Question 6.1: Construct an argument as to why indirect Communication may be appropriate in volatile Environments. To what extent can this be traced to time uncoupling or indeed a Combination of both.

Answer: Reason for possibility of indirect communication in volatile environment.

→ The following is the reason for using the indirect Communication in volatile environment.

→ The direct communication is not able to deal with the changes in the client server communication; this is because, in direct communication, it is more complex to reflex replace the alternative server with the same functionality.

→ Moreover, if the server fails then it directly affect the client which must

obviously fails the communication; but the indirect communication can handle these problems of direct coupling and inherits the properties through space by uncoupling and time uncoupling.

- Extent of space uncoupling and time uncoupling:

→ Space uncoupling: The space uncoupling is that in which sender does not know about identity of receiver and receiver doesn't know about the identity of sender.

→ Time uncoupling: In this coupling technique the sender and receiver have separate lifetime; because of this separate lifetime, this does not involve the

sender and receiver have separate lifetime; because of this separate lifetime, this does not involve the sender and receiver for the communication at the same time. So, there will not be any communication failure between client and server.

Question 6.2 Section 6.1: States the message passing in both time- and space-coupled- that is, message are both directed towards a particular entity and require the receiver to be present at the time of the message send. Consider the case, though, where message are directed towards a name rather than an address and this name is resolved using DNS. Does such a system exhibit the same level of indirection.

Answer 6.2

Explanation: "Yes" the above given information also faces the same level of indirection and it is explained as follows:

→ It is a known fact that that DNS name searches for more the one IP adress and this is to reduce the workload among the multiple computers.

→ With this, it is clear the name server Provides the indirection which means the render does not exactly bound to the given receiver because the address may be bounded to any of possible receivers; So, this follows the concept of space uncoupling which is extremly different on communication.

→ In space uncoupling, the communication is made explicitly through intermediary such as group multicasting and message

queuing. Therefore, the given case faces some level of indirection.

Question 6.3: Section 6.1: refers to a system that are space coupled but time-uncoupled - that is, message are directed towards a given receiver (or receivers) but that receiver can have a lifetime independent from the senders. Can you construct a communication paradigm with these properties? for example, does email fall into this category?

Answer 6.3

Explanation: with the given case, the communication is possible because the message is directed toward the known identity and it is partially based upon different life-time of sender and receiver to make communication;

the given case required to have the following assumption:

Assumption 1:

while making the communication between render and receiver to make communication; because with the given property rule of space-coupled but time uncoupled, it is interpreted that receiver may not exist on the other side.

Assumption 2: With the given property rule of space-couple but time uncoupled, it is interpreted the receivers is available but not available to receive the message on given time.

Question 6.4: As a second Example, consider the communication paradigm refered to as queued RPC as introduce in Rover [Joseph et al. 1997] Rover is a toolkit to support distributed System Programing in mobile environments where participants in communication may become disconnected for periods of time. The System offers the RPC Paradigm and hence call are directed towards a given server. (clearly space-coupled) The calls though are routed through an intermediary, a queue at the sending side and are maintained in the queue until the receiver is a avaiable. To what extent is this time uncoupled? Hint: Consider the almost philosophical Question of weather a recipient that is temporarily unavaiable exists at that point in time.

Answer 6.4

Extent of time-uncoupled property for given comm let need to identify up to which extend the time uncoupled in followed on communication Paradigm.

The decision in based upon the point of interpretation of different lifetimes between sender and receiver on communication and the interpretations are as follows.

→ If the interpretation in assumed that the receiver is not exist to receive the communication then, this in not the property of time uncoupled.

→ If the interpretation in assumed that the receiver in present but not available at the given time which means that the server exist but disconnected due

to some problem then, this follows property of time uncoupled.

Question 6.5: If a communication paradigm is asynchronous is it also time uncoupled? Explain your answer with examples as appropriate.

Answer 6.5: Relation between asynchronous communication and time uncoupled follows the same rule. The best example, according to given scenario in mail communication a file transfer

Example 1: The email communication fits into Relationship of both asynchronous and time uncoupled.

→ If the sender sends a mail which is directed to corresponding receiver who may or may not present at the time to receive the message, but the receiver receive the message when they are connected to mailbox.

→ The communication is possible in this case because the delivery of message is made to corresponding person and it's achieve later.

→ Thus, the sender and receiver do not depent upon the time.

Question 6.6 : In the context of group communication service, provide example message exchanges that illustrate the difference between causal and ordering.

Answer 6.6 : The group communication must allow the people to process on different host and it must provide support for communication and synchronization between them.

"Difference between canual and total Ordering":

Canual Ordering	total Ordering
→ The canual order multicast is a process which needs to Prove the following statement: multicast $(g,m) \rightarrow$ multicast (g,m')	→ In this operation, each Process maintain same ordering decission based upon the identifiers.
→ The contain Symbol "->" and it represent the happened before relation.	→ This include two operation's such as "To multicast" and To deliver.
→ In group communication, the canual ordering allow's the Process once the message "happen's before" another message in distributed System	→ In group communication, the message must be delivered before another message at Process; So that it follow's t same order in all the proces
→ The canual ordering relation-ship maintain's the result of related message at all process.	→ The total ordering relationsh Preserve the same order at all process.

Question 6.2: Consider the fire Alarm example as written using JGroup (Section 6.2.3). Suppose this was generalized to support a variety of alarm types, such as fire, flood, intrusion, and so on. What are the requirement of this application in terms of reliability and ordering.

Answer: Requirement in terms ordering:

for ordering; there are not important req. discussed in "fire Alarm" example, because there is no strong requirement to protect the ordering across alarm types.

Moreover, this application is simple and there is no sequence of message related to alarm. Thus there is no important requirement for ordering.

Question 6.8: Suggest a design for a notification mailbox service that is intended to store notification on behalf of multiple subscribers, allowing subscribers to specify when they require notification to be delivered. Explain how subscriber that are not always active can make use of the service you describe. How will the service deal with subscribers that crash while they have delivered turn on.

→ Use of mailbox service:

If the subscriber are not always active, then the following is the way to make use of the service

- The service is used by the registering the client with it and the client receives the registration object.
- This object is saved in a file to register the "RemoteEventListener" provided by the mailbox service.

→ This creates the event generators for the event that requires the notification; thus by this way the notifications are notified later even though the subscribers are not always active in the mailbox service.

→ Use of mailbox on crashing.

- The mailbox can be restored by the registration object when it is restarted.
- So, whenever the mailbox needs to receive the events than the delivery is turned on and if it is not req. than it makes the delivery off.

Question 6.9: In Publish-subscriber system explains how channel-based approaches can trivially be implemented using a group communication service? why is this a less optimal strategy for implementa content-based approach.

Answer 69: Channel based approach on public subscribe system:

This is one of the comfortable approach for Public subscribe system.

⇒ This is the scheme which is successfully used in common object Request Broker Architecture (CORBA Event Service)

= In this approach, the events are published by the pabishers to named channels and subscriber select anyone frome the name channel the to receive all the event's --- Ported by publisher.

Reason for less optimal in content based approach.

The content based approach consider on less optimal strategy because of following reason.

- This is more expensive than the channel and topic based approach in public-Subscribe system.
- The query language involved in this content based approach varies from System to System.
- Mapping operation cannot be possible; So, the communication is more annoying tive and content oriented.

Question 6.10 : Using the filtering-based routing algorithm in figure 6.11 as a starting Point, develop an alternative algorithm that shows how the use of advertisement can result in significant optimization in terms of message traffic generated.

Answer 6.20: Working method of filtering based routing algorithm:

This is the algorithm in which the broker receives the request and it passes the notification to all connected nodes.

- The match function matches the event from subscription list and then it forward the events to all the nodes in subscription.
- while using the math function, the event is matched against the routing table and then it forwards path to lead to a subscription

Advertisment based Approach: The above filtering based approach, the advertising approach creates a lot of traffic due to subscriptions and this can be reduce by the advertisment based approach.

- Similar to filtering based approach the advertising approach follows the same principle to publish the events.
- The only difference is that each node is now supported with the additional advertisement-based routing table.

Question 6.11: Construct a step-by-step guide explaining the operation of the alternative rendezvous based routing algorithm shown figure 6.12.

Answer 6.11: Step by step procedure of rendezvous routing algorithm:

This is the approach which contain rendezvous nodes and these nodes referred as broker nodes. This algorithm is

achieved:

- first the subscription 's' is received on the (SN) and then it returns one or more rendezvous nodes. These nodes take the responsibility for the given subscription and additionally the nodes maintain the list of subscriptions like filtering based approach and based on the list it forwards all the events matches to the subscription's nodes.
- The second step is whenever the event "e" is published, atleast one or more rendezvous nodes is returned by the function $EN_{(i)}$ and it matches the event "e" against a subscription.

Question 6.12: Building on your answer to exercise 6.11, discuss two possible implementation of EN(e) and SN(s). Why must the intersection EN(e) and SN(s) be non-null for a given e that matches s (the intersection rule)? Does this apply in your possible implementation.

Answer 6.12: Possible implementation of "EN(e)" and "SN(s)":

Rendezvous routing algorithm is one of the approach which control the subscription and this contains rendezvous nodes. This algorithm achieved only if the following steps are achieved:

- first Subscription "s" is received on "SN(s)" and then it returns one or more rendezvous nodes. These

nodes takes the responsibility for the given subscription and additionally, the nodes maintains the list of subscription like filtering based approach and based on the list it forwards all the matching events to rest of subscribing nodes.

- The record step is whenever the event "e" published. it returns the rendezvous nodes and these nodes matches the event "e" against subscriptions.

Reason for the intersection rule: In rendezvous based routing algorithm, the subscription events are sent to one or more nodes and publish event routes all the subscription. for any specific event. the nodes calculated and

offered by "EN" must overlap with the calculation of "SN" to find the matching nodes to the subscription and then it in forward in the network.

Implementation: Consider the following two example implementation of rendezvous based routing algorithm.

Example:

Assume the first example an implementation of distributed hash table (DHT) which contain publish subscription System. In which EN and SN are the identical operation which implement the hash function used for topic Name.

Application of Rendezvous based routing in implementation : "Yes" both the above implementation applies the rule of interrection and argument rule.