Multimedia Network

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UIUC
Background

What is 3D Teleimmersion (3DTI)?

- Bring people virtually together
Background

3-tier architecture:

- capturing tier — multiple cameras, single gateway
- dissemination tier — send streams across sites
- rendering tier — render streams, play video
Background

Features:

• 3D video by multiple cameras
• Flexible views

Challenges:

• High bandwidth
• Frequent view changes requires better multi-stream management
Background

View switch & view-based stream drop
Background

Seamless view change
Uses SDN to manage 3DTI stream at network layer to support frequent and seamless view change, and to improve bandwidth and latency.
OpenSession v.s. Application Layer Stream Management

- Local bandwidth
- End-to-end delay
- Processing load
- System resiliency
OpenSession Architecture

- Global Session Controller
- Local Session Controller
- Switch Controller
Session Routing Table

Match field
- stream ID
- Destination port
- Source IP address

Forwarding action
- IP addresses the packet should be forwarded to

Dirty bit
- indicates if this entry has been changed or not
Session Routing Table

<table>
<thead>
<tr>
<th>Match Field</th>
<th>Forwarding Address</th>
<th>Dirty Bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway ID : Stream ID : Destination Port</td>
<td>Gateway Addresses</td>
<td>bit</td>
</tr>
<tr>
<td>192.168.1.2: 1: 9876</td>
<td>192.168.10.13 192.168.1.3</td>
<td>1 1</td>
</tr>
<tr>
<td>192.168.1.2: 2: 9876</td>
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<td>1</td>
</tr>
<tr>
<td>192.168.5.6: 1: 9876</td>
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Mapping SRT to gSRT & Flow Table

- Each gateway maintains a gSRT, which has only one destination to forward each packet.
- The rest of forwarding functionalities are done by switch.
- Split SRT to gSRT (at gateway) and Flow Table (at switch).
Mapping SRT to gSRT & Flow Table

For each stream generated within the same site, send the stream to one subscriber.

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IP Type of Service

The stream ID is written into IP ToS (Type of Service) field

- Less frequently used
- Overwrite 5 higher bits but keep 3 lower bits (used for congestion control)
- \((192.168.1.1: 1: 9876) \rightarrow (192.168.1.1: 00001000: 9876)\)
Seamless View Change Challenge

Consistent update in both gSRT and Flow Table
Consistent Route Update — Labeling Packets

Add a label \( \eta \) to match field in packet header. (source port)

\[(192.168.1.1: 1: 9876: \eta)\]

When updating rules:

- Install new rules with a new label at all gateways and switches. (not effective)
- GSC tells generator to switch to the new label.

Obsolete rules are deleted with an idle_timeout by OpenFlow (30s in the paper).
Evaluation Setup

• 4 3DTI sites in home network, campus network, company network and department network.

• 8 video streams per site, 1.5-2 Mbps.

• Each view demands 4 streams.
Evaluation Metrics

• Local bandwidth (expected to be 1/4 at generator)
• CPU processing load
• End-to-End delay
Evaluation Result
View Change

View change resiliency

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Avg</th>
<th>Stdev</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>OpenSession</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No OpenSession</td>
<td>20.35</td>
<td>9.12</td>
<td>45</td>
<td>9</td>
</tr>
</tbody>
</table>
Lessons Learned

• Consistent update with labels (recall Fabric)

• Use application layer information in network layer?
Discussion

• Forwarding table is separated to gSRT (application layer) and Flow Table (network layer). Can we put all forwarding information to network layer?

• 30 sec idle_timeout may delete a valid entry due to temporary failure. How can we fix this problem?
Understanding the Impact of Video Quality on User Engagement

Florin Dobrian, Asad Awan, Dilip Joseph, Aditya Ganjam, Jibin Zhan, Vyas Sekar, Ion Stoica, Hui Zhang
Conviva, Intel Labs, UC Berkeley, CMU
Motivation

How different video quality metrics impact user engagement in various types of content?
Approach

• Collect data from large scale online video services.

• Define user engagement metrics (at both view level and viewer level) and quality metrics.

• Analyze the correlation between them.
Data Classification

- Video on Demand (VoD)
  - Long VoD — 35-60 mins (e.g. TV shows)
  - Short VoD — 2-5 mins (e.g. movie trailers)

- Live (e.g. World Cup)
Engagement Metrics

- View level: play time of a view
- Viewer level: number of views per viewer, and the total play time across all videos watched by the viewer.
Quality Metrics

• Join time (content demanded - play starts)

• Buffering ratio (freeze time)

• Rate of buffering events (how many times video freezes)

• Average bitrate

• Rendering quality — ratio of rendered frames to encoded frames
Take-aways

• For long and short VoD content, Buffer Ratio is the most important quality metric.

• For live content, Average Bitrate in addition to Buffer Ratio is a key quality metric. Additionally, the requirement of small buffer for live videos exacerbates buffering events.

• JoinTime has significantly lower impact on view-level engagement than the other metrics.

• Render quality has negative correlation. (counter intuitive)

• View-level and viewer-level are consistent.
Discussion

• Data quantity v.s. data quality. Can we achieve both?

• What are other possible metrics to measure video quality?