

Advanced Web Technologies

Dr. Stephan Steglich & Dr. Louay Bassbouss | Open Distributed Systems | lecture winter term 2023/24

Agenda

1. Fraunhofer FOKUS / FAME
2. Module information
3. Goals of the course
4. Project course topics
5. Resources
6. Agenda
7. Web Technologies – Intro and motivation
8. Q&A



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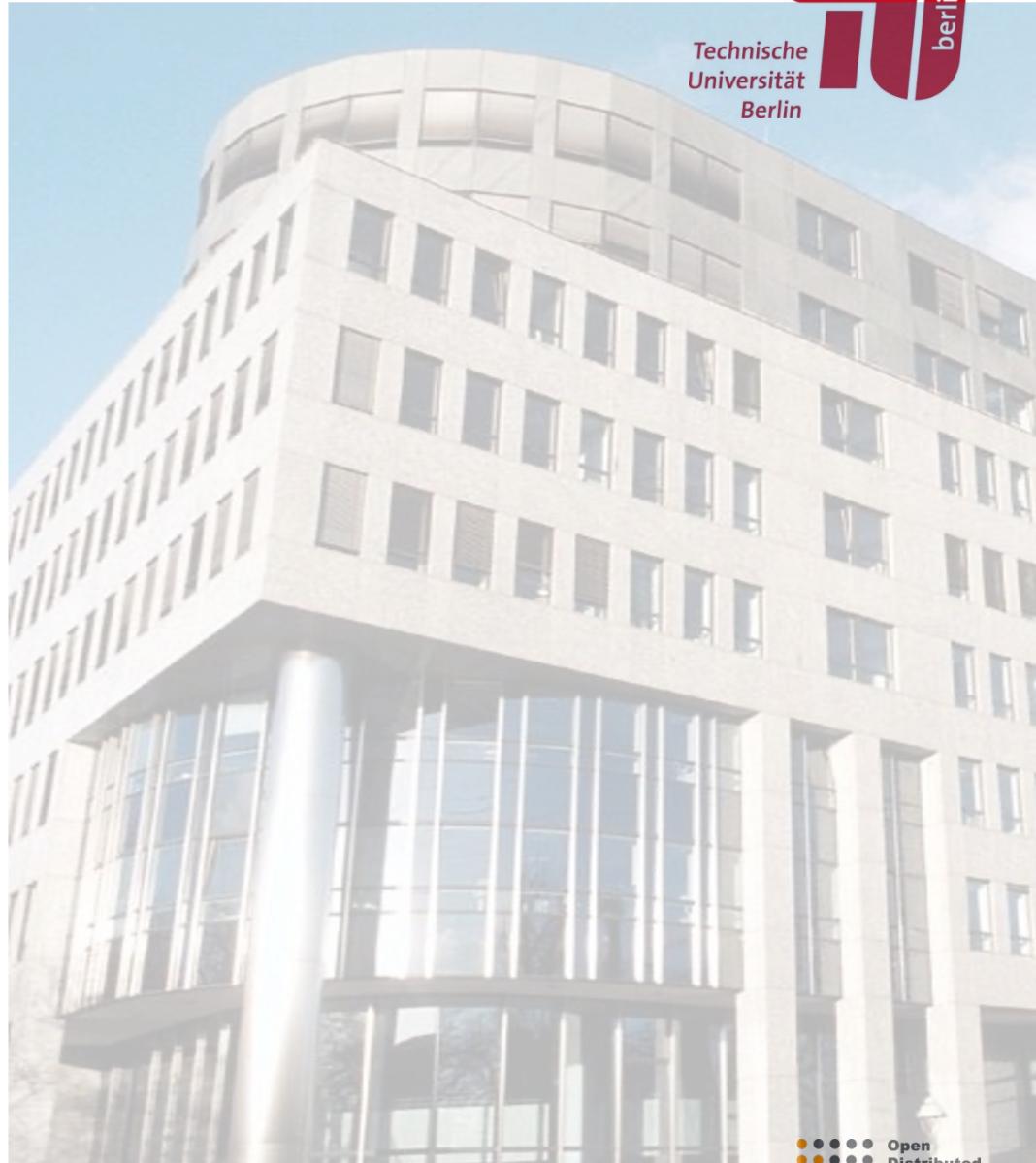


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We connect everything

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The Fraunhofer-Gesellschaft

Research budget: 2.9 billion euros, of this sum, 2.5 billion euros is generated through contract research

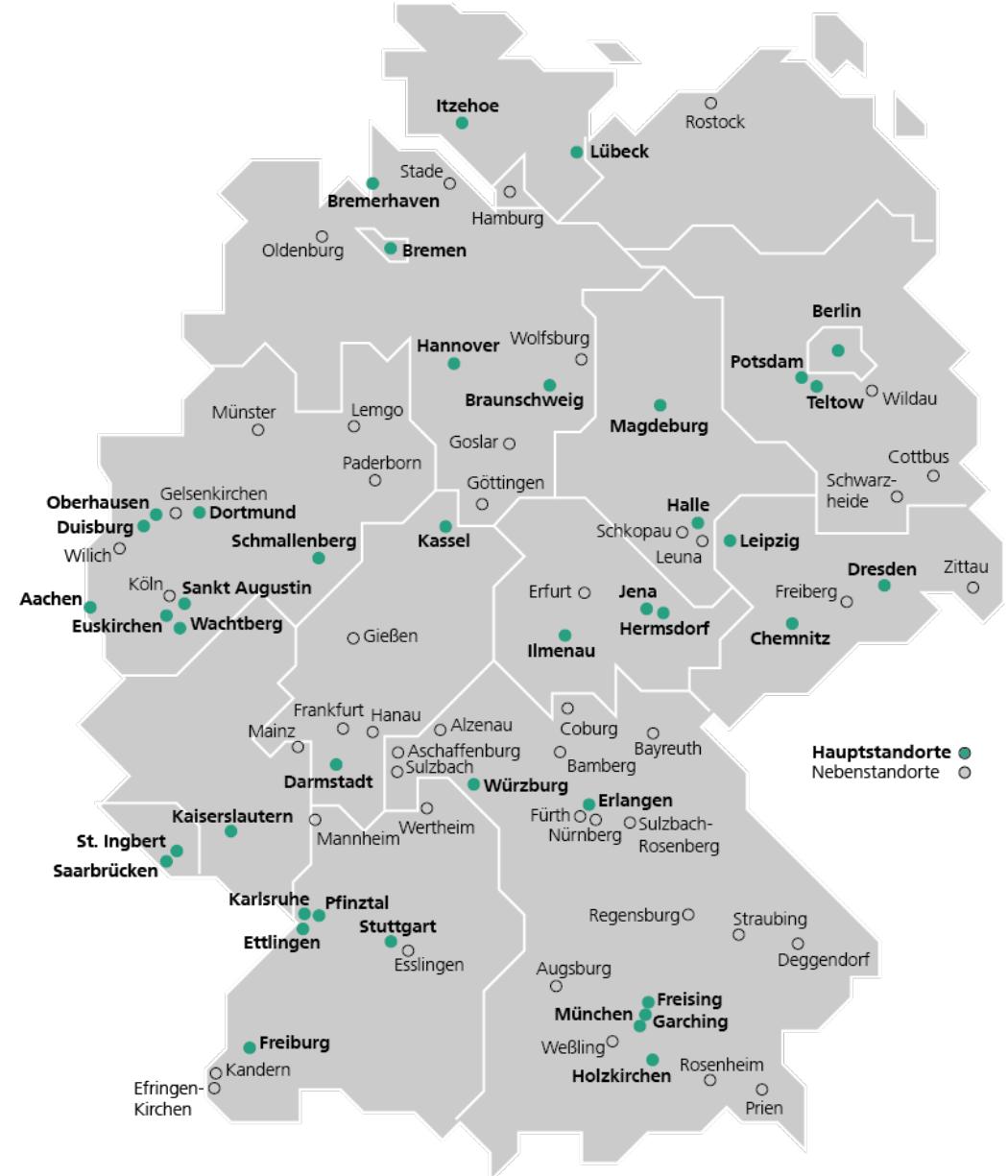
- Around two thirds of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects
- Around one third is contributed by the German federal and state governments in form of base funding



30.000
Employees



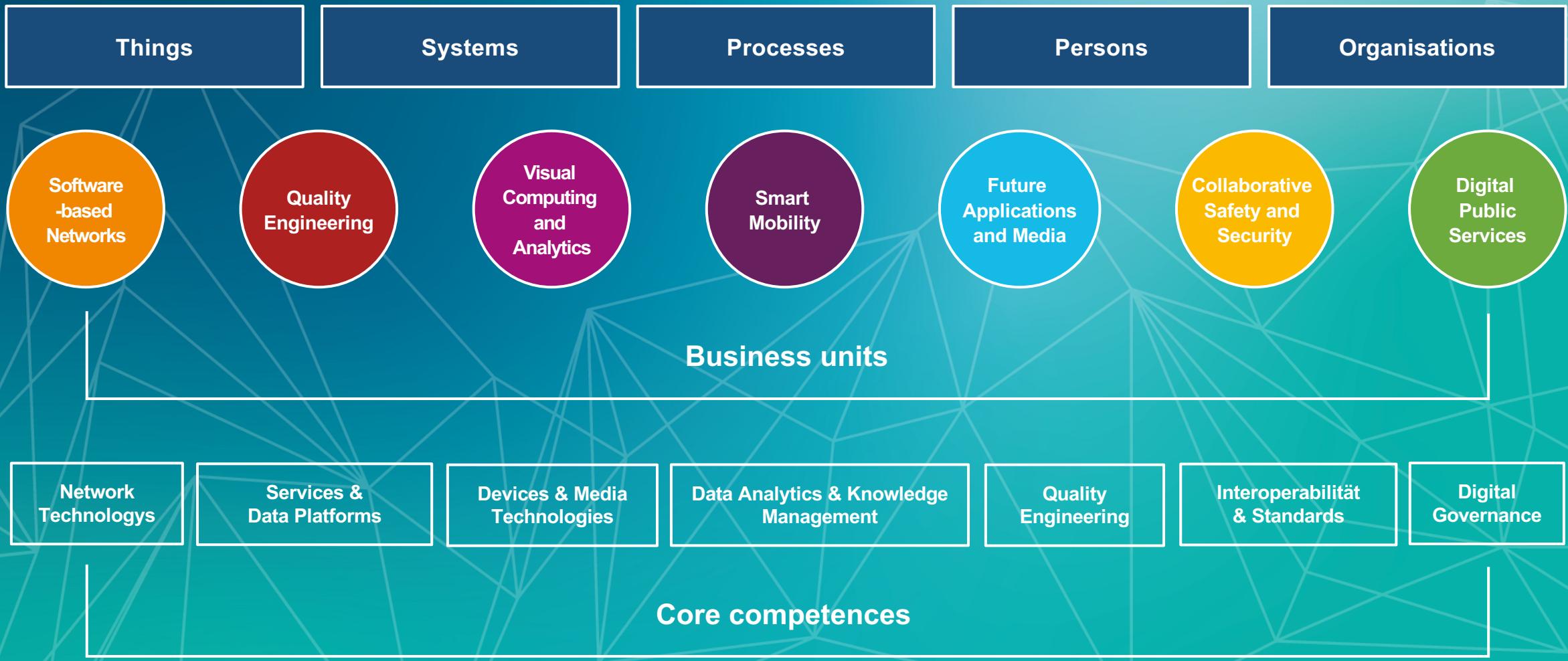
76
Institutes and research units



Fraunhofer FOKUS in numbers



Our business units and core competences



Future Applications and Media

We support companies in the digital transformation of media processing – starting with the technical creation of content, its secure transmission and its presentation to the consumer.

Consulting and research, prototyping and proof-of-concept implementations, test environments and evaluation of media technology in these areas:

- Video-Streaming and Digital Rights Management
- Interactive Media, Mixed Reality, Augmented Reality, Virtual Reality, eXtended Reality
- Deep Media (AI, Machine Learning, Deep Learning)
- Quality of Experience, Media Tracking & Audience Measurement
- Organizer of the Media Web Symposium



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Fraunhofer FOKUS – Future Applications and Media

Highlight Projects

W3C Interest Group N

Architecture

W3C Interest Group Note 8 June 2017

This Version:

<https://www.w3.org/TR/2017/NOTE-cloud-browser-arch-20170608/>

Latest Published Version:

<https://www.w3.org/TR/cloud-browser-arch/>

Latest Editor's Draft:

<https://w3c.github.io/Web-and-TV-IG/cloud-browser-tf/>

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Abstract

A Cloud Browser is a browser running and executing on a server. This document describes the concepts and architecture for the Cloud Browser. The

W3C Cloud Browser

Task Force within the Media and Entertainment Interest Group led by Deutsche Telekom and supported by Fraunhofer FOKUS



360° Cloud Playout

360° Video Streaming solution for Flatscreen Devices.
Applications: FIFA World Cup 2018 (ERT), Biathlon World Cup 2019 (ZDF)



dash.js

Reference MPEG DASH Player for Web browsers maintained by Fraunhofer FOKUS and used in many DT Streaming products



Virtual Live

First Hybrid Live Concert using immersive media technologies distributed media production powered by DT 5G connectivity

Fraunhofer FOKUS – Future Applications and Media Standardization

Fraunhofer FOKUS is an active contributing member in many media related standard bodies and foras



14:30 - 16:00 PANEL Video Standardization Panel

Panel Chair: Jörn Krieger, Media Journalist



#FOKUSMWS - June 2022
Video Standardization Panel

DASH-IF

Nicolas Weil, AWS Elemental, Senior Product Manager

WAVE

Will Law, Akamai, Chief Architect, Edge Technology Group

DVB

Peter MacAvock, EBU, Head of Delivery, Platforms and Services, EBU Technology & Innovation, Chair of the DVB Project

HbbTV

Jon Piesing, TP Vision, Director Standardisation TP Vision and Vice-Chair HbbTV Association

3GPP/MPEG

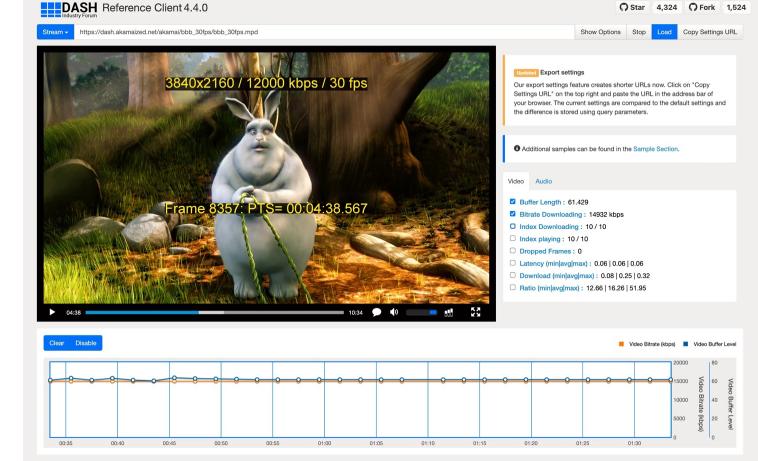
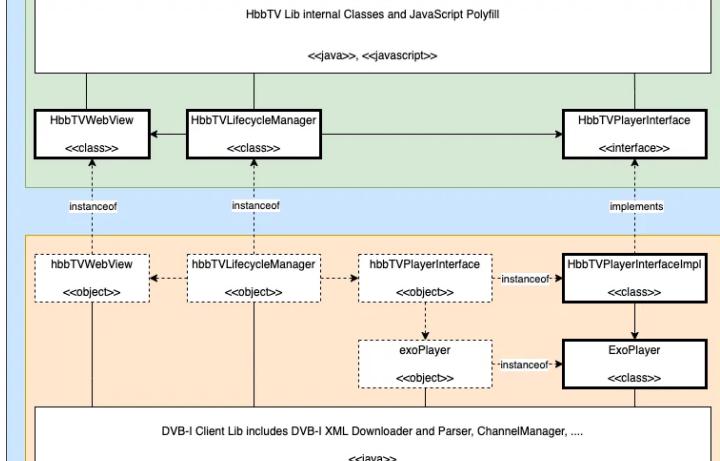
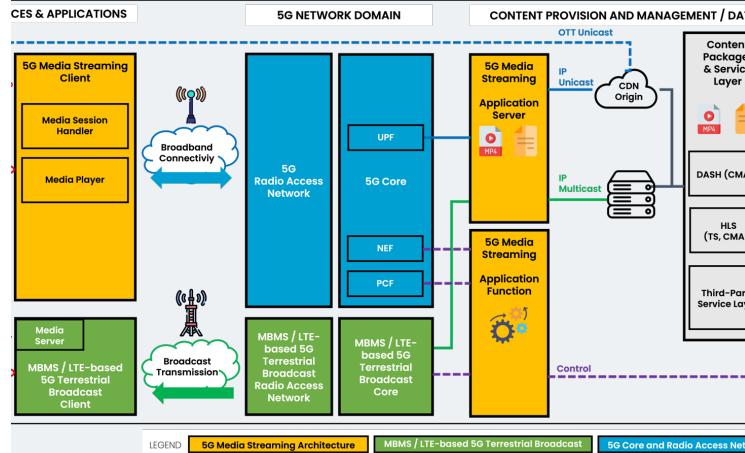
Thomas Stockhammer, Qualcomm, Director Technical Standards

W3C

François Daoust, W3C, Media & Entertainment champion

<https://www.fokus.fraunhofer.de/en/fame/mws22/detailed-program>

Fraunhofer FOKUS – Future Applications and Media FAME Technologies



5G-MAG Reference Tools

Building the 5G Media Distribution Platform

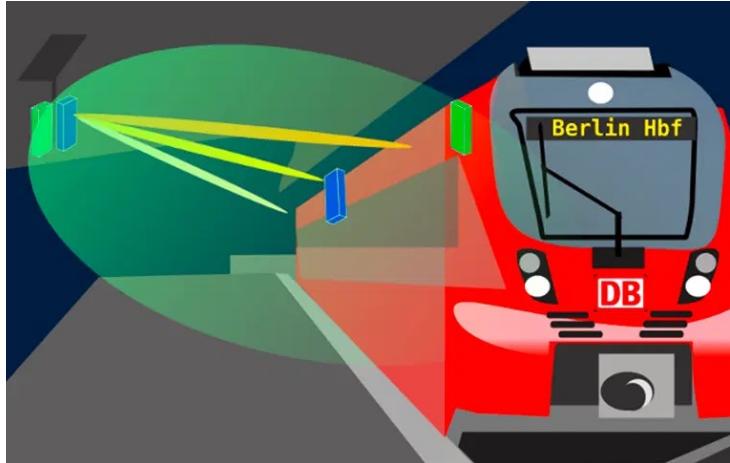
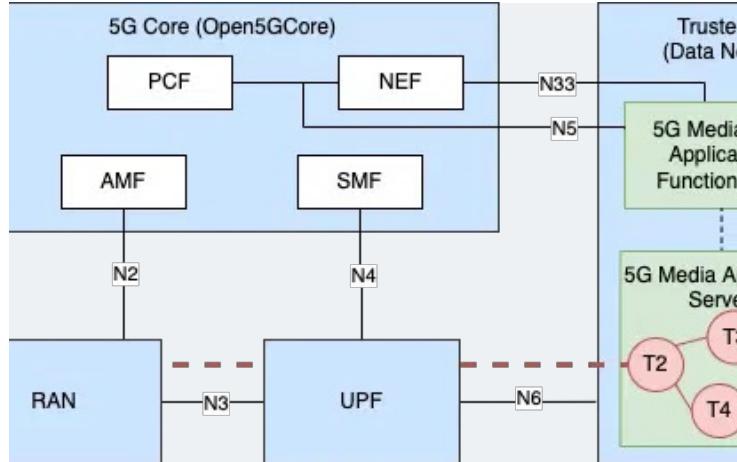
FAMIUM DVB-I HbbTV Library

DVB-I & HbbTV support for Android

FAMIUM Player

Based on dash.js and ExoPlayer

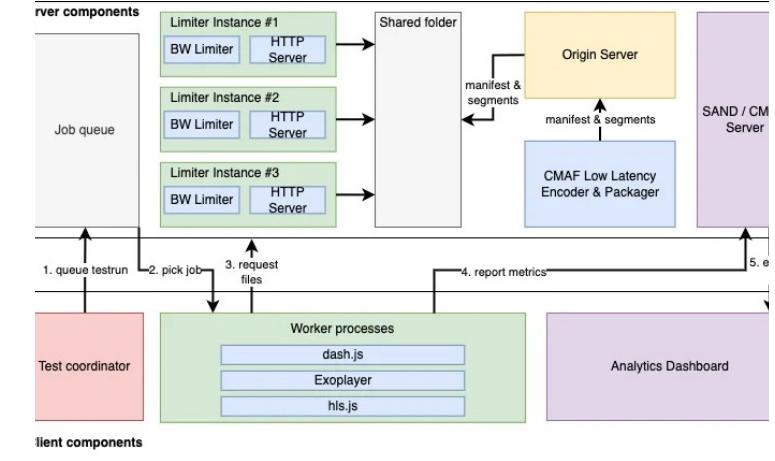
Fraunhofer FOKUS – Future Applications and Media FAME Technologies



FAMIUM 5G Media Testbed

Playground for your Media Services over 5G

CDN enabled by 5G mmWave connectivity in a railway env.
at-home media experiences in public transport

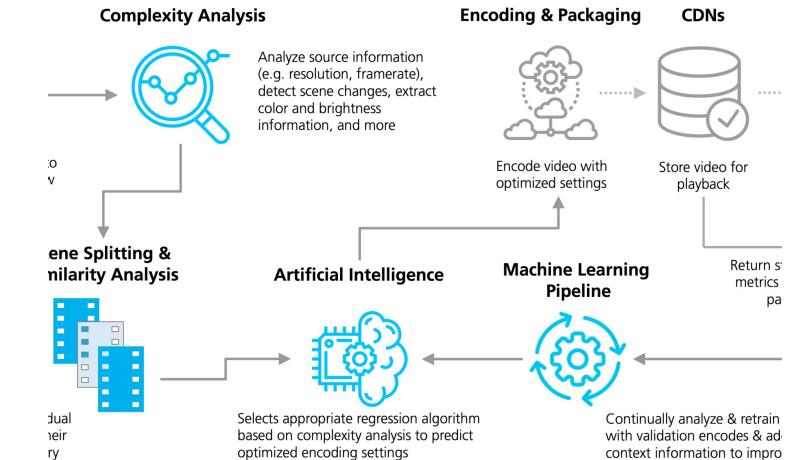
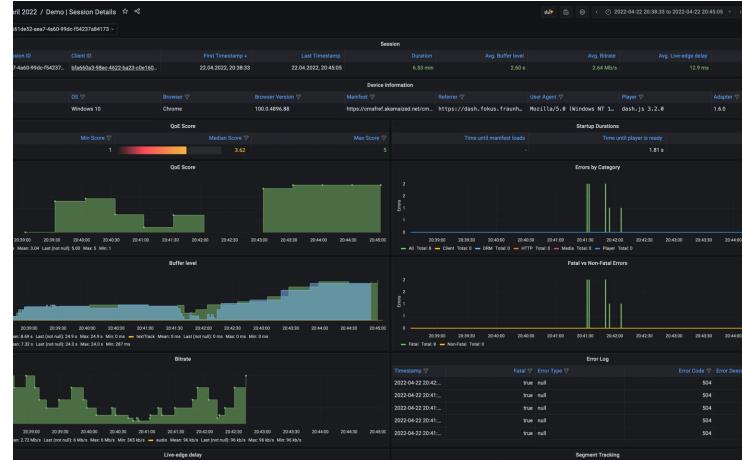
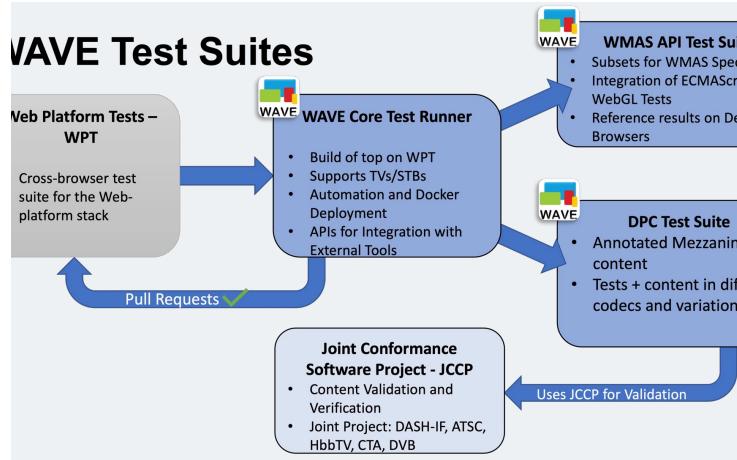


FAMIUM ABR Testbed

Automated ABR testing for DASH and HLS media players

Fraunhofer FOKUS – Future Applications and Media

FAME Technologies



CTA WAVE Tools

Test Suites for WMAS & DPC Specs and Conformance Validator JCCP

FAMIUM SAND

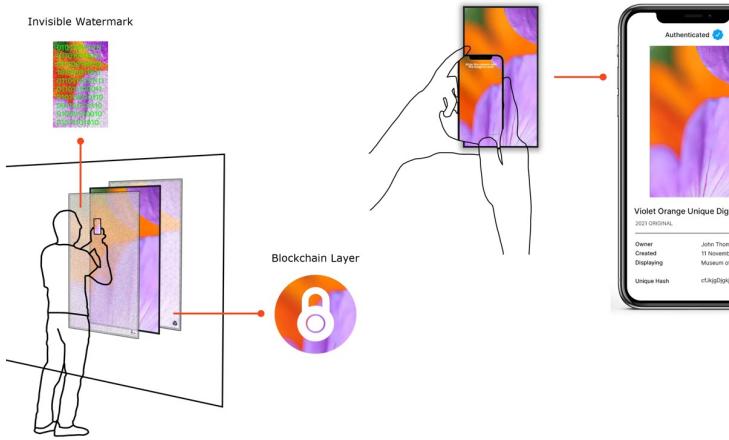
Streaming Analytics for DASH & HLS, AI based NW steering

FAMIUM Deep Encode

Content-aware Encoding for VoD and Live

Fraunhofer FOKUS – Future Applications and Media

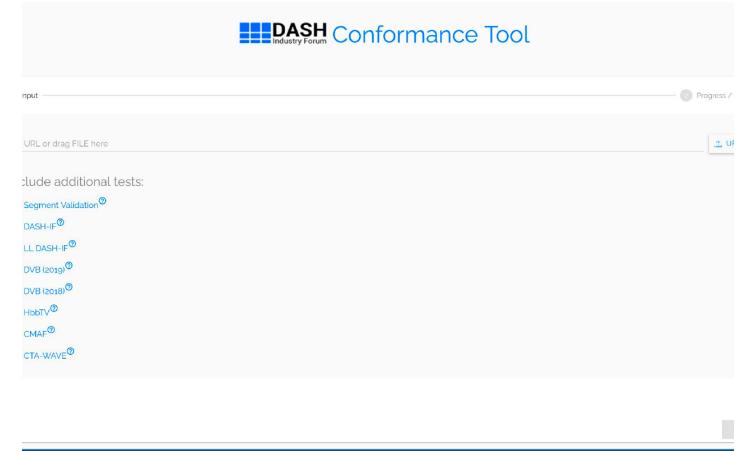
FAME Technologies



Digital Uniqueness Ecosystem
Media Uniqueness, Authenticity
& Provenance / C2PA

W3C EME Level	PlayReady	FairPlay	Widevine
1	SL2000	(Apple)Baseline	SW_SECURE_CRYPTO (L3)
2	SL2000	(Apple)Baseline	SW_SECURE_DECODE (L3)
3	SL2000	(Apple)Baseline	HW_SECURE_CRYPTO (L2)
4	SL2000	(Apple)Baseline	HW_SECURE_DECODER (L1)
5	SL3000	(Apple)Main	HW_SECURE_ALL (L1)

Content Security
A/B Watermarking, hardware-secured DRM



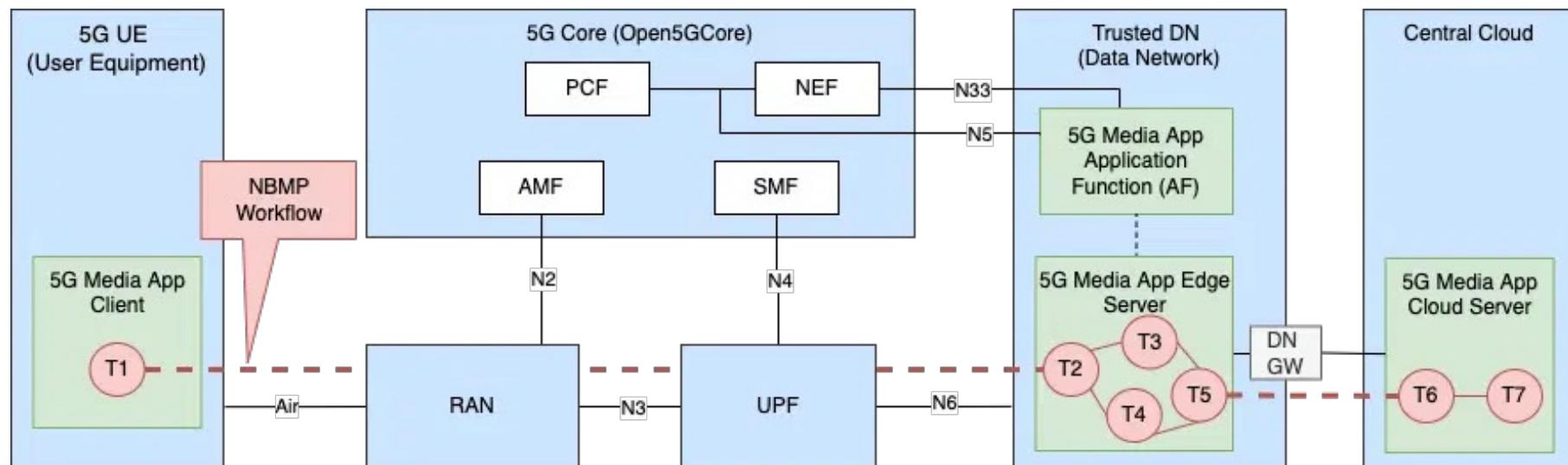
Joint Content Conformance Project (JCCP)
DASH-IF, ATSC, HbbTV, CTA,
DVB

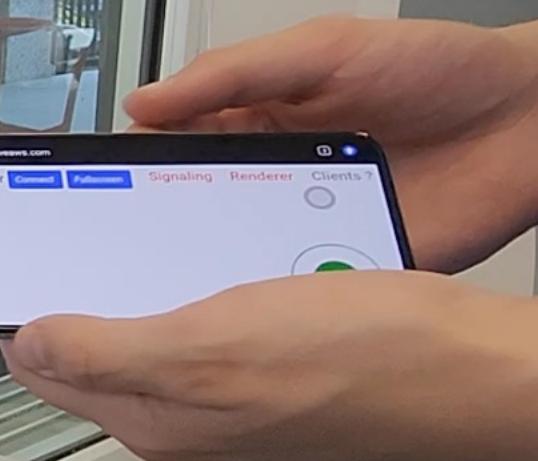
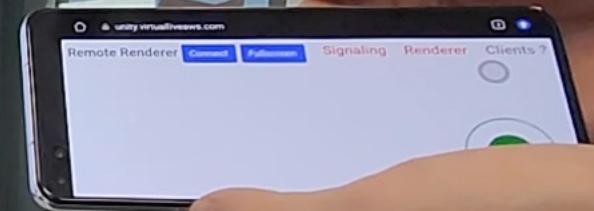
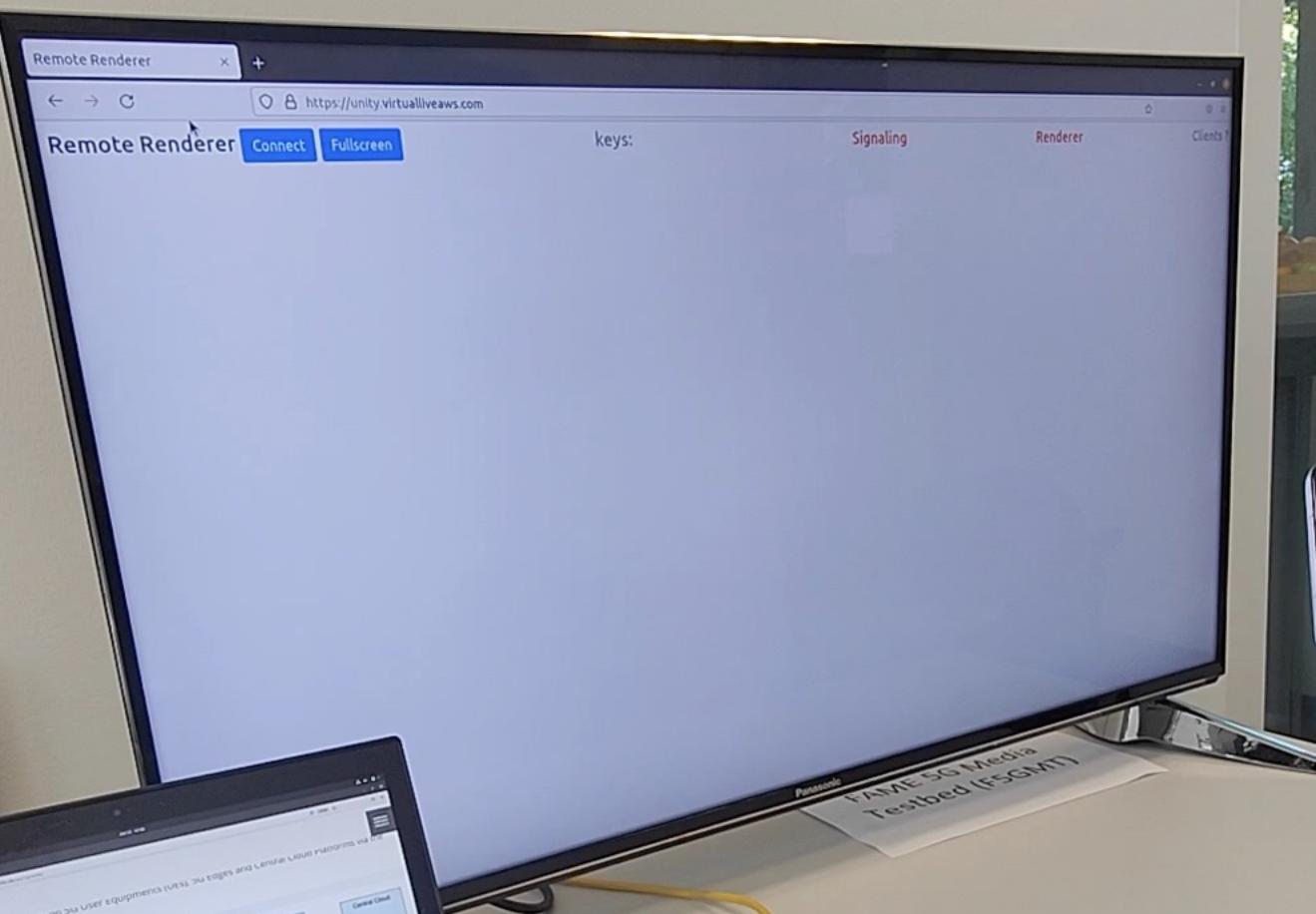
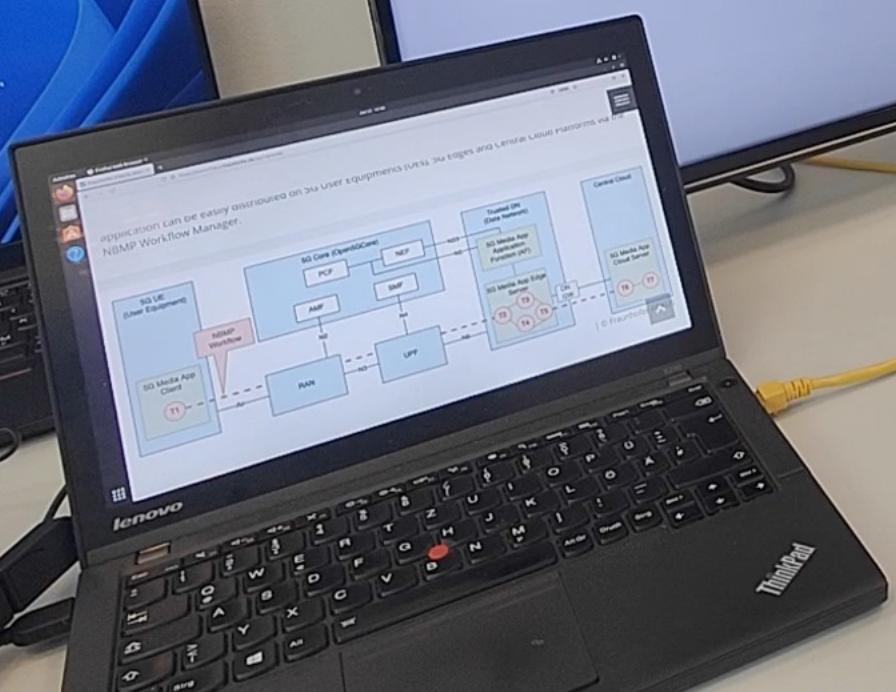
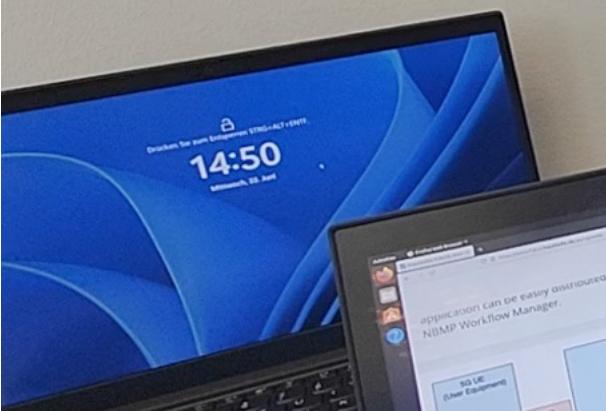
Fraunhofer FOKUS – Future Applications and Media

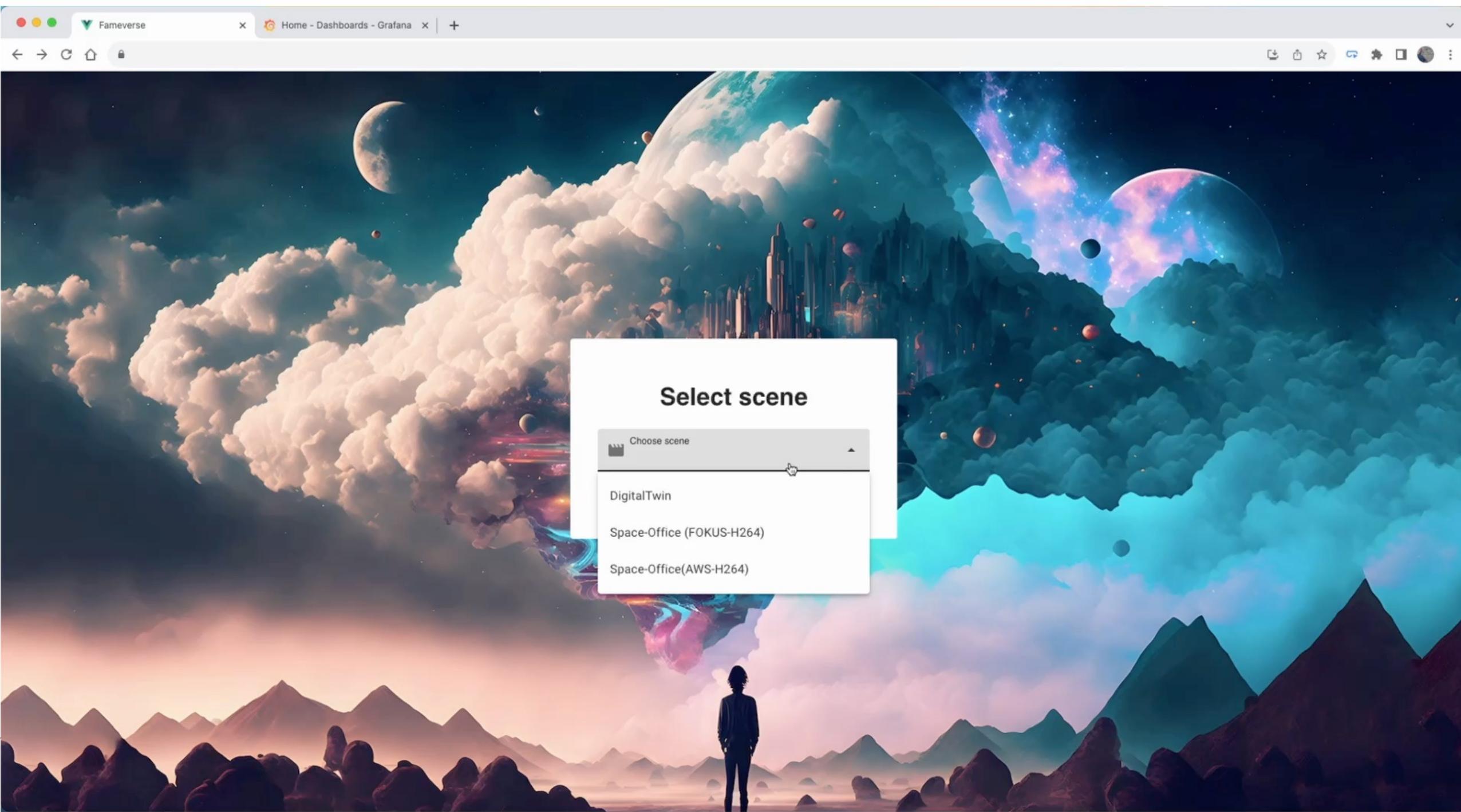
FAMIUM 5G Media Testbed (F5GMT)

Playground for your Media Services over 5G

- The testbed enables the development, testing, evaluation and demonstrations of Media Applications and Services operated within a 5G Environment
- Seamless integration with the MPEG Network Based Media Processing standard (**NBMP**) for leveraging processing capabilities and resources in the 5G Edge Cloud
- Network Assisted Edge Rendering enabled by 5G MEC, NBMP and taking advantage of the **low latency** of 5G connectivity
- Remote Media Production with sub-second latency for streaming professional content utilizing **5G Edge** capabilities and **WebRTC**







FAME Labs

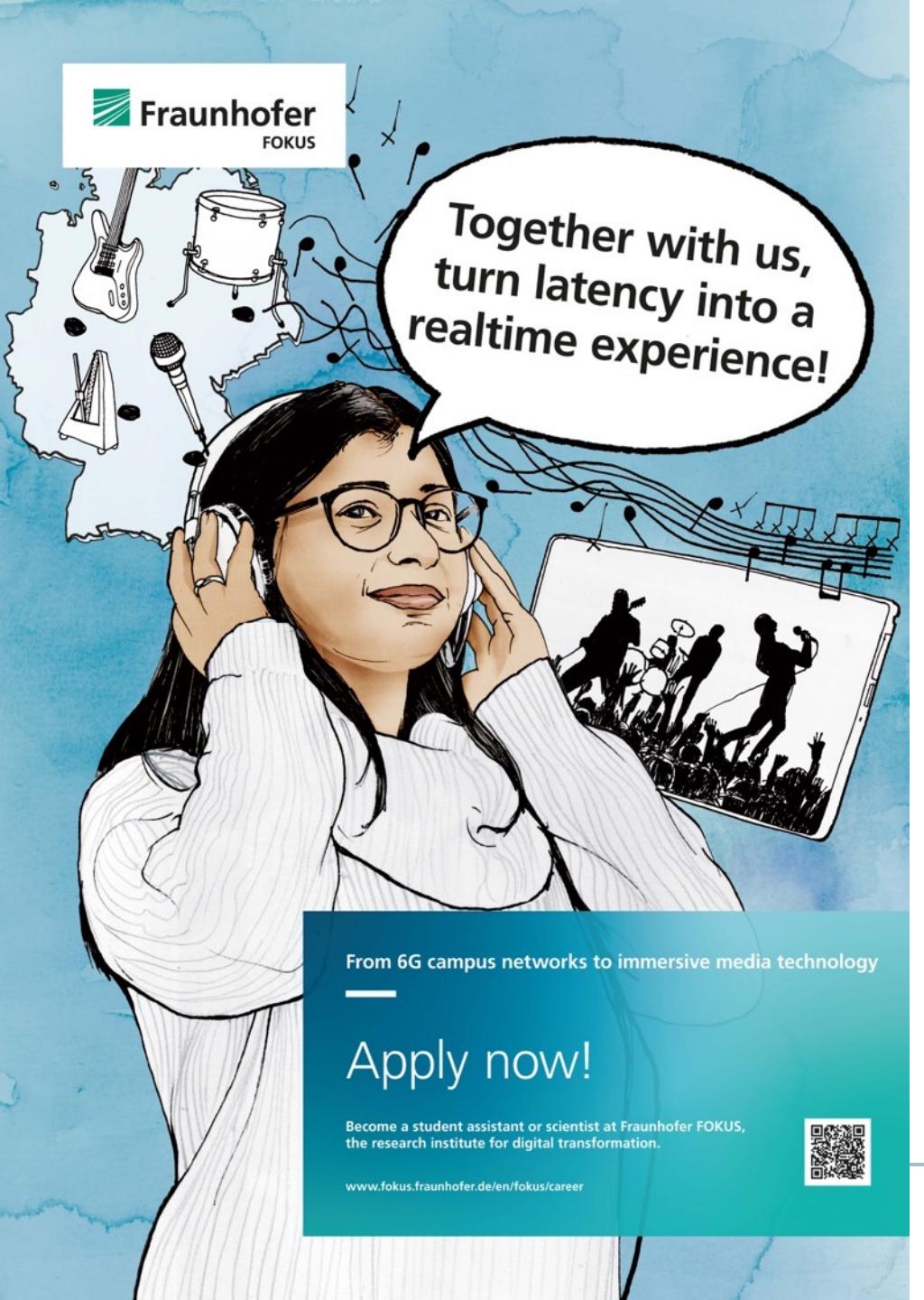


FAME Smart Media Lab



FAME TV Lab

<https://www.fokus.fraunhofer.de/en/fame/laboratories>



**Together with us,
turn latency into a
realtime experience!**

From 6G campus networks to immersive media technology

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Become a student assistant or scientist at Fraunhofer FOKUS,
the research institute for digital transformation.

www.fokus.fraunhofer.de/en/fokus/career



FOKUS takes you further

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- Advance relevant social issues
- Take on tasks independently early on
- Learn to keep an eye on the commercial application
- Benefit from the good reputation of the Fraunhofer-Gesellschaft
- Write your thesis in cooperation with one of our business units
- Build your launchpad into business, science, or self-employment

FOKUS makes working while studying possible:

- Flexible working hours and mobile working
- Join as a student assistant or intern



„Advanced Web Technologies“ Modules

Open Distributed Systems

Chair for Open Distributed Systems

- At department of Telecommunication Systems of TU Berlin
[https://www.ods.tu-berlin.de/menue/fachgebiet open distributed systems/](https://www.ods.tu-berlin.de/menue/fachgebiet_open_distributed_systems/)
- Prof. Dr. Manfred Hauswirth
[https://www.ods.tu-berlin.de/menue/fachgebiet open distributed systems/ueber uns/professor/](https://www.ods.tu-berlin.de/menue/fachgebiet_open_distributed_systems/ueber_uns/professor/)
- **Secretary:**
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sekretariat[at]ods.tu-berlin.de

„Our“ Modules

Number	Module Title	LP/ECTS	Module Description
40240	<u>Advanced Web Technologies</u>	12	https://moseskonto.tu-berlin.de/moses/modultransfersystem/bolognamodule/beschreibung/anzeigen.html?nummer=40240&version=6
40253	<u>Projekt Advanced Web Technologies</u>	9	https://moseskonto.tu-berlin.de/moses/modultransfersystem/bolognamodule/beschreibung/anzeigen.html?nummer=40253&version=6

Module „Advanced Web Technologies“

- Module No **“40240”**
- 12 Credit points (LP/ECTS)

Course Name	Type	Number	Cycle	Language	LP/ECTS
Advanced Web Technologies	PJ	0432 L 753	WS/SS	English	9
Advanced Web Technologies	VL	0432 L 752	WS	English	3

👉 <https://moseskonto.tu-berlin.de/moses/modultransfersystem/bolognamodelle/beschreibung/anzeigen.html?nummer=40240&version=6>

Module „Projekt Advanced Web Technologies“

- Module No “40253”
- 9 Credit points (LP/ECTS)

Course Name	Type	Number	Cycle	Language	LP/ETSC
Advanced Web Technologies II	PJ	3433 L 10563	WS/SS	English	9

👉 <https://moseskonto.tu-berlin.de/moses/modultransfersystem/bolognamodule/beschreibung/anzeigen.html?nummer=40253&version=6>

ISIS Courses

- Advanced Web Technologies Lecture (VL) →
<https://isis.tu-berlin.de/course/view.php?id=35302>
- Advanced Web Technologies Project (PJ) →
<https://isis.tu-berlin.de/course/view.php?id=35292>

Please check the ISIS pages periodically!! We will use ISIS to share all documents/slides and for announcements.

Feel free also to use the ISIS Forum.

Available project topics in WS 2023/2024

1. Metaverse: developing Unreal Engine experience using MetaHuman
2. Metaverse: developing Digital Twin experience e.g. using NVIDIA Omniverse
3. Develop a system for measuring Motion-to-Photon Latency
4. Large Language Models for Education: Generative Agents
5. Evaluation of Neural Radiance Fields
6. Evaluation of 3D Gaussian Splatting for capturing humans as 3D avatars
7. Porting Unity 3D Application into Godot Engine
8. Develop a Unity XR DVB-I Player
9. Develop a Unity Experience for Apple Vision Pro (Simulator)
10. Green Streaming - Sustainable Content Delivery: Green Streaming Analytics
11. Green Streaming - Sustainable Streaming: Optimizing Mobile Device Energy Efficiency
12. Integration of W3C WoT Thing Description in XR Applications

→ For more details, please check ISIS: <https://isis.tu-berlin.de/mod/page/view.php?id=1645313>

Module enrollment

All students need to enroll

- via QISPOS
- For each module!
- By deadline
 - See ISIS, QISPOS

Without enrollment (before deadline), the course cannot be credited!

Goals of the Lecture

- The World Wide Web: most successful and widespread platform for offering online services and applications
 - Started as (from today's perspective) simple platform for linked documents
 - today for all types of distributed services and applications
- Web technologies have made radical inroads in many other technology areas, such as
 - Protocols and interfaces for media and telecommunication applications, as well as for standardized data exchange between systems
 - Hybrid Broadcast Broadband (HbbTV) standard for interactive television broadcasts entirely on web technologies.
 - Web technologies are therefore seen today as the relevant basis for implementing interoperable systems and interfaces.
- Web technologies are developed and standardized by the World Web Consortium (W3C), with over 400 members (companies). These include HTML, as the basic page description language, as well as protocols and APIs (e.g. WebRTC API), on which web applications can be developed.
- **This module imparts knowledge about relevant web technologies and gives an outlook on future developments, e.g. from research projects and current standardization.**

Resources

1. Slides and detailed information at <https://isis.tu-berlin.de/course/view.php?id=35302>
2. <https://www.w3.org>
3. <https://www.w3schools.org>
4. Internet Search... ☺
5. Ask us



Course Schedule

Please check ISIS for updates:

<https://isis.tu-berlin.de/course/view.php?id=35302>

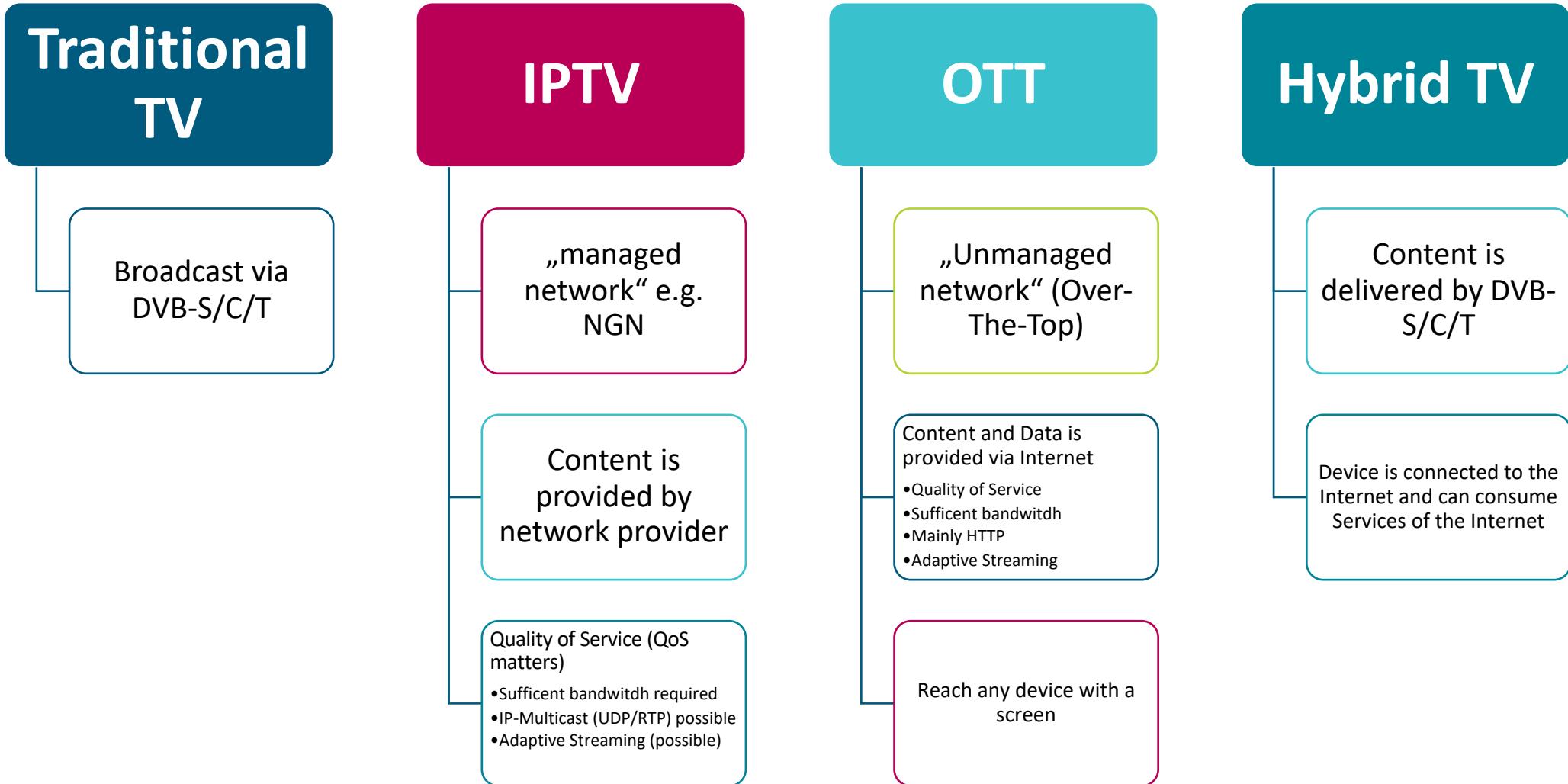
No	Week	Date	Topic
1	42	16.10.2023	Introduction and Framework
2	43	23.10.2023	Web Technologies Basics / Media Entertainment for the Web
3	44	30.10.2023	Foundations of Media Streaming
4	45	06.11.2023	Advanced Media Streaming
5	46	13.11.2023	Multiscreen Technologies and Standards
6	47	20.11.2023	HbbTV and Smart TV
7	48	27.11.2023	Media Players - dash.js, Exoplayer
8	49	04.12.2023	Dynamic Advertisement
9	50	11.12.2023	Context-Aware Media Streaming & Encoding
	51	18.12.2023	Holiday break
	52	25.12.2023	Holiday break
	1	01.01.2024	Holiday break
10	2	08.01.2024	Media Delivery in 5G Networks (1)
11	3	15.01.2024	Media Delivery in 5G Networks (2)
12	4	22.01.2024	Metaverse Platforms and Technologies
13	5	29.01.2024	Securing Content-Provenance and Authenticity
14	6	05.02.2024	Interoperable Web-supported Learning Technologies
15	7	12.02.2024	Exercise and Test Preparation
16	8	19.02.2024	Written Test (60min) first slot (details will be announced during the semester)
17	13	25.03.2024	Written Test (60min) second slot

DASH/HLS

MPEG – DASH (Dynamic Adaptive Streaming over HTTP) HLS (HTTP Live Streaming)

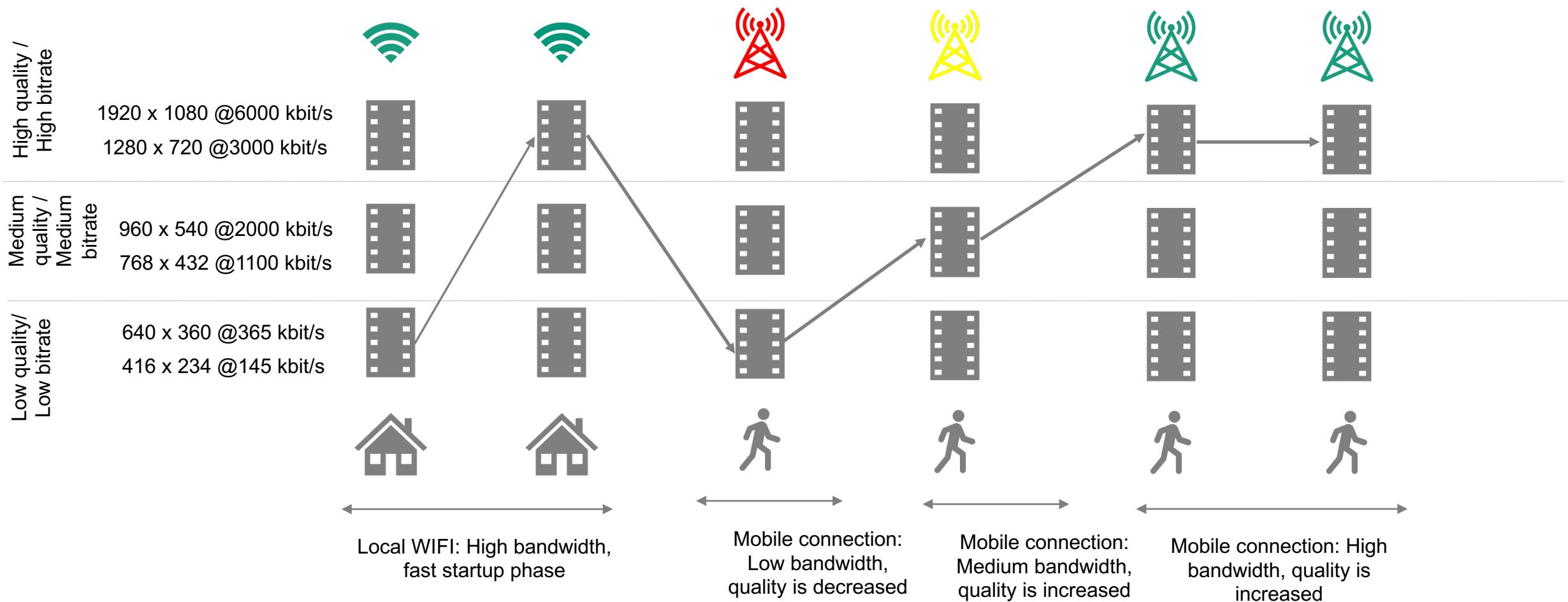
- Based on an MPD (Media Presentation Description) file
 - Provides a structured description of the content in XML format
 - Typically used on non-Apple devices and platforms
 - Serves as input for dash.js, ExoPlayer
 - Typically uses the ISOBMFF/CMAF media container
- Based on master and media playlists (m3u8 files)
 - Master playlist links to media playlists
 - Media playlists describe the content
 - Mainly used on Apple platforms due to native support
 - Typically uses the Transport Stream (TS) media container
 - Added support for f-mp4/CMAF

Linear TV Distribution



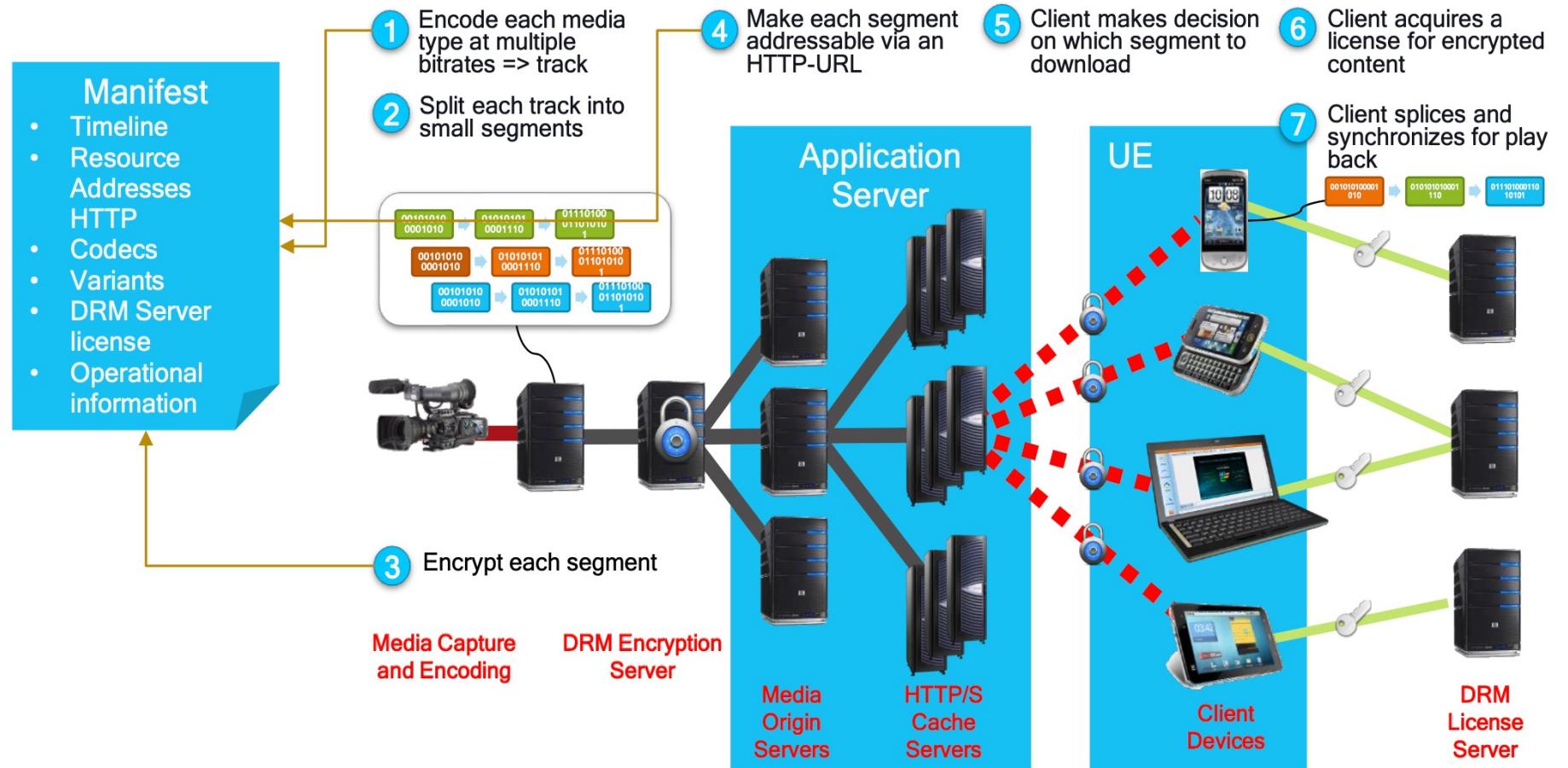
ABR Streaming

Network Adaptation



OTT Streaming

- OTT Streaming:**
- Best Effort
 - No Guaranteed QoS



Today's DRM Systems

Microsoft
PlayReady



Google
Widevine



Apple FairPlay



FairPlay

Huawei
WisePlay

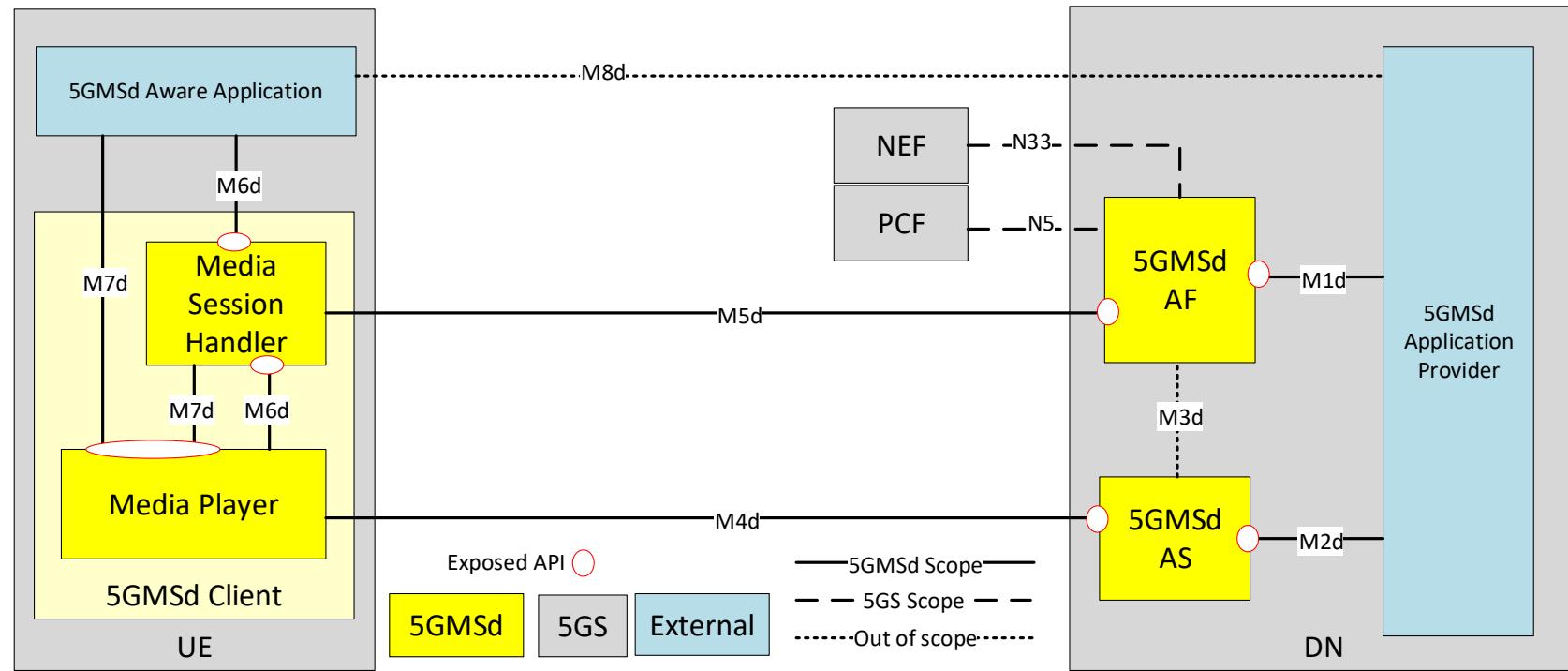


5G Media Streaming (5GMS)



Framework aligned with today's OTT media distribution practices by Supplementing MNO and third-party media services to easily access 5GS and 5GMS features

- 5GMS:
 - Guaranteed QoS/QoE (Consumers desire premium content anytime-anywhere)
- Dynamic Policies, incl Premium QoS and charging policies
- Consumption and Metrics Reporting
- Network Assistance



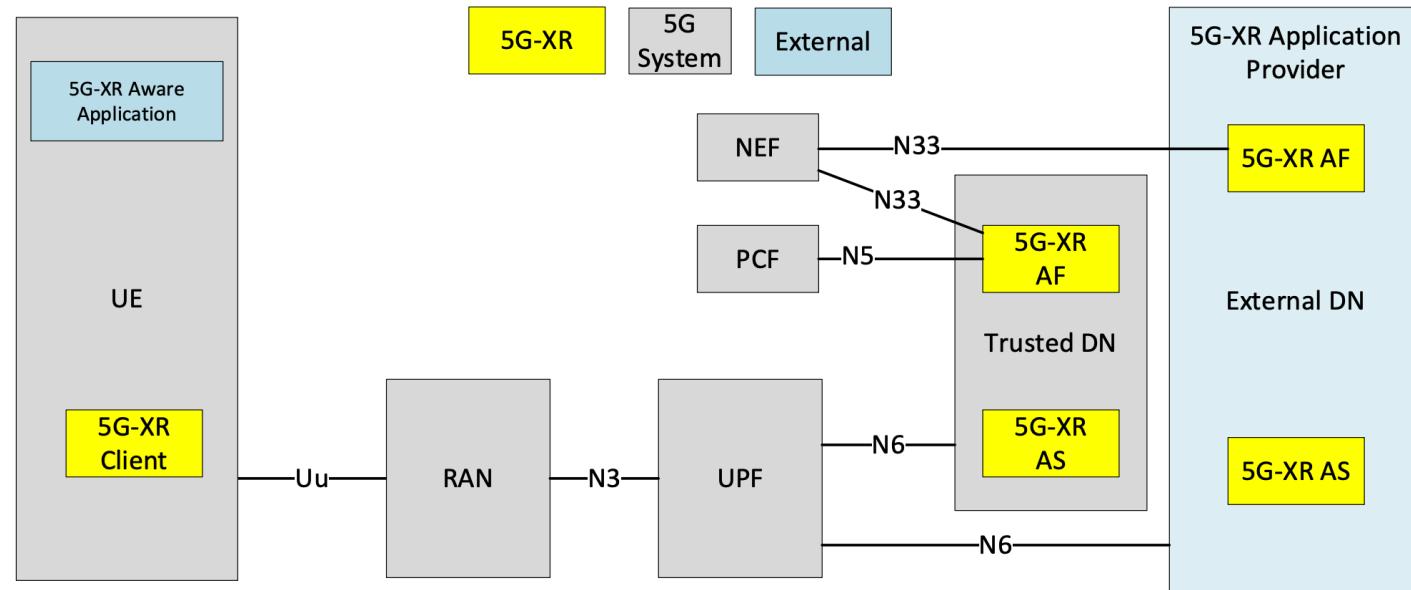
Future topics and cooperation

3GPP Work on XR over 5G



Relevant 3GPP activities:

- Release 16 Work Item: "Study on eXtended Reality (XR) in 5G" (FS_5GXRF)
- Release 17 Work Item: "Study on 5G Glass-type AR/MR Devices" (FS_5GSTAR)
- Release 18 Work Item: "Media Capabilities for Augmented Reality" (MeCAR)
- 3GPP TR 26.928: XR integration in 5G follows a similar model of 5G Media Streaming defined in 3GPP TS 26.501

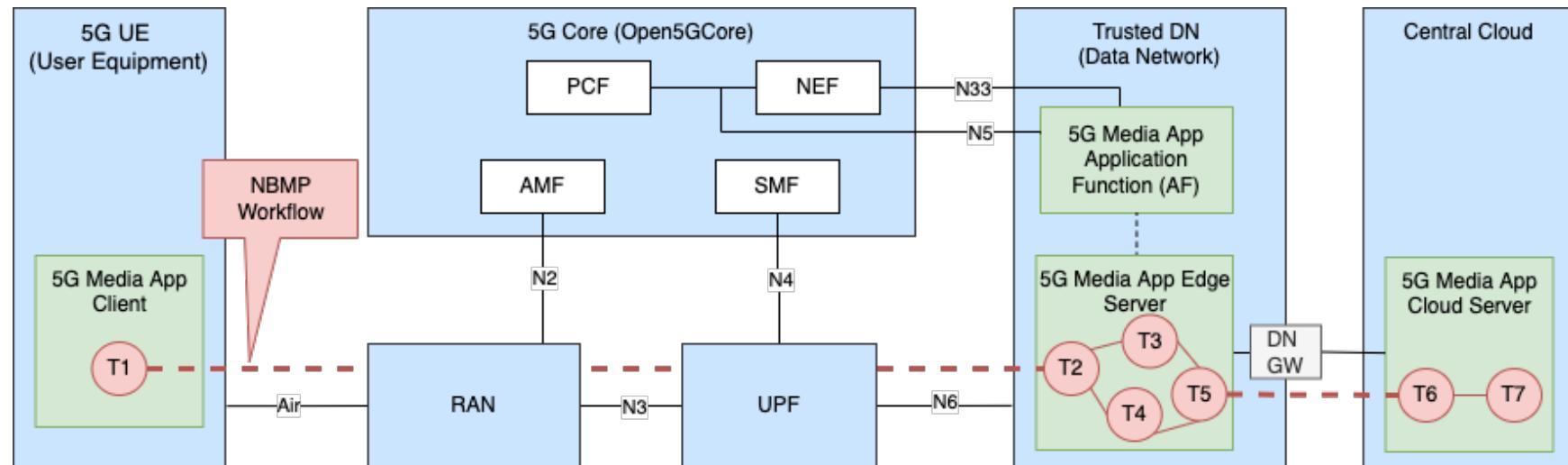


5G-XR functions integrated in 5G System (3GPP TR 26.928)

Sources: https://drive.google.com/file/d/1bITEzOsZEaimCFM_LgMGUveBpI5gQXLQ/view (Thomas Stockhammer)
https://www.etsi.org/deliver/etsi_tr/126900_126999/126928/17.00.00_60/tr_126928v170000p.pdf

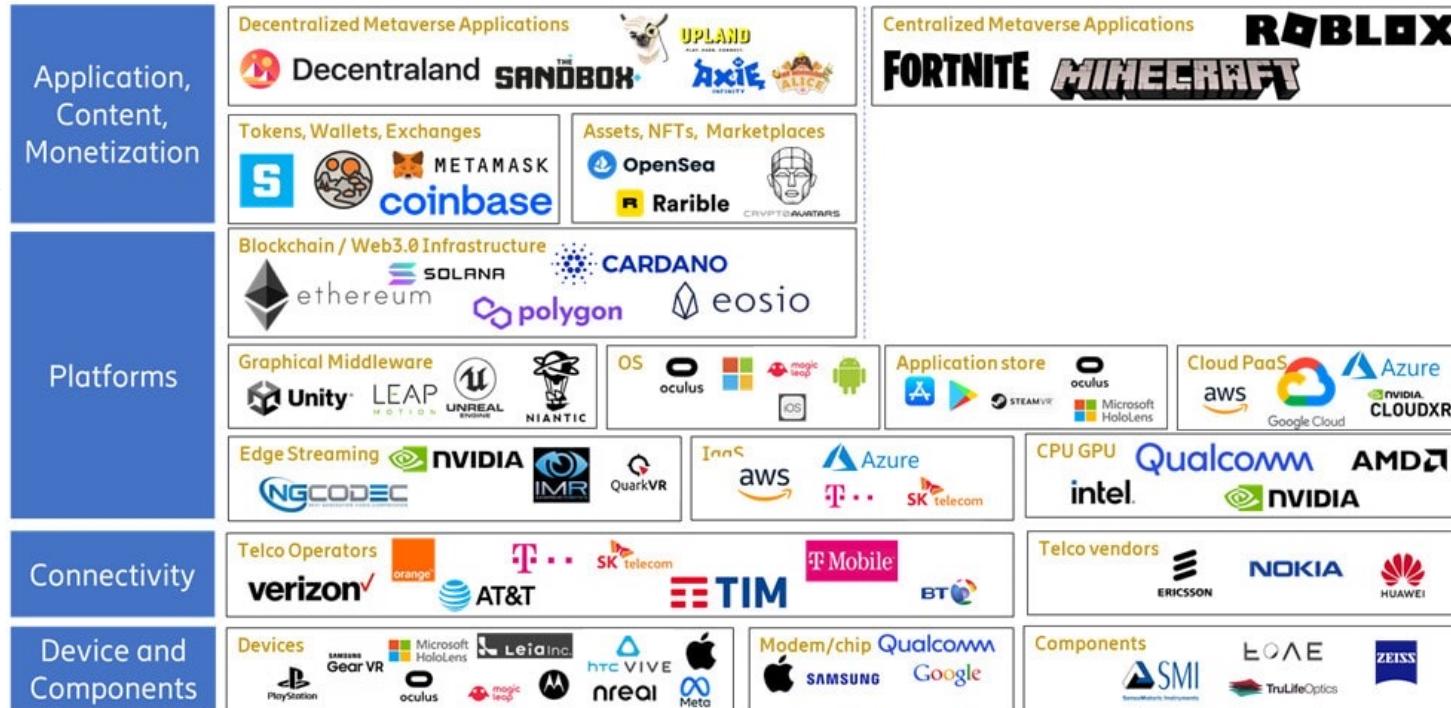
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- Remote Media Production with sub-second latency for streaming professional content utilizing 5G Edge capabilities and WebRTC



Metaverse and 5G

- 5G is counted as a key technology to enable the use of Extended Reality (XR) in the Metaverse
- 5G (eMBB) offers rate, range, reliability, latency to deliver high bitrate XR experiences including 3D assets, volumetric videos, holograms, etc. to end-user devices like HMDs and XR glasses in real-time.
- 5G MEC enables Edge/Cloud XR processing by offloading the rendering of the XR experience. This facilitates the development of more lightweight XR devices.
- 5G Network Exposure Function (NEF) provides 3rd party access to the 5G CN



Metaverse, VR/XR, Split Rendering



5G will enable
XR

Forum

com Technologies
Hugo Swart, vice
thrilled to join the
urish with a healthy

ing better

Offloading XR Processing towards the
edge/cloud is key for future Metaverse!

One-Click
Experience

XR devices are gateway
to future Metaverse

High-Costs barriers for
powerful HW (GPU)

High-Costs (HW)
barriers

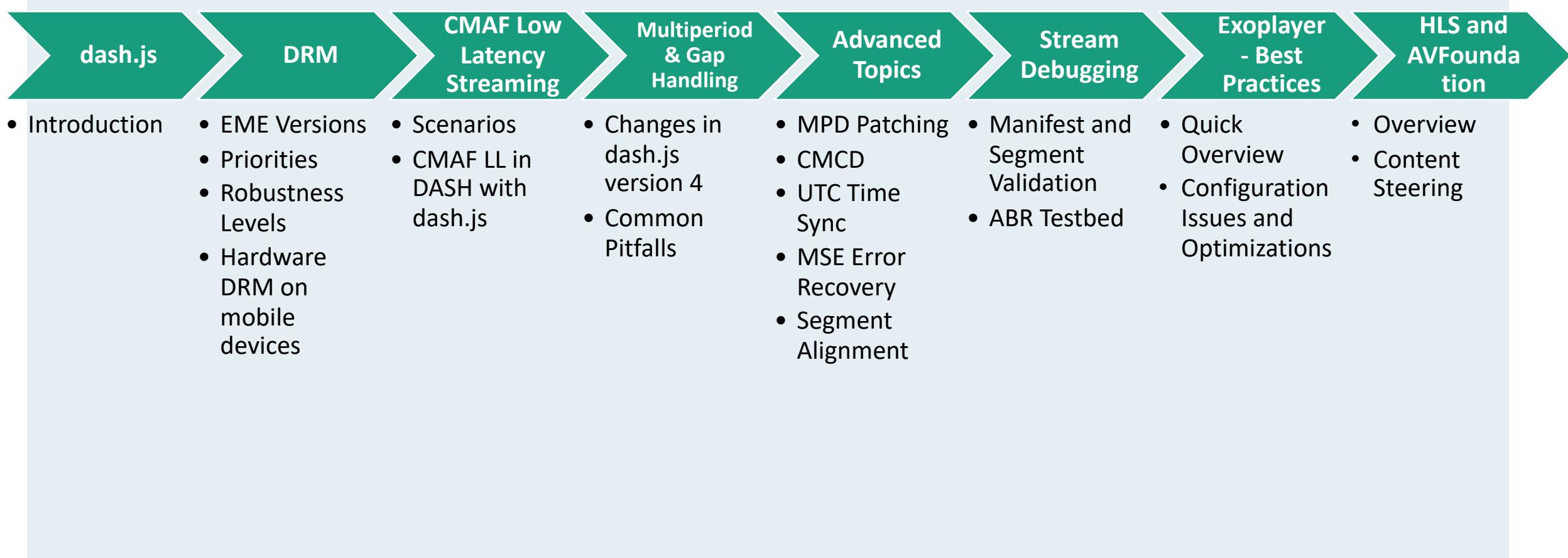
better form factor for
XR glasses

Low Power
Consumptions

Boundless VR uses split rendering over 5G

Distribute computation between the edge cloud server and device to deliver truly immersive XR over 5G

Video Player



Low Latency Streaming

Use cases



Sport streaming

- Some viewers may be using a provider which distributes the content using DVB-T or DVB-S services whilst others may be using DASH ABR.
- Viewers with a high latency will have their viewing spoiled as they will hear cheers for the goal before it occurs on their local screen

Sports betting

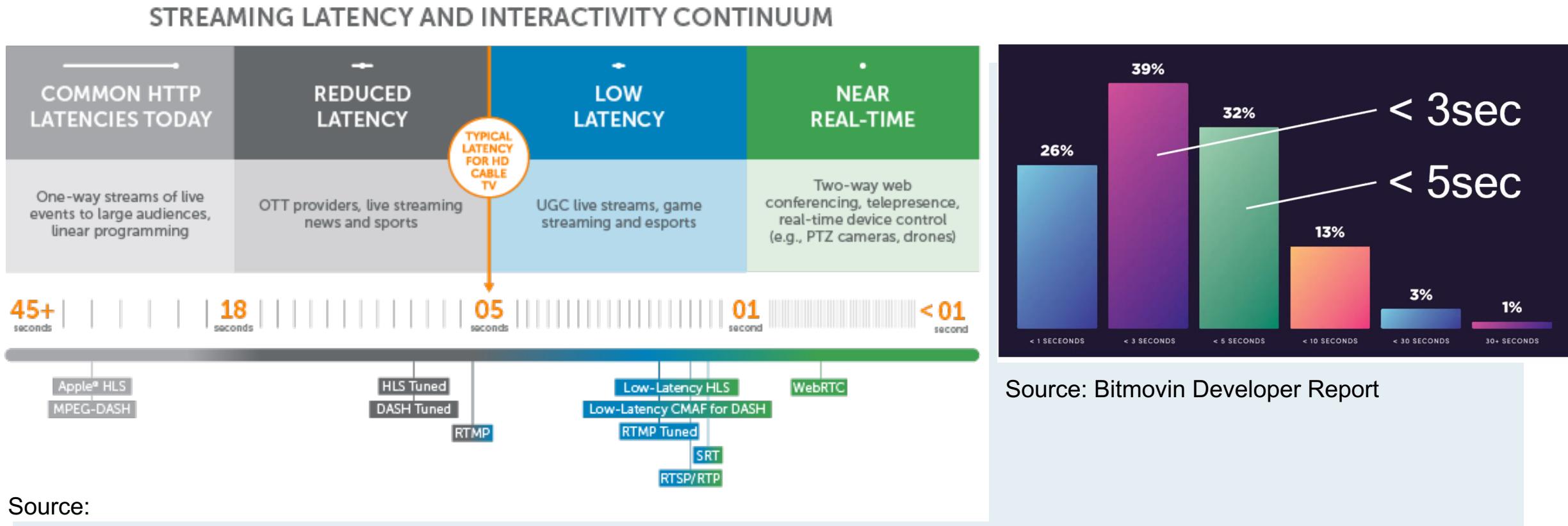
- The lower the latency the more opportunities for “live in play betting”
- Legal Considerations:
Content cannot be shown if it is more than X seconds behind live

eSports/Professional streamer

- Streamers interacting with chat directly.
- A high degree of interactivity between the streamer and the audience is required to enable engagement
- A low latency enables direct feedback from the viewers e.g applause after a song, cheering during a song.
- Example: Gamers, Musicians

Low Latency Streaming

Typical latencies



Content Aware – What, Why & How?

Content Aware Basics - Motivation

Low complexity

High redundancy



Animation



Nature Documentary

High complexity

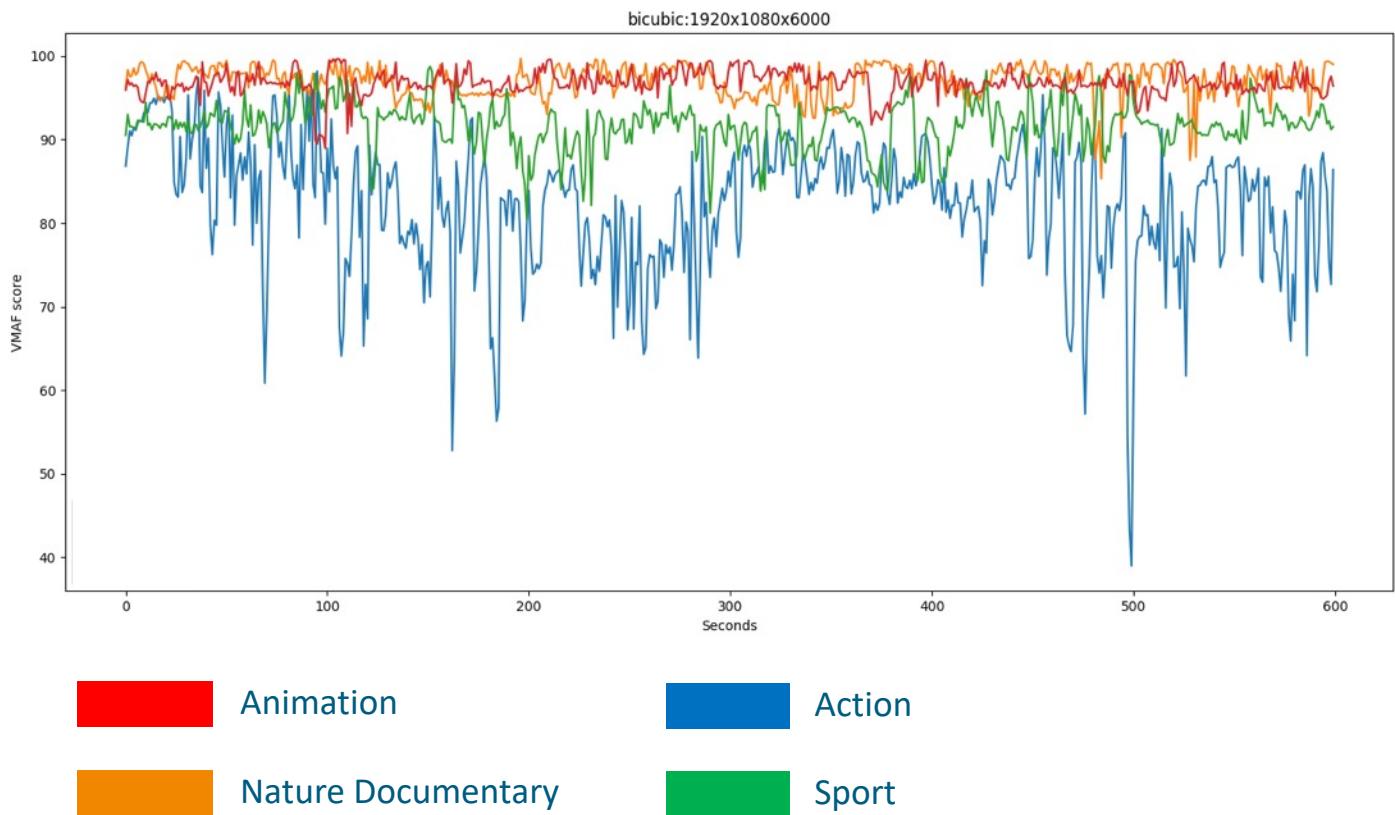
Low redundancy



Action



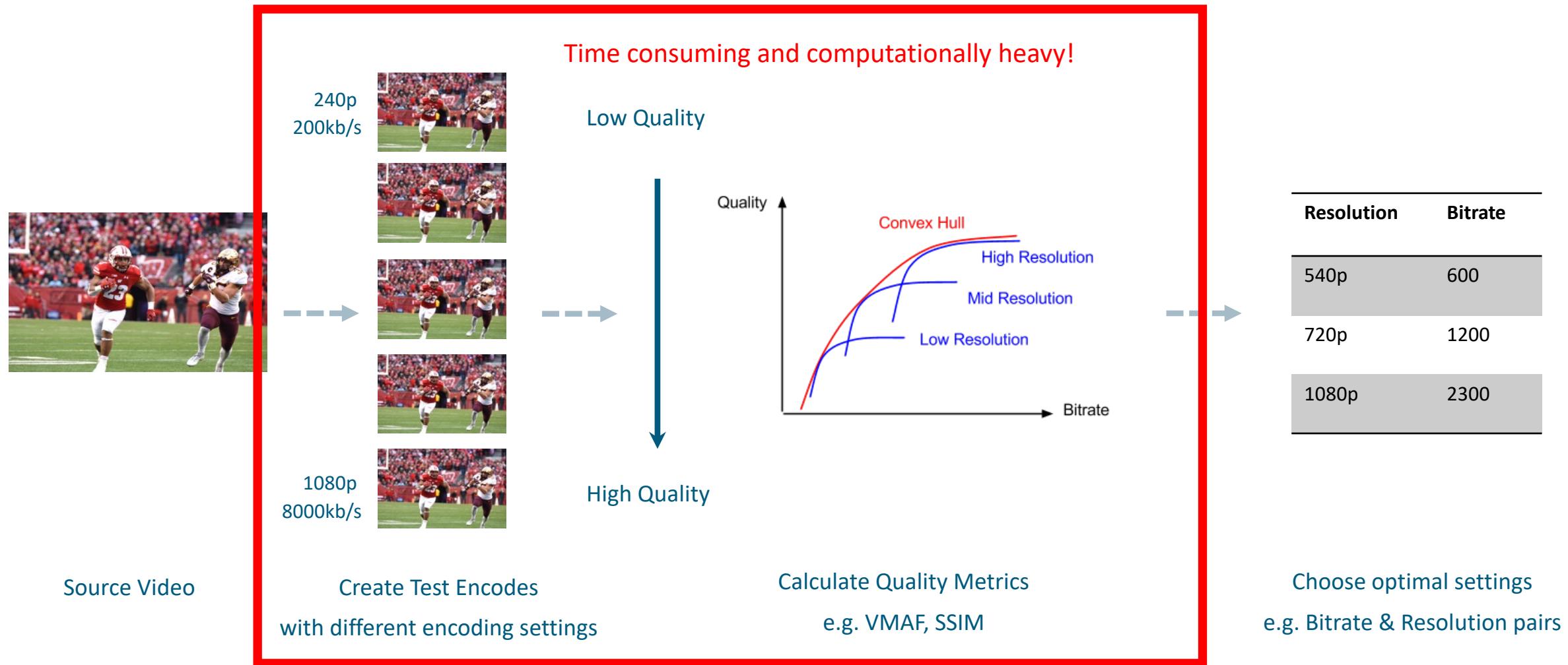
Sport



- Different types of content require different encoding settings to achieve same quality

Content Aware – What, Why & How?

A Solution: Per-Title Encoding



Motivation for Streaming Analytics

Viewers start abandon streams that take more than 2 seconds to startup

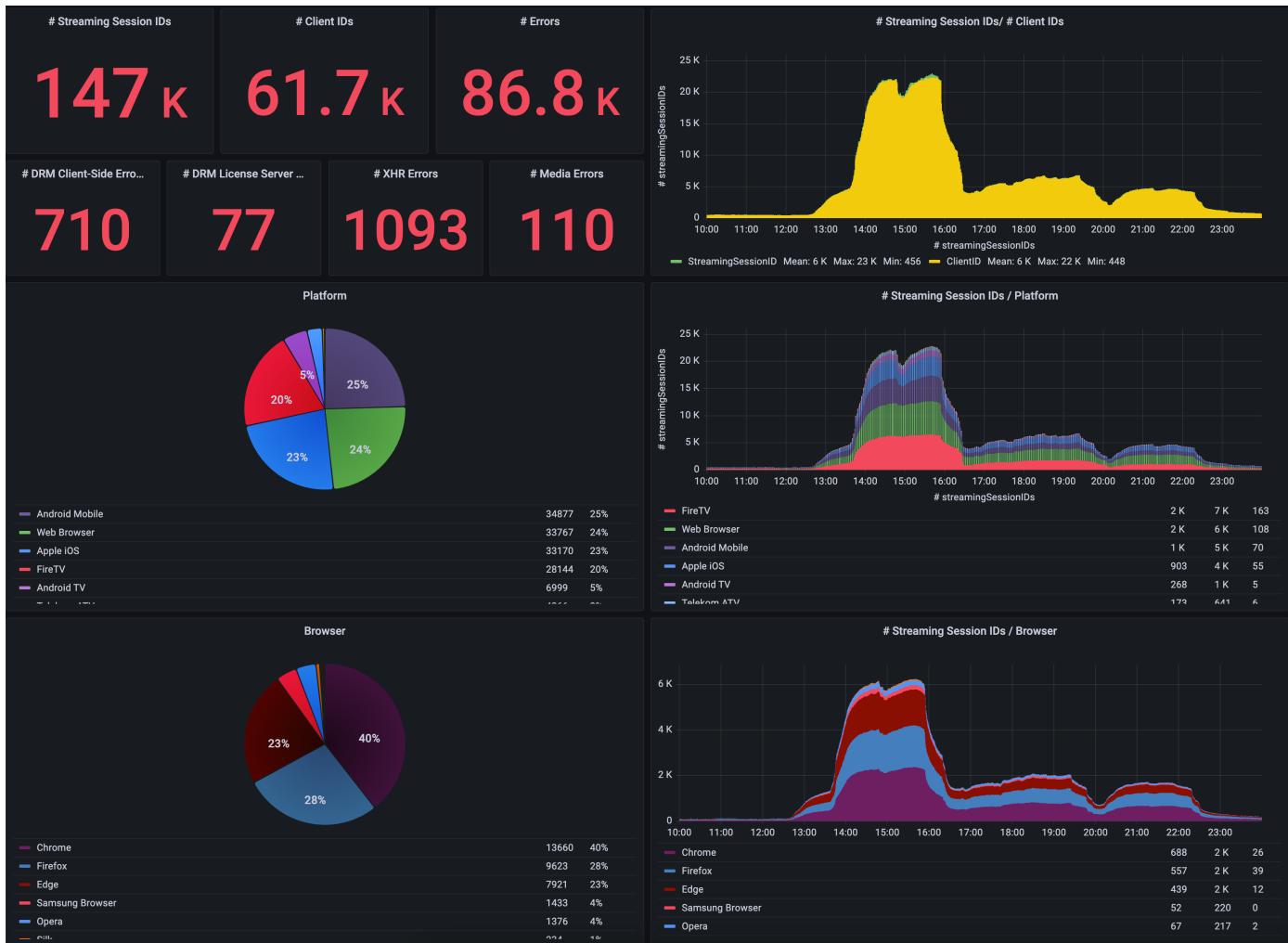
1% of rebuffering causes people to watch 5% less of a video

Viewers who experience video failure are less likely to revisit a web page

40% of customers are unlikely to give a streaming service a chance on a second device after being confronted with an inferior stream

Streaming Analytics

FAMIUM SAND



✓ Video Streaming Analytics for DASH/HLS

✓ Debugging, Alerting and Troubleshooting

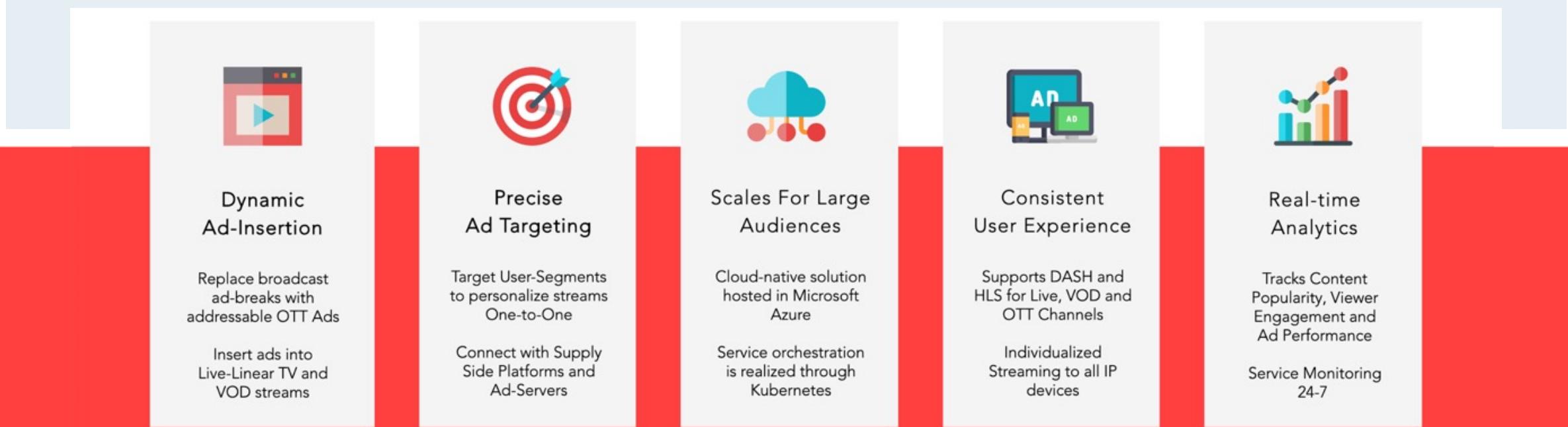
- Detect problems with new devices, software updates..
- Error analysis
- Reliability of VoD/Live, ad-insertion sessions

• Reporting Dashboard

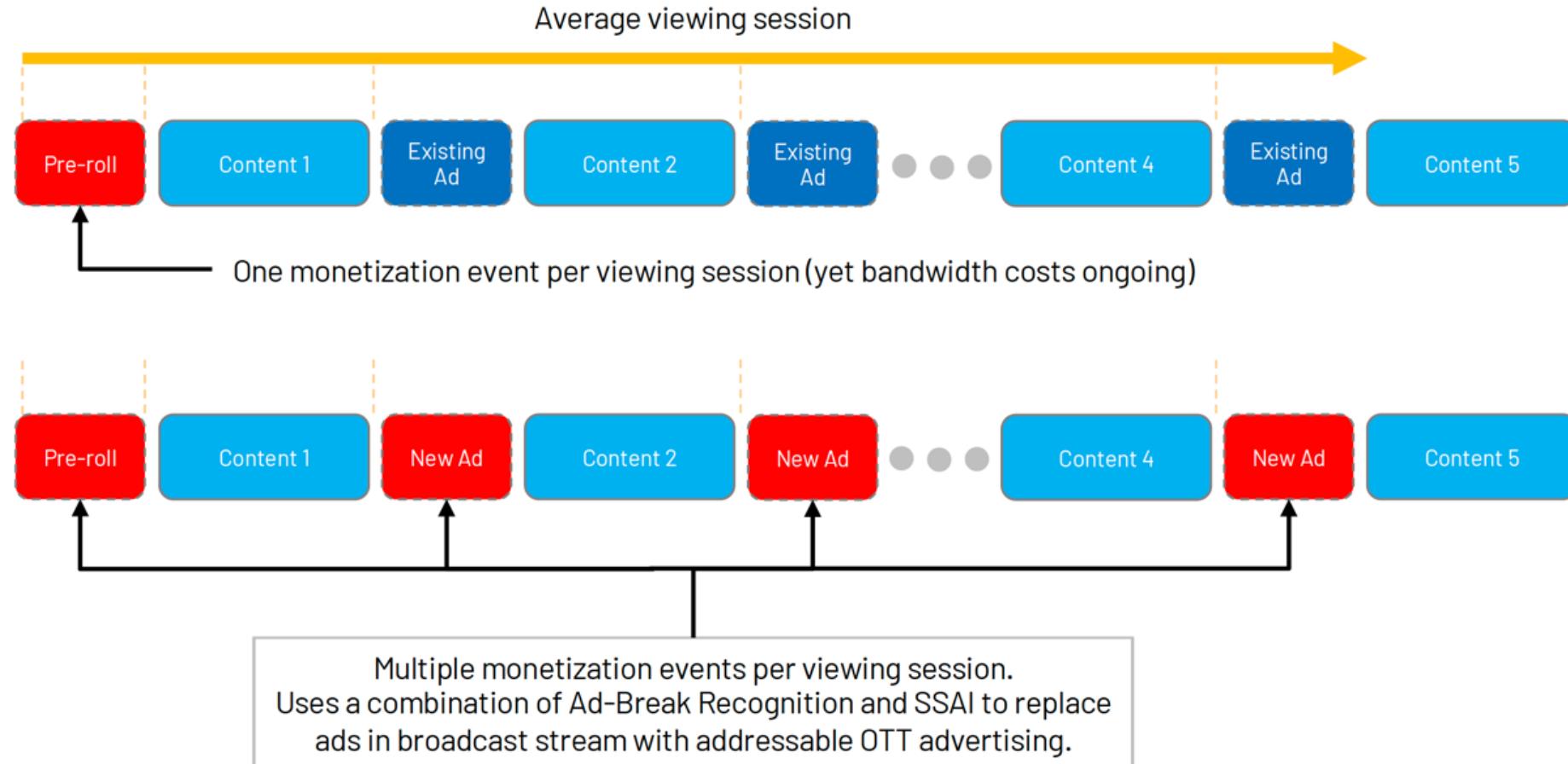
- Overall usage and performance of streaming sessions

Dynamic Ad Insertion

Server-Side Ad-Insertion is a technology to **insert ads dynamically into video content**. It allows a **seamless transition** between content and ads in a streaming environment **delivering a personalized broadcast TV experience** across devices. This provides media owners and video publishers more usage with **better ad-viewing completion** and **higher return on ad-revenues** due to precise targeting.

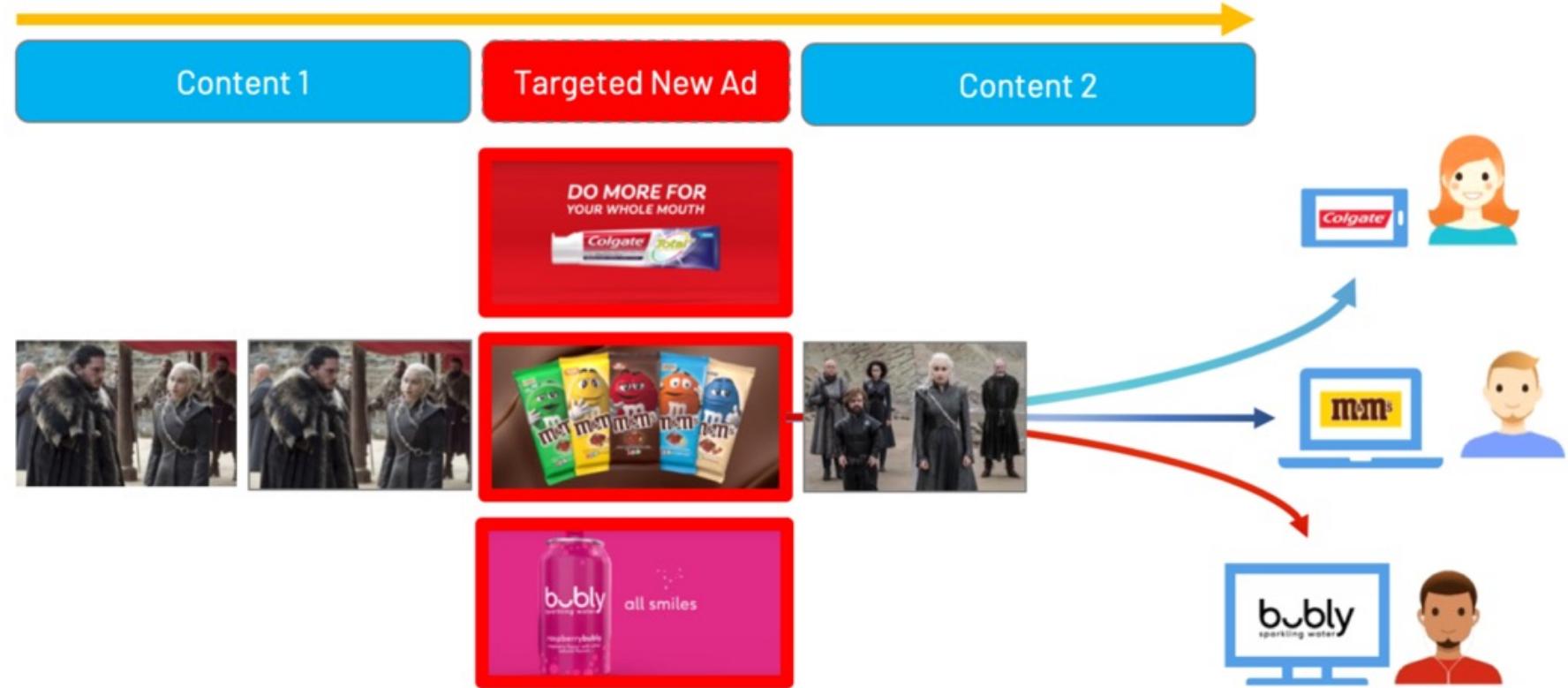


Dynamic Ad Insertion in Live-Linear OTT TV



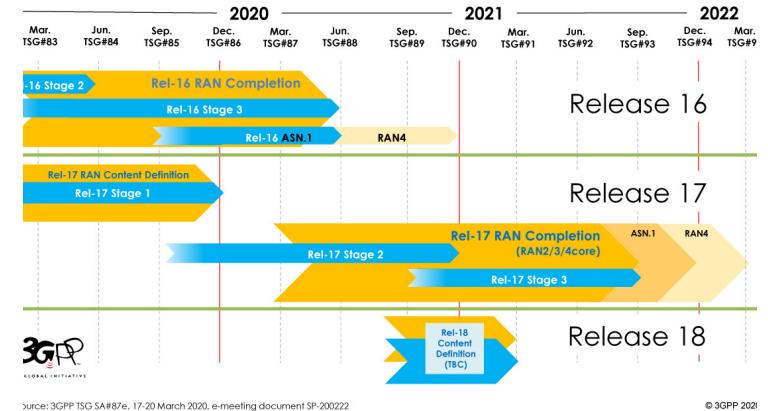
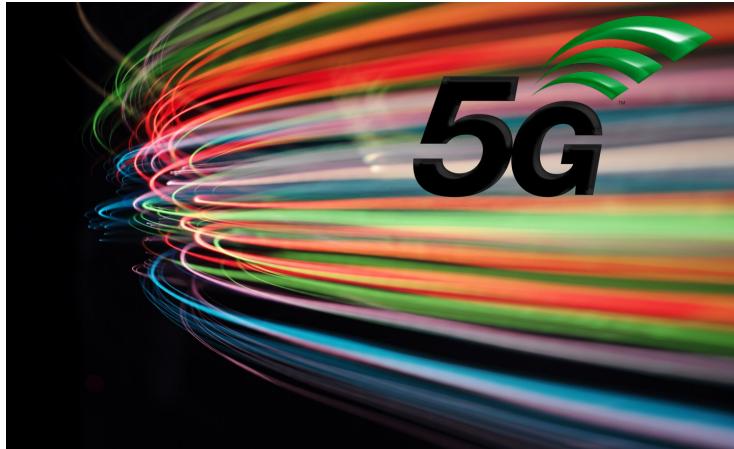
SSAI allows for personalization

**Advertisers
pay a higher
CPM when
targeting of
ads is
established**



5G Media – Standards and Technologies

Agenda



1 5G Foundation and Evolution of 5G

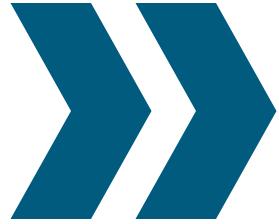
5G Core Concepts, Network Function Virtualization, Network Slicing and QoS Control, 5G Standalone (SA) vs Non-Standalone (NSA), MEC, eMBB, FWA, URLLC, ...

2 5G Media Use Cases and Application Areas

Remote Media Production, Hybrid Broadcast/Unicast Delivery, Ultra Low Latency Streaming for Interactive Services, Metaverse, Cloud Gaming, 5G Terrestrial TV Broadcast, ...

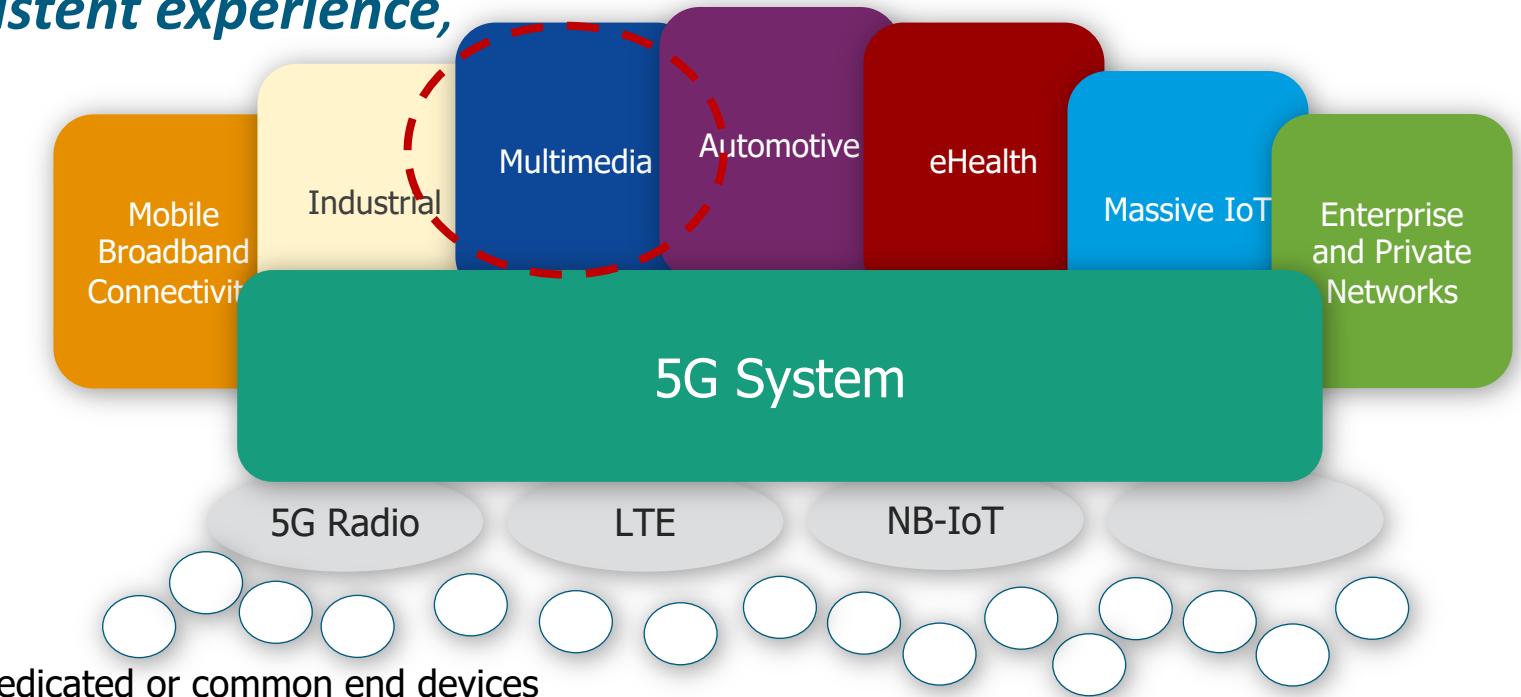
3 5G Media-related Standards and Technologies

Media-related specs in 3GPP releases, MBMS, 5GMS, 5G-MAG, DVB-I over 5G, Protocols: MPEG-DASH, HLS, CMAF, FLUTE, ...



What is 5G?

"5G is an end-to-end ecosystem to enable a fully mobile and connected society. It empowers value creation towards customers and partners, through existing and emerging use cases, delivered with consistent experience, and enabled by sustainable business models."



Source: NGMN 5G Vision

5G Media & Entertainment Use Cases

The media and entertainment industry is one of the most significant sectors that benefit from 5G technologies

- Improved In-stadium Viewing Experience
- 5G Remote Media Production
- Distributed Media Production
- Immersive Real-Time Communication
- Metaverse (AR/VR/XR)
- 5G Terrestrial TV Broadcast
- Cloud Gaming
- CDN enabled by 5G mmWave connectivity in a railway environment



360° Video for ERT HbbTV

powered by
Fraunhofer FOKUS 360° Video Playout



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360° VIDEO STREAMING TO TV DEVICES

- 360° Video Technology for TVs / TV sticks
- Cloud-based 360° Video Rendering
- Playout for TVs and „limited“ devices

