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SCENARIO 1: YouTube's Global Video Streaming Challenge.

1] Analyzing the Problem:

- What are the possible reasons why users in some countries experience buffering while watching YouTube videos?

  Buffering occurs when a video pauses or loads because data isn't downloaded fast enough for smooth playback. This happens when the internet or server can't supply video data quickly enough to keep the buffer full.

  Possible Reasons:

  - Slow or unstable internet connection.
  - Network congestion during peak hours.
  - Long distance between user and YouTube server.
  - Limited or overloaded CDN servers in that region.
  - Poor ISP routing or peering connections.
  - Device Limitations (old hardware or software).
  - ISP bandwidth throttling or regional restrictions.

- How do internet speed, CDN infrastructure, and server locations affect video streaming quality?

  A CDN (Content Delivery Network) is a group of servers placed worldwide to deliver videos from the nearest location to the user.

  Effect on Quality:

  - Internet Speed: Higher speed gives smoother, HD playback, slow speed causes buffering.
  - CDN Infrastructure: More CDN servers mean faster delivery and less delay; fewer servers cause slow streaming.

- Server Location: The closer the server, the lower the latency and better the video quality.

2] Optimizing the Streaming:

- Explain how CDNs [Content Delivery Networks] help in delivering Youtube videos faster.

- CDNs store (cache) YouTube videos on servers placed in different regions.

- Users get videos from the nearest server, not the main one, reducing distance and delay.

- This lowers buffering and speeds up video loading.

- CDN's balance traffic among many servers to prevent overload.

- They also improve reliability, as if one server fails, another nearby serves the video.

- How does adaptive bitrate streaming (ABR) improves user experience, even on slow networks?

ABR: ABR is a streaming technique where a video is stored in multiple quality levels (bitrates). The player constantly checks the user's internet speed and automatically switches between qualities to keep playback smooth.

ABR Improves User Experience:

- Adjusts video quality based on real-time internet speed.

- Prevents buffering by lowering quality when the network slows down.

- Switches back to higher quality when speed improves.

- Keeps playback smooth and continuous on all types of connections

3] Decision - Making:

- If you were in charge of YouTube's Streaming Infrastructure what three improvements would you implement to ensure smooth video playback for all users?

1) Expand CDN Servers:

Add more CDN and edge Servers in different regions so user gets videos from nearby locations, reducing buffering and delay.

2) Smarter ABR System:

Improve adaptive bitrate streaming to quickly adjust video quality based on speed changes for smoother playback.

3) Use Advanced Video Codecs:

Use modern compression formats like VP9 and AV1 to reduce file size without losing quality, helping video loads faster on slow networks.

- Consider factors like server distribution, caching strategies, and advanced compression techniques e.g VP9, AV1.

Server Distribution:

Place server closer to users.

Caching Strategies:

Store popular videos at edge servers for faster access.

Advanced Compression:

Use VP9 or AV1 to reduce video size without losing quality.

SCENARIO 2: Launching a Decentralized Video Streaming Platform.

1] Explaining the Technology:

- What are the key benefits of using a decentralized P2P video streaming network instead of traditional CDNs?

Decentralized P2P Streaming:

Decentralized P2P streaming means video data is shared directly between users (peers) without relying on central servers. Control storage are distributed across the network.

Key Benefits over Traditional CDNs:

- Decentralized P2P streaming shares video data directly between users without central servers.

- Reduces infrastructure costs since users provide bandwidth and storage.

- Allows faster local delivery from nearby peers.

- Eliminates single points of failure; content remains available if some nodes go offline.

- How can blockchain technology help in content security and copyright protection?

Blockchain is a decentralized, temper-proof digital ledger that records transactions or data in linked blocks, visible to all participants.

How it helps in Content Security and Copyright protection:

- Records Content ownership and licensing on an immutable Ledger.

- Enables automatic royalty payments via Smart Contracts.

- Provides transparent access Control for authorized users.
- Verifies content authenticity and tracks distribution.

2] Addressing Challenges:

- What are the major risks of using P2P networks for video streaming?

1) Unreliable peer availability:
Peers may join or leave anytime, causing missing data.

2) Variable upload Speeds:
Not all peers can provide consistent streaming rates.

3) Security risks:
malicious peers can send corrupted or fake Content.

4) Latency and buffering:
Data may arrive slowly from distant or low-quality peers.

5) Regularity Issues:
Harder to Control copyrighted Content distribution.

- How can your platform ensure Smooth playback, Scalability, and minimal buffering for millions of users?

Use a hybrid model: combine P2P with edge caches or central Servers for reliability.

Implement chunking and error correction so missing pieces can be reconstructed.

Select reliable peers based on bandwidth, latency, and Past Performance.

- Deploy supernodes or stable high-bandwidth peers to anchor the network.
- Use adaptive bitrate streaming and multi-source downloads to maintain smooth playback.

3] Business Strategy & Future Growth:

- If you had to convince investors that a decentralised platform is better than YouTube or Netflix, what three key advantages would you highlight?

- Lower distribution costs: Users provide bandwidth and storage, reducing server expenses.

- Censorship resistance and reliability: No single point of failure; content stays available even if some nodes go offline.

- New monetization models: Smart contracts and token-based systems enable direct creator payments and innovative revenue streams.

- Predict how 5G technology and AI-driven content distribution will impact the future of streaming services.

5G technology: Provides higher speeds and lower latency, enable smooth HD/4K/8K streaming and faster peer-to-peer delivery.

AI driven content distribution: Optimizes video quality, predicts demand, prefetches content, and improves adaptive bitrate streaming for minimal buffering.

Together, they enable faster, smarter, and more reliable streaming for millions of users.