

# MoWIE for Network Aware Application

draft-huang-alto-mowie-for-network-aware-app-00

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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

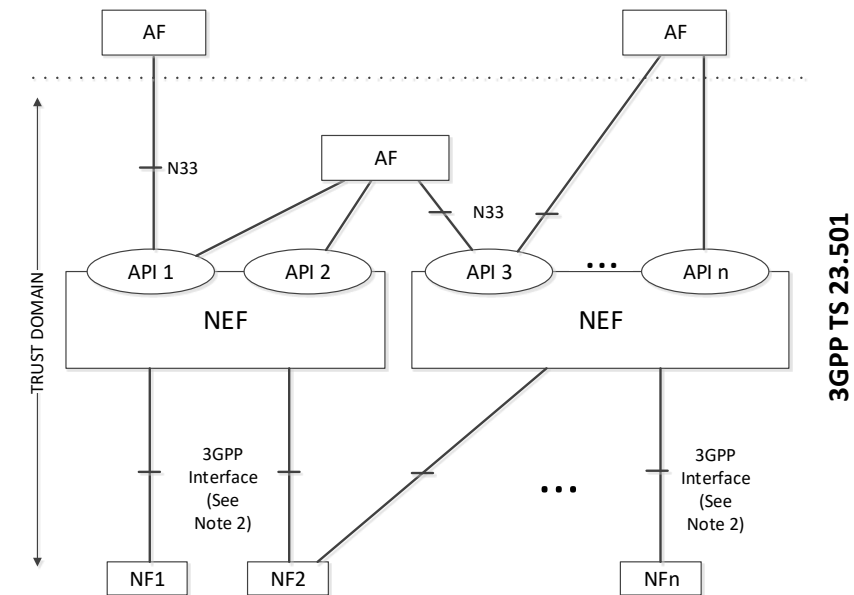
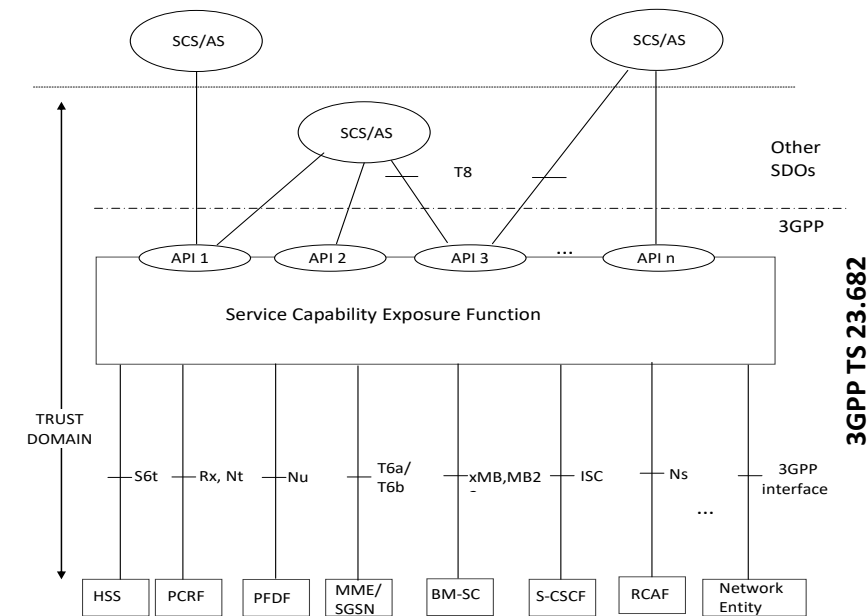
- Target: Good QoE and the **current precisely** Bitrate/available Bandwidth



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

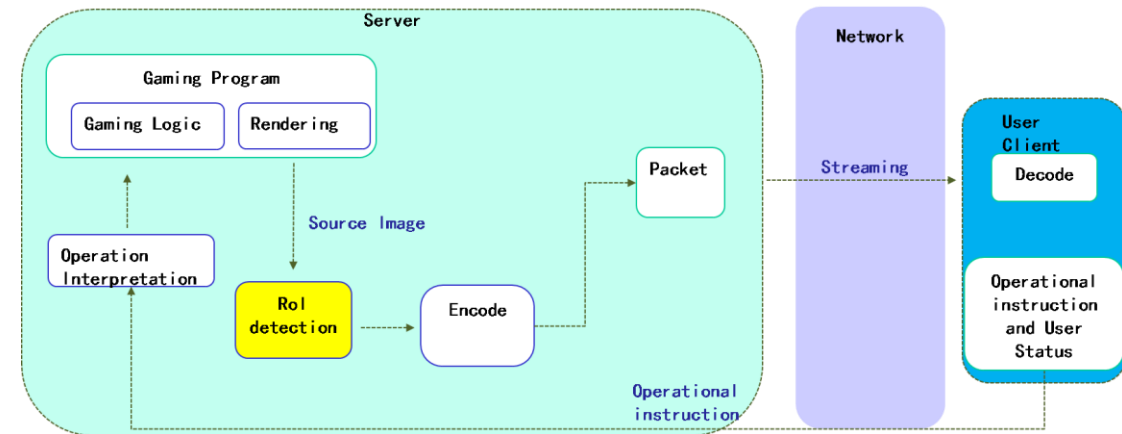


# MoWIE: Mobile and Wireless Information Exposure

- 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

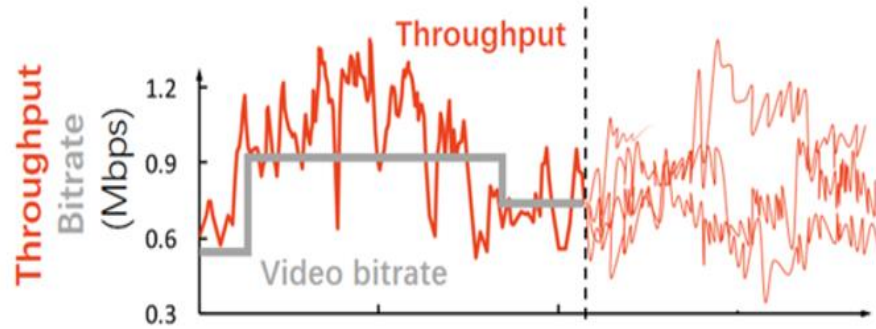
	Network 1		Network 2		Network 3	
	QoE	BW Saving	QoE	BW Saving	QoE	BW Saving
1	3.8	0	4.8	0	4.3	0
2	3.8	5%	4.8	9%	4.3	7%
3	2.2	2.1%	4.6	38%	3.1	34%
4	3.6	9%	4.7	33%	4.3	25%

Figure 4-1: QoE and Bandwidth Saving

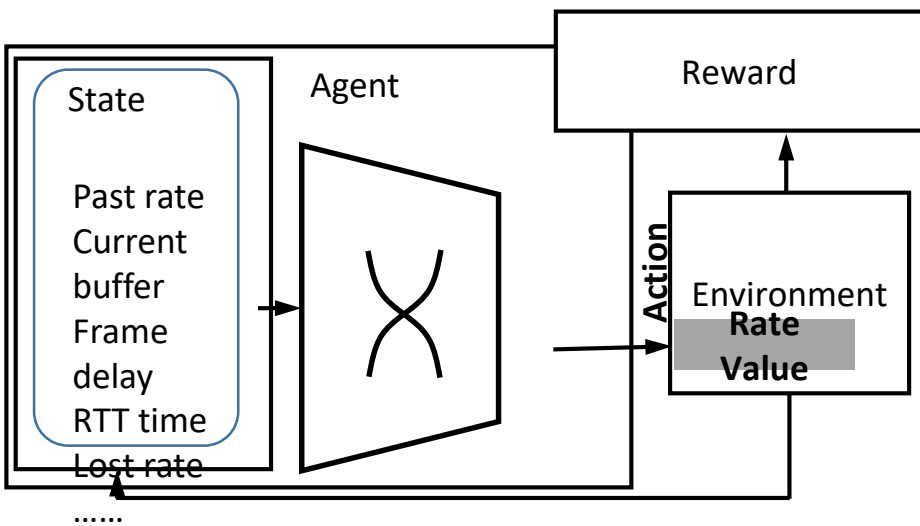
## Testing Results:

- 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 Interference 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

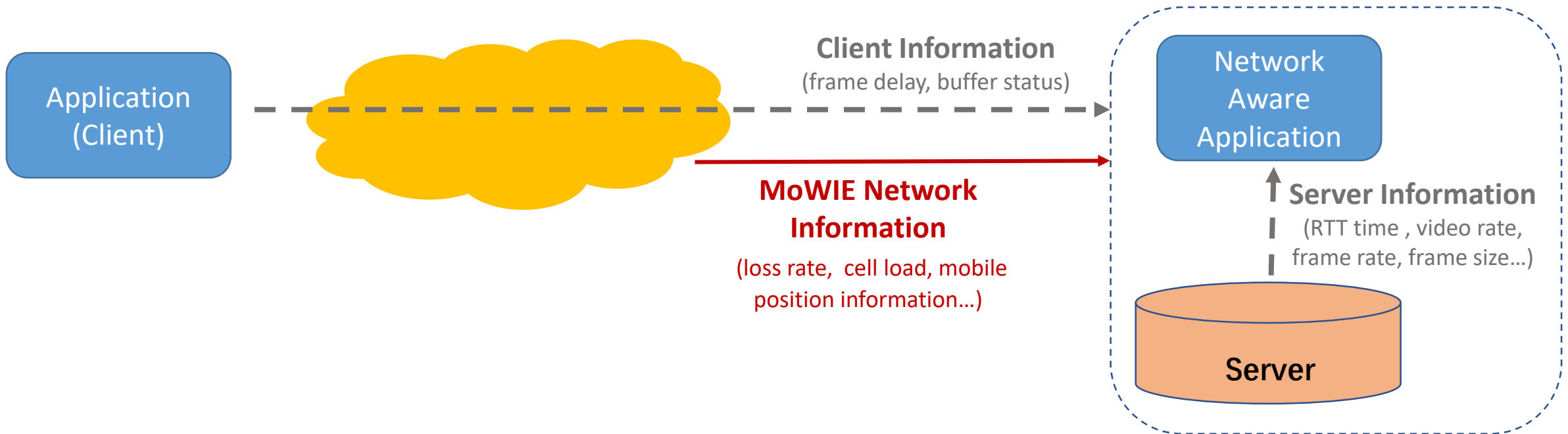
- Tests on 9 different scenarios with two NI indicators
- Test 1: Weak network
- Test 2: User competition
- Test 3-9: Random user movement trace and user distribution
- NI indicators: MCS and PRB, reflecting the real-time network fluctuation and user competition .
- Compare the reduction of delay when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

Test Scenario	Reduction of Lagging Rate
1	46%
2	21%
3	37%
4	56%
5	32%
6	67%
7	33%
8	57%
9	48%

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.



# 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!**