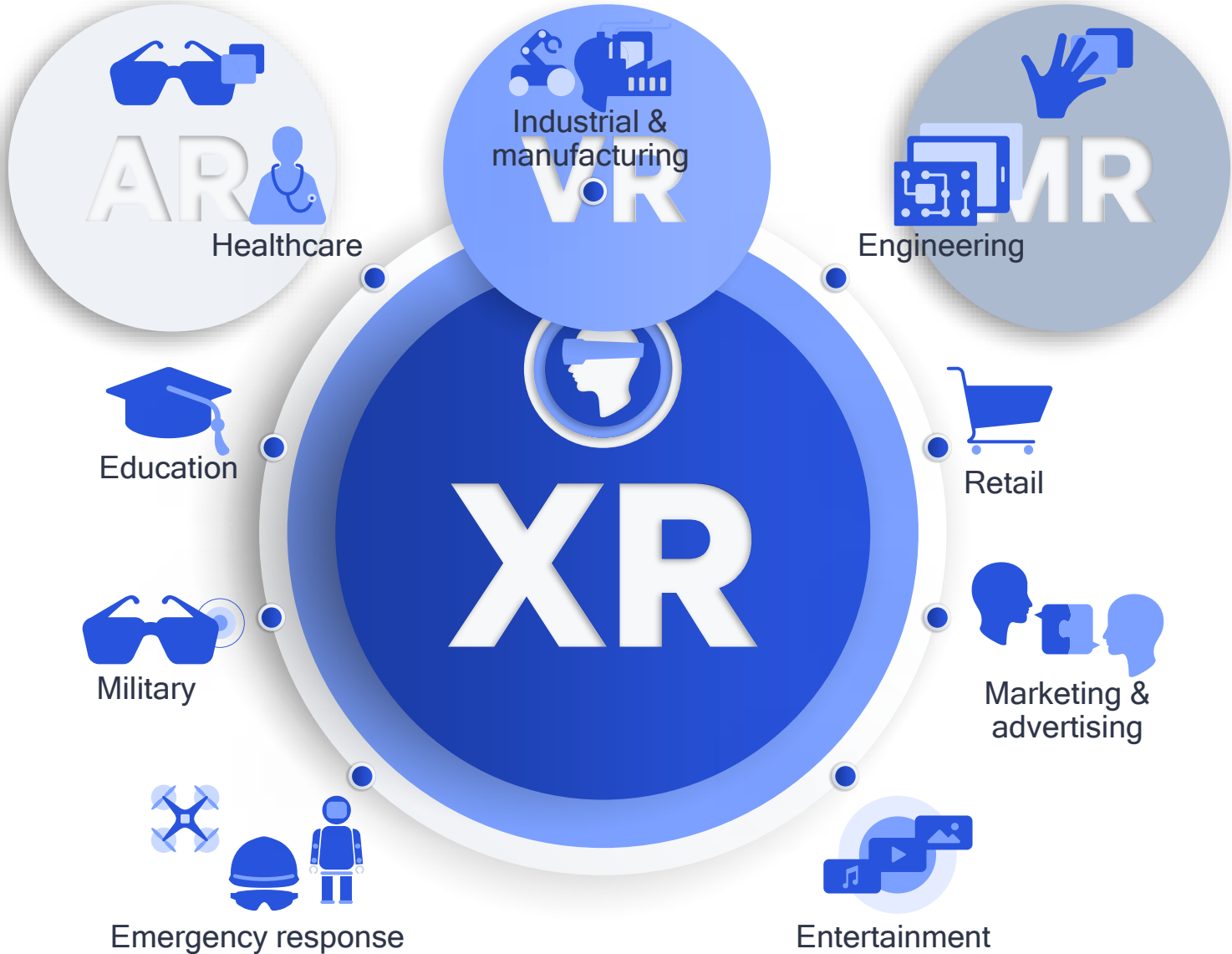


STANDARDS FOR THE STREAMING OF SPLIT AND NETWORK-RENDERED IMMERSIVE EXPERIENCES

MHV'23

Imed Bouazizi
Thomas Stockhammer
Nikolai Leung

XR is meant to be mobile



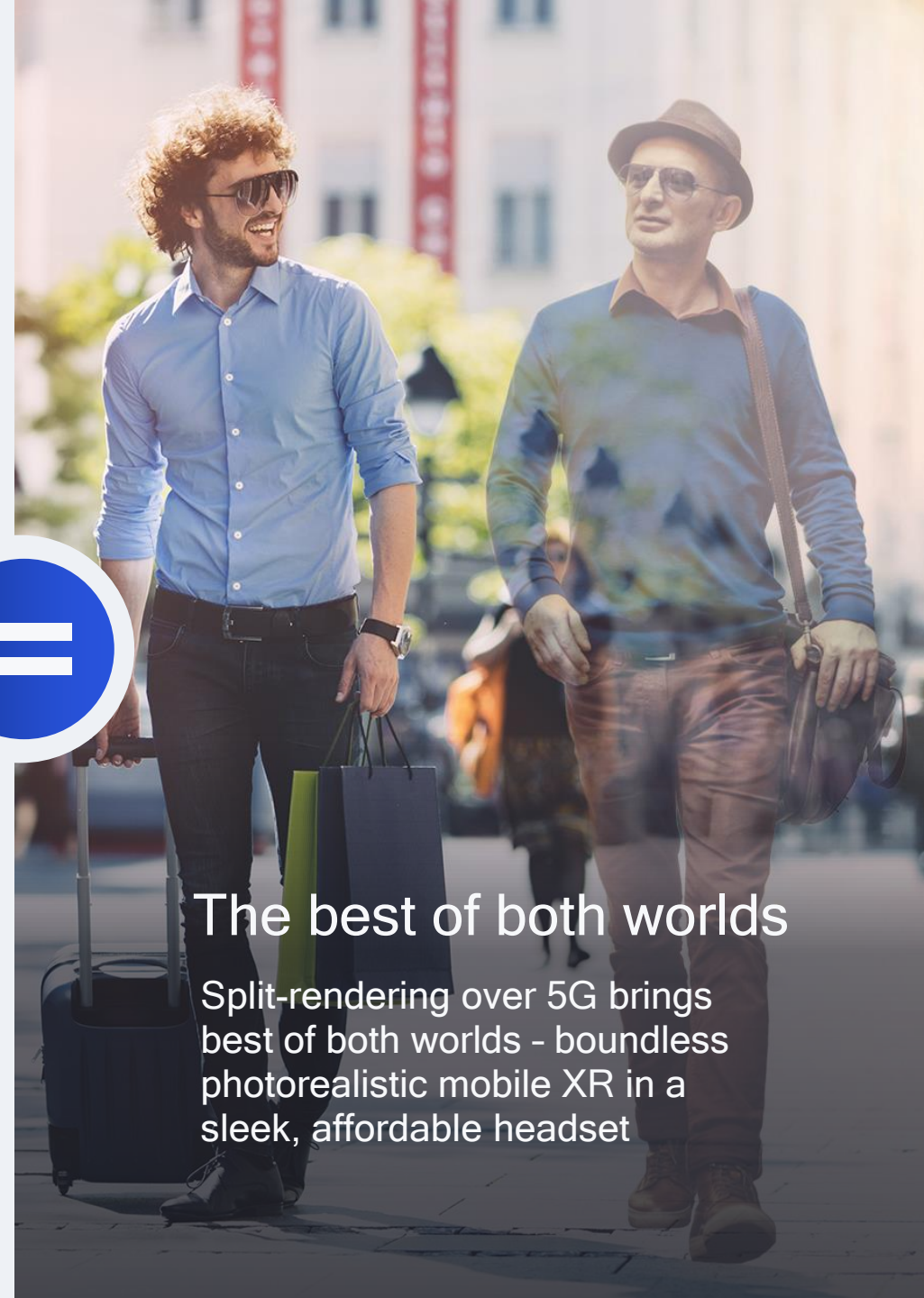
Mobile XR

- Reliable, anywhere anytime usage
- Ease of use with no setup
- Battery powered sleek, ultra-light design
- Leverages mobile ecosystem scale



PC-tethered XR

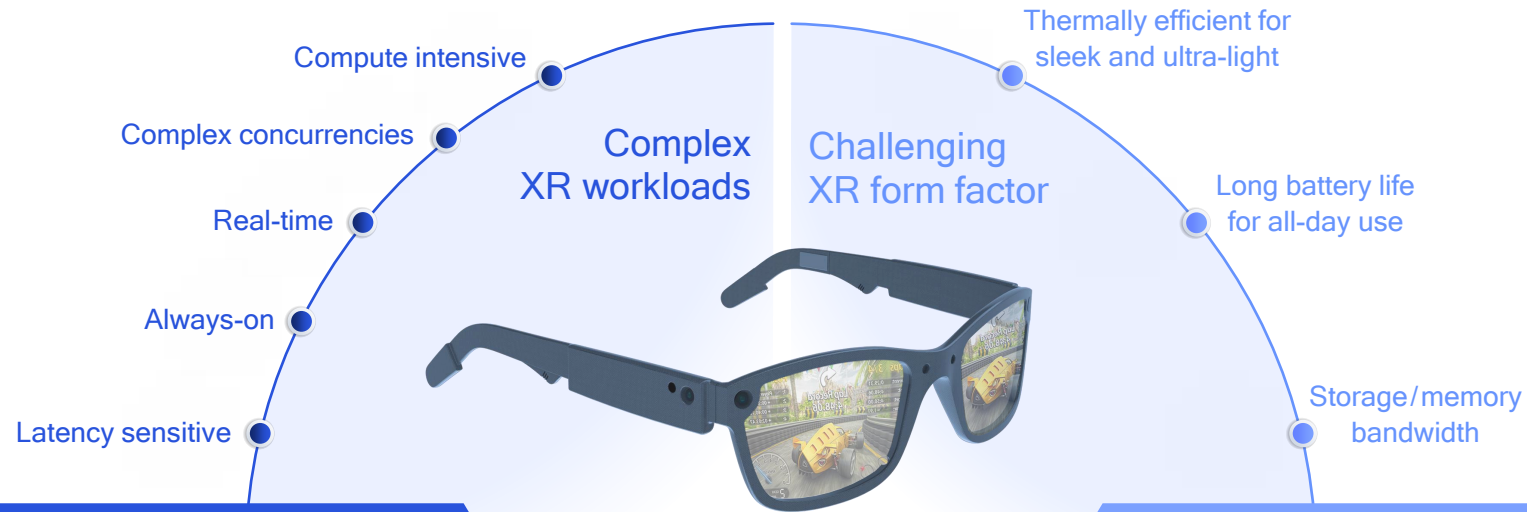
- Not limited by power and thermal constraints
- Expensive and niche for high-end experiences
- Wires limit intuitive actions and immersion
- Usage limited to a fixed location



The best of both worlds

Split-rendering over 5G brings best of both worlds - boundless photorealistic mobile XR in a sleek, affordable headset

Distributed Processing



Essential on-device processing

Split rendering

Augment by edge processing

Optimized under strict power, thermal, size constraints

Premium experiences today that continuously improve



Low latency
High capacity
Reliable link

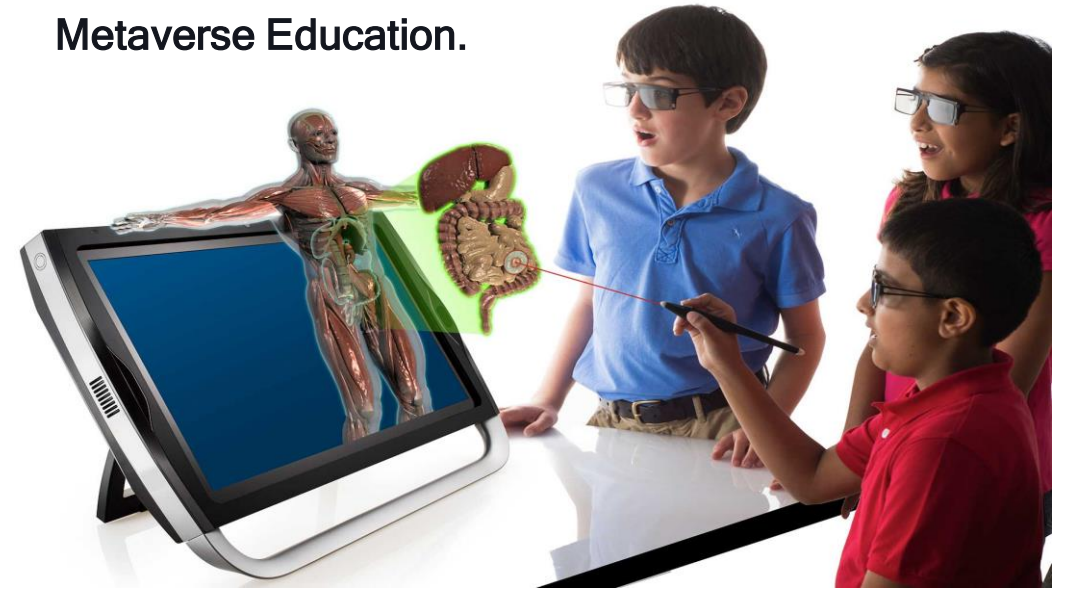
Significantly higher power envelope—beyond PC class

Augment on-device rendering with edge cloud rendering

Metaverse

- Infinite worlds and experiences
- Diverse Use Cases
- Potential to disrupt today's web surfing experience

Metaverse Education.



Metaverse Entertainment.



Metaverse Gaming.

Standardizing Split Rendering



Scene Description

Video Decoding
Interface (VDI)

Video, Audio, Haptics



**SR_MSE: Split Rendering
Media Service Enabler**

XR Architectures

Media Formats

Optimized Audio Codecs for
Split Rendering

Integration in 5G system



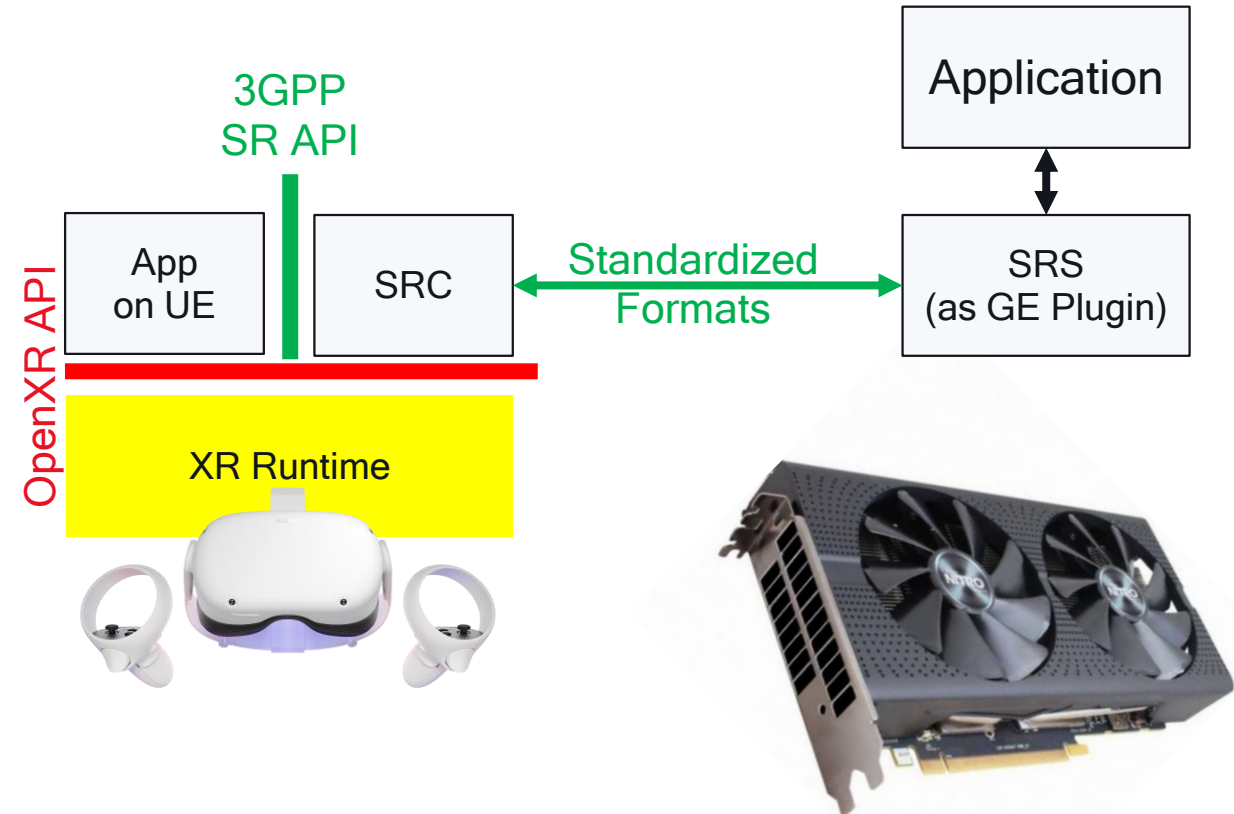
Vulkan.

OpenXR™



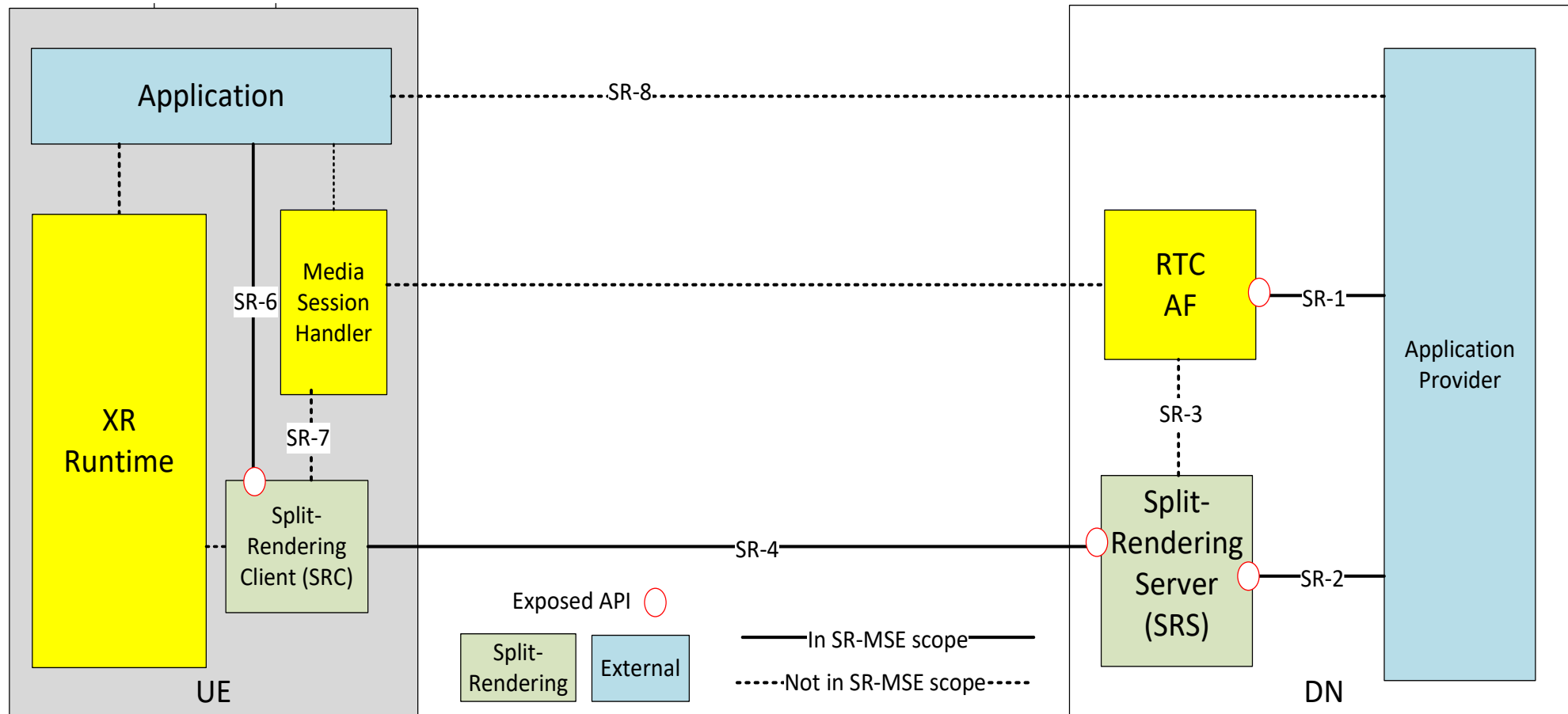
Split Rendering Design

- **SRS: Split Rendering Server**
 - Connects directly or indirectly to application
 - Maybe implemented as a Game Engine plugin
 - Configures Application rendering (e.g. sets it to stereo or cubemap to match OpenXR view/projection configuration)
 - Emulates game input
 - Captures/encodes/transmits rendering output to UE
 - Syncs up with SRC
- **SRC: Split Rendering Client**
 - Runs on the UE/HMD
 - Discovers and connects to SR Streamer App
 - Application on UE owns the OpenXR session
- **Interoperable Design**
 - SRC and SRS may come from different vendors
- **Robustness**
 - App on UE can fallback to local rendering

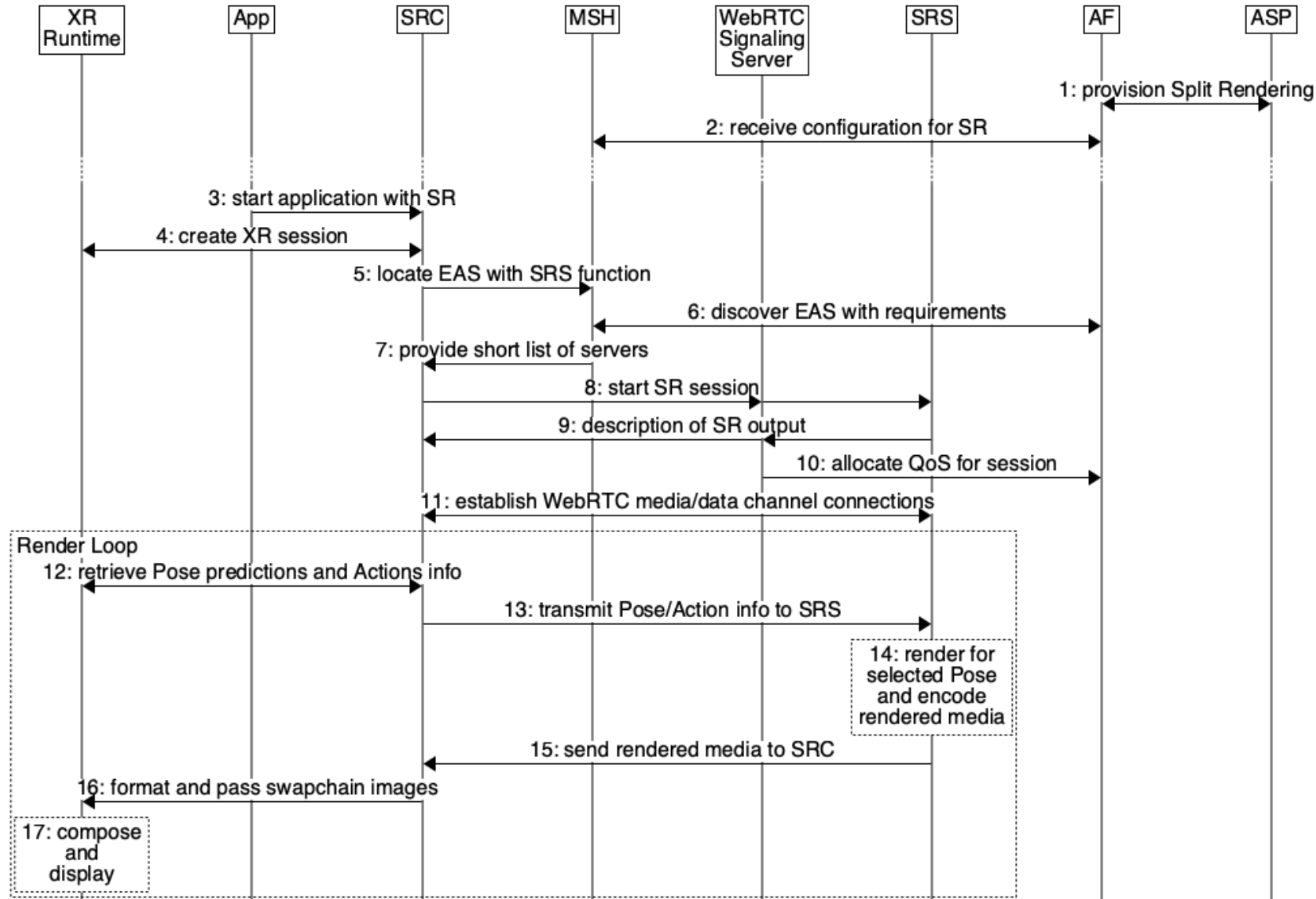


Split Rendering Architecture

3GPP TS26.565

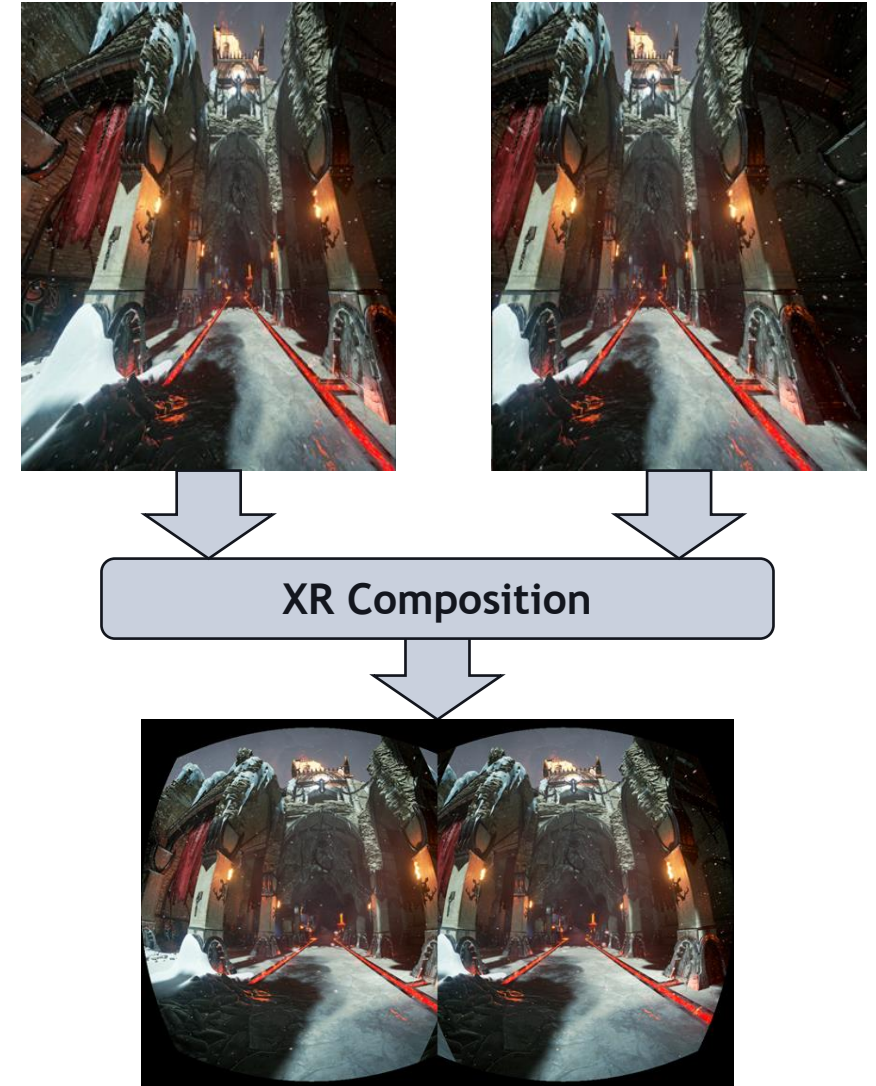


Split Rendering Call Flow



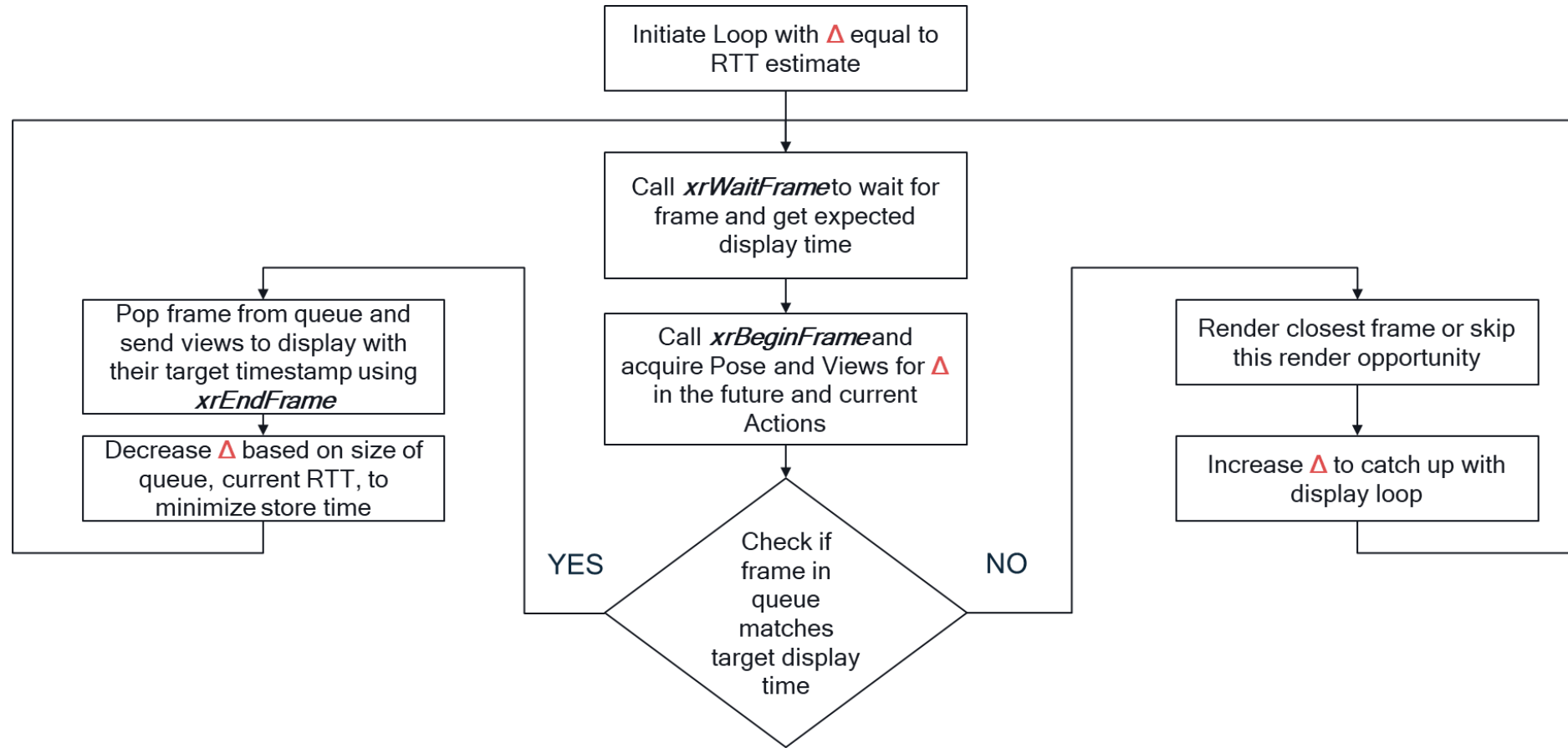
Split Rendering Negotiation

- Split Rendering Client maintains XR session
- SRC tells SRS about configuration of the XR session and its rendering capabilities
- SRS replies with a description of the rendered format
 - May cover a wide range of configurations from 2D to 3D
- Configuration information may include:
 - View configuration
 - Composition layer configuration
 - Swapchain resolution and level of detail
 - Rendering capabilities
- SR Description is proposed to be a glTF + extensions
 - Allows for alternative operation points



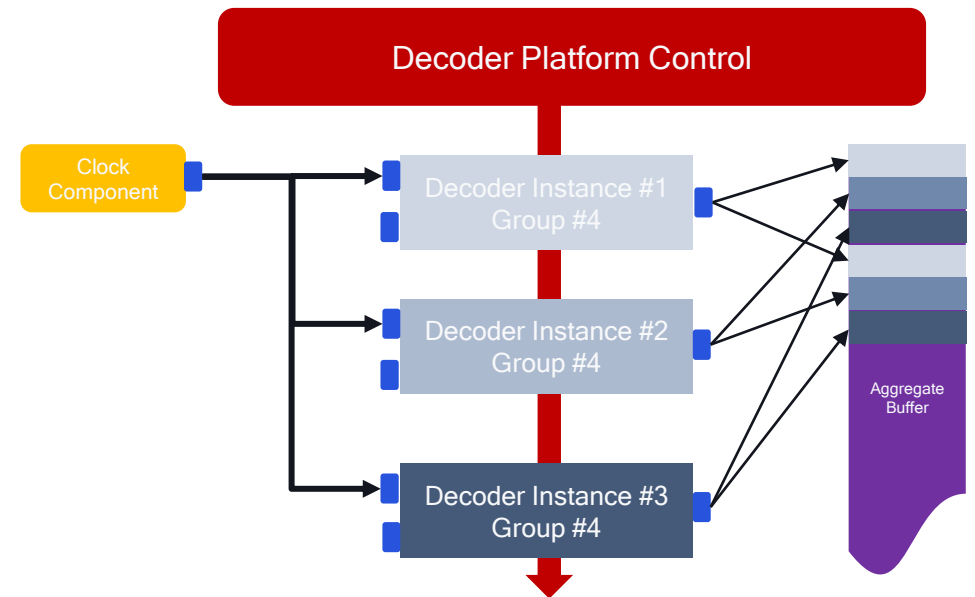
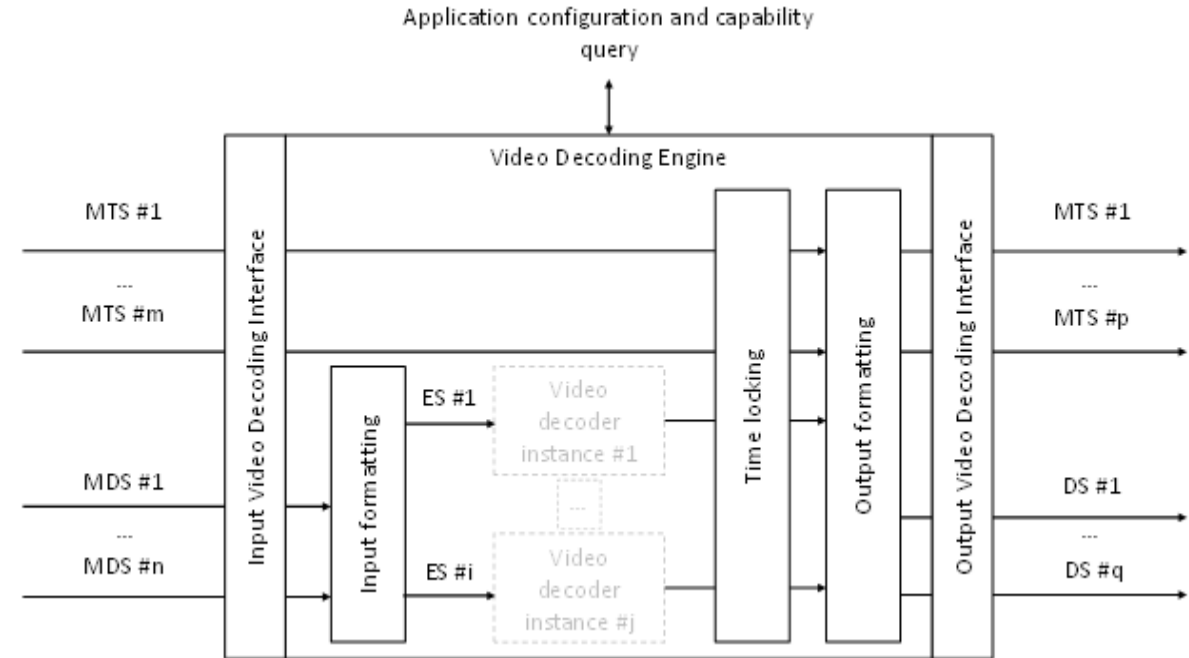
Render Loop Operation

An Adaptive Control Loop with goal to optimize quality and reduce M2R2P



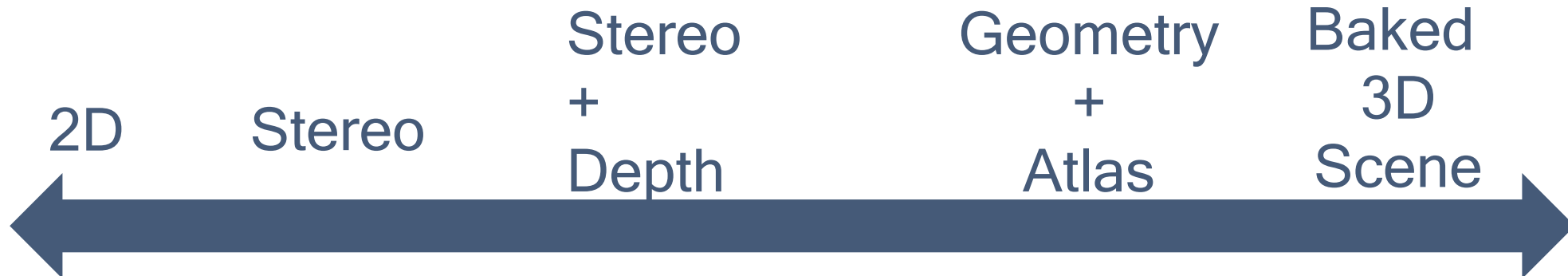
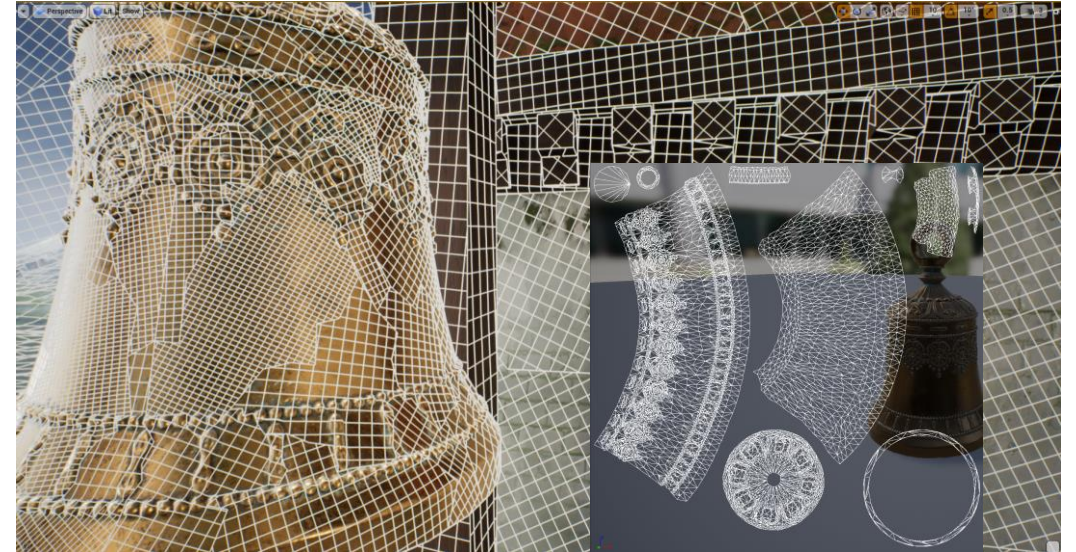
Video Decoding Interface

- Current video decoding interfaces
 - OpenMAX (OMX)
 - Android Codec2
 - iOS CoreVideo/CoreAudio
- Optimized for single 2D Audio/Video decoding
- Split Rendering has different requirements:
 - Decoders for same rendered frame need to be synced and paced
 - Synchronization at frame accuracy (different from A/V sync)
- MPEG VDI
 - Manage decoding resources efficiently and with certainty
 - Enhance control interface for decoder platform
 - Specify pre- and post-processing instructions for input and output
 - Abstract API with mappings to
 - OpenMAX
 - WebCodecs
 - Vulkan Video API



Future Developments

- Encode configuration recommendations
- Error concealment
- Adaptive Split Rendering
- Support more advanced Split Rendering profiles



Thank you

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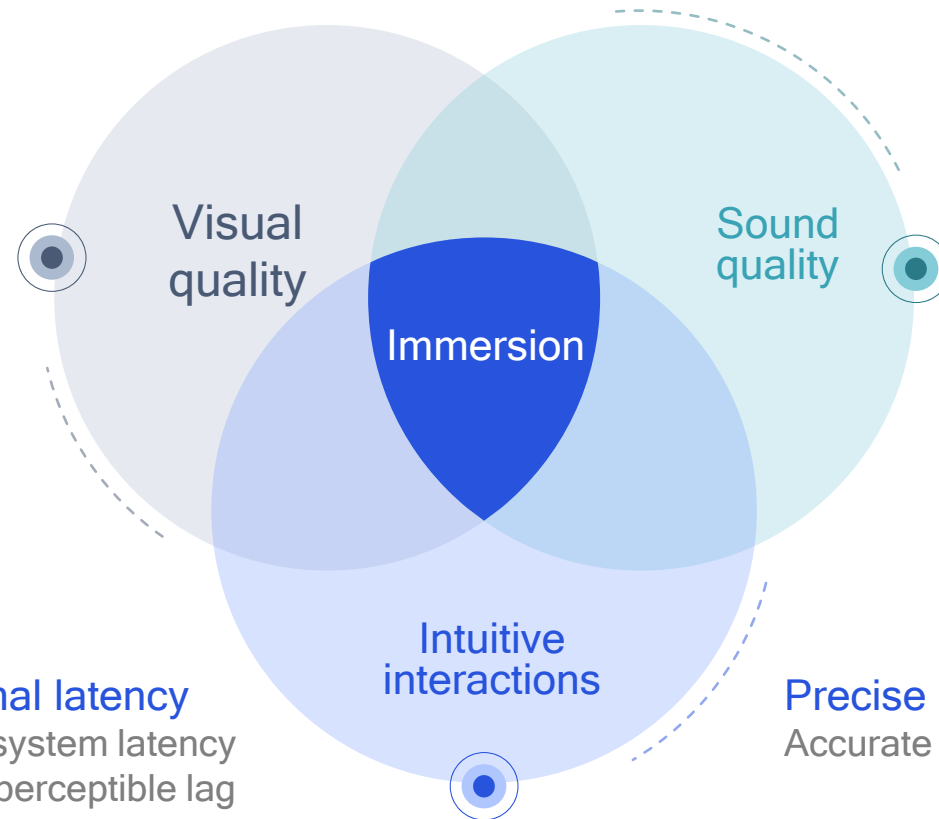
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Challenging Goals

Extreme pixel quantity and quality
Screen is very close to the eyes

Spherical view
Look anywhere with a full 360° spherical view

Stereoscopic display
Humans see in 3D



High resolution audio
Up to human hearing capabilities

3D audio
Realistic 3D, positional, surround audio that is accurate to the real world

Minimal latency
Minimized system latency to remove perceptible lag

Precise motion tracking
Accurate on-device motion tracking

Natural user interfaces
Seamlessly interact with VR using natural movements, free from wires

A glimpse into the future – sleek and stylish XR glasses

How do we get there?

Bone conduction transducers

Directional speakers

Tracking and recording cameras

Inertial, haptic,
and health sensors

Multiple high sensitivity
audio microphones

Multimode connectivity
(4G, 5G, etc.)

Many passive and active cameras
with fisheye and telephoto lenses
Optoelectronic night vision
and thermal imaging sensors

Ambient light sensors

Eye tracking cameras

New optics and projection
technologies within a durable,
semitransparent display

