FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF INFORMATION TECHNOLOGY

IDLAB-IMEC

TRULY IMMERSIVE VOLUMETRIC MEDIA DELIVERY

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GHENT UNIVERSITY

IDLab INTERNET & DATA LAB

imec

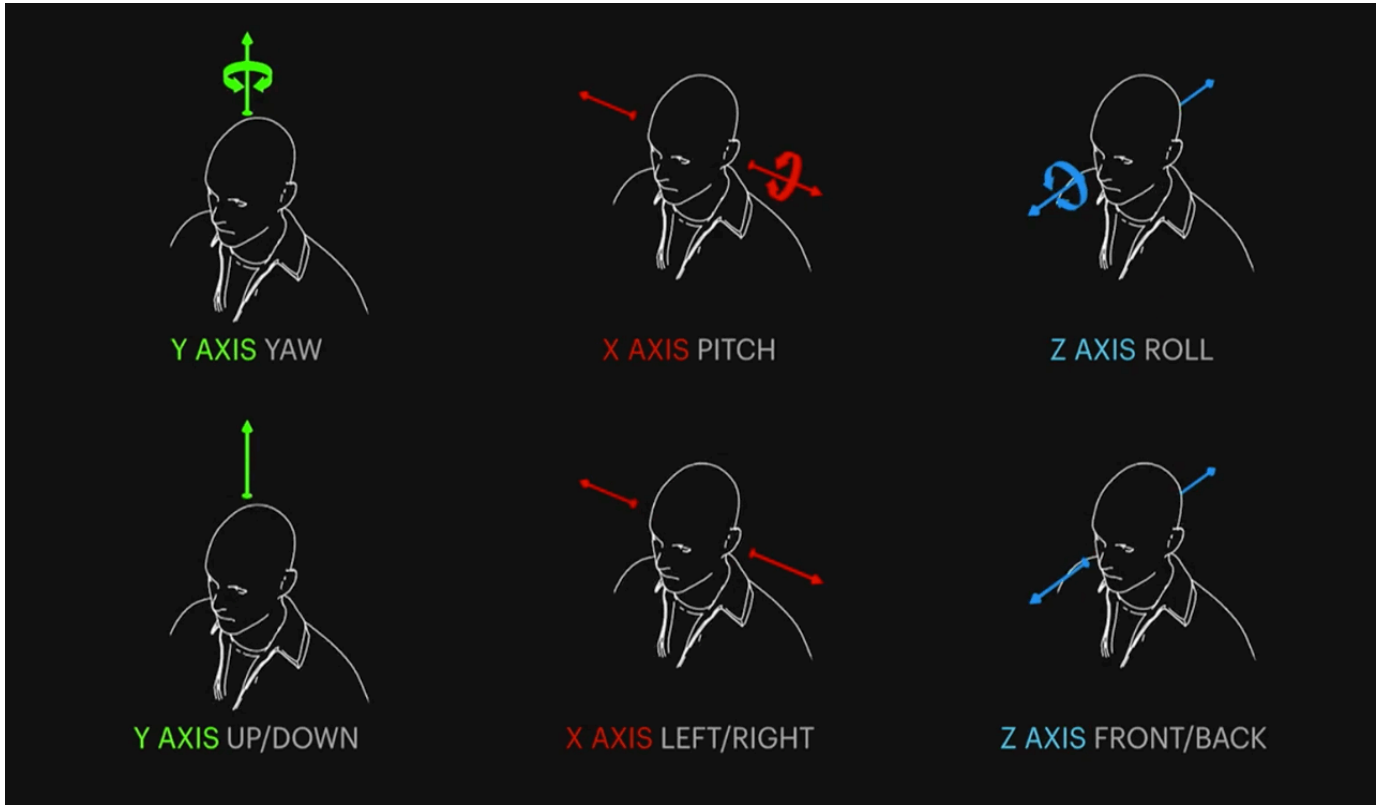
FROM 2D TO IMMERSIVE VIDEO

2D Video

Volumetric Media (Point Clouds)

360 Degree Video

WHAT DOES VOLUMETRIC MEDIA PROVIDE?



Adds parallax → multiple views

Six Degrees of Freedom

VOLUMETRIC MEDIA: USE CASES

Holographic Collaboration & Conferencing

Tele-Surgery & Remote Patient Monitoring

Remote Industrial Monitoring & Management

CAN CURRENT TRANSPORT AND APPLICATION INFRASTRUCTURES DEAL WITH VOLUMETRIC MEDIA DELIVERY?

DYNAMIC POINT-CLOUD SCENES REQUIRE A SIGNIFICANT AMOUNT OF DATA

STREAMING THIS SCENE WOULD REQUIRE 19.2 GB/S!

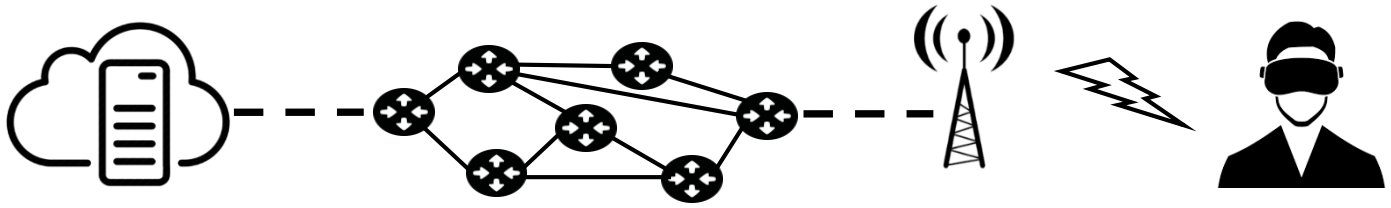
WE CAN SOLVE THIS BY USING COMPRESSION

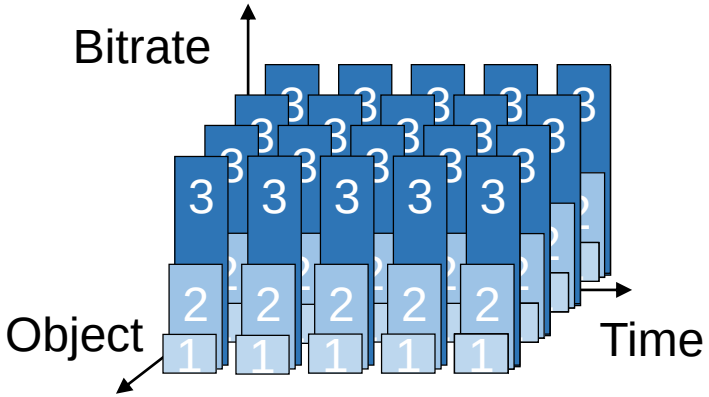
4.5 Mb/s

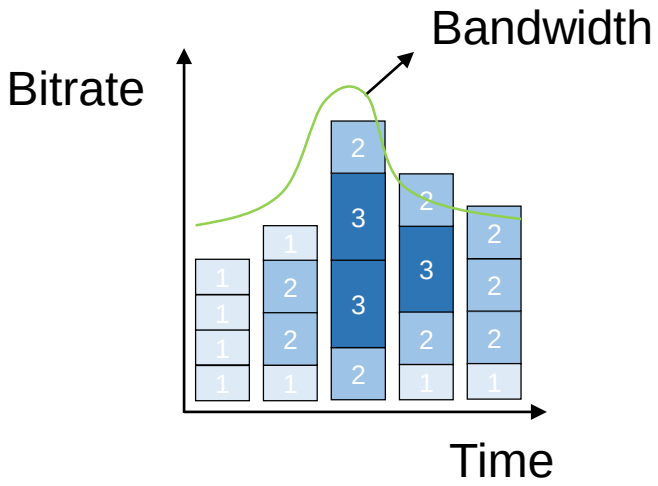
40.4 Mb/s

5.7 Gb/s

WE CAN STREAM IT USING ADAPTIVE STREAMING







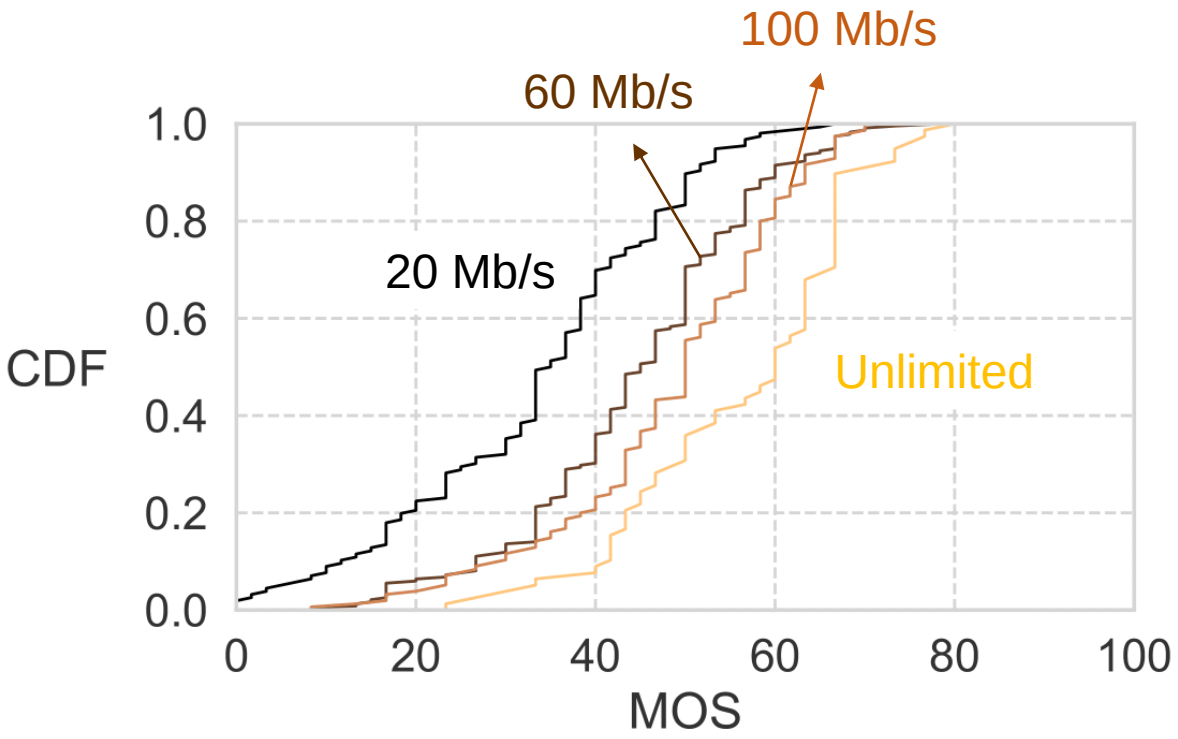
WE CAN EVALUATE THE QUALITY BY MEANS OF SUBJECTIVE STUDIES…

- Four Point Clouds
- Raw data rate of 19 Gb/s
- Three such videos
- 30 subjects

EVALUATION OF SUBJECTIVE QOE - CONFIGURATION

Bandwidth [Mb/s]	Allocation	Prediction
20	Visible objects	0
60	Visible objects	0
100	Visible objects	0
20	Visible objects	1
60	Visible objects	1
100	Visible objects	1
60	All objects	0
∞	N/A	N/A

OUR OBSERVATION



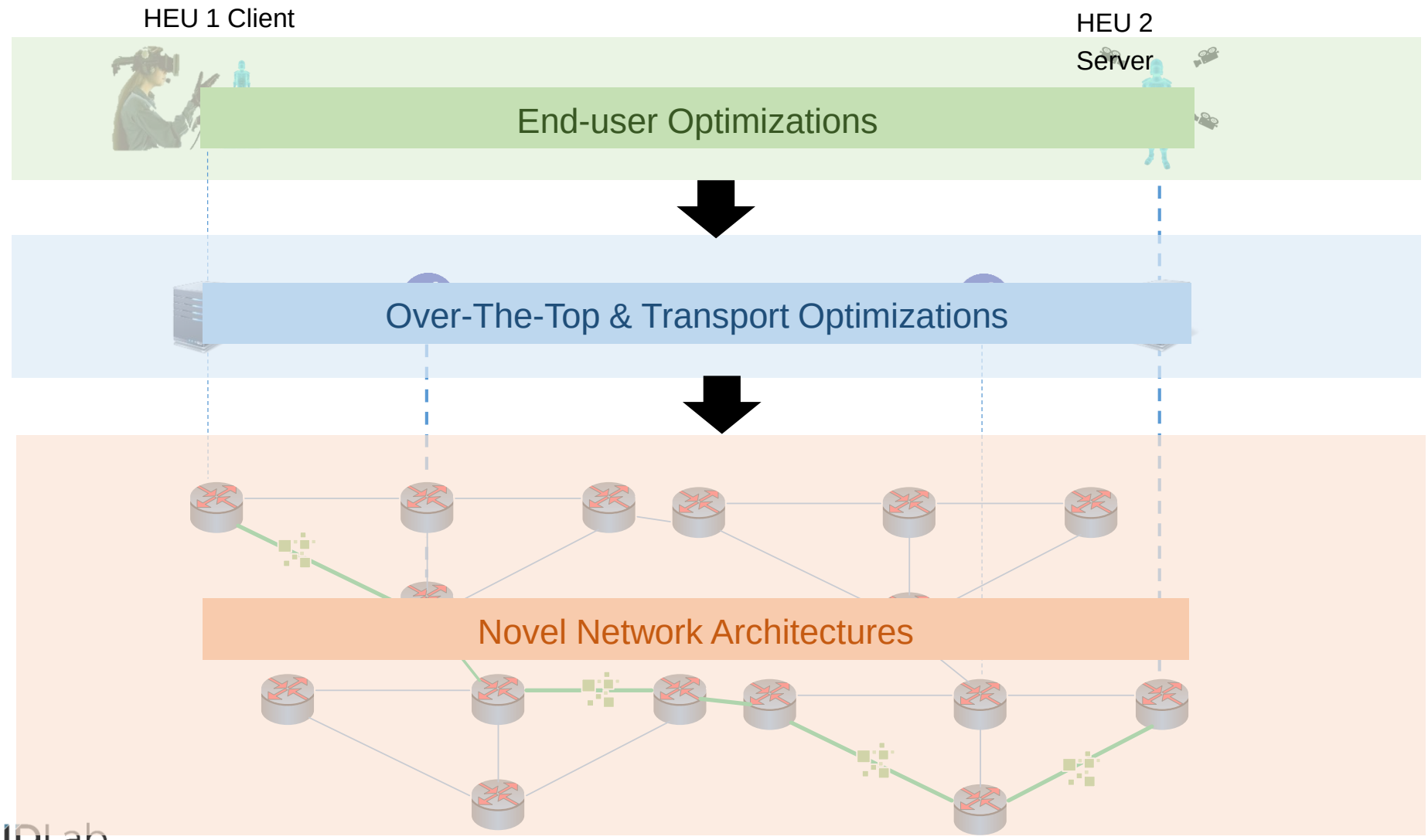
- Subjects can distinguish between different bitrates
- However, the difference in QoE is not significant
- People do not perceive delivered data as good quality: MOS < 80% in all cases and close to 60% in average

WHAT DOES IT MEAN TO THE NETWORK?

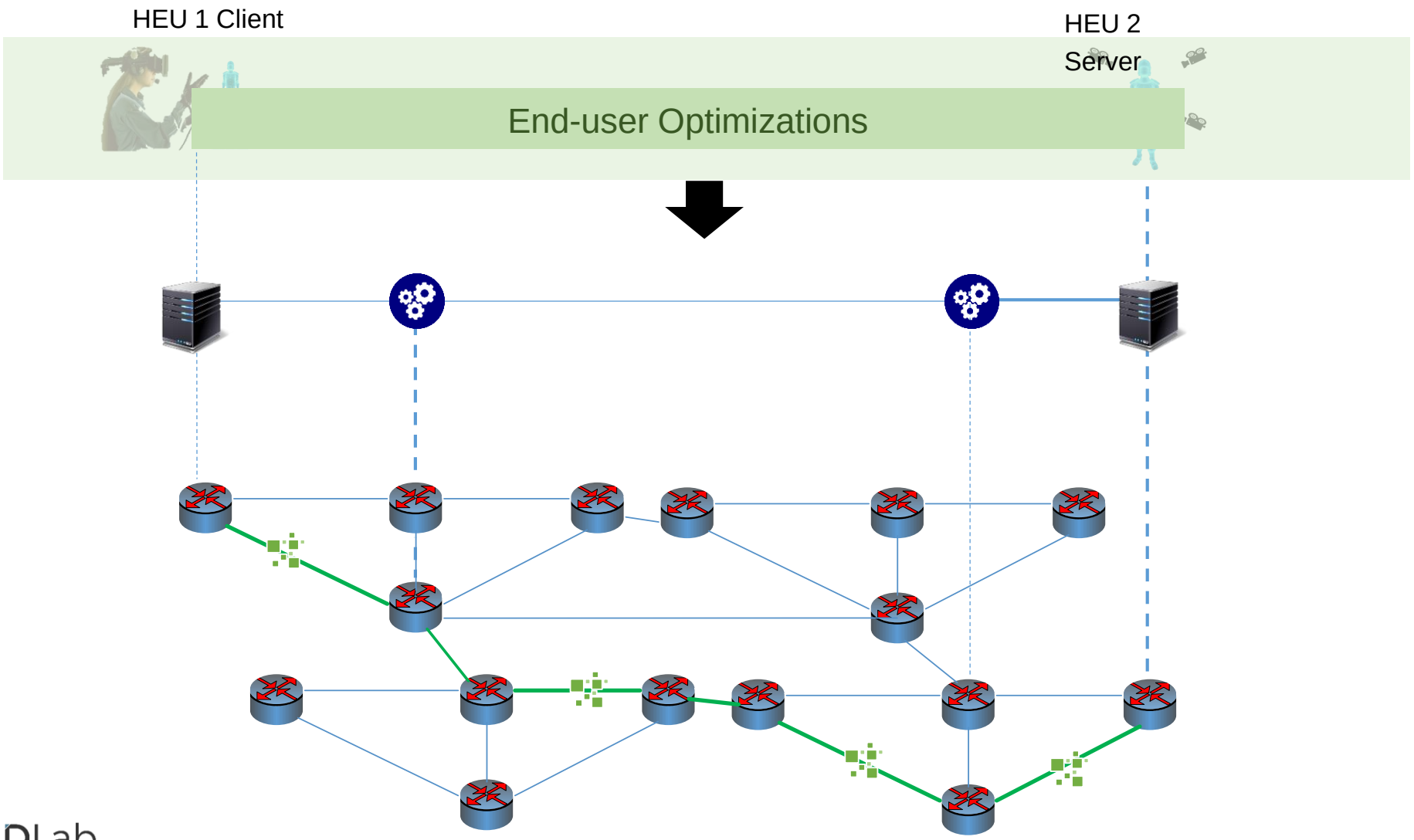
- End-user based or over the top optimizations are not sufficient to satisfy the user (MOS < 60%)
- These techniques do not cater to the latency requirement
- Network layer needs complement the application layer approaches
- Cross-layer based end-to-end architecture for volumetric media delivery

HOW TO ACHIEVE TRULY IMMERSIVE VOLUMETRIC DELIVERY? A CROSS-LAYER APPROACH

TRULY IMMERSIVE HTC: A CROSS-LAYER APPROACH



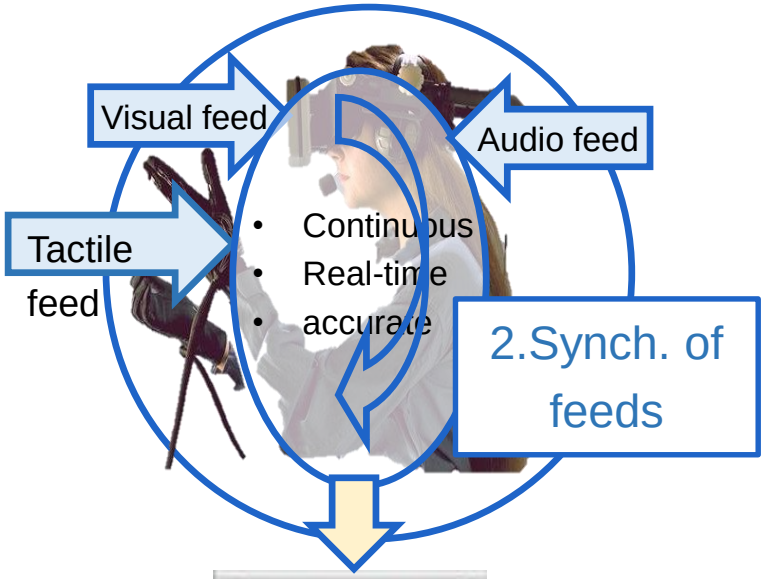
A CROSS-LAYER APPROACH: END-USER



END-USER OPTIMIZATONS

Client-side Optimizations

1.Viewport Prediction



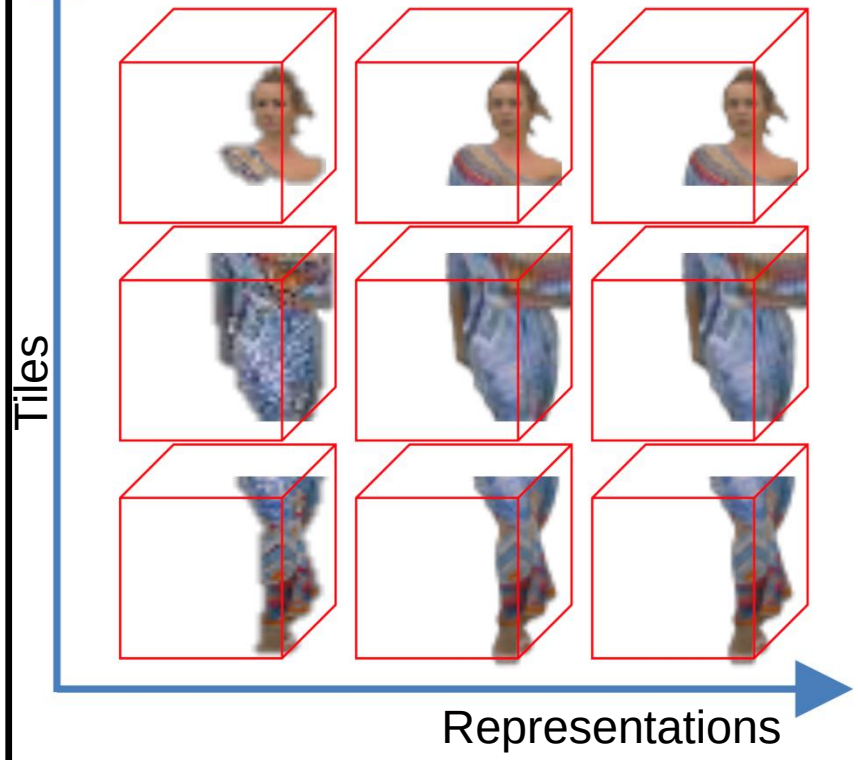
2.Synch. of feeds

3.QoS/QoE assessment

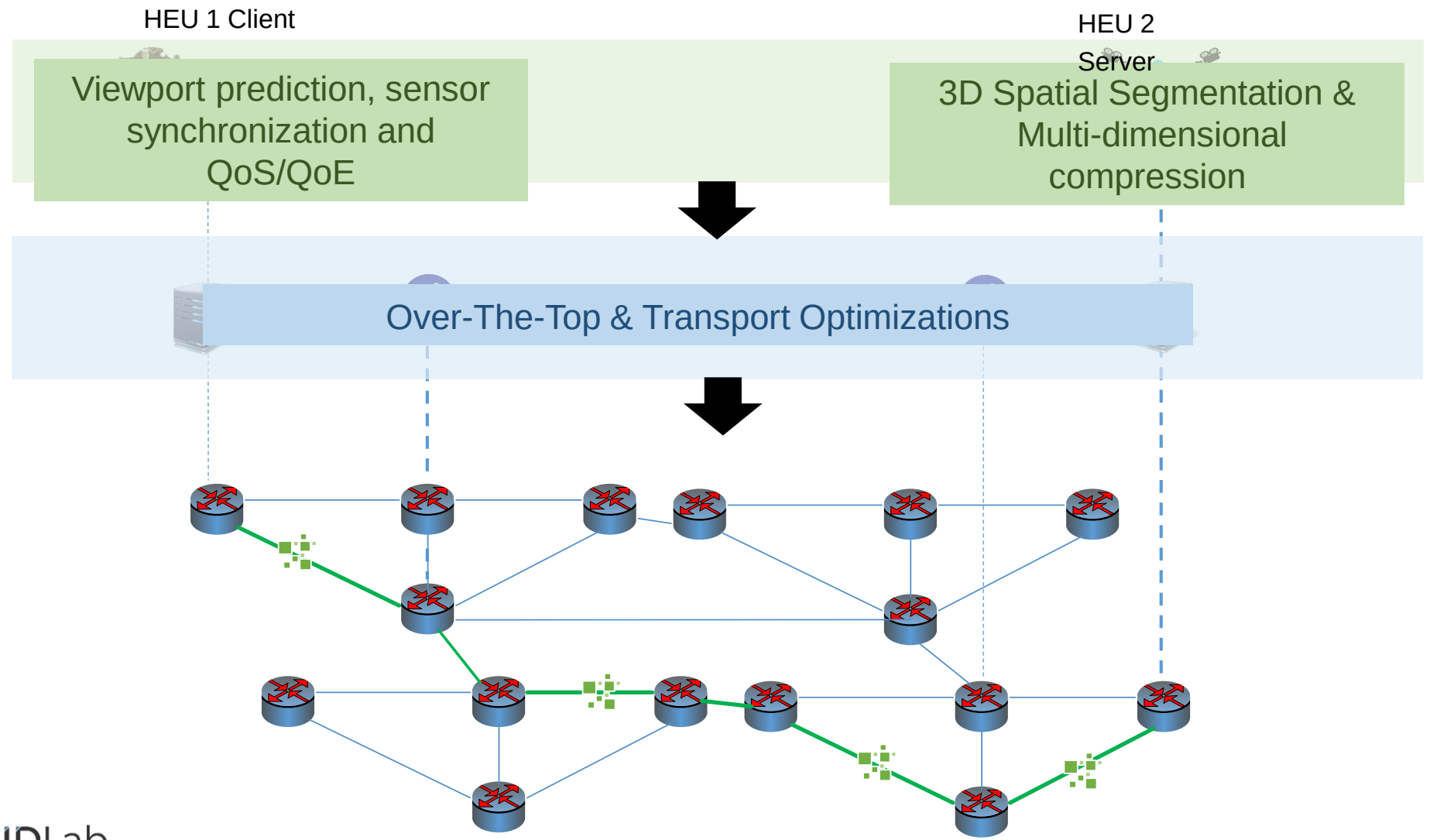
Viewpoint info & Quality

Server-side Optimizations

3D tiling and Multiple representations encoding

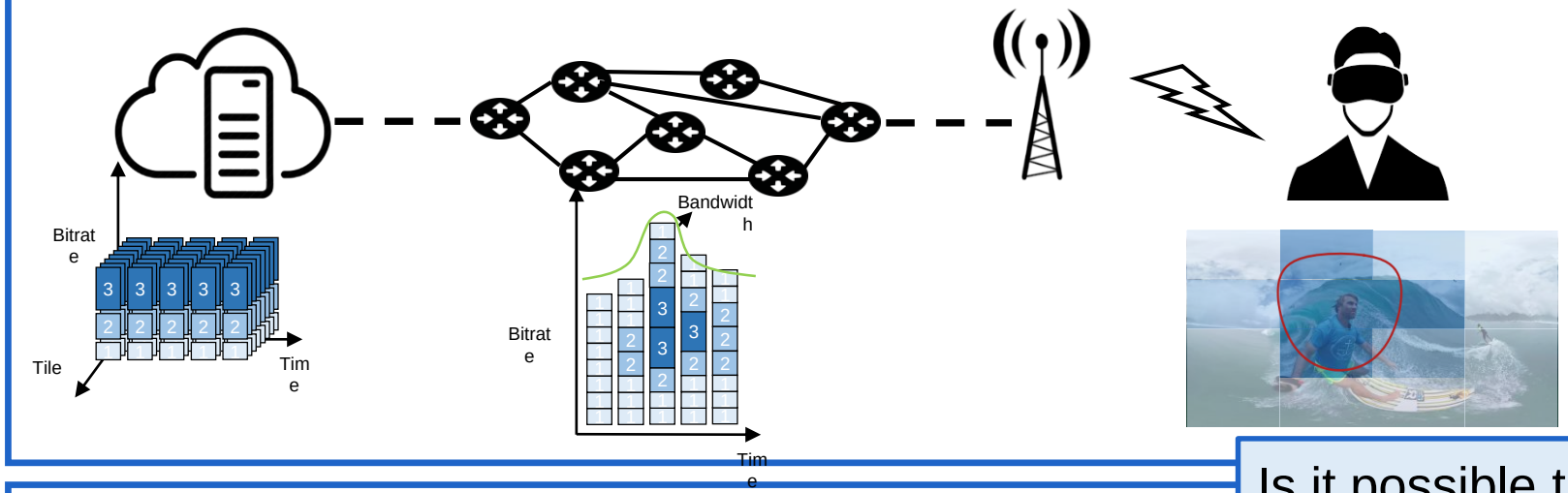


A CROSS-LAYER APPROACH: TRANSPORT



CURRENT VIDEO TRANSMISSION: QUALITY VS DELAY

HTTP ADAPTIVE STREAMING: QUALITY OPTIMIZATION



☺ Quality and Bandwidth optimization

😐 Segmentation: no life

☹ Processing, buffering and protocol overhead: no real-time

Is it possible to get the best of both worlds?

RTP/UDP STREAMING: LATENCY OPTIMIZATION

RTP/UDP streaming

WebRTC & QUIC: Browse-based real time streaming

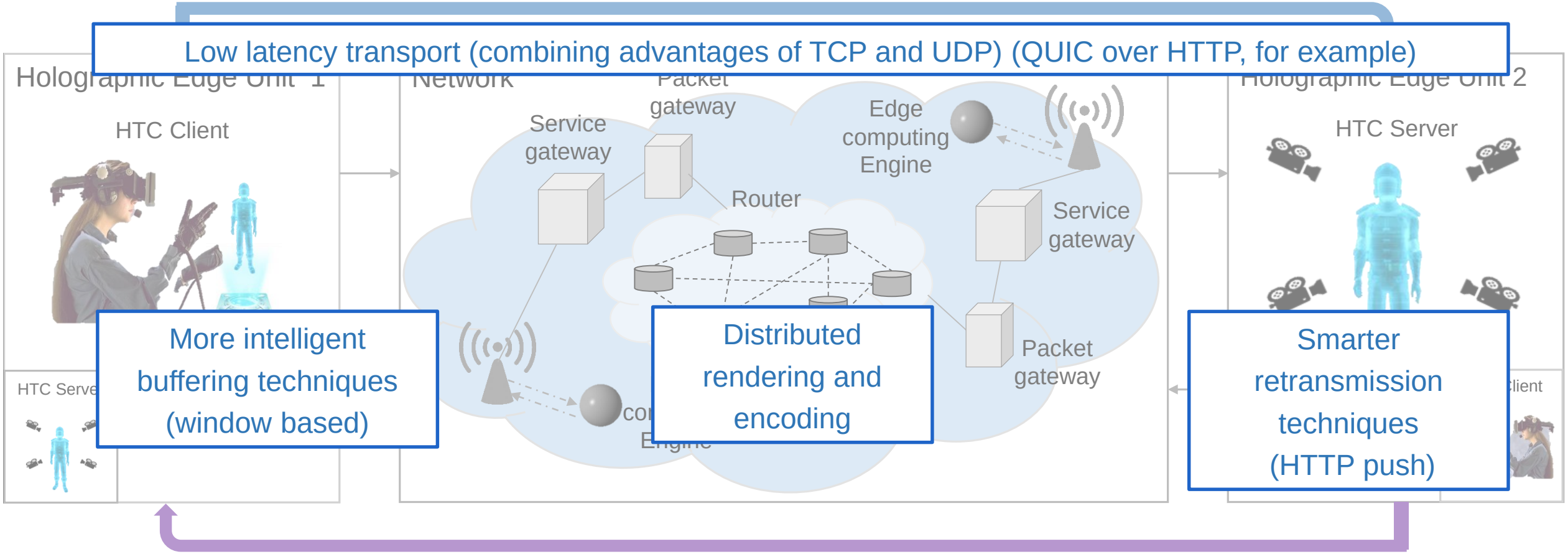
☺ Latency optimization

😐 Very limited quality control -> problem for HTC

☹ Very low resilience (packet loss prone)

OVER THE TOP & TRANSPORT OPTIMIZATIONS

Low latency transport (combining advantages of TCP and UDP) (QUIC over HTTP, for example)



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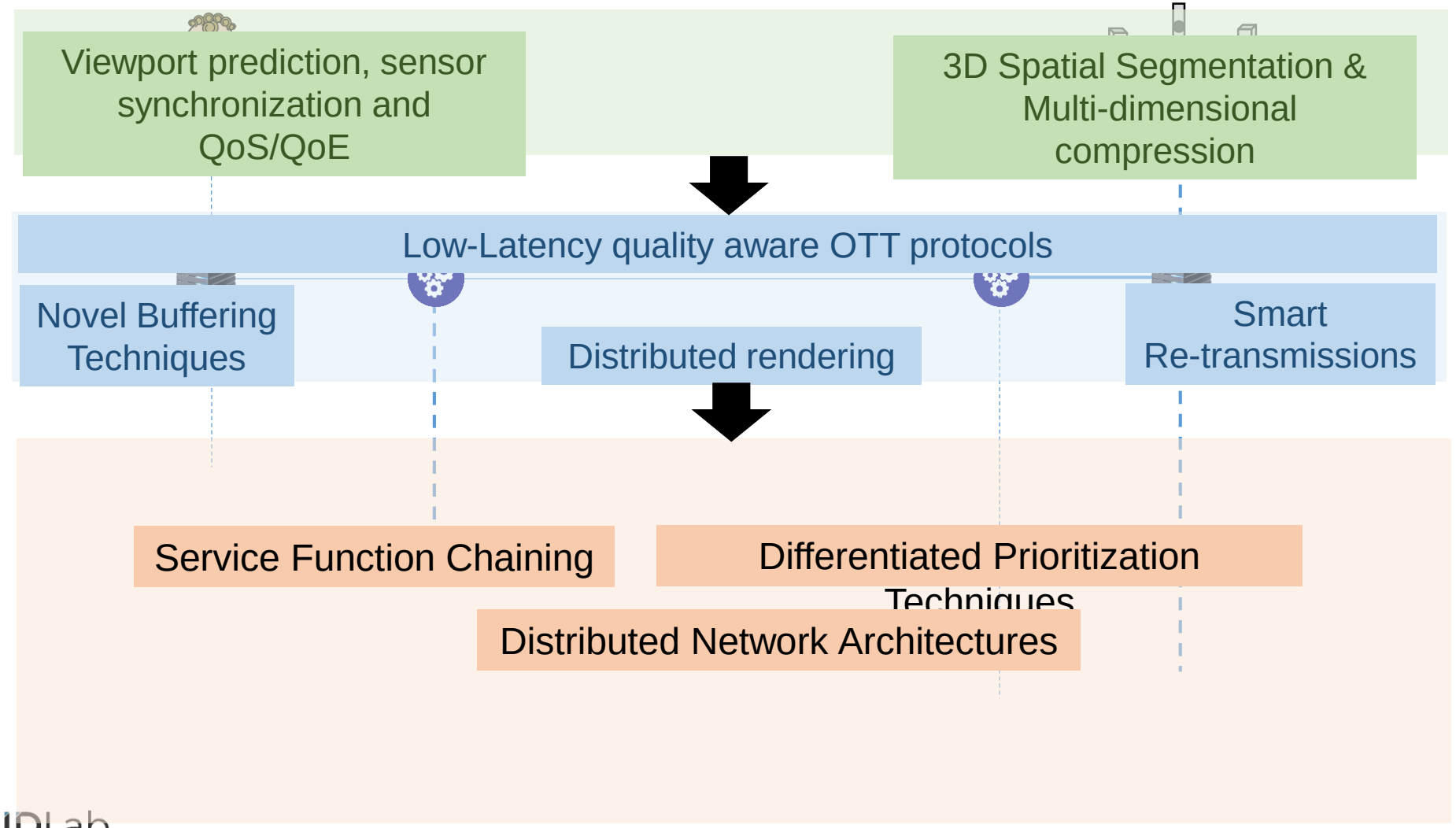
TRULY IMMERSIVE HTC: A CROSS-LAYER APPROACH

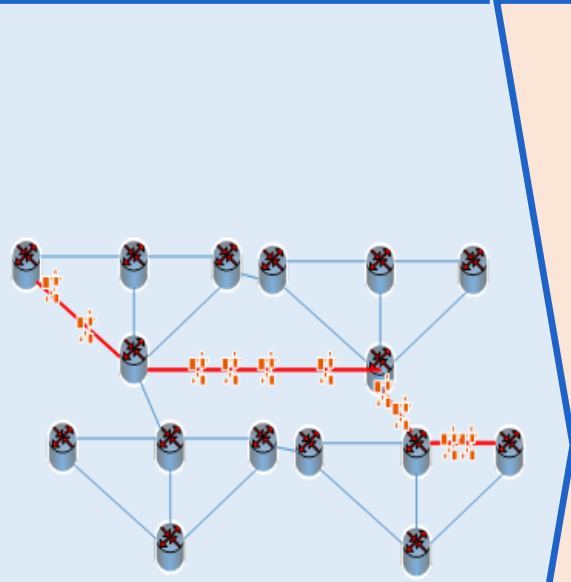


“***No, you can’t wipe `em off. They’re holograms***.” - Tobias Becket to Chewbacca in Solo (2018)
“***Holograms are the next video***” – Philip A. Chou

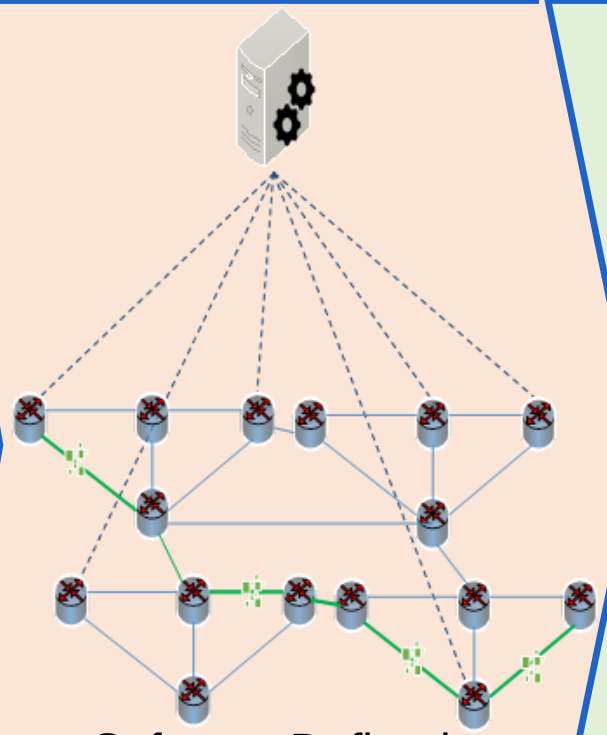
Thank you for your attention!

Any questions or comments?

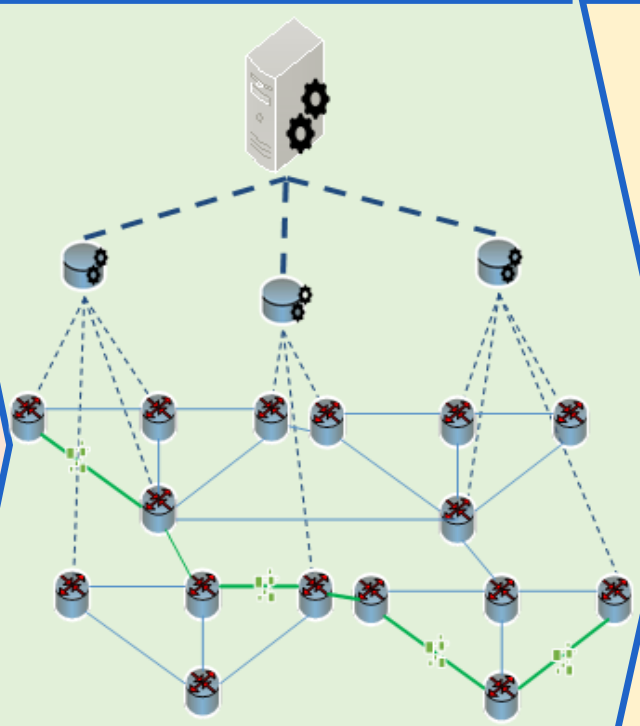
TOWARDS FULLY DECENTRALIZED NETWORKS…



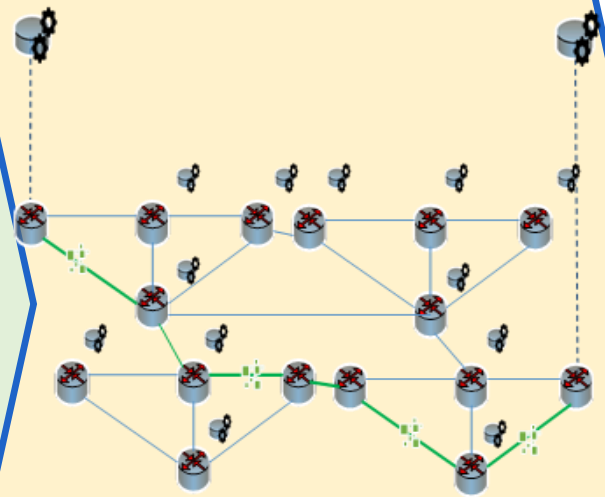
Current network infrastructure



Software Defined networks



Hierarchically decentralized SDN



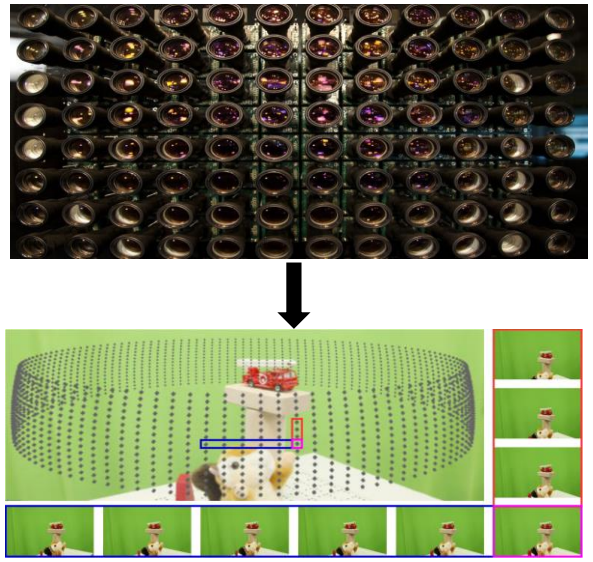
SDN with logically (&completely) decentralized controller

LIGHT-FIELD VIDEOS VS POINT CLOUDS

Light-field Videos

- Large set of cameras: Images from different angles and views
- Massive amount of data:

30° viewing, 10° tilt = 3300 separate images



Wijnants *et al.*, 2018

Point clouds

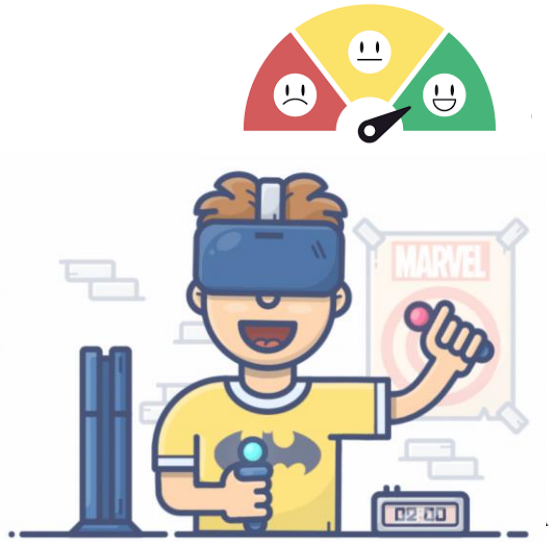
- Less cameras, more optimized
- Sets of 3D volume pixels, or voxels

VOLUMETRIC MEDIA: REQUIREMENTS

What makes a media truly immersive?

- Real-time interactivity
- Ultra-high quality to avoid cyber sickness

What does true immersiveness require from the network infrastructures?



1. ULTRA-HIGH BANDWIDTHS REQUIREMENT

HD (1080p)

1-5Mbps

360°(4K)

15-25Mbps

360° (16K)

100-500Mbps

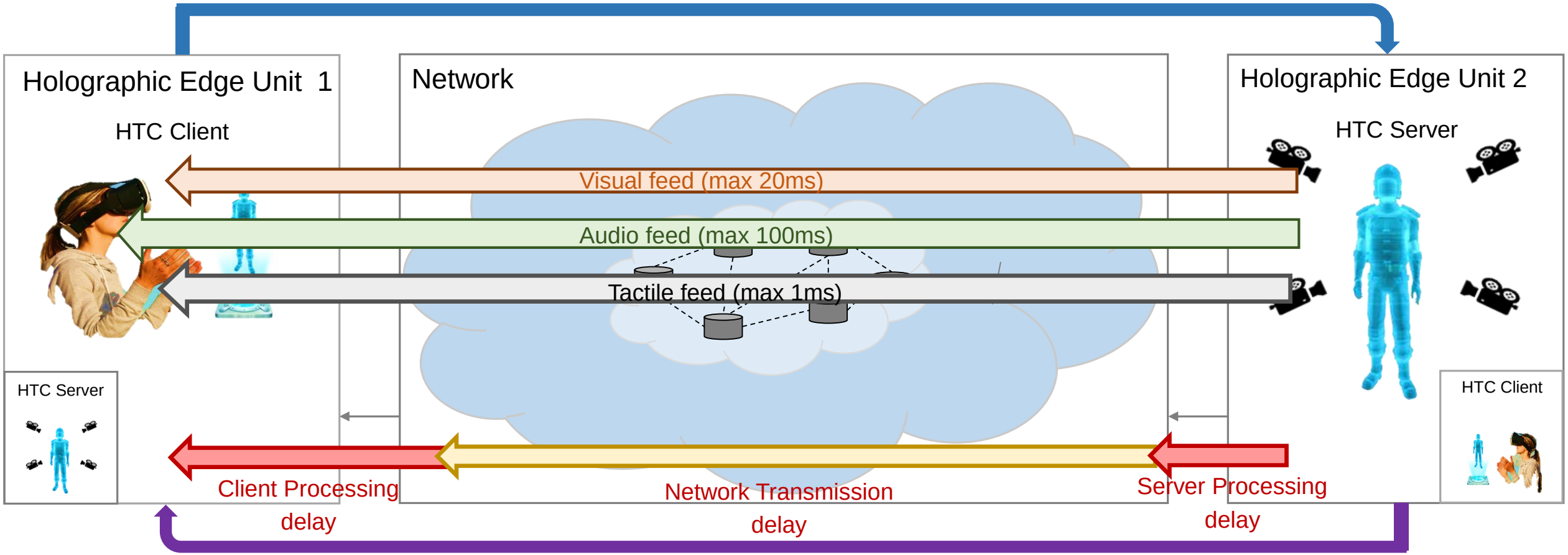
Hologram (Point cloud)

0.5-2Gbps

Hologram (Light field)

100Gbps-2Tbps

2. ULTRA-LOW LATENCY VS ULTRA-HIGH RELIABILITY



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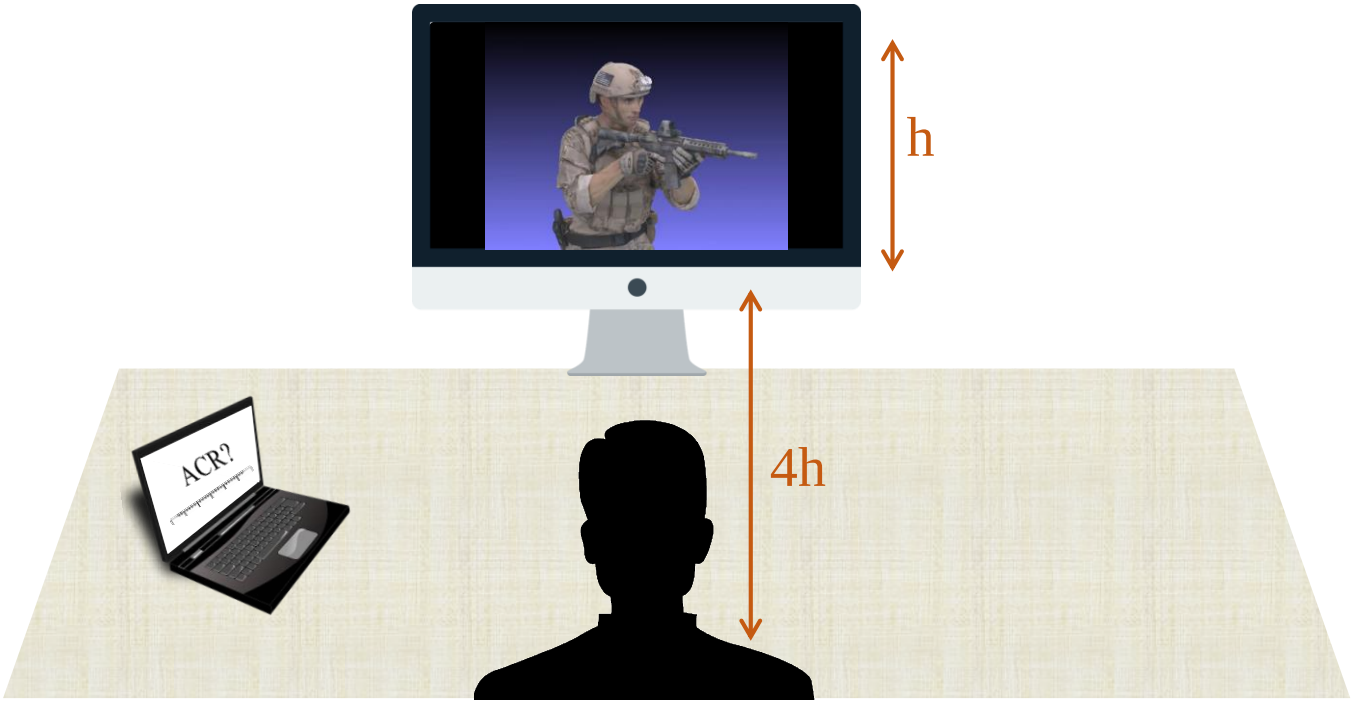
3. SYNCHRONIZATION OF STREAMS

Synchronized

Desynchronized

EVALUATION OF SUBJECTIVE QOE - SETUP