MoWIE for Network Aware Application

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New Applications in 5G era

• Cloud Gaming
• Low Delay Live Show
• Cloud VR/AR/MR
• 4K/8K Meeting

Cloud based Application(CBA) during Coronavirus disease period
• Cloud Office
• Cloud Education
• Cloud Meeting
Requirements for CBA

- Target: Good QoE and the current precisely Bitrate/available Bandwidth

Network Aware
Current Network Awareness

• The application assumes the network as a black box and continuously uses client or server measurement to detect the network characteristics, and then adaptively change the parameters as well as logical function of the application.

• Some drawbacks
  • Not precise
  • Not real time
  • More blind packages enroute

• Some Network Awareness technologies:
  • MPEG-DASH
  • ECN
  • 3GPP (5G) NEF (Network Exposure Function)
  • 3GPP (4G) SCEF (Service Capability Exposure Function)
  • 3GPP (5G) QNC (QoS Notification Control)
  • 3GPP (5G) Alternative QoS Control
  • 3GPP (5G) QoS Sustainability
MoWIE: Mobile and Wireless Information Exposure

- MoWIE can provide a lot of network information **beyond current scope**
  - Based on the 5G real network
  - Provide Cell level network information
  - Provide User level network information

- **MoWIE + AI based ROI / ABR ➔ Good QoE under general circumstances**

- ROI (Region of Interest)
  - Adaptive encoding based on the available network bandwidth from the MoWIE
  - Based on Cloud Gaming to investigate the ROI

- ABR (Adaptive Bitrate)
  - following the available changed network bandwidth
  - AI dynamically learn the network characteristics (from the MoWIE) to improve the ABR
ROI Detection and Video Compression

- Only small fovea region (i.e. ROI) captures most visual attention
- Enabling the ROI region higher rate while making other regions a lower rate.
- The whole rate of the video is **reduced** while the watching experience will **not** be harmed.
- Different ROI detection and encoding scheme can introduce different latency. So adaptive ROI schemes are used based on the network status.
ROI Detection Experiment with NI

• Using 4 ROI methods in 3 different networks:

1. The original video
2. Quick saliency detection and encoding, 10ms delay
3. More accuracy saliency detection, 40~70ms delay
4. ROI detection with NI.

• Using 4 ROI methods in 3 different networks:

1. Network 1: bad and fluctuate
2. Network 2: Good.
3. Network 3: fluctuate dramatically

Testing Results:

1. Increase the detection accuracy → Saving about 30% bandwidth under same QoE
2. Reduce detection speed → only 10ms-30ms
3. Changing algorithms and rate allocation (in one frame) based on the network status
4. Balance between detection delay and detection accuracy
Adaptive Bitrate Streaming and AI-ABR

- High rate codec may cause delay
- Low rate may harm the QoE
- To avoid large delay and guarantee quality, ABR is used in MPEG-DASH

- AI can dynamically optimize its policy for different network characteristics and QoE metrics directly from experience.
- AI utilizes observed data in application layer to train ABR algorithms, like past rate, current buffer, RTT time and and outputs rate.
- More data input, especially direct network data in a timely manner, can help reinforcement learning.
AI-Adaptive Bitrate with NI Exposure

• We launched NAA-enabled cloud gaming testing in China Mobile LTE network, with the enhancement in eNB supporting base station information exposure.
  • Cell level information: common for all the UEs under a serving LTE cell
  • UE level information: specific for different UEs.

• **cell level** information:
  • The number of Downlink PRBs (Physical Resource Block) occupied during sampling
  • The Downlink MAC data rate per cell

• **UE level information (without privacy information)** includes:
  • The Uplink SINR (Signal to Inference plus Noise Ratio)
  • MCS: The index of MCS (Modulation and Coding Scheme)
  • The number of packets occupied in PDCP buffer
  • The number of Downlink PDCP SDU packets
  • The number of PDCP SDU packets lost
  • The Downlink MAC data rate per UE

• Data interval :1s
Tests on AI-ABR with NI Exposure

- Tests on 9 different scenarios with two NI indicators
  - Test 1: Weak network
  - Test 2: User competition
  - Test 3-9: Random user movement trace and user distribution
- NI indicators: MCS and PRB, reflecting the real-time network fluctuation and user competition.
- Compare the reduction of delay when PRB and MCS data are utilized with constant rate method (without any NI)

<table>
<thead>
<tr>
<th>Test Scenario</th>
<th>Reduction of Lagging Rate</th>
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<tbody>
<tr>
<td>1</td>
<td>46%</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>37%</td>
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<tr>
<td>8</td>
<td>57%</td>
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<tr>
<td>9</td>
<td>48%</td>
</tr>
</tbody>
</table>

Figure 4-2: Reduction of Lagging Rate
MoWIE Based Network Aware Application

- NAA APP requests and collects MoWIE information.
- UE and Cell level information can be collected with MoWIE interface.

Client Information
(frame delay, buffer status)

MoWIE Network Information
(loss rate, cell load, mobile position information...)

Network Aware Application

Server Information
(RTT time, video rate, frame rate, frame size...)

Application (Client)
Proposal in IETF

- Extending ALTO with MoWIE
  - Allow ALTO to exposure lower layer and real-time network information to enhance QoE
- Out-of-Band information Exposure
  - Convery more complex and rich network information
MoWIE in ALTO

• NI selection and binding
  • To provide generic, open NIE

• Compact NI encoding
  • JSON
  • To support SSE and SSE extension

• Stability and reliability
  • To allow more flexible, better coordinated control
Thank you!