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MULTIMEDIA BRIDGE
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Cloud Conferencing: Practical Cases and Solutions

(云端会议：实际案例和解决方法)

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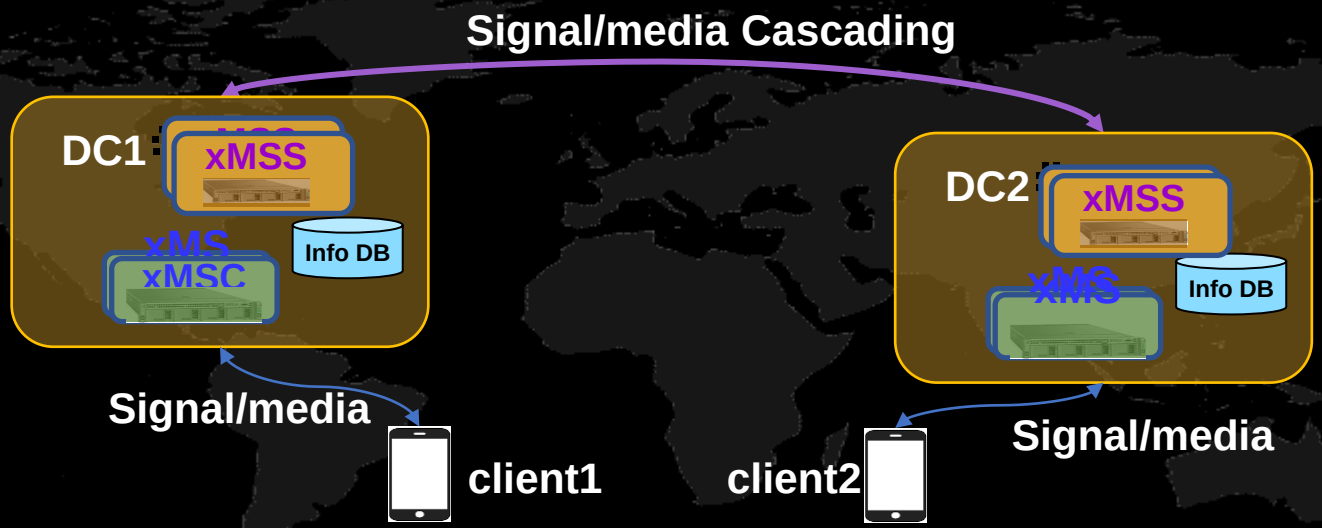
Topics

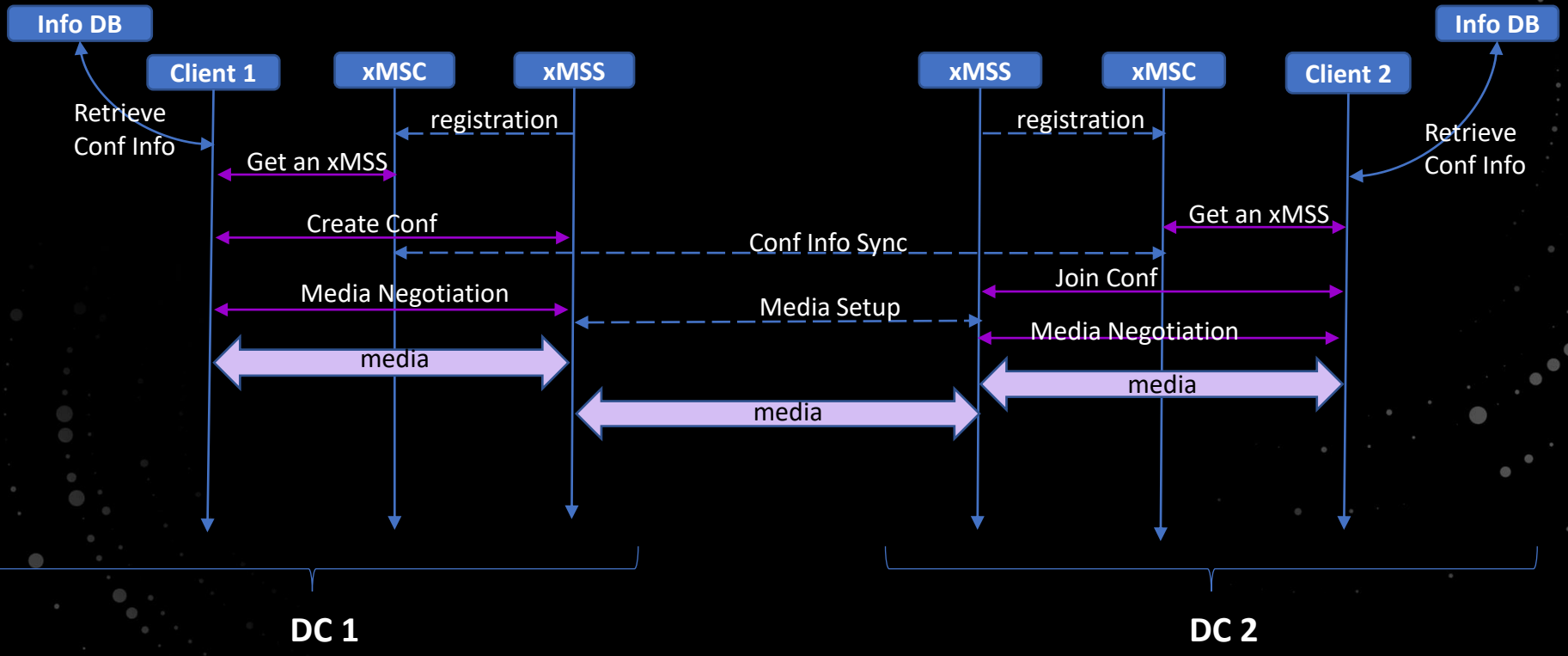
- **A System Infrastructure for This Talk （系统结构）**
- **Basic Call Flows （工作流程）**
- **Path Finding from Clients (寻找最佳路径)**
- **Client-Server Connections and Cascading Topology （连接和级联）**
- **Cloud Audio Mixer (音频混合器)**
- **Aggregated Packets for multiple audio streams and Video Grid View (聚合包)**
- **Client and Server Failover （故障转移）**
- Smooth Video Switching **（视频转传）**
- Media Quality Control (Packet retransmission, Pacing, FEC, Keyframe Request, Compensation， **媒体流质量控制**)
- Split Meeting and Join-Meeting Time, **（ 分裂会议和加会时间）**
- Firewall Penetration **（防火墙穿透）**
- Cloud and Enterprise Service Fusion **（云企无间隙服务）**
- Meeting Security （会议安全性）
- Metrics and Troubleshooting **（测量指标和故障排除）**

A High-Level System Infrastructure for This Talk （系统结构）



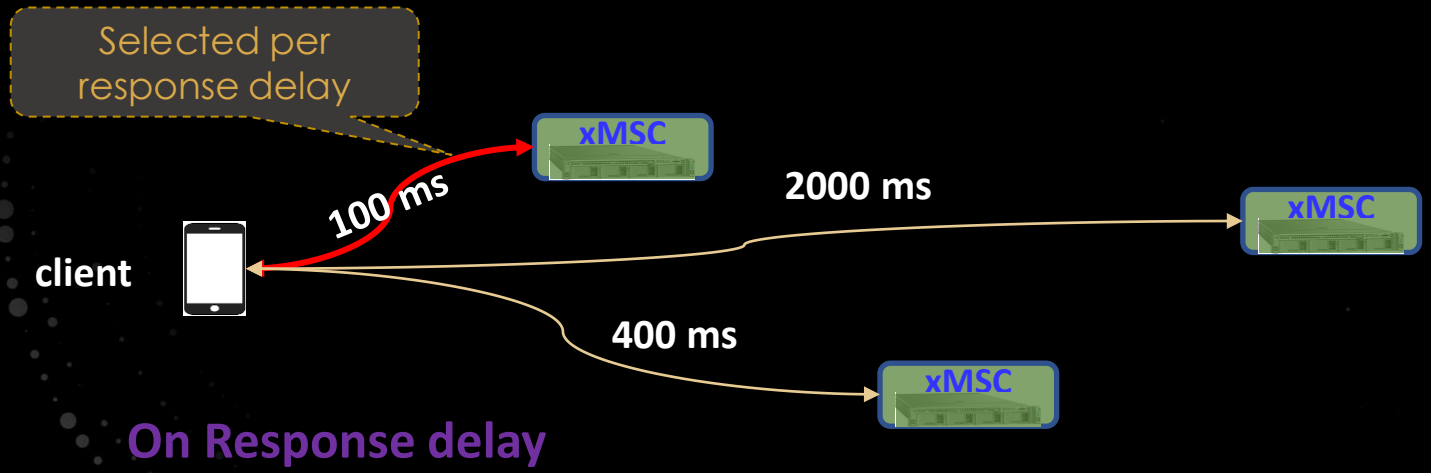
xMSS: Media Service Server providing the actual conference and media services
xMSC: Media Service Controller managing xMSS resource and controlling and monitoring conferences
Info DB: Information DB containing the conference information for starting/joining a conference.
DC: Data Center

Basic Call Flows （工作流程）



Path Finding from Clients (寻找最佳路径)

- Problems
  - A client has multiple media servers to select.
  - The goal is to fine the “shortest” path to the media server.



Path Finding from Clients cont'd

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Common Approaches

- Geolocation

- Use the IP geolocation information

- Ping

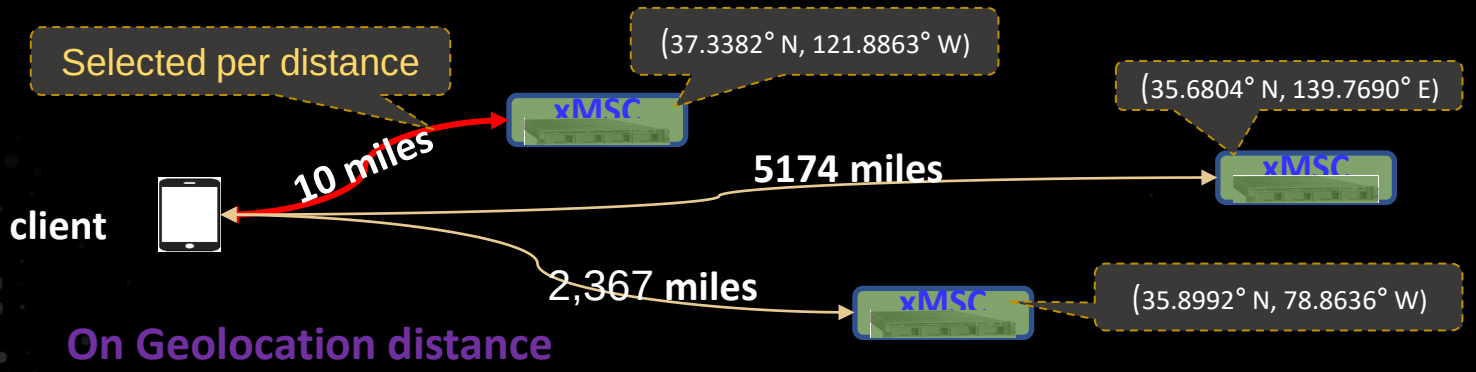
- *Base on HTTPS response time*

- Anycast

- **Rely on BGP/IGP to find the nearest route**

Path Finding from Clients: Geolocation

- Pre-determine the server geolocations
- Dynamically determine the client location
  - `navigator.geolocation.getCurrentPosition()`
- Select the server with the “shortest” distance

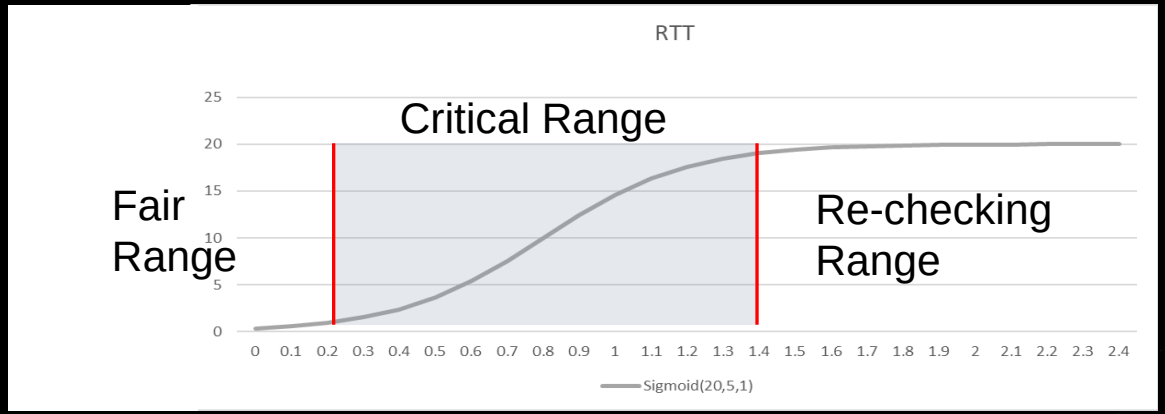


Problems:

- *information out of date, particularly for the new IP*
- *Metrics not directly from the media path – not accurate*

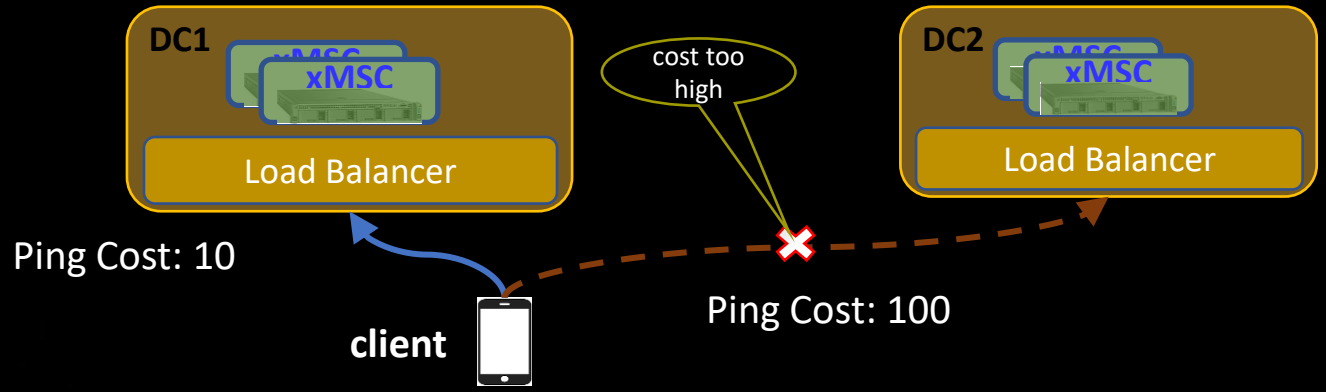
Path Finding from Clients: Ping

- Define a cost function: *response time + resource usage etc*.
- The goal is to find the path with the least cost from the list of xMSCs.



- Cost on RTT : sigmoid function: $\text{cost}(x) = \frac{20}{1+e^{-5(x-0.8)}}$

Path Finding from Clients: Ping – cont'd



Problems:

- Ping takes time. The cost number ➔ media traffic latency.
- Not reliable due to **the initial route creation**.

Solutions:

- Take the partial results
- Continue ping after the initial setup and re-setup if needed.

Path Finding from Clients: Anycast

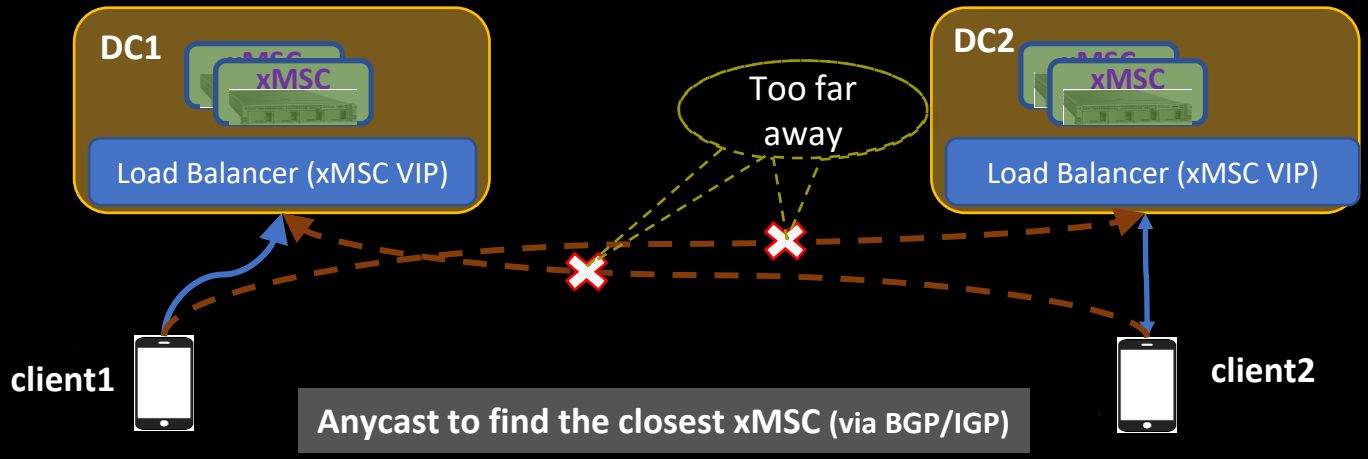
Anycast:

- *Used first in DNS. Used in CDN today.*
- *A single IP for multiple devices*

- *Shortest-path routing through BGP/IGP*
- *Redundancy with well-distributed deployment*

Anycast Ref: https://www.slashroot.in/what-anycast-and-how-it-works

Path Finding from Clients: Anycast –cont'd

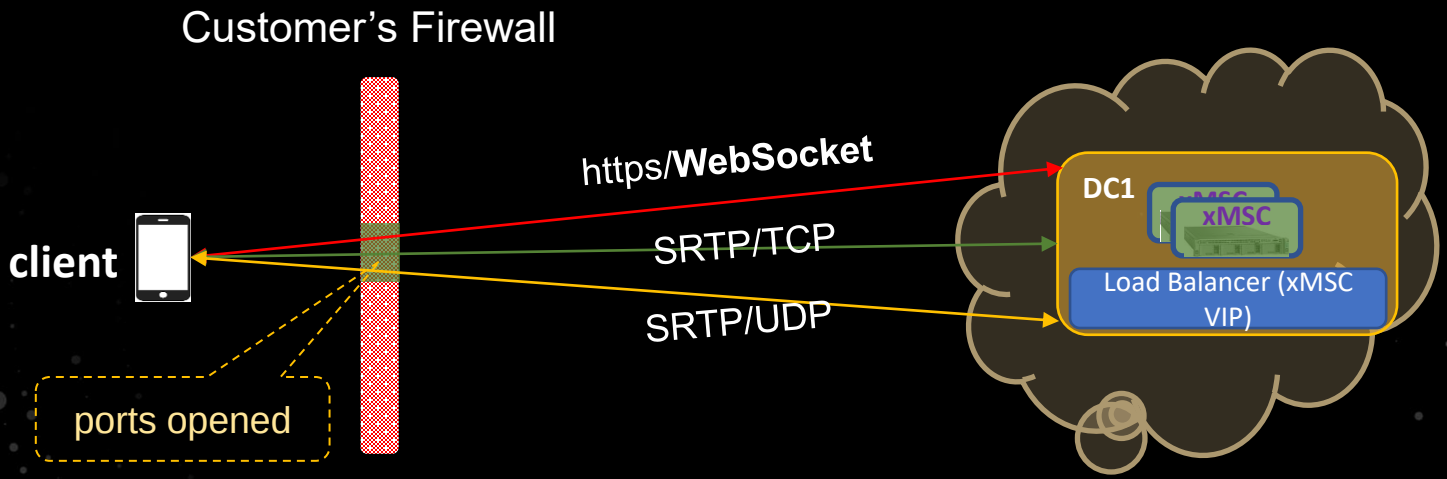


Notes:

- Leverage the anycast to obtain the shortest routes
- All of xMSC VIP have **the same IP address**
- Based on Network layer anycast (or application layer)
- Local xMSC load controlled through the edge router load balancer

Connections and Server Cascading (连接和级联)

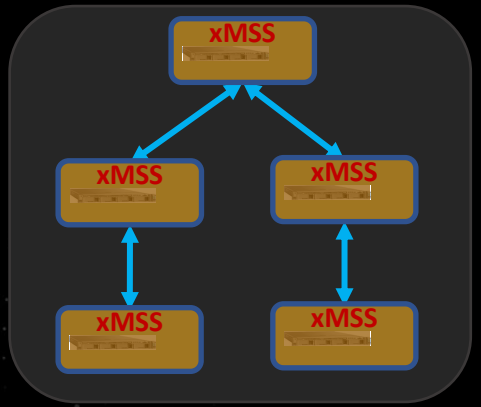
- **Client to Server**:
  - Connect to the server with the “shortest” route in networks



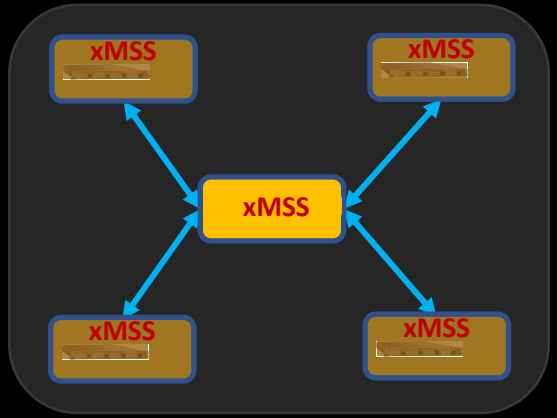
Media over WebSocket for fallback

Connections and Server Cascading -*Cont'd*

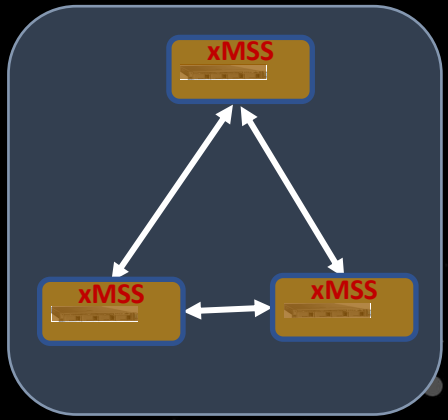
- **Server to Server Cascading**:



- Tree Topology, T120
- Meeting service
- Long Delay

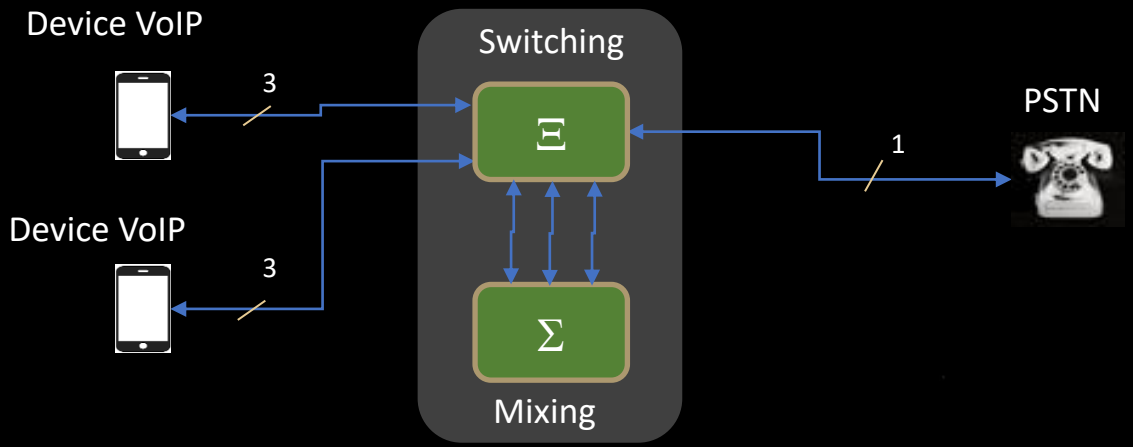


- Star Topology
- Global Audio Mixer and arbitrator for active speakers
- medium Delay



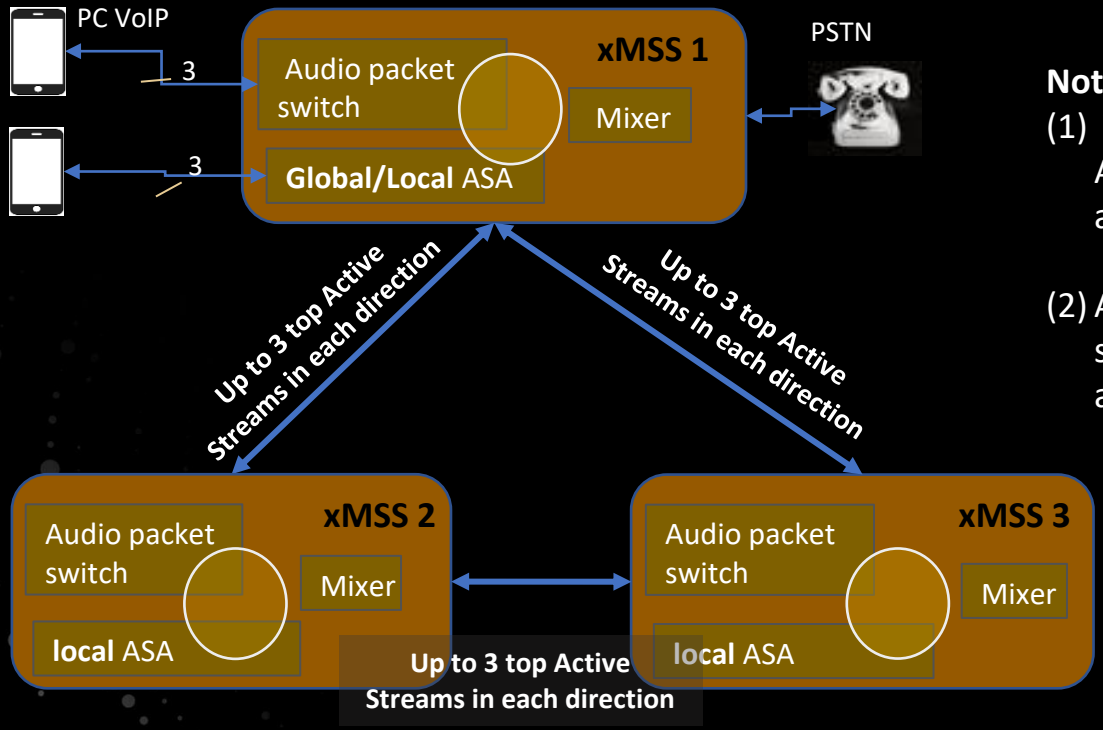
- Full-Mesh Topology
- Audio mixer and Audio/Video Switch
- low Delay

VoIP, PSTN and Audio Mixer (音频混合器)



- Devices such as PCs can take more than one stream without mixing
- Telephones take one mixed stream only

Distributed Audio Mixer (分布式音频混合器)

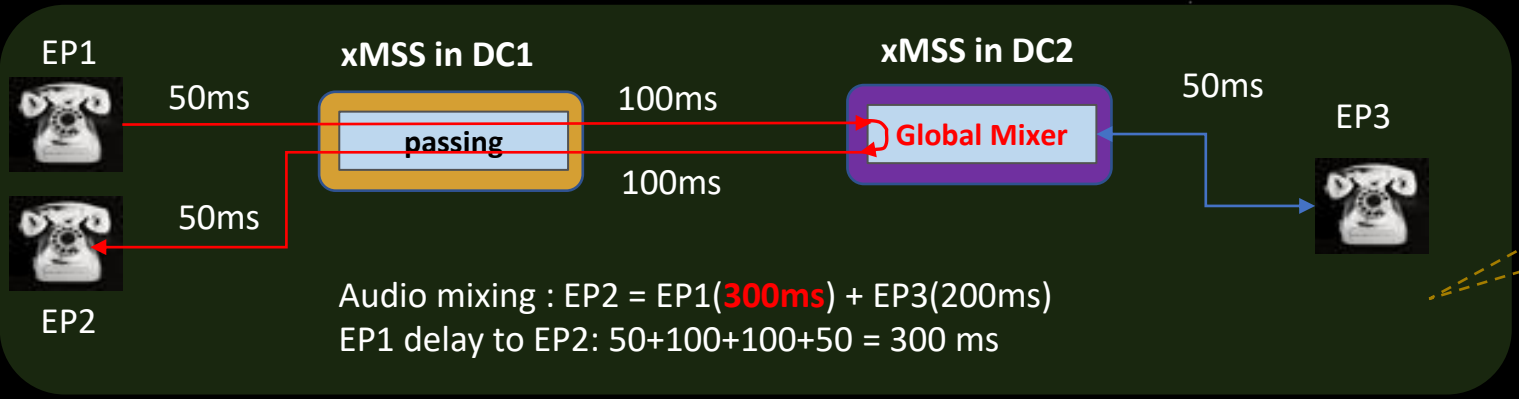


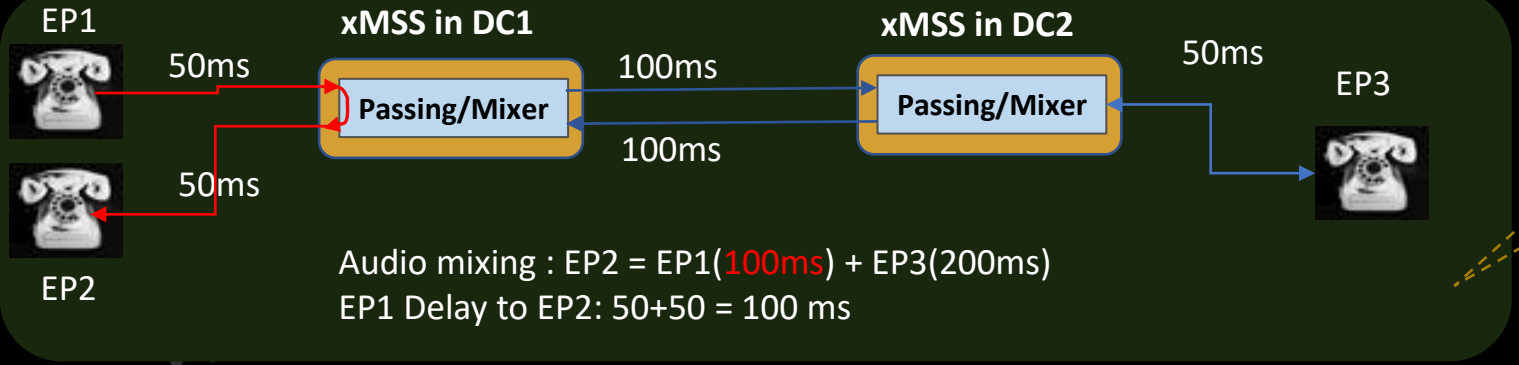
Notes:

(1) Without Global ASA (Active Speaker Arbitrator), each xMSS may pick up different active streams in the active transition time.

(2) A global ASA will help to sync up the active stream among all of xMSS, which will help the active video speaker determination.

Delay in Distributed Audio Mixer

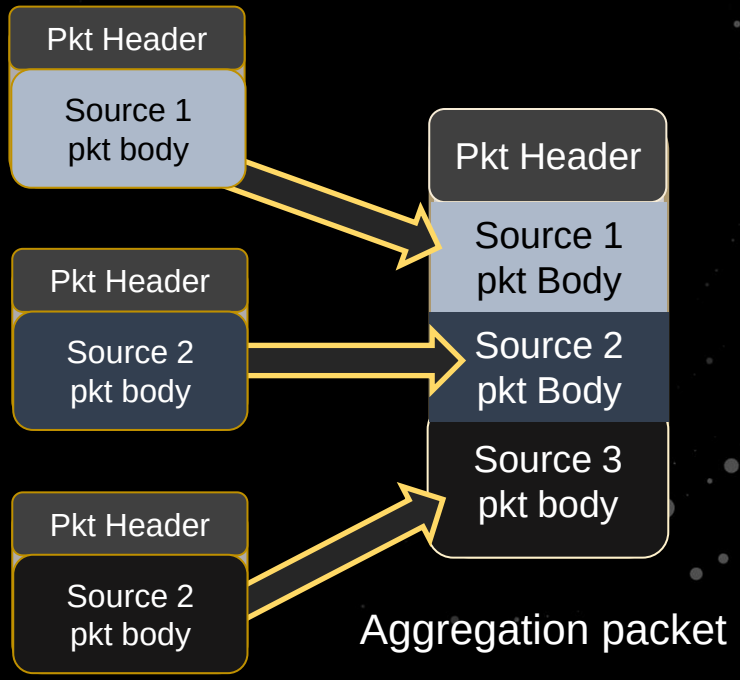




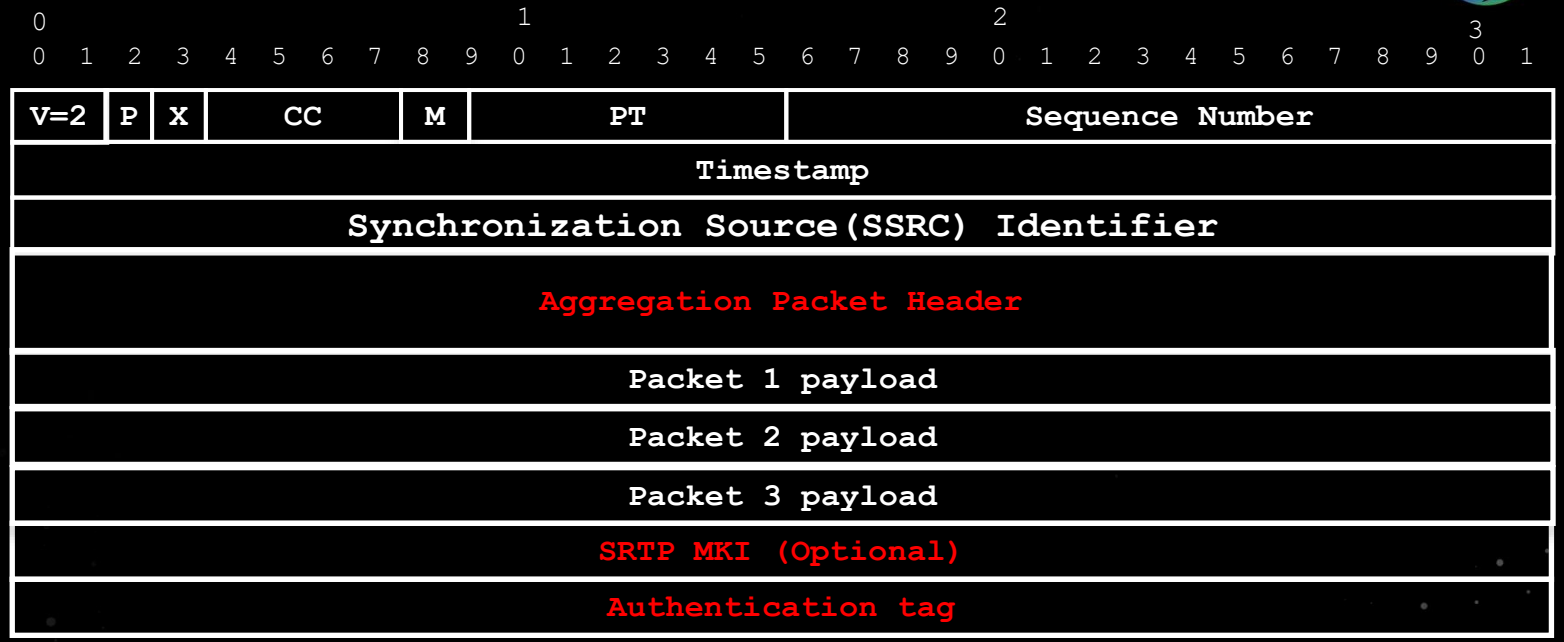
With distributed audio mixer, avoid 200 ms delay from EP1 to EP2.

Aggregation Packets for Multi-Audio Streams (聚合包)

- **Audio packets are small**
  For WB Opus 20kbp and frame size 10ms:
  - average packet size: 25 bytes
  - Networks overhead: 42 bytes (UDP)
- **Audio Local Mixing**
  - Save server CPU on Authentication
  - Good for Lip-Sync
- **Aggregation packets from different sources**
  - Improve the overall throughput



Aggregation Packets (聚合包) – *Cont'd*



Notes:

1. *The number of packages aggregated can be determined based on the aggregated packet size.*
2. *The aggregation packet is a good tool for the case which has more than a few of active speakers.*

Aggregation Packets for Video Grid View (网格视频)

- Local composition
- Small video resolution in each grid-panel
- Pack more than one grid video, reducing PPS
- Pack audio and video to one packet ➔ improve the lip-sync.

Client and Server Failover (故障转移)

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Failure Cases:

- **Client Failover**:
  - Networks Dropping, Server Failure, Client Failure
- **Server Failover**:
  - Server Crashing, New Image Deployment, DC shutdown

Client Failover


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Client Failover Types and Recovering:

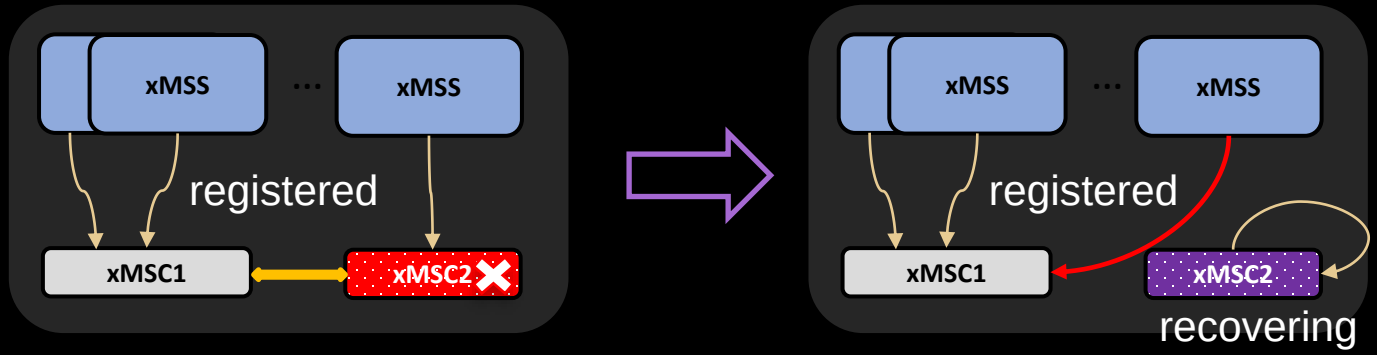
- Media:
  - ~5 second gap (WebRTC)
  - re-negotiation on media only
- Signaling on Sessions:
  - ~ 30 second gap
  - Re-connection on signaling only if media is in-touch.
  - Re-connection on both signaling and media. (common way)
- Meeting:
  - ~ 150 second gap
  - Re-setup and re-connection on the meeting

Server Failover

Failover Types:

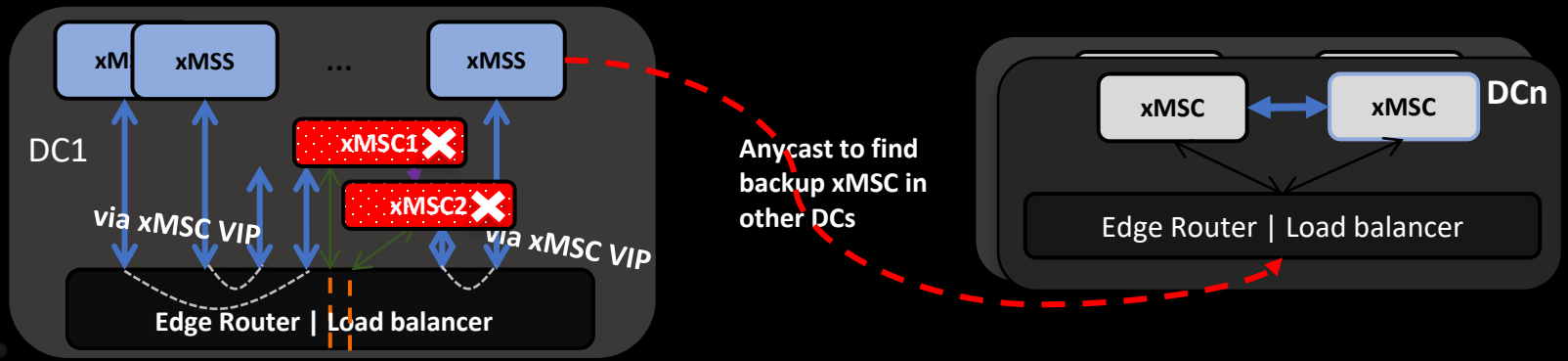
- Single xMSC failure
- All of xMSC failure in one DC
- xMSS failure

Server Failover: Single xMSC Failure



- **All local xMSC share all node and conference information**
- **When an xMSC is down,**
  - all its xMSS ➔ other xMSCs
  - The other xMSCs update the failed xMSS records.

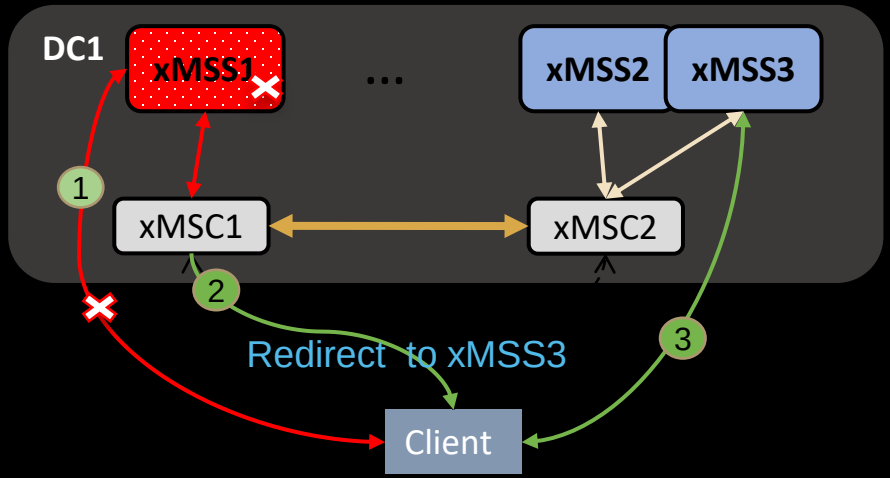
Server Failover: All xMSC Failure in a DC



All xMSCs are down within a DC

- All of DC xMSS ➔ other DC xMSC
- Other xMSCs update the hot conference information.

Server Failover: xMSS Failure



- The hosting xMSC detects the xMSS failure and removes it from the serviceable xMSS list
- The clients detect the failure and re-join the meeting, which results in a different (alive) xMSS.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To Be Continued

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Thank you

Cloud Conferencing: Practical Cases and Solutions

Summary

- This talk will cover the fundamental aspects to implement the large-scale distributed cloud-based conferences. The main topics include (1) The Best Path, (2) Cloud Audio Mixer, (3) Connections and Cascading (4) Aggregated Packets for Video Grid View and (5) Client and Server Failover. More topics may also include (1) Smooth Video Switching, (2) Media Quality Control, (3) Split Meeting and Join-Meeting Time, (4) Firewall Penetration, (5) Cloud and Enterprise Service Inter-op, (6) Metrics and Troubleshooting and (7) Meeting Security. Several patented ideas will be covered in the talk.