EXPERIENCES FROM A FIELD TEST USING ICN FOR LIVE VIDEO STREAMING

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INTRODUCTION

• A live video streaming system built on the NetInf ICN architecture

• System was field tested at the FIS Nordic Ski World Championship in February 2015 in Falun, Sweden

• System includes a set of NetInf routers + Mobile streaming application for video recording and live viewing
MOTIVATION

• System targets the use case at “events with large crowds” e.g. Sports events, concerts, festivals, fairs
  – ICN is very well suited
  – Current cloud-based services → One unicast data stream per client
  – No dependency on global ICN infrastructure

• ICN treats data objects as a first class citizen
  – Caching of content at the data level
  – Request aggregation at the data level
  – Reduced congestion and improved delivery speed
ARCHITECTURE

• System built on the NetInf ICN architecture → Overlay on existing Internet protocols
  – Connectivity to the global internet
  – Incremental deployment of the system possible

• Name Resolution Server (NRS)
  – Stores Name-Locator bindings
  – Stores metadata and provides search function

• NetInf Service Discovery
  – Local WiFi infrastructure → Multicast DNS (mDNS)
  – Internet → DNS resolution

• Caching
  – NDOs cached on-path
  – Primarily useful when playing “recorded” videos

• Request Aggregation
  – Subscription and GET requests aggregated
  – Place NetInf routers at network edges
VIDEO STREAM REPRESENTATION

• In ICN content is abstracted in the form of Named Data Objects (NDOs)
  – A video can be organized into several video chunks/NDOs

• Entire video stream is represented by a single Header NDO
  – The Header NDO contains metadata for each video

• Video chunk NDOs are linked to the Header NDO through a field in their metadata
SUBSCRIBE-NOTIFY PROTOCOL AND CONTENT RETRIEVAL

- Hop-by-hop subscription relationships
- Subscription requests are aggregated
- Hierarchical point-to-multipoint tree
- Subscribe-Notify messages → Netinf UDP convergence layer
- NetInf GET and GET RESP messages → NetInf HTTP convergence layer
ANDROID APPLICATION

• Recording and viewing clients

• Event Browser
  – Video stream selection

• Video encoding and chunking
  – H.264 encoding
  – MP4 packaging
  – Data rate = 1 Mbps
  – 1 chunk = 2 secs
  – Playout buffer = 10 secs
Network setup for the field test

- Subnet separation for the two sites
  - For proper functioning of mDNS

- Traffic aggregation over the VPN tunnel

- Why was a VPN tunnel needed?
  - Only one public IP address in Falun

- NRS hosted at Toaster

- Software for NetInf routers written in Erlang; streaming mobile app is Android-based
TESTS AND MEASUREMENTS

• End-to-end live streaming delay
  – Comparison with Twitch and YouTube

• System scalability with a large number of clients
  – Huge number of emulated clients used to measure the aggregation efficiency of the NetInf router across the 10 Mbps link

• System robustness ➔ Qualitative field tests performed with 20 Android mobile devices
  – Several recording clients publishing at the same time
  – Several playing clients streaming at the same time
RESULTS – PLAYBACK DELAY MEASUREMENTS

Network streaming client is attached to:
- Local WiFi
- Kista WiFi
- HSPA+
- 4G

Network recording client is attached to:
- Local WiFi
- 4G
- Telia WiFi

Playback delay (secs)

- Test run 1: 13.37, 12.40, 12.92, 21.50, 13.60, 16.70
- Test run 2: 17.18, 14.18, 15.10, 16.40, 17.18, 15.10
- Test run 3: 13.60, 12.40, 12.92, 21.50, 13.60, 16.70
- Test run 5: 22.38, 21.92, 16.17, 17.93, 22.38, 18.10
- Test run 6: 21.50, 21.92, 16.21, 17.93, 24.63, 22.38

Test run #
RESULTS – AGGREGATION EFFICIENCY OF THE NETINF ROUTER

Bandwidth utilization on links with non-aggregated traffic (Mbps) vs. No. of clients served

- Red line: Bandwidth utilization on links with non-aggregated traffic (Mbps)
- Blue line: CPU utilization (%)

Bandwidth on link with aggregated traffic = 10 Mbps
Total bandwidth on links with non-aggregated traffic = 2 Gbps
RESULTS – QUALITATIVE FIELD TEST I

- Network and CPU load with many publishers
- 10 recording clients simultaneously published live streams
- Average NetInf publish rate = 2 per second
- Average CPU load = 4%
- Average Network RX load = 7.8 Mbps
EXPERIENCES FROM THE FIELD TEST AND CONCLUSIONS

• System has been very stable → NetInf routers have been running for months

• When publishing/viewing did not work it was in most cases due to bad connectivity (usually WiFi problems)
  – User would benefit from having more information directly in the app about the current connectivity status

• ICNs and global flash crowds
  – Current CDNs do not work well when the demand for the services is unknown; for true flash crowds there are no solutions that scale to global audiences
  – We have performed limited field tests; we still think that the scalability properties of ICN and NetInf look very promising
  – We can aggregate more than 2000 clients on one router; with a three-level hierarchy we can stream to a global audience of 8 billion users from one Android phone without having to do any pre-configuration in the network
Questions and Discussion