Low Latency Low Loss Streaming using In-Network Coding and Caching

Kazuhisa Matsuzono (NICT)
Hitoshi Asaeda (NICT)
Thierry Turletti (Inria)

Motivation

• Target
  – UHD-level (4K/8K) delay-sensitive video streaming

• Requirements
  – **Low latency** (about 150ms) for interactive communication
    • ITU-T recommendation G.114
  – Low packet loss to maintain high QoE
  – **Efficient packet delivery** to support a large number of receivers

• Proposal
  – L4C2 (Low Latency Low Loss streaming using In-network Coding and Caching)
L4C2: Basic Idea

- Leveraging CCN/NDN features
  - Name-based data requests/forwarding, including multicast and multipath
- Enabling adaptive hop-by-hop data forwarding within an acceptable end-to-end delay
  - In-network coding (RLNC)/caching for efficient data recovery
  - Data recovery within an estimated acceptable link delay (not end-to-end delay)
  - Data recovery based on a measured data loss rate
- Newly defined Symbolic Interest (SMI) and Control Interest (CNI)
  - SMI: stream request including layer information
  - CNI: RTT measurement, notify redundancy level, switch to RGI
Three types of interest messages:
- (1) SMI, (2) RGI (retransmission request), and (3) CNI.

Network Coding:
- Applied for each coding group which consists of the k different original/coded data packets
  - Encoding vectors are randomly selected from GF(2^8)
  - k is set to a constant value considering the waiting time to recover lost data
L4C2: Estimating Link Conditions

• Data loss rate
  – Calculated from Seq-num and NC-params (k) stated in Data header

• Acceptable link delay
  – Router knows the acceptable e2e delay (e.g. 150ms) when receiving Data.
  – Router $i$ retrieves $D_{(s,j)}$ using CNI
  – Router $i$ informed $D_{(u,i)}$ when receiving CNI

**Symbolic Interest (SMI)**

**Data**

/ABC.com/content-A

Control Interest (CNI)

Response

Router $i$

Acceptable link delay for this flow ??

$D_{l(i,j)}^{MaxAlw} = D_f^{allow} - (D_{(u,i)}^{min} + D_{(s,j)}^{min})$

$D_{l(i,j)}^{MinAlw} = D_f^{allow} - (D_{(u,i)}^{max} + D_{(s,j)}^{max})$

Consumer $u$

Source $s$
Simulation

- Parameters
  - Real-time video rate (total 35Mbps): 20/10/5 Mbps
  - Interest/Data packet size: 120/1024 bytes
  - Acceptable E2E delay: 150ms

- Scenario
  - Investigate user’s QoE, using an existing QoE model
  - Comparison with state-of-the art for multipath data retrieval in CCN.

LinkBW/Queue/Delay: 100Mbps/100pkt/5ms
(a) Normalized QoE of real-time video streaming flows

(b) Interest traffic rate at link (9,8)

Potential Work in NWCRG

• (Describe common research challenges)
• Describe a baseline scenario for NC for ICN/CCN
• Discuss about in-network coding, including;
  – Clarify problem statement and introduce recent work
  – Compare with RLNC and other codes
  – Investigate block coding vs. sliding window coding approaches