FACULTY OF ENGINEERING AND ARCHITECTURE

DEPARTMENT OF INFORMATION TECHNOLOGY

IDLAB-IMEC

TRULY IMMERSIVE VOLUMETRIC MEDIA DELIVERY

Hemanth Kumar Ravuri

GHENT UNIVERSITY

IDLab INTERNET & DATA LAB

imec

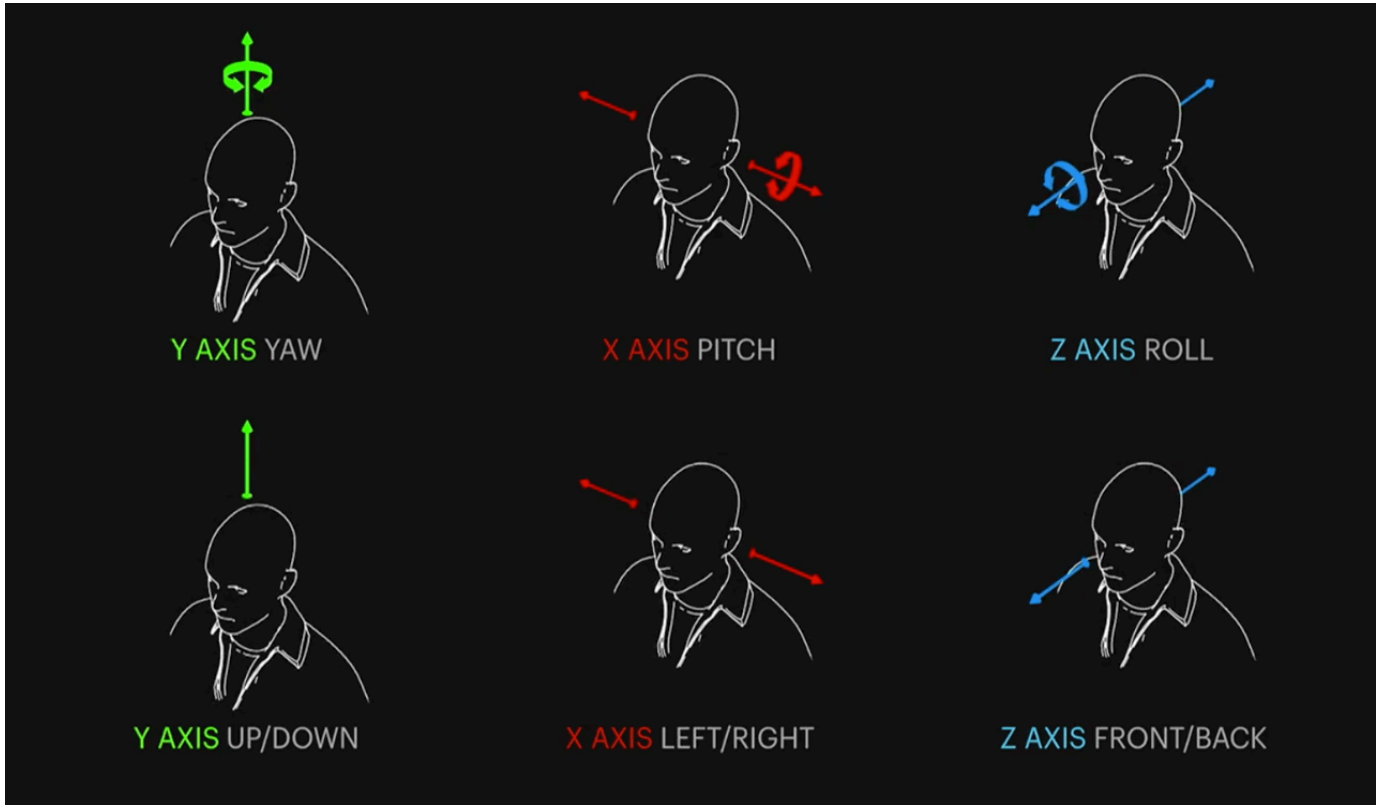
FROM 2D TO IMMERSIVE VIDEO

2D Video

Volumetric Media (Point Clouds)

360 Degree Video

WHAT DOES VOLUMETRIC MEDIA PROVIDE?



Adds parallax → multiple views

Six Degrees of Freedom

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?

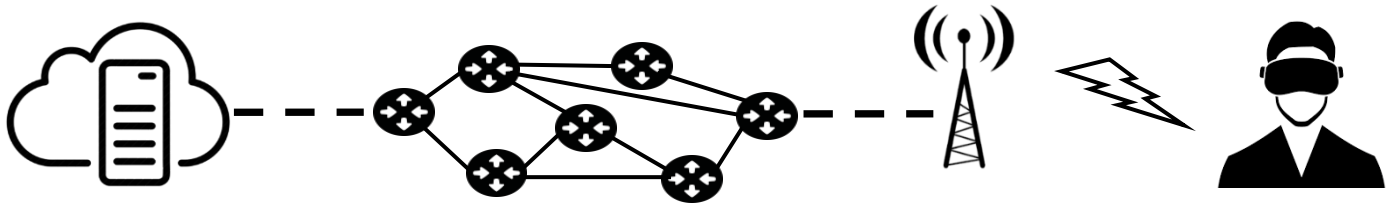
DYNAMIC POINT-CLOUD SCENES REQUIRE A SIGNIFICANT AMOUNT OF DATA

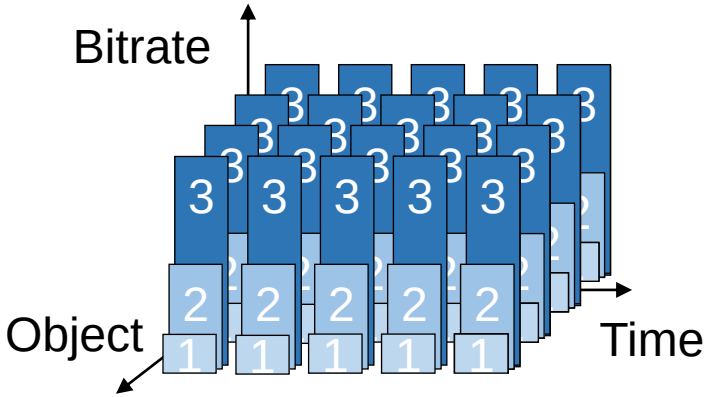
4.1 Gb/s

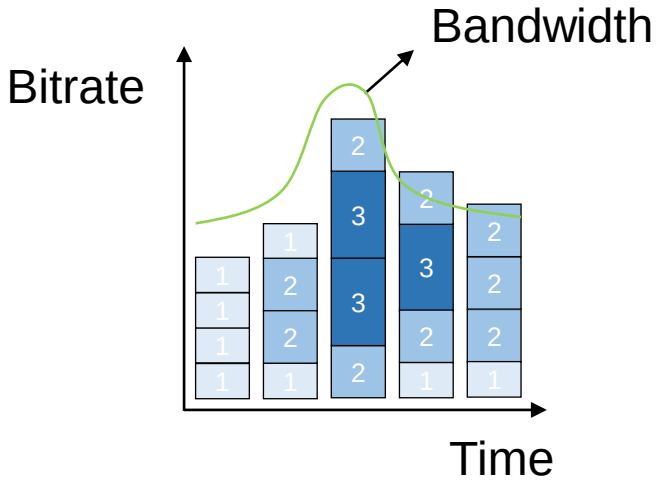
5.6 Gb/s

STREAMING THIS SCENE WOULD REQUIRE 19.2 GB/S!

WE CAN STREAM IT USING ADAPTIVE STREAMING







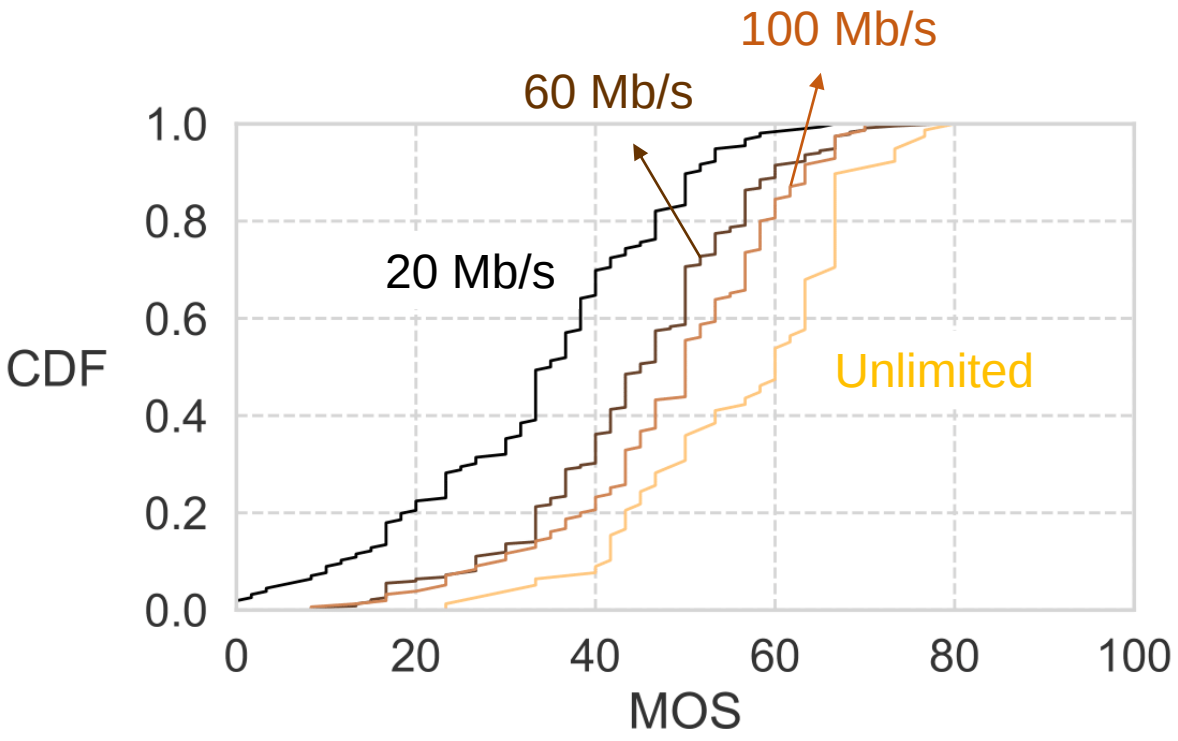
WE CAN EVALUATE THE QUALITY BY MEANS OF SUBJECTIVE STUDIES…

- 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



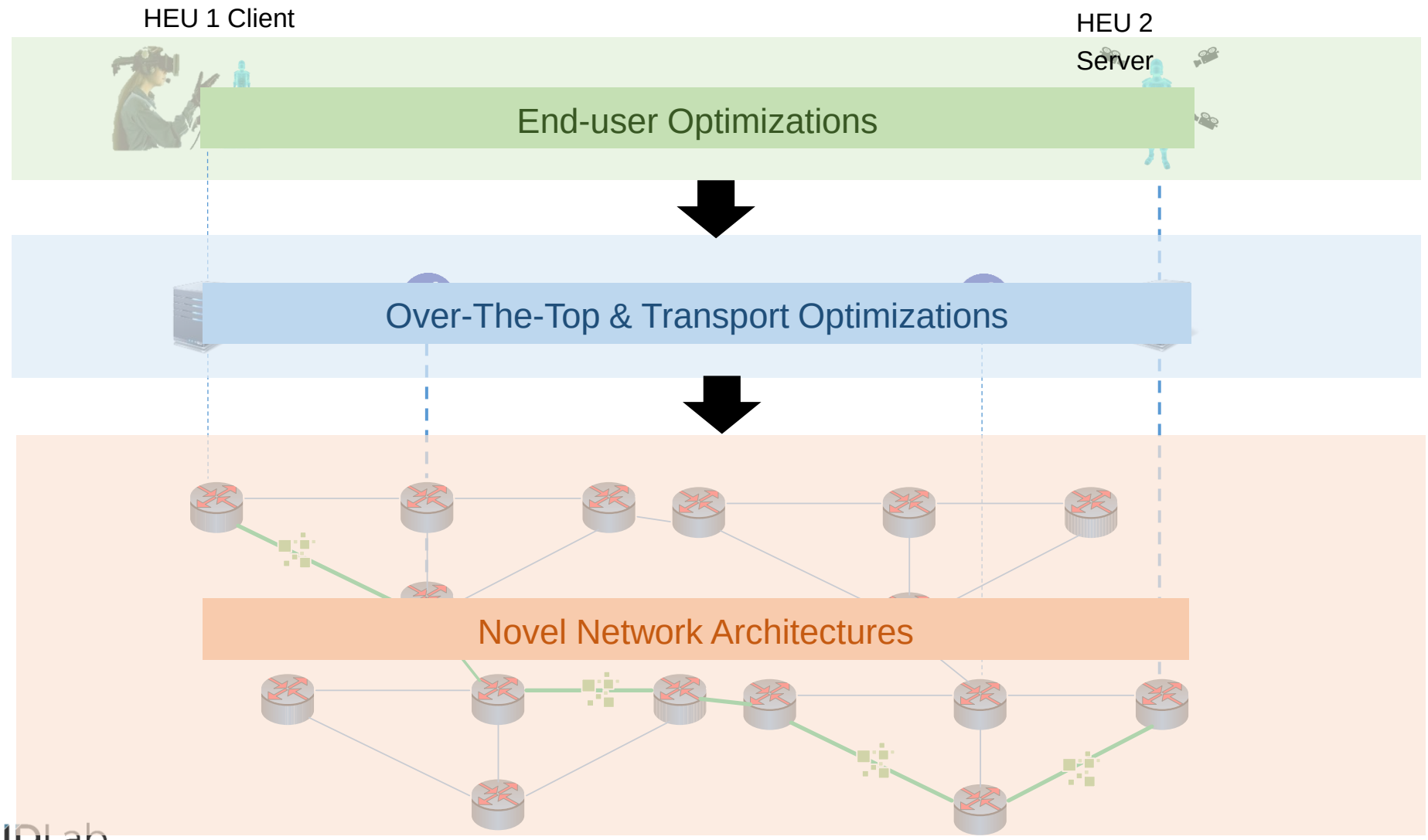
- Subjects can distinguish between different bitrates
- However, the difference in QoE is not significant
- People do not perceive delivered data as good quality: MOS < 80% in all cases and close to 60% in average

WHAT DOES IT MEAN TO THE NETWORK?

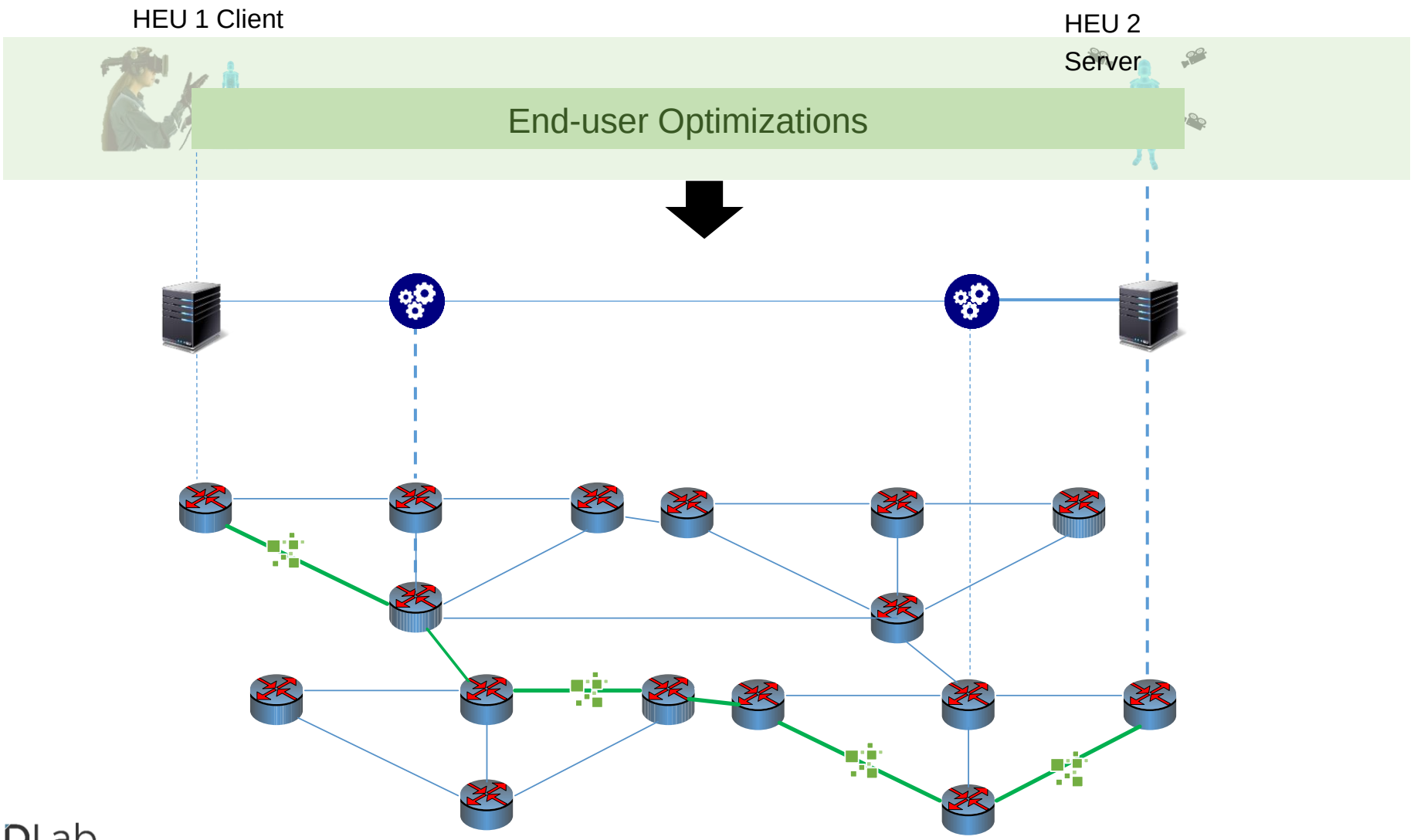
- End-user based or over the top optimizations are not sufficient to satisfy the user (MOS < 60%)
- These techniques do not cater to the latency requirement
- Network layer needs complement the application layer approaches
- Cross-layer based end-to-end architecture for volumetric media delivery

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

TRULY IMMERSIVE HTC: A CROSS-LAYER APPROACH



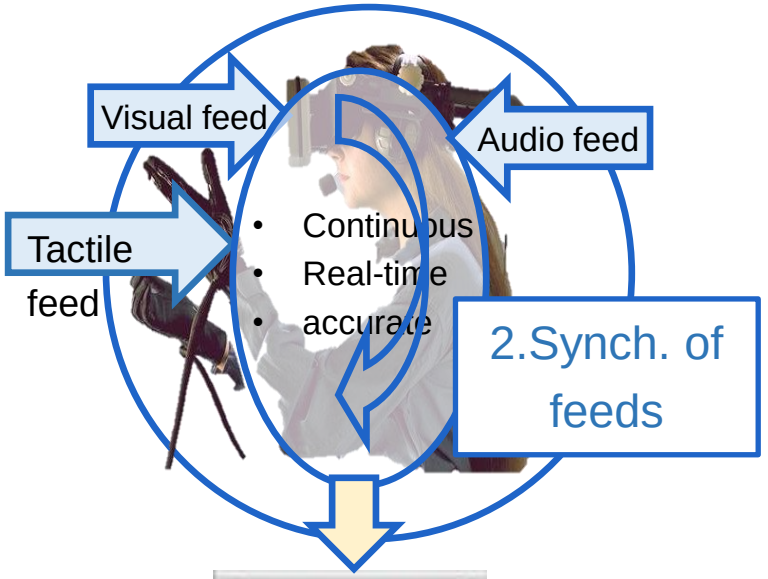
A CROSS-LAYER APPROACH: END-USER



END-USER OPTIMIZATONS

Client-side Optimizations

1.Viewport Prediction



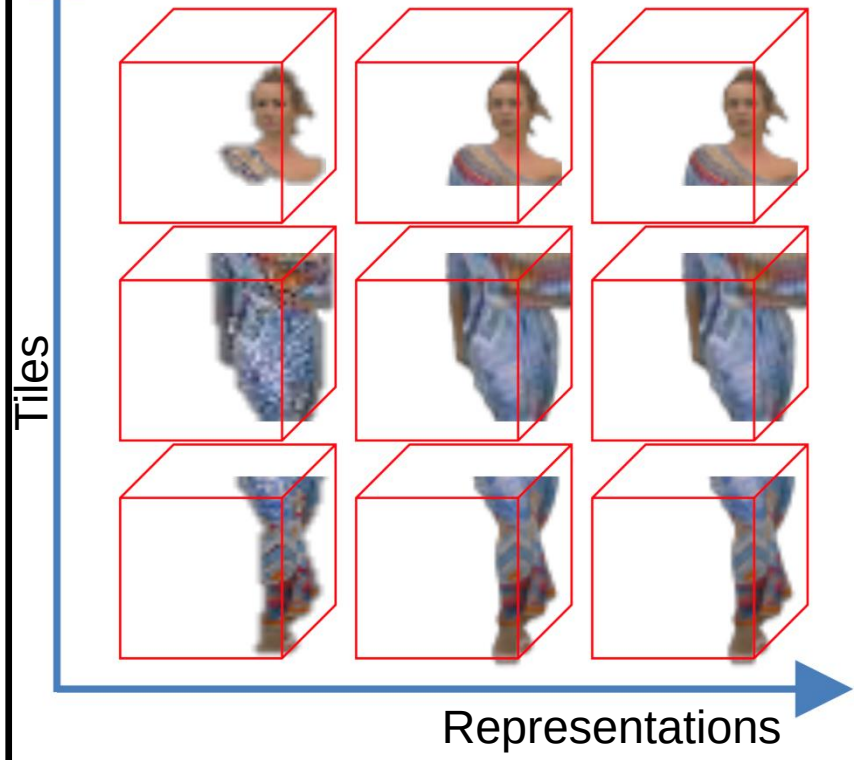
2.Synch. of feeds

3.QoS/QoE assessment

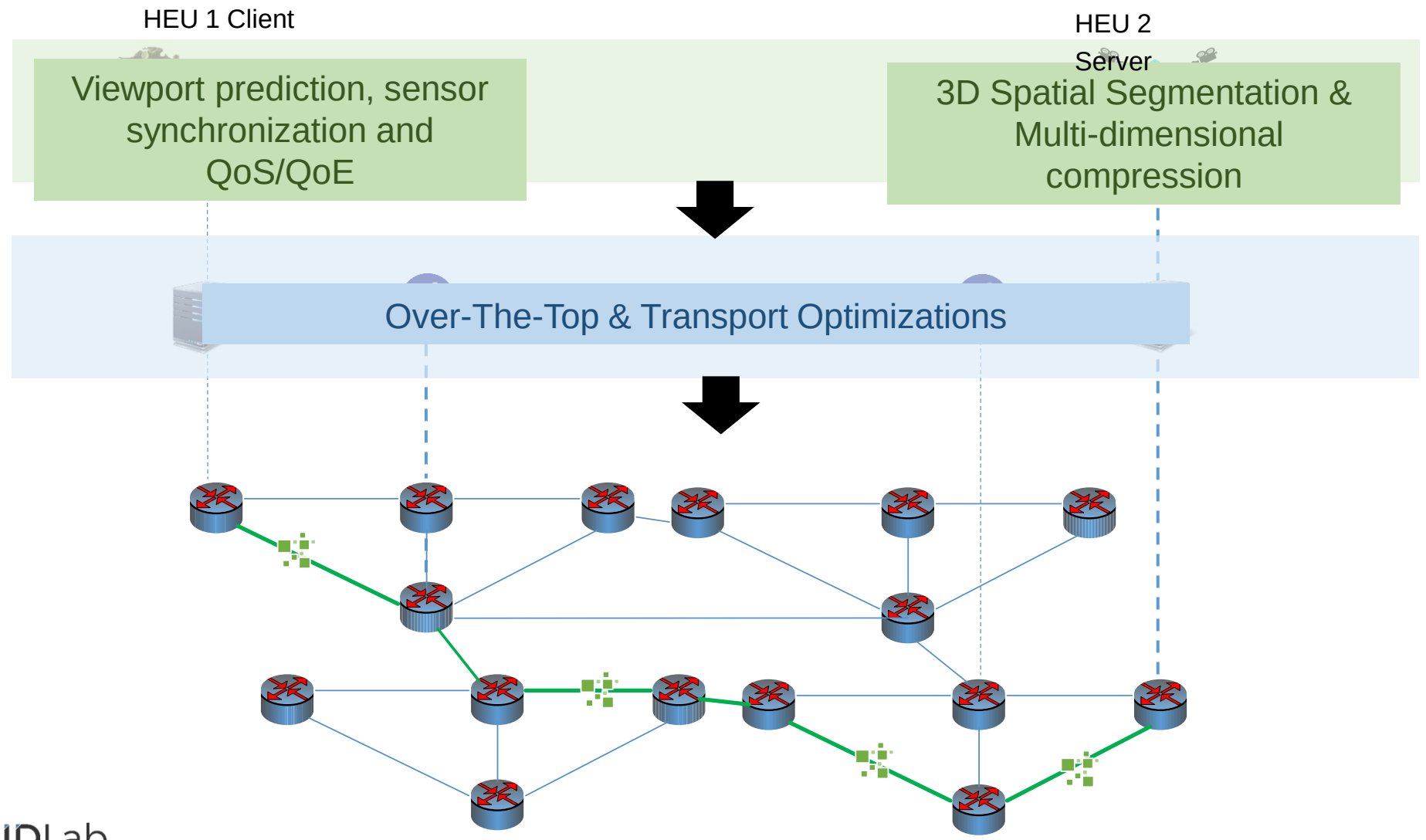
Viewpoint info & Quality

Server-side Optimizations

3D tiling and Multiple representations encoding

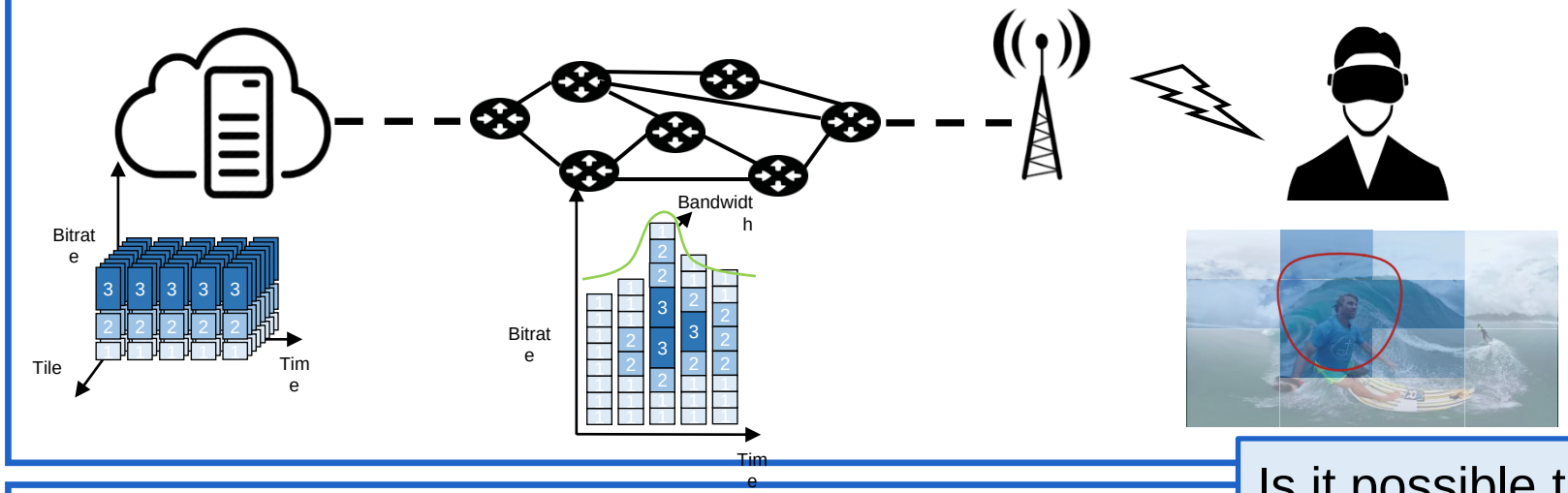


A CROSS-LAYER APPROACH: TRANSPORT



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

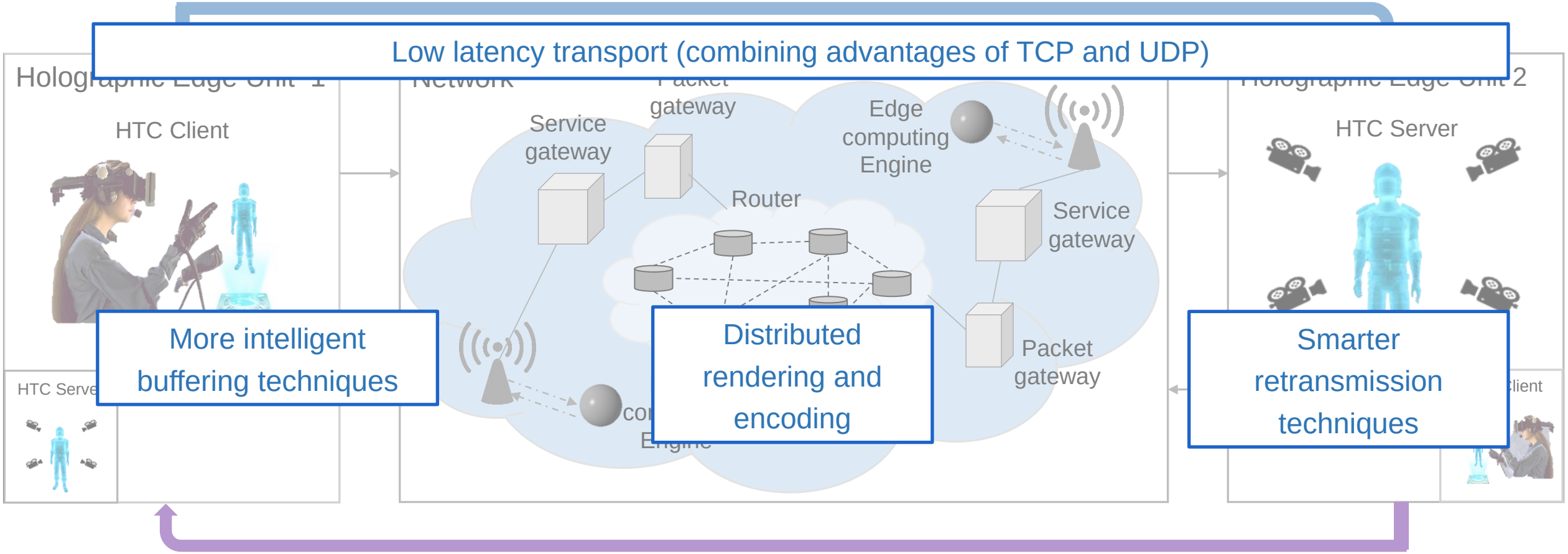
WebRTC & QUIC: Browse-based real time streaming

☺ Latency optimization

😐 Very limited quality control -> problem for HTC

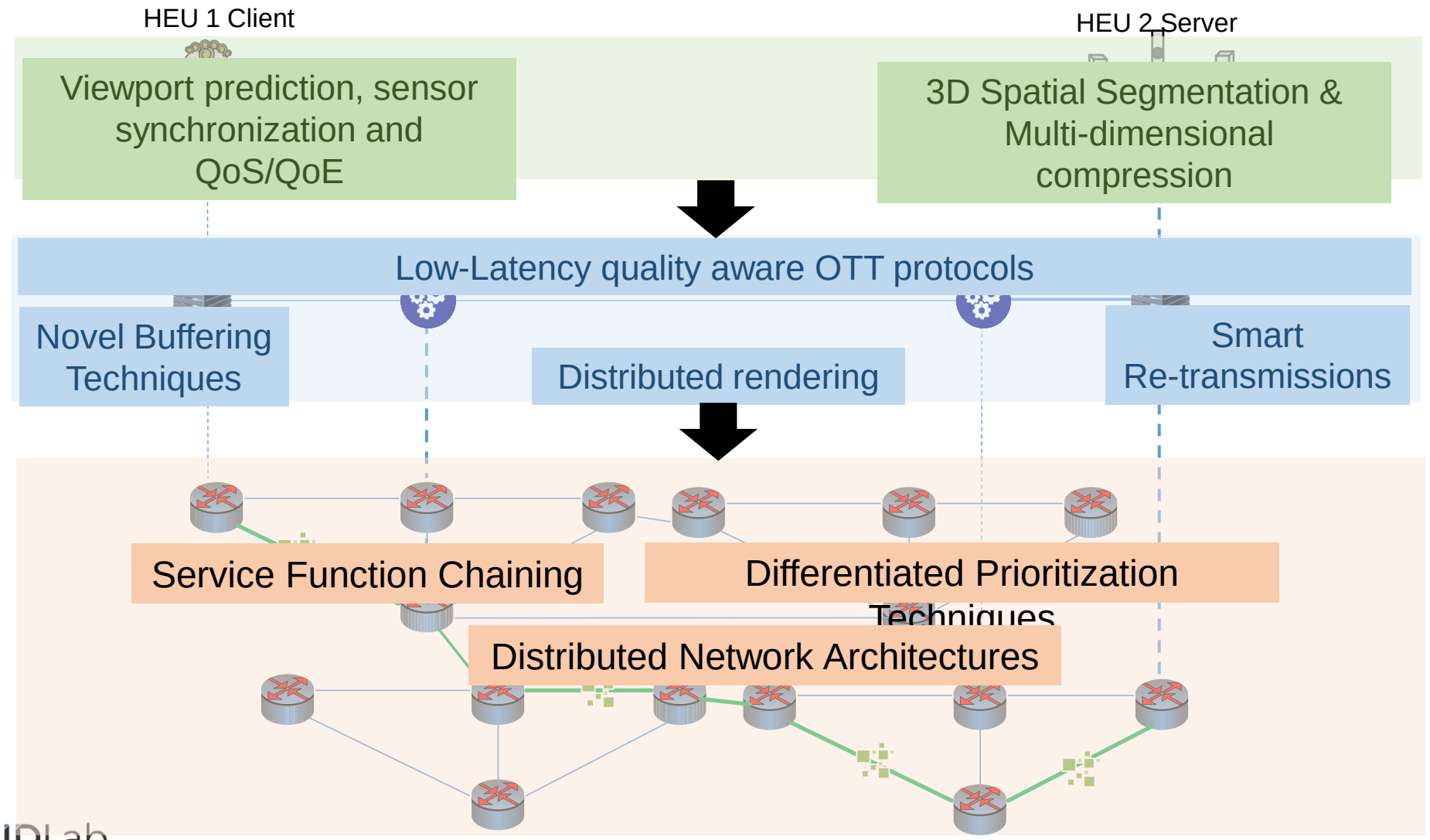
☹ Very low resilience (packet loss prone)

OVER THE TOP & TRANSPORT OPTIMIZATIONS



GHENT UNIVERSITY IDLab INTERNET & DATA LAB imec

TRULY IMMERSIVE HTC: A CROSS-LAYER APPROACH



CONCLUSION

- End-user based or over the top optimizations are not sufficient to satisfy the user
- Need for a cross-layer approach
- Open Challenges:
  - End-User side: Viewport prediction techniques
  - Transport side: novel buffering, smarter retransmission
  - Network side: computation support on the edge, synchronization, differentiated prioritization.

"***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?