1) What is/are the difference between end-to-end delay and packet jitter? What are the causes of packet jitter?

End-to-end delay: It is the time taken by a packet to travel across the network from source node to destination node. It is the accumulation of transmission, processing and queuing delays in routers; propagation delays in links and end system processing delays.

Packet Jitter: The crucial component of end-to-end delay is the varying queuing delays that a packet experiences in the network's routers. Because of these varying queuing delays, the time from when a packet is generated at the source until it is received at the receiver can fluctuate from packet to packet. This phenomenon is called packet jitter.

- End-to-end delay is because of sum of number of different delays whereas packet jitter is only because of Queuing delay.
- End-to-end delay is a single packet's delay measure. Jitter is the difference in two packets delay. In other words, jitter is measuring time difference in packet inter-arrival time.

Causes of packet jitter:
Jitter is an undesirable effect caused by the inherent tendencies of TCP/IP networks and components. The sending side transmits packets in a continuous stream and spaces them evenly apart. Consider an audio being sent over the network. Because of network congestion, improper queuing, or configuration errors, the delay between packets can vary instead of remaining constant. This variation causes problems for audio playback at the receiving end. Playback may experience gaps while waiting for the arrival of variable delayed packets.

 2) Why is a packet that is received after its scheduled playout time considered Lost?

A packet is lost either if it never arrives at the receiver or if it arrives after its scheduled playout time. Because the application will be unable to place this packet in other packet's schedule. It cannot be played out in other time apart from the playout time that was scheduled for it. Hence it is considered to be lost from application's perspective. Packet loss is typically caused by network congestion.

3) What is the role of a SIP registrar? How is the role of an SIP registrar different from that of a home agent in Mobile IP?

Role of SIP registrar:
- The SIP registrar translates fixed human identifiers (for example, bob@domain.com) to dynamic IP addresses.
- A SIP registrar is a server(device) that accepts REGISTER requests from the users.
- It places the information it receives in those requests into the database known as "Location Service" for the domain it handles.
- The process of registration associates a user with a particular location, (IP address); this association is known as a 'binding' in SIP.

In Mobile Internet Protocol (Mobile IP), a home agent is a router on a mobile node's home network that maintains information about the device's current location, as identified in its care-of address. A home agent may work in conjunction with a foreign agent, which is a router on the visited network.

The main role of the Home Agent is to log and discard care-of-address that was used by the mobile node or foreign agent. And the requested logging and discarding is done within a given lifetime, after which it is not valid.

  Whereas, a SIP registrar is a server that accepts registrations from users and places these registrations, (which are essentially location information), in a database known as a Location Service. The process of registration associates a user with a particular location, (IP address); this association is known as a 'binding' in SIP. When there is an incoming session for a user within a domain, the proxy

server will interrogate the Location Server to determine the route for the signaling messages.

4. Consider a DASH system for which there are N video versions (at N different rates and qualities) and N audio versions (at N different rates and versions). Suppose we want to allow the player to choose at any time any of the N video versions and any of the N audio versions.

A. If we create files so that the audio is mixed in with the video, so server sends only one media stream at given time, how many files will the server need to store (each a different URL)?

B. If the server instead sends the audio and video streams separately and has the client synchronized the stream, how many files will the server need to Store?

    A) Considering only one media stream is sent by the server,
       then at a given time, (N*N) files need to be stored in the server.
    B) Considering audio and video streams are sent separately then,
       (N+N) files will be stored in the server.