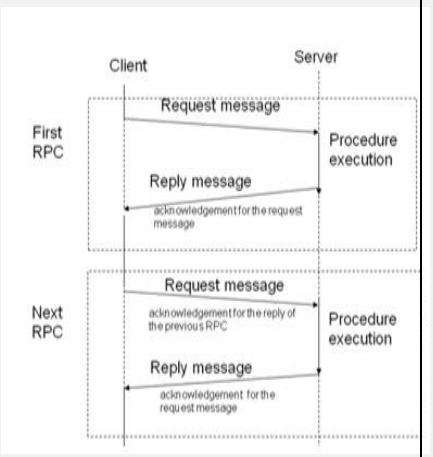
Q2. Write the answer with justification:

(i) Illustrate the protocols such as R, RR, and RRA protocol with a diagram and a comparison table.

R protocol	RR protocol	RRA protocol
This protocol is also called as R (request) protocol.	This protocol is also known as RR(request/reply) protocol.	This protocol is also known as RRA(Request/Reply/Acknowledge).
It is used in RPC when a called procedure has nothing to return as a result of execution and the requirement of client confirmation about procedure execution is not needed.	It is useful for designing systems which involve simple RPCs.	RRA protocol implements exactly once semantics which requires storage of a lot of information in the server cache and can lead to loss of replies that have not been delivered.
As no acknowledgement or reply message is involved, only single message is transmitted from client to server.	In a simple RPC all the arguments and result fit in a single packet buffer while the call duration and intervals between calls are short.	To overcome the limitations of RR protocol, RSA protocol is used.
The client proceeds after the request message is sent as there is no reply message.	This protocol is based on the idea of using implicit acknowledgement to eliminate explicit acknowledgement messages.	In this clients acknowledge the receipt of reply messages and the server deletes information from its cache only after it receives an acknowledgement from client.







(ii) State "TRUE" or "FALSE"."WWW is a distributed system but Internet is a computer network".

The above statement is **true.**
Distributed system is defined as "a collection of independent computers that appears to its users as a coherent system." This means that even if there are multiple heterogeneous components within the distributed system communicating with each other, but from a user's point of view it is a single system. An example of a distributed system would be the World Wide Web (WWW) where there are multiple components under the hood that help browsers display content but from a user's point of view, all they are doing is accessing the web via a medium. From an end-user perspective, the Internet might appear to be a single system (e.g., email) but in reality, email is not the Internet but a service provided on top of the Internet utilizing existing Internet infrastructure.

(iii) What is NIC in a distributed system? What are various components in an NIC?

- Network Interface Card (NIC) is a hardware component that is present on the computer.
- It is used to connect different networking devices such as computers and servers to share data over the connected network.
- It provides functionality such as support for I/O interrupt, Direct Memory Access (DMA) interfaces, partitioning, and data transmission.

Network Interface Card contains the following essential components –

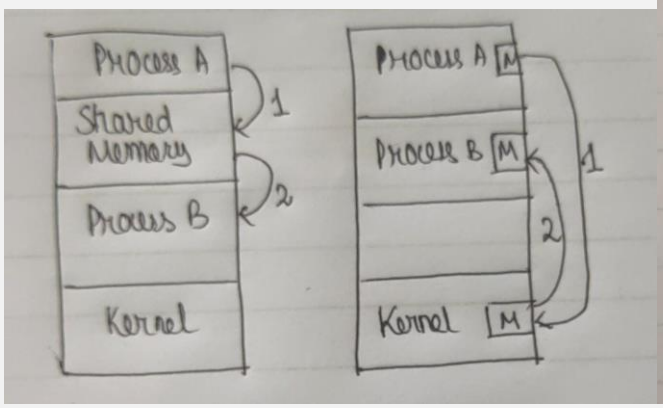
1. Memory: Memory is one of the most important components of the NIC. It is used to store the data during communication.
2. Connectors: connectors are used to connect the cables to the Ethernet port.
3. Processor: Processor is used for converting the data message into a suitable form of communication.
4. Jumpers: Jumpers are the small device that is used to control the communication operations without the need of any software. It is also used to determine settings for the interrupt request line, I/O address, upper memory block, and type of transceiver.
5. Routers: To provide wireless connectivity, routers are used.
6. MAC address: MAC address is also referred to as a physical network address. It is a unique address that is present to the network interface card where ethernet packets are communicated with the computer.

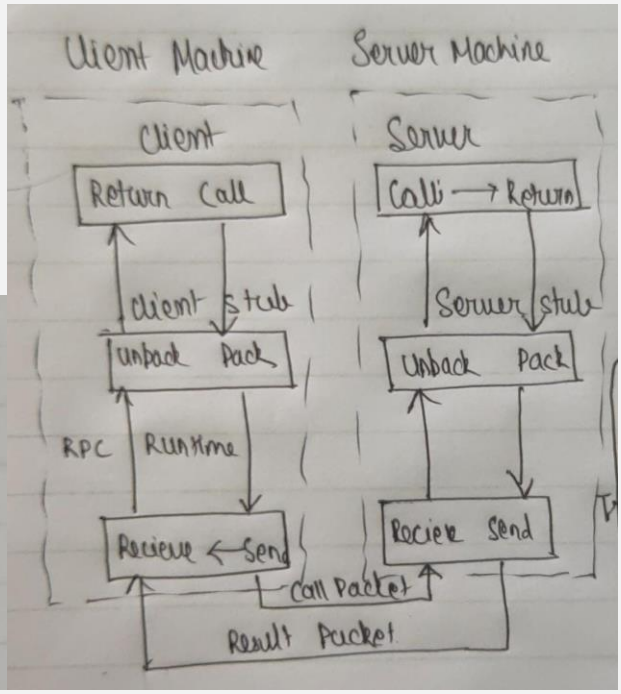
(iv) What is the need of marshalling and unmarshalling in a distributed system? Give an example scenario for the marshalling and unmarshalling.

Marshalling is the process of transforming the memory representation of an object to a data format suitable for storage and transmission. Unmarshalling refers to the process of transforming a representation of an object that is used for storage or transmission to a representation of the object that is executable. Marshalling allows communication between remote objects by converting an object into a serialized form. Remote procedure call (RPC) mechanisms are implemented via marshalling, where different processes and threads typically have different data formats, which require the use of marshalling between them. One machine Marshalls the data to send it to its destination where it is unmarshalled.

(v) Differentiate between IPC and RPC. Illustrate using a diagram.

IPC	RPC
Inter-process communication (IPC)	Remote procedure call (RPC)
a set of techniques for the exchange of data among multiple threads in one or more processes.	an Inter-process communication technology that allows a computer program to cause a subroutine or procedure to execute in another address space (commonly on another computer on a shared network) without the programmer explicitly coding the details for this remote interaction.
Processes may be running on one or more computers connected by a network.	subroutine or procedure to execute in another address space (commonly on another computer on a shared network)





(vi) What do you mean by RPC Call Semantics? Which is better? Justify.

- In RPC system the call semantics determines how often the remote procedure may be executed under fault conditions.
- "Exactly Once Semantics" is the strongest and the most desirable call semantics.
- It eliminates the possibility of a procedure being executed more than once irrespective of the number of retransmitted call.
- The implementation of exactly-once call semantics is based on the use of timeouts, retransmission, call identifiers with the same identifier for repeated calls and a reply cache associated with the callee.

(Vii) What features justify the periodic execution of diagnostic software in a large scale distributed system?

features that justify the periodic execution of diagnostic software in a large scale distributed system are:

- Reliable
- Scalable
- Maintainable Applications

(viii) Write the classification of faults in a distributed system with respect to behavior and duration of the fault.

Classification of faults:-

1.Fail stop:- A process halts and remains halted. Other processes can detect that the process has failed.

2.Crash:- A process halts and remains halted. Other processes may not be able to detect that the process has failed.

3.Omission:- a message inserted in an outgoing message buffer never arrives at the other ends incoming message buffer.

4.Arbitrary:- Process or channel exhibits arbitrary behavior.

5.Timing failure:- Clock drift exceeds allowable bounds.

(ix) What is state holding time? Explain with an example.

State holding time refers to the amount of time node remains in a particular state either faulty or fault-free.

Q3. (a) Write the similarities & difference between following using a table.

i) Synchronous Vs. Asynchronous Distributed Systems

Similarities
The distributed systems is based on computer clocks and timing events.

Synchronous	Asynchronous
Each message is sent and received under known bounded time.	There are messages with transmission delays.

ii) Reliable Vs. Unreliable Systems

Similarities
Both the models are used to perform real world tasks

Reliable	Unreliable
These systems are used when accurate deliveries are required	These systems are used when fast deliveries are required.

iii) Completely Connected Vs. Not-Completely Connected Topology

Similarities
In these topology, there exists a path between any 2 nodes.

Completely Connected	Not-Completely Connected
There is a direct path between any 2 nodes and hence costly to construct.	There may or may not be a direct path between 2 nodes and hence cheap to construct.

iv) Monolithic Vs. Microkernel Architecture

Similarities
Both are used for Inter-Process Communication.

Monolithic	Microkernel
Old architecture and bigger in size.	New architecture and generally smaller in size.

v) Syndrome Decoding Vs. Fault Model

Similarities
Both are methods to decode a linear code over a noisy channel.

Syndrome Decoding	Fault Model
Lookup table is used in syndrome decoding.	Lookup table is not used in fault model.

(b) A node in a distributed system can work on two types of tasks. Type-1 tasks arrive according to a Poisson process with a rate of 100 per second and type-2 tasks according to a Poisson process with a rate of 200 per second. The two arrival processes are independent. Both types of tasks have exponentially distributed service times, with a mean of 3 milliseconds. Tasks are processed in order of arrival.

(i) What is the probability that during 10 milliseconds no new tasks arrive?

- Let $\lambda 1$ = the arrival rate of type-1 tasks
  $\lambda 2$ = the arrival rate of type-2 tasks.
- So $\lambda 1 = 0.1$ and $\lambda 2 = 0.2$ tasks per millisecond.
- The arrivals of type-1 & type-2 tasks are also Poisson with rate $\lambda 1 + \lambda 2 = 0.3$ tasks per millisecond.
- Hence, the probability that during 10 milliseconds no new task arrives is
  $P(\text{no arrival in } [0, 10]) = e^{-(\lambda 1+\lambda 2)\cdot 10} = e^{-3} \approx$ **0.05** .

(ii) Determine the mean number of tasks at the node

- Let ρ be the utilization of the processor, so $\rho = (\lambda 1+\lambda 2)\cdot 3 = 0.9$.
- The mean number of tasks, $E(L) = \rho/(1-\rho) =$ **9**.