Scalable Real-time Collaborative Communication over NDN using Service Edge Routers

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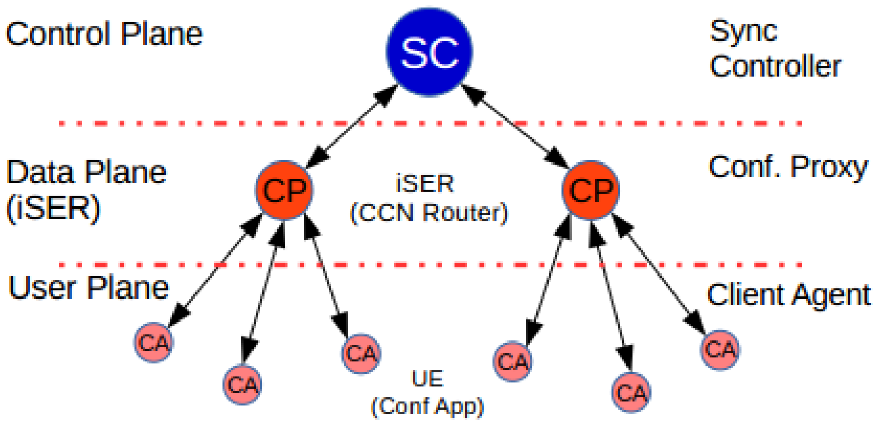
Introduction

- Recently we have converted our Audio/Video conferencing application to NDN from CCNx-0.8.2
- Reasons:
  - Scalability, after 12 participants (each consumes and produces the AV stream), the CCNx forwarder didn't seem to scale well.
  - To experience NFD performance

Quick Revision



[A]: Conference Agent

- CA discovers the CP to join the conference. CP returns the namespace to CA to join an active conference session
- Conference session namespace is pushed to CP and also shared with CA
- Namespace contains the time-stamp, sequence identifying the content
- CA maintains a local digest tree of namespaces for recovery

[B]: Conference Proxy

- CP maintains a local digest tree of namespaces for recovery
- Digest updates from remote conference participants are pushed to CA
- CP handles multiple conference sessions simultaneously using conf-Id
- CP pushes the digest updates to SC and receives updates from SC to be pushed to CA

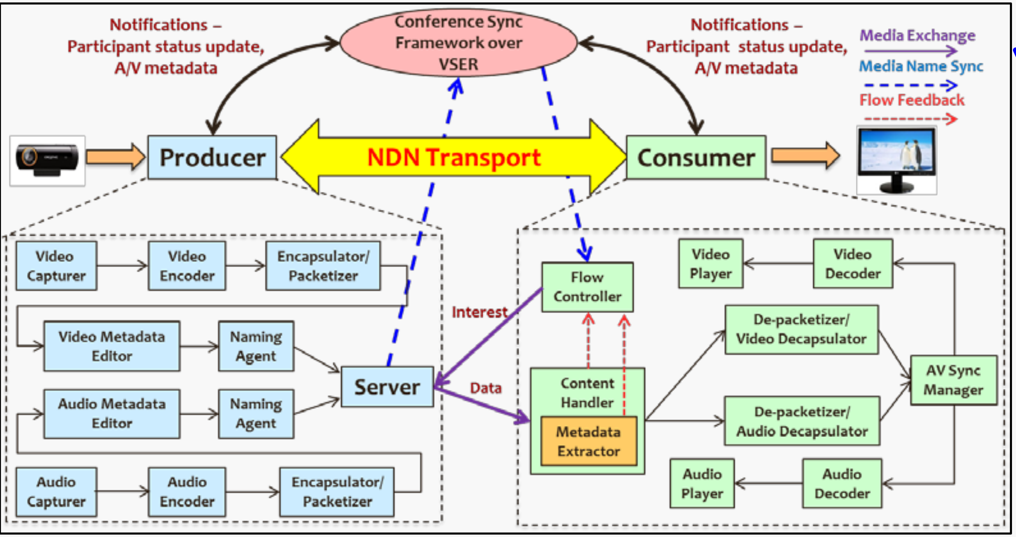
[C]: Sync Controller

- SC relays the namespaces among distributed CP instances
- Maintains a digest tree of conference state updates received from remote CP
- Updates from one CP are pushed to the remote CP based on the conference state and the Interest shown by specific CP

#R. Ravindran, X. Liu, A. Chakraborti, X. Zhang, and G. Wang, "Towards software defined icn based edge-cloud services," in Cloud Networking (CloudNet), 2013 IEEE 2nd International Conference on, pp. 227–235, Nov 2013

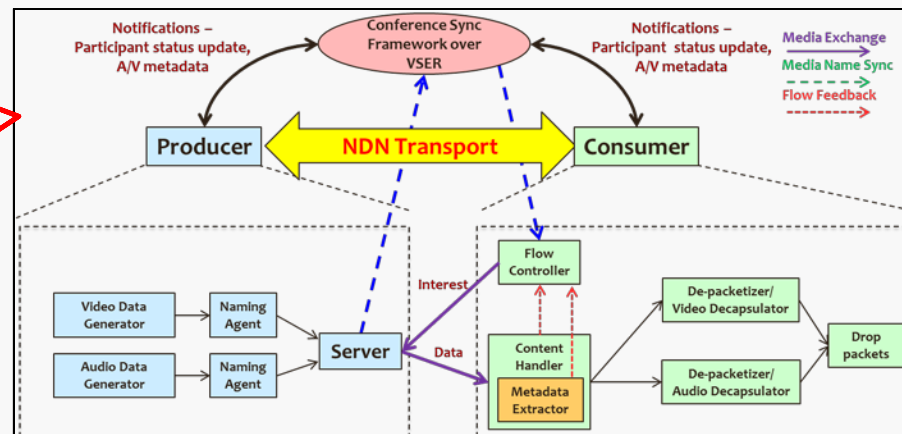
Application Architecture

GUI based version



- Used for actual demo
- Live feed is captured from Camera and Microphone

Headless version



- Used for emulation
- No GUI
- Emulated generation of AV packets
- Goal: testing scalability

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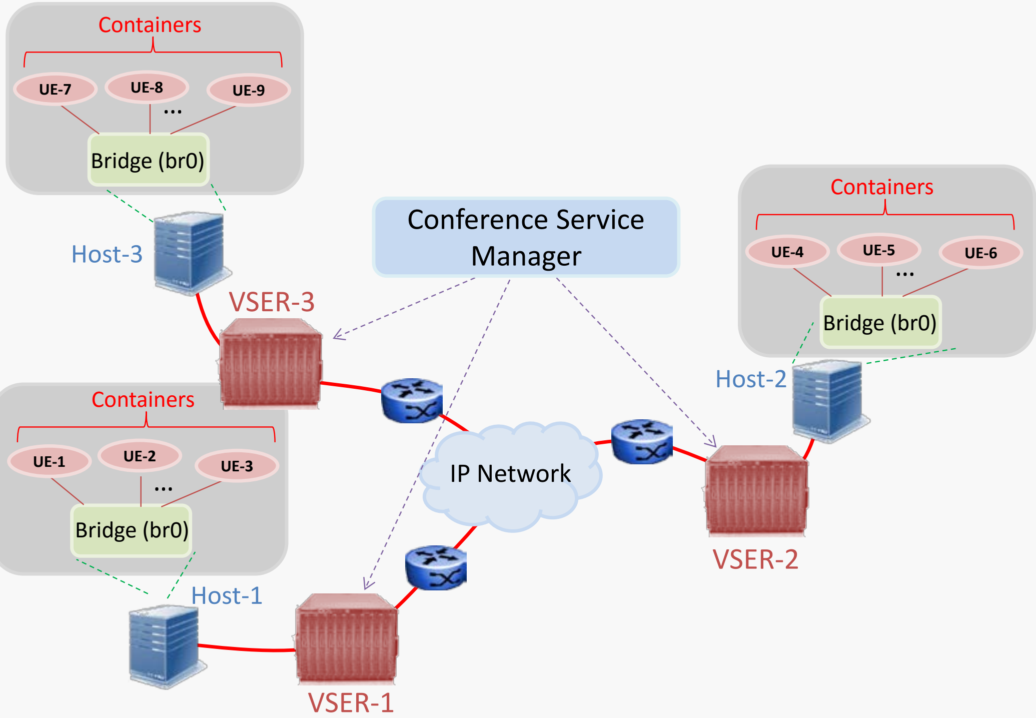
Emulation Details using Headless Version

- 3 Service Edge Routers
- 5 host server each running 9 containers
- Video traffic model was derived from our earlier prototype
- Audio content was modeled after G.729 codec generating CBR traffic of 30Kbps



Emulation Results

- ❑ Two sets of experiments:
  1. All participants are producing and consuming
  2. One consumer rest of the participants act as producer
- ❑ Caching affords better performance even for real-time applications
- ❑ The 90th percentile is <150ms and <250ms for Audio and Video

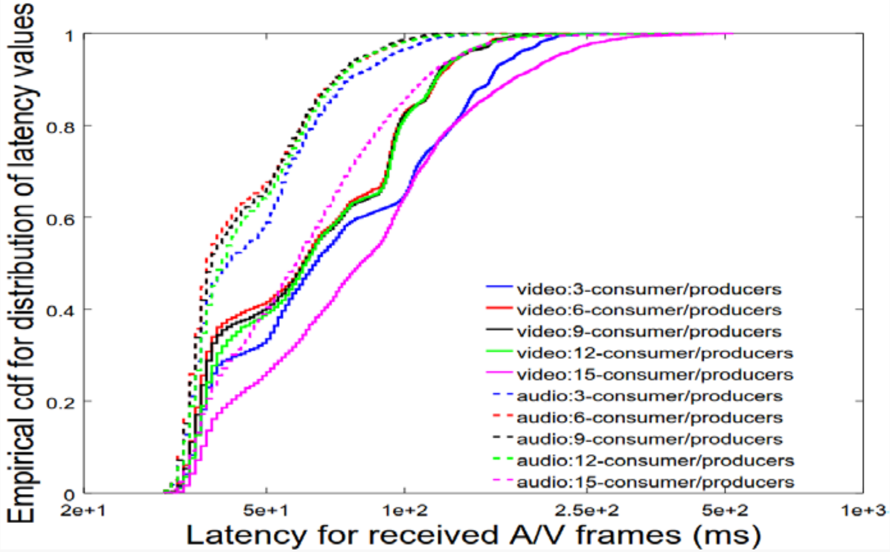
Percentage of usable contents at the consumer side (packets which are not lost and arrive within the deadline)

ALL CONSUMER-PRODUCER PARTICIPANTS

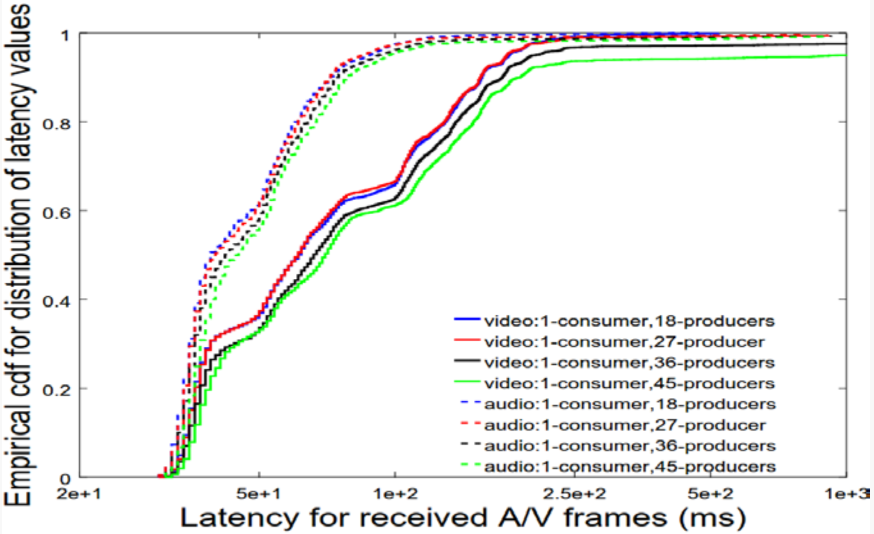
#Participants	3	6	9	12	15
$Quality_{AUDIO}$ (%)	99.93	99.98	100.00	99.76	97.69
$Quality_{VIDEO}$ (%)	99.91	100.00	99.97	99.81	97.46

SINGLE-CONSUMER MULTI-PRODUCER CASE

#Participants	19	28	37	46
$Quality_{AUDIO}$ (%)	99.51	99.01	98.53	97.93
$Quality_{VIDEO}$ (%)	99.16	98.91	96.78	93.63



Audio and video latency performance with all consumer-producer nodes



Audio and video latency performance with single consumer and multiple producer nodes

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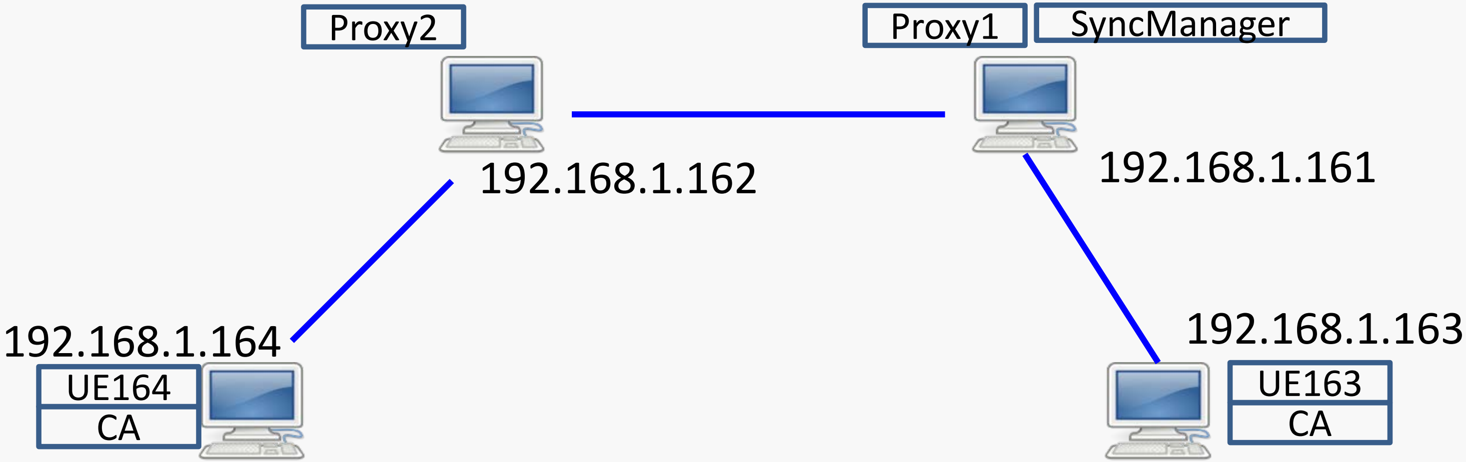
The Demo Topology

UE: User Entity
CA: Client Agent
NFD: NDN Forwarding Daemon



Thanks!

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Backup slides

Motivation

- ICN Deployment
  - Caching and aggregation at the Edge
  - Names for service/content/device enable context aware networking
  - Potential for new business models for network operators
- Service from the Edge
  - Service-centric Compute, Storage and Bandwidth scaling using virtualization
  - Tailor services to locality and user context (mobility, social parameters)
  - Minimize latency and jitter
  - Avoid backbone bottlenecks
- NFV/SDN programmability
  - Enables compute and network virtualization
  - Allows realization of new network architectures like ICN
  - 5G Network Slicing using the same technologies

AV Conferencing Survey

- Many existing solutions support only multi-party audio conference and 2-party video conference
- P2P systems:
  - High control signaling overhead, complex client design
- Client/Server:
  - Centralized processing, complex design, expensive, limited scalability
- IP Multicast:
  - Due to lack of extensive IP multicast deployments, very few IP multicast based conferencing solutions are available

	Max. frame rate (frames/second)	Max. # of simultaneous video participants	S/C or P2P
Eedo WebClass		6	web-based S/C
IOMeeting	30	10	web-based S/C
EarthLink	30	24	S/C
VideoLive	30	6	web-based S/C
Himeeting	17	20	S/C
VidSoft	30	10	S/C
MegaMeeting	30	16	web-based S/C
Smartmeeting	15	4	S/C
Webconference	15	10	web-based S/C
Mebeam		16	web-based S/C
Confest	30	15	S/C
CloudMeeting	30	6	S/C
Linktivity WebDemo	30	6	web-based S/C
WebEx	30	6	web-based S/C
Nefsis	30	10	S/C
Lava-Lava	15	5	decentralized P2P
Qnext		4	centralized P2P
Vsee	30	8	decentralized P2P

"Measurement Study of Multi-party Video Conferencing", Yue Lu, Yong Zhao, Fernando Kuipers, Piet Mieghem, in Proceedings of IFIP Networking, 2010.

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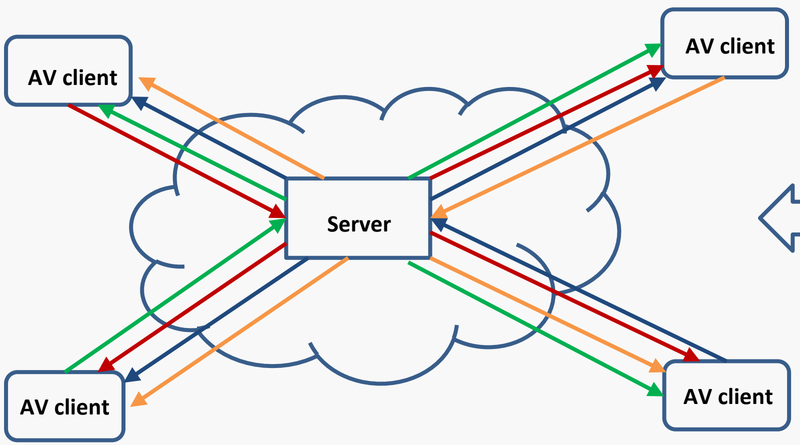
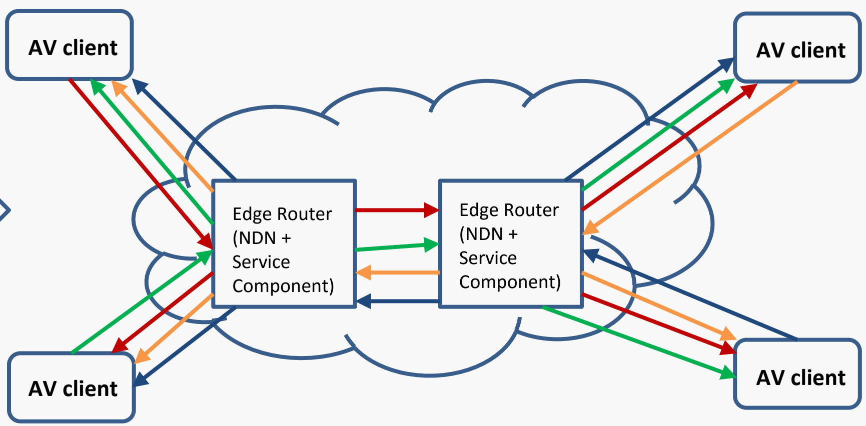
Comparison of different conferencing model

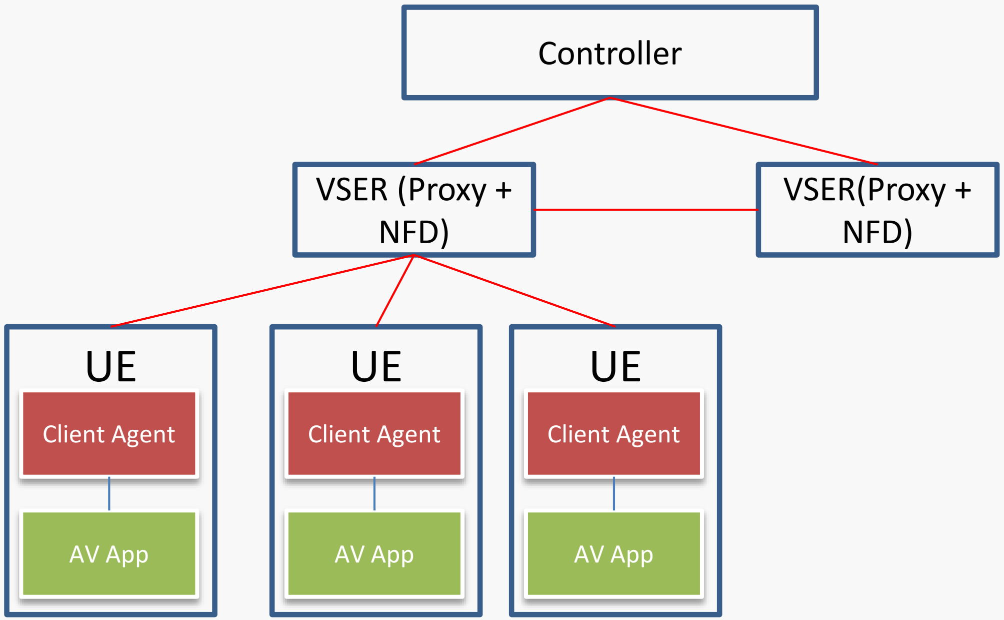




Centralized, IP based: Bandwidth with in the network is $O(N^2)$ Where N is the number of clients

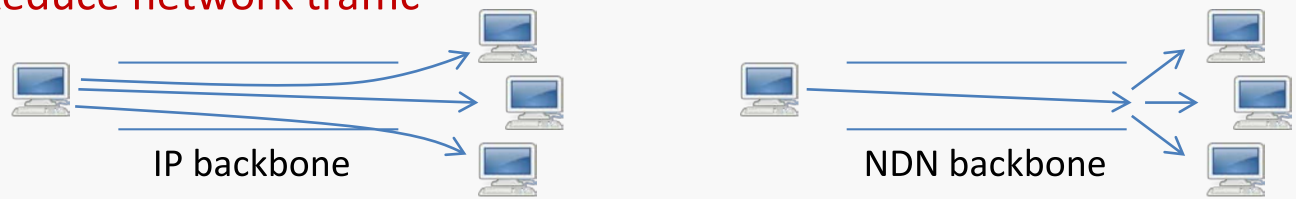
Decentralized, ICN based: Bandwidth consumed in the network is O(N * R) where N is the number of clients, R is the number of Edge Routers

Simplified System Design



Why NDN-based video conference

- NDN has built-in cache/multicast support
  - Reduce network traffic



- NDN has built-in mobility support
  - No concept of end-to-end connection
  - Do not need to tear down old connections and set up new connections again
- NDN has built-in security support
  - Provide a way to verify the identities of data publishers
  - Provide a way to secure the video data directly (do not rely on third parties)