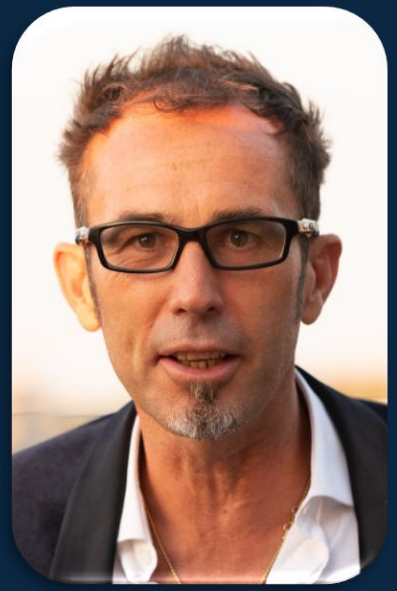
Qualcomm

WI_010 - 5G-MAG Workshop on 6G Media
28 January 2024
5G-MAG UC0070

(extension to 5G-MAG UC0041 from February 2024)

Qualcomm's early input to 5G-MAG on 6G Media

Fundamental motivation of 6G, use cases and some media related thoughts



Presenter

Dr. Thomas Stockhammer
Senior Director, Technical Standards
Qualcomm Europe, Inc., IEEE Fellow

Leading and driving among others

- DVB: 5G TF, DVB-I
- MPEG: MPEG-I, CMAF and DASH
- 3GPP: XR over 5G, 5G Video, 5GMS
- DASH-IF: Interop WG, Test
- ETSI & 5G-MAG: 5G Broadcast and 5GMS
- CTA WAVE: CMAF Device PB, Test
- Metaverse Standards Forum: Chair, Board

Agenda

Fundamental 6G Motivation

Some Guiding Use Cases

Cost Reductions

Standardization principles

Selected Topics

Invitation for Collaboration

Fundamental 6G motivation

Operators networks

- Increasing revenue with new use cases/services

- Reducing network TCO (total cost of ownership)

Enhanced and New Experiences

Sustainability

6G

Advancements in underlying technology, new services enabled by them & a holistic look at sustainability will drive the 6G design

Use Cases and Fundamental Technologies

Next Generation Broadband

Description: Use cases requiring significantly higher peak data rates and user experience than those that are supported in 5G

Backhaul for Wireless Data Centers

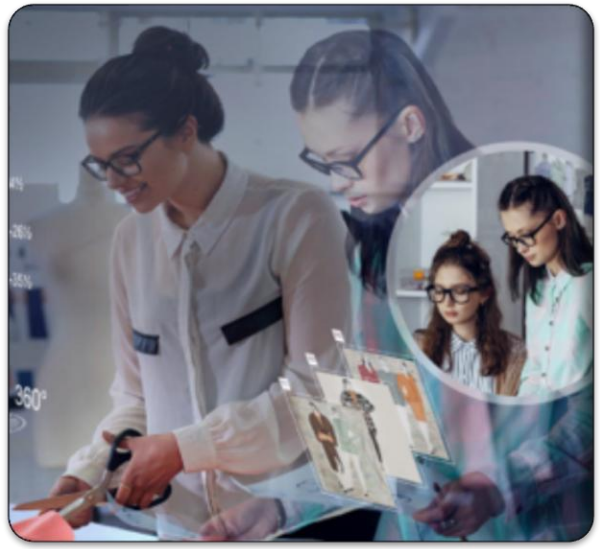
Wireless Fiber to Home

Immersive Platforms and Services

Description: Use cases involving high data rate and very low latency for supporting multimedia, highly immersive and multi sensory interactions

Other Examples:

- Metaverse Gaming/Entertainment and Collaboration
- Mixed Reality Co-Design, Mixed Reality Telepresence,
- Holographic Video Conferencing



Holographic Telepresence

Metaverse Collaboration

Real Time Control

Description: This class of services will push the technology boundary to deliver even lower latency and higher reliability/availability beyond 5G

Other Examples:

- Vehicle Platooning/Cooperative Maneuvering
- Autonomous Service Robots,
- Rescue robots

Collaborative Industrial Robots

Autonomous and Interactive Service Robots

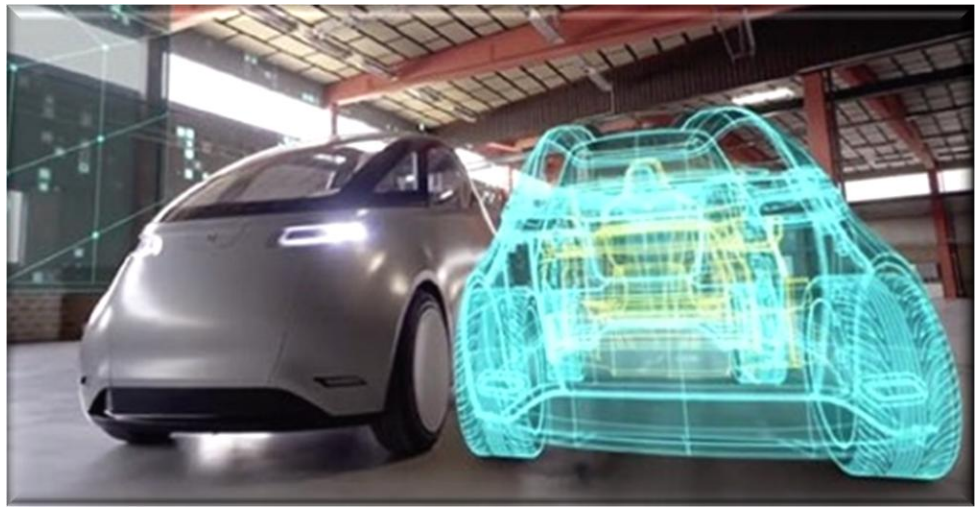
Spatial Perception

Description: Use cases exploiting new/improved capabilities of wireless sensing (and positioning) to offer services

Other Examples:

- Smart Agriculture
- Environmental Monitoring
- Brain Communications and human implants

Sensing Networks



Digital Twins*

*A digital twin is the real-time digital replica of a real-world object, which connects physical systems and digital spaces. Digital twin can monitor, design, simulate, analyze, optimize and predict the behavior of physical systems.

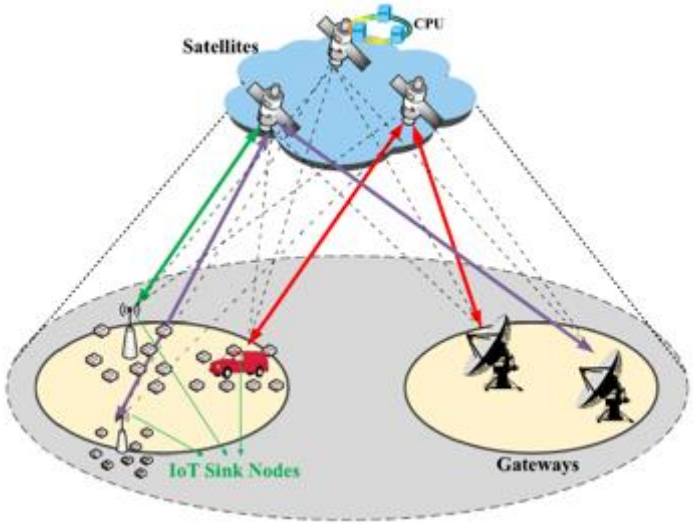
Pervasive Access

Description: Use cases supporting very high density of devices, specially, devices with low complexity

Other Examples:

- Public Safety applications
- Next Generation Smart Grid

Asset Management using Zero powered tags



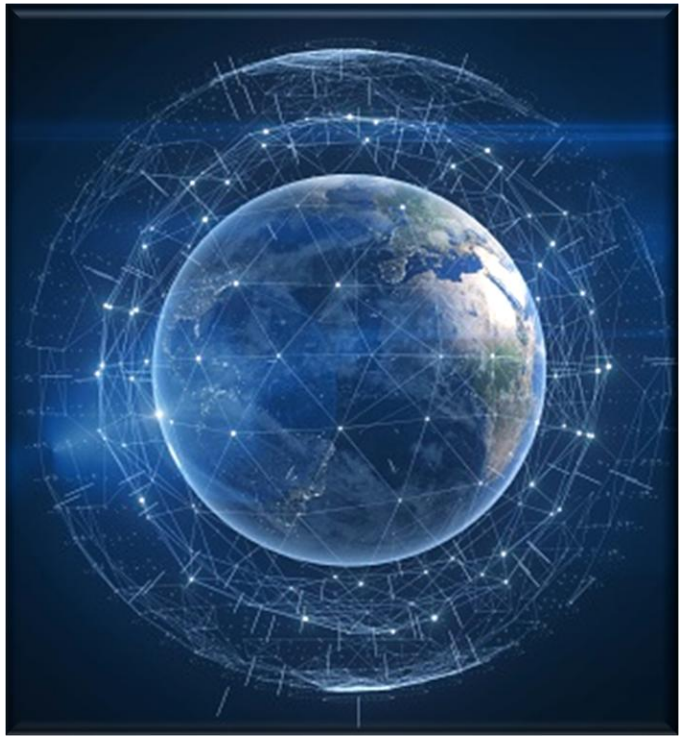
Wide Area IoT Network with NTN

Sustainability

Description: Use cases that address social, environmental and economic sustainability challenges

Other Examples:

- Seamless and ubiquitous coverage and connectivity e.g., for bridging the divide
- Multi-connectivity using UAVs, GEOs, LEOs and HAPs
- Devices with scalable affordability



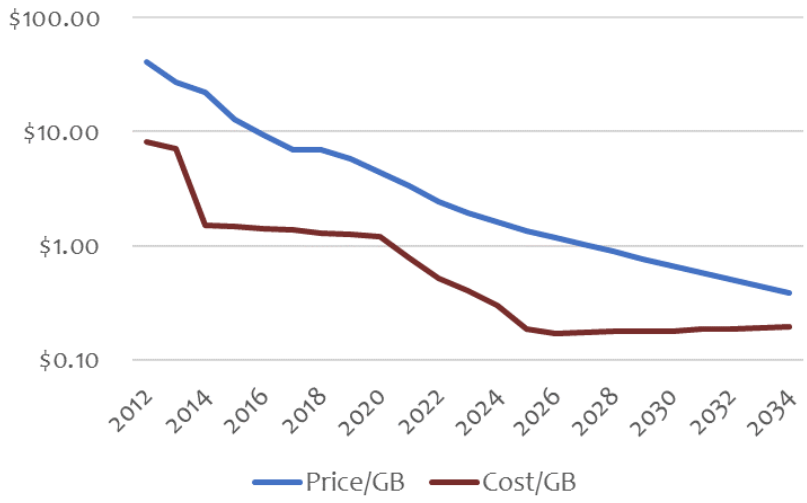
Global/3D Coverage and Connectivity

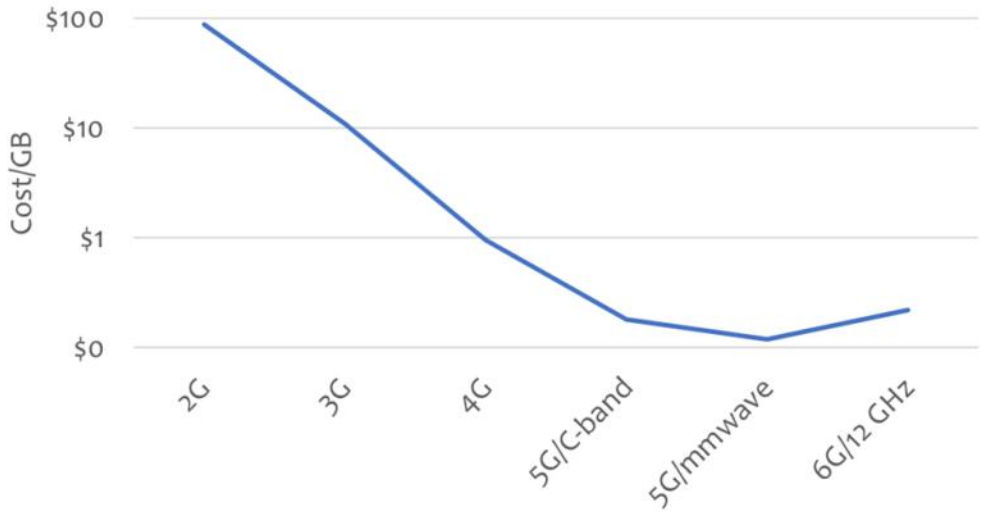
Why? Cost Reductions

Trouble ahead: 6G cost per GB may pose problems

https://www.fiercewireless.com/tech/trouble-ahead-6g-cost-gb-may-pose-problems-madden

- In 2014, after the introduction of LTE, the American telcos spent about $0.96 per GB to deliver data, but charged more than $10 per GB....a 10:1 ratio ➔ allowed the operators to offer ‘unlimited’ plans because the cost of delivery was so much smaller than the revenue created





- Today, the cost has dropped to $0.30 but the retail price per GB is down to $2. By 2028, the retail price will drop below $1/GB, but the operators will have very few ways to reduce cost, and their costs are likely to remain in the range of $0.30 ➔ 3:1 ratio

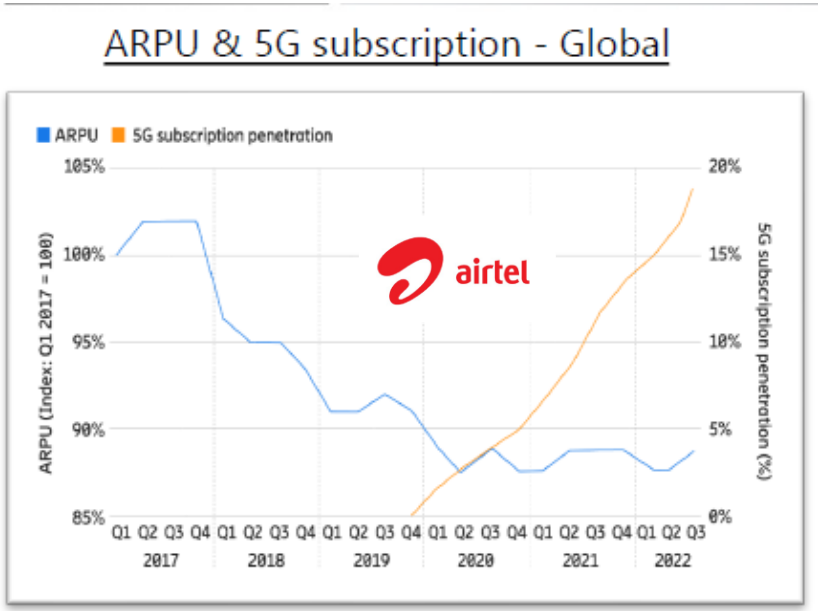
Cost Reductions - General

Deployment cost reduction

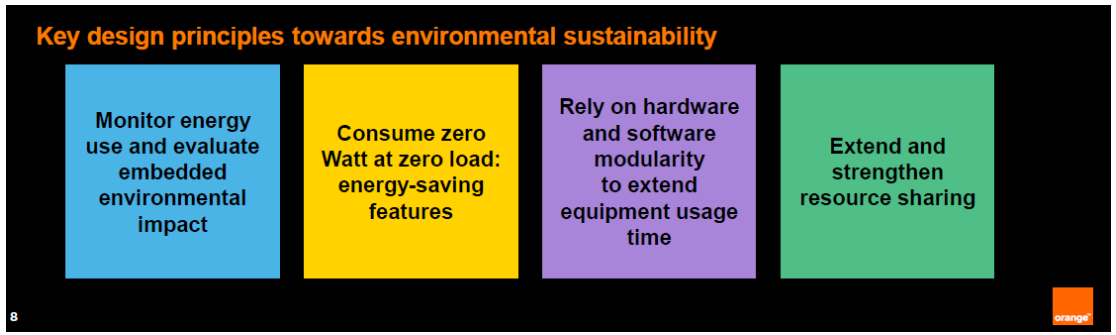
New spectrum deployment, existing network upgrade, cost effective coverage, leverage device density, ..

Operating cost reduction

Network energy saving, automation, cooperative communications, …



Ericsson analysis of Strategy Analytics data, Q3 2022.



NGMN

6G POSITION STATEMENT

An operator view by NGMN Alliance

OPERATIONAL PRIORITIES

1. Network simplification leading to lower operational cost whilst retaining scalability and flexible deployment models.
2. Absolute energy reduction when assessed across mobile and fixed networks to support the transition towards low carbon economies.
3. Features (such as AI) that support automated network operations and orchestration to enable efficient, dynamic service provisioning.
4. Proactive network management capabilities across fixed and mobile networks to predict and address issues before they impact user experience.
5. Quantum safe infrastructure, resistant to attack by Quantum computers.

Cost Reduction Example 1: 6G RAN sharing

More advanced forms of RAN sharing can play a major role for TCO reduction and should be studied in the 6G era

Shared RAN deployment ➔ CapEx and OpEx reduction

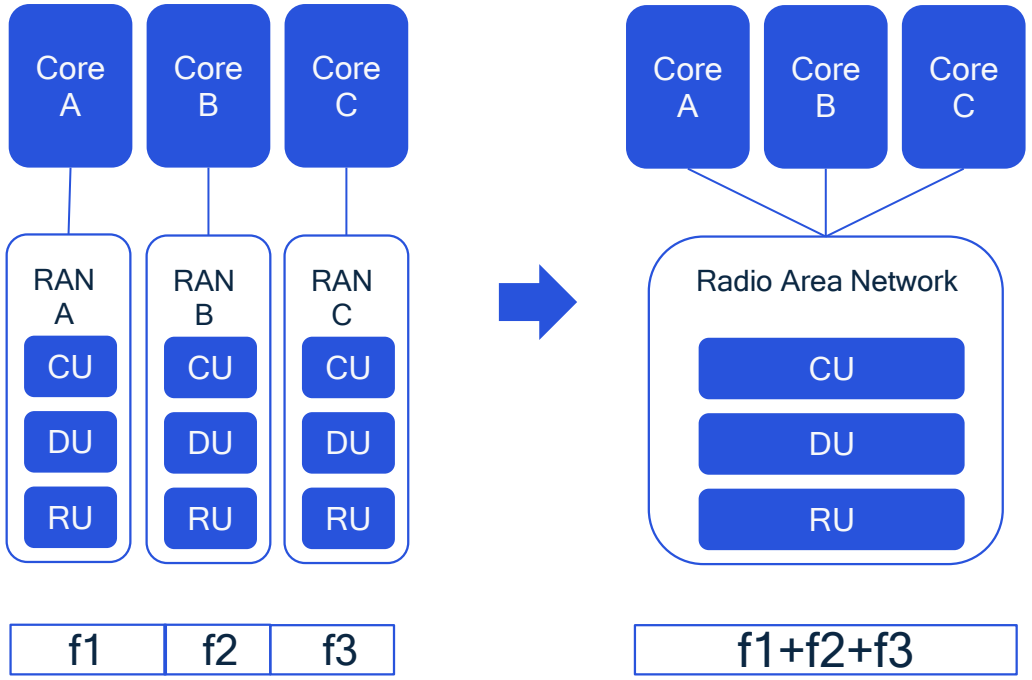
- Sharing could be the full RAN, as illustrated, or some components of RAN, e.g., RU-only

Separate Core networks ➔ Differentiating services

- Differentiating services for competition

RAN resource sharing alternatives

- Alt 1: Cost reduction only, equipment sharing without spectrum sharing
  - E.g., 200+100+200 for three operators based on their spectrum holdings
- Alt 2: Spectrum sharing within a wide carrier 500 MHz
  - Single carrier/scheduler, QoS enforced based on operator agreements
  - Benefits include higher trunking efficiency; better coexistence with non-IMT services on sub-bands; enabling new wideband services (e.g., high-resolution sensing)



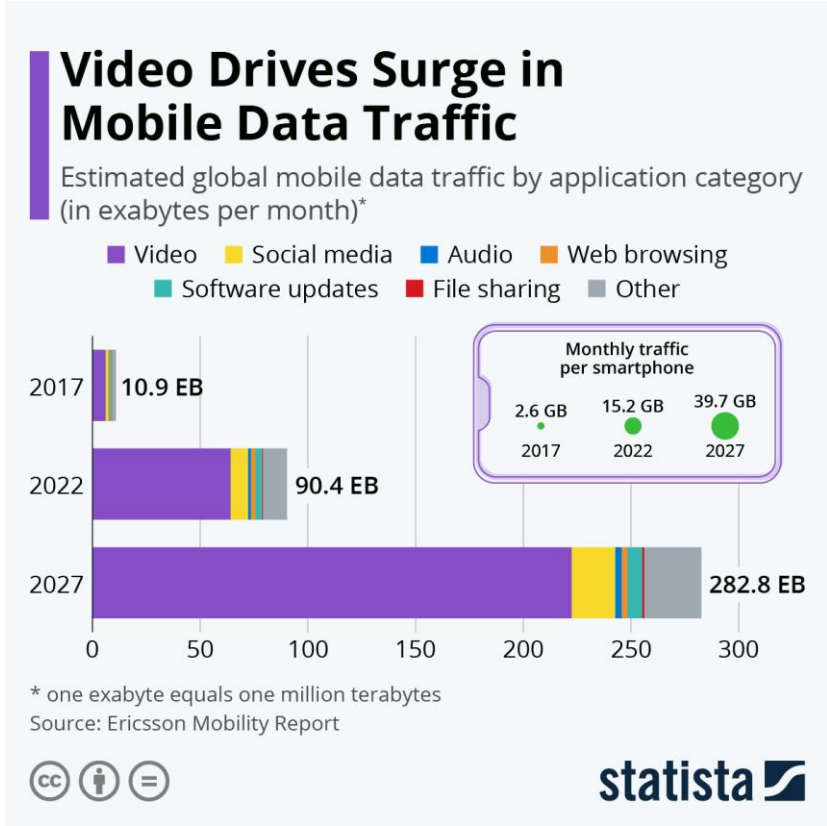
Cost Reduction Example 2: Video Delivery

Provide technologies for operators and service provider to invest in cost saving technologies

- Data points
  - At the end of 2023, video traffic is estimated to account for 73 percent of all mobile data traffic (Ericsson Report)
  - With 97 percent, video traffic has significantly more downlink than uplink traffic (Ericsson Traffic Analysis)
  - Video content to account for almost 80 percent of mobile traffic, which is projected to triple in the next five years.
- The cost of video delivery needs to be reduced
- Potential objective for 6G

Amortization of the MNO loss on Gbyte 10:1 ➔ 3:1 needs to be addressed for video delivery (80% of all traffic)

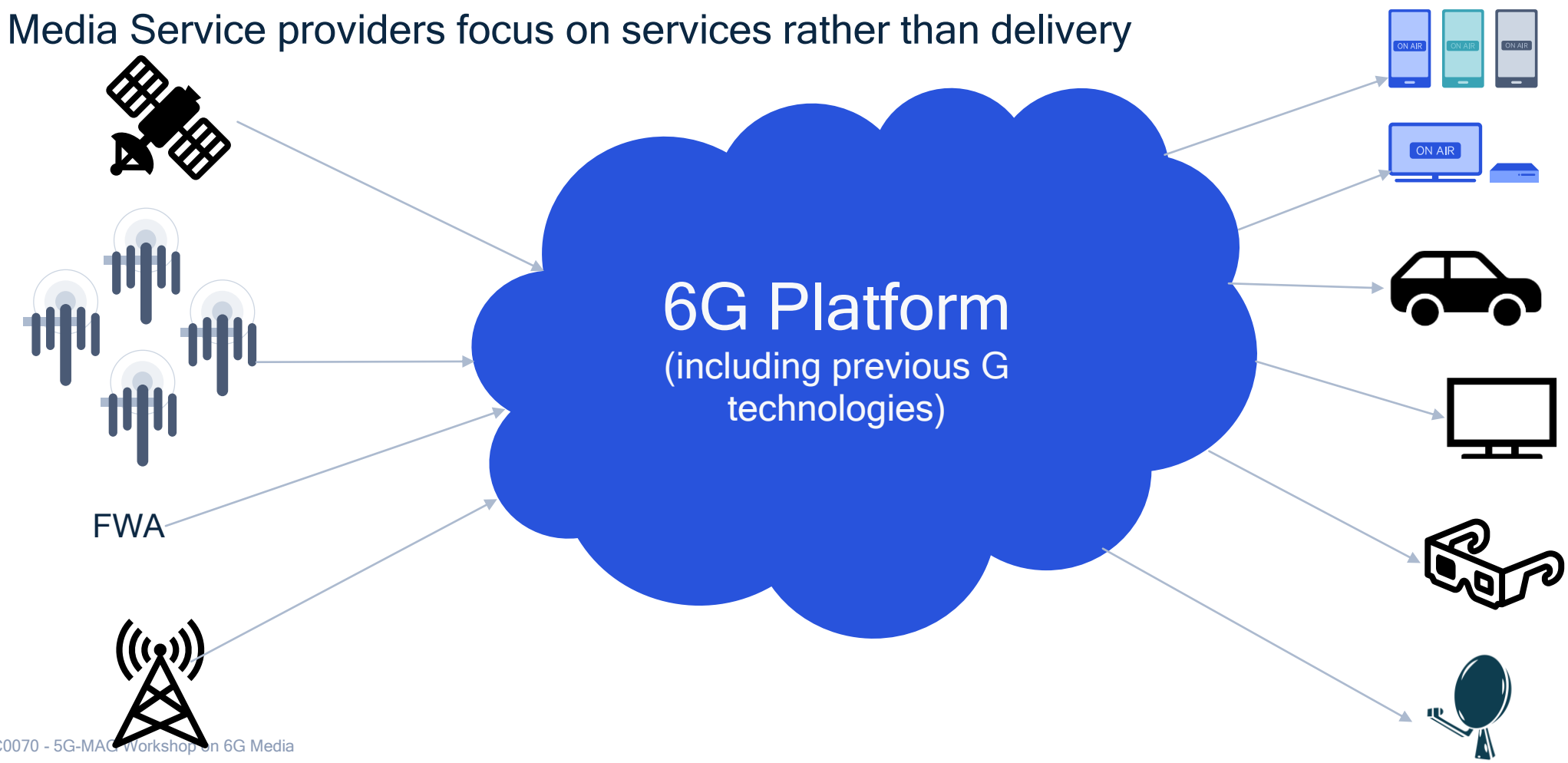
- Potential Technologies:
  - New codecs, AI, Smart delivery, Monetization, New KPIs, Energy Saving
- Collaboration between Media Service provider and MNO



Cost Reduction Example 3: Global universal Media Delivery Platform

Continue and accelerate the integration of Media Verticals to 3GPP global delivery platform – economy of scale

- Unified technology – many emitters can access many devices
- Media Service providers focus on services rather than delivery



Some standardization ideas and principles

Feature	Commercial ?	Certification/ Regulation ?	Broad support/ Participation ?	Test specs/ vectors ?	API/SW ?	Comment
DASH	Yes		Yes	Yes	Yes	(SW outside 3GPP)
H.264/AVC	Yes		Yes		Yes	(SW outside 3GPP)
H.265/HEVC	Yes		Yes		Yes	(SW outside 3GPP)
AMR	Yes	Yes	Yes	Yes	Yes	
AMR-WB	Yes		Yes	Yes	Yes	
EVS	Yes		Yes	Yes	Yes	
Acoustics	Yes	Yes	Yes	Yes		
MTSI	Yes	Yes	Yes	Yes		
MMS	Yes		Yes			
PSS	Yes		Yes			No longer deployed
IVAS			Yes	Yes	Yes	
VR/XR Studies			Yes			
5GMS			Yes		Yes	(SW outside 3GPP)
LTE/5G Broadcast			Yes	Yes	Yes	MBMS/LTE had been deployed commercially for some time/ SW/Tools outside 3GPP
eCall		Yes	Yes	Yes	Yes	
Video characterization			Yes	Yes		
IMS Data Channel			Yes	Yes		
5G RTC, iRTC, WebRTC			Yes			

(Un)-Successful Projects in 3GPP SA4 - the media WG for 6G

Success defined by commercial adaption

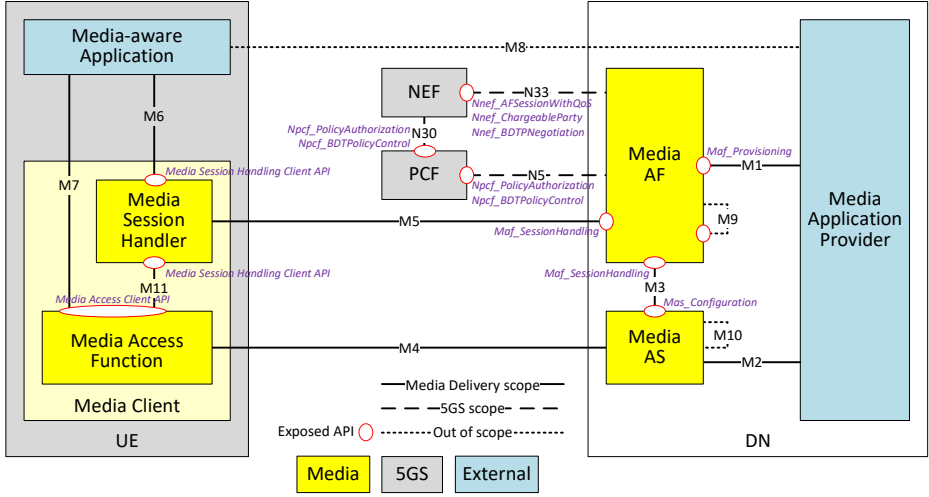
Lessons learned from 5G: verticals

Important to avoid duplication of work vs what already exists

- (1) Focus on requirements first
  - Identify very specific requirements for the 6G version of a new vertical
- (2) Once requirements are identified, perform a gap analysis vs the 5G/5G-Advanced version
  - What is missing?
    - Are there commercially available products for the 5G/5G-A version?
    - Does the extent of what is missing / gain in performance justify a redesign from scratch?
    - Could one just evolve the “5G version” of that vertical (thus preserving compatibility) and rebrand it “6G”?
- (3) Consider stickiness & replacement rate of the vertical
  - Verticals work under different timelines compared to smartphone industry (vs. 3GPP Releases cycle)
- Concrete examples based on 4G-5G transition to learn from
  - **5G Massive IOT** and **5G Broadcast** were “based” on solutions developed during the 4G era following a gap analysis => duplication was avoided
  - **NR V2X** was developed very rapidly, before **LTE V2X** could gain adoption => Some perception of fragmentation was created

Some more thoughts wrt to Media & 5G-MAG

To be refined and improved



- Verticals & RAN
  - Early RAN design consideration for verticals such as Broadcast, NTN, Production – even if not addressed in first release, ensure extensibility, not an afterthought
  - Examples: Time Frequency Interleaver, Multiplexing with legacy broadcast, UHF band support, channel bandwidth
- 3GPP should be well-recognized for important media-related specifications, including
  - Developer-friendly: APIs, code, examples, git-environments, exchange with developers
  - Implementability of the specifications (test, evaluation, code, reference software)
  - addressing market needs, deployment feasibility, sustainability, innovation platform, monetization opportunities, cost-conscious
  - Timeliness: allow things to do quicker, do things at the right time, leave time to address essential work
  - Develop specifications against meaningful KPIs for media services
  - Collaboration with the industry and market representation partners
  - Generally, build on the principles established in the 5G era and evolve and adapt based on experiences and learning
- Media Delivery Architecture and Services
  - build on existing architectures: 5G Media Delivery Architecture and IMS
  - No revolution, but evolution and adaptation to 6G core, radio and design principles
  - Support foundational technologies such as cloud, AI, virtualization, orchestration, split processing ➔ develop more use cases
  - Create enablers for richer media experiences (Media Service Enablers), but not full services

Reference Implementations and Software

Do we need reference/evaluation implementation of 3GPP defined technologies?

- Validation and Verification of the Standard/specification
- Allows early demos and proof-of-concepts
- Minimizes the barriers to introduction of new technologies
- Can be used as reference for more optimized implementation in SW or HW
- Shares the efforts across multiple companies contributing to the standards
- Can be used in production and commercial services
- transparency and trust as literally you can open the code and inspect it

Selected Topics

5G Advanced and 6G Vision

Concrete ideas for Rel-20 5GA

Planning not yet complete, but at least an indication

Avoid starting substantial new topics in Rel-20 5GA unless required by SA1/SA2

Continue normative work on studies not yet completed in Rel-19, e.g. for

Advanced Media Delivery (see remaining Key Issues and possibly new ones)	Avatar Representation	VOPS and Beyond2D (extensions to VOPS)	For AI4media, if we focus on commercially relevant use cases	Acoustics-related topics (ATIAS and DACAS), if not completed in Rel-19

A vision for 6G

Preliminary thoughts priorities – value add for Operators and Service Providers

Full-body Avatar communication

Video Codecs

- How to deal with external next-generation video codecs?
- Do we have specific scenarios and use cases from mobile/3GPP for new codecs?

Audio Codecs (very-low bitrate supporting satellite) and NTN media

AI-based media compression and work flows ➔ how can collaboration be done

Advanced Media Delivery ➔ Media Distribution architecture (with other orgs)

Trusted and private communication and media in GenAI era

6G Media Messaging – Media formats and interoperability

Gaussian Splats – use cases, work flows, user generated content

User-experience based services and traffic analysis

Codec Specifications

What can SA4 do?

Speech/Audio – typically developed in 3GPP SA4

Full specification done in 3GPP ➔ good

Better integration of technologies in apps and web

Usability of core codec components in different app environments – more MSE like

Video – typically relying on external technologies

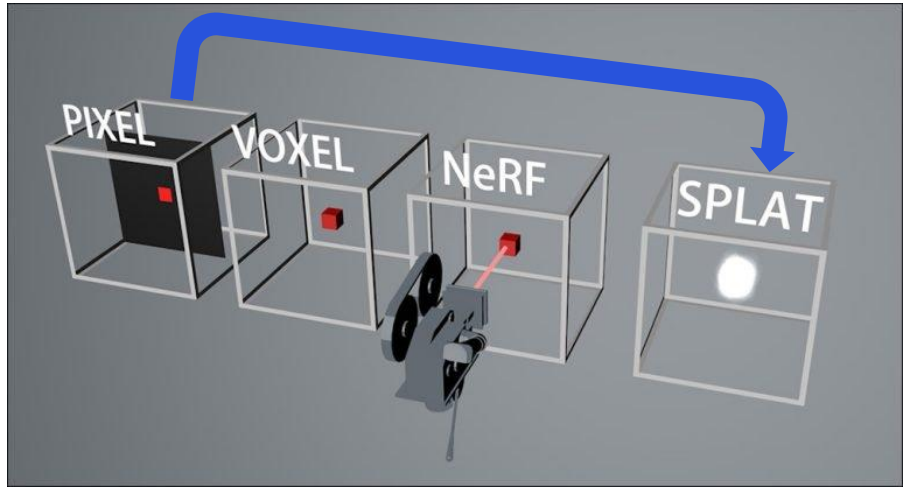
For NGVC, different levels may be considered:
1) Characterization framework (i)
2) Interoperable Operation Points (n)
3) permitted/recommended for a 3GPP service (n)
4) mandatory for a 3GPP Service (n)

New use cases and requirements may be defined to create input to standardization work in external organizations

Gaussian splats

The representation format the 6G era?

$$GS = \left\{ \overbrace{(x, y, z)_i}^{geometry} \;\middle|\; \overbrace{(sh_1, \ldots, sh_{48})_i}^{sh_{RGB}} \;\middle|\; \overbrace{o_i}^{opacity} \;\middle|\; \overbrace{(s_1, \ldots, s_3)_i}^{scale} \;\middle|\; \overbrace{(r_1, \ldots, r_4)_i}^{rotation} \right\}_{i=1..N}$$



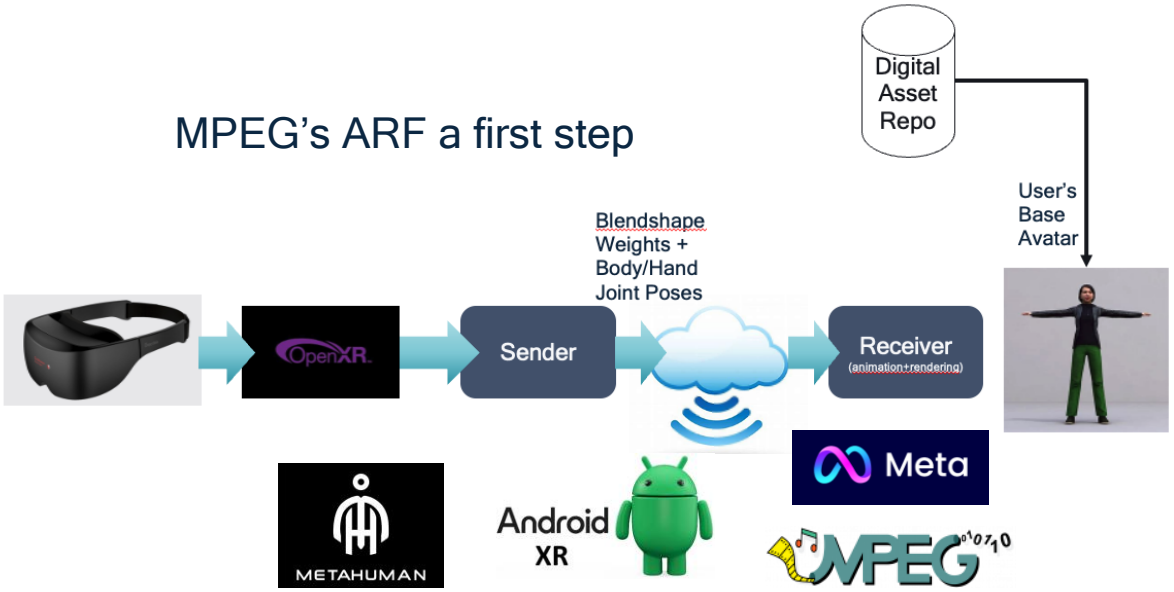
- 2D Pixels are state of the art – do we need “Voxels” at all ➔ commercially no
- However, Gaussian Splats have the potential to surpass other volumetric representations
- Why are "a bunch of blobs in space” so interesting:
  - 3D Representations can be generated from a set of simple images (typically 50-100 images) ➔ UGC
  - Rendering of Gaussian splats is relatively trivial on GPUs using native functionalities (DirectX, WebGPU, Vulkan)
  - Gaussian splats can be edited locally, are not a whole-scene model (in contrast to NeRFs)
- Gaussian Splats may be the representation formats in the 6G era ➔ hands-on study needed
  - Representation and work-flow centric, compression-agnostic, user-generated content
- Simple is important – focus on manageable real use cases, static images, device-based processing, etc.

Avatar Communication

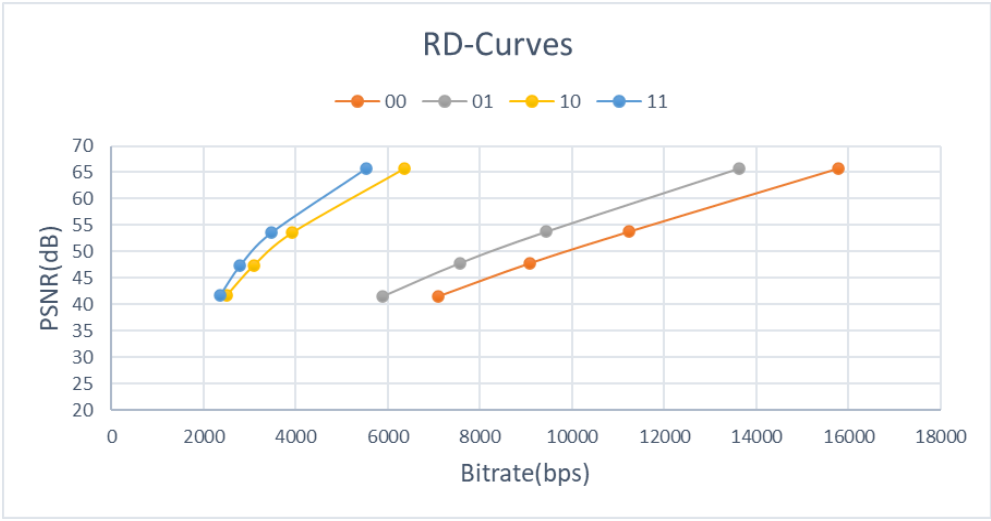
Making the Lex Fridman – Mark Zuckerberg interview a reality

- A combination of technologies provides realistic Avatar-based calling
- Many steps towards making this a broadly available service, with many question marks on technology, privacy, user experiences, social impacts, authenticity, security, and and and.

MPEG's ARF a first step



Animation Bitstreams – not a bitrate challenge



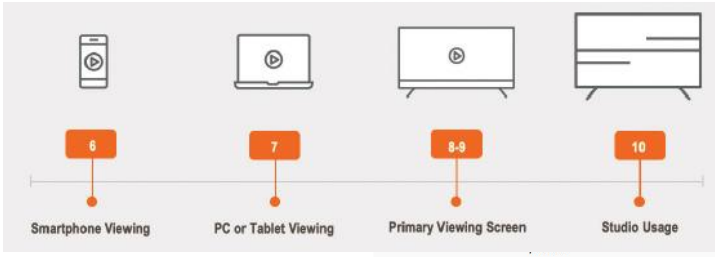
User Experience – Content & Device Aware Streaming and Delivery

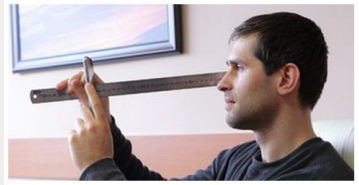
Take into account devices, users, content, resources, subscription models, latency, etc. for overall quality improvement

- Controlled fairness of players
- A couple of good pointers and resources:
  - TR 26.949
  - Content-Aware Encoding (Yuriy Reznik, Brightcove)
  - Achieving Great Video Quality Without Breaking the Bank (AWS)
  - Netflix: Optimized shot-based encodes: Now Streaming!

AI and Big data may help

Device Consumption





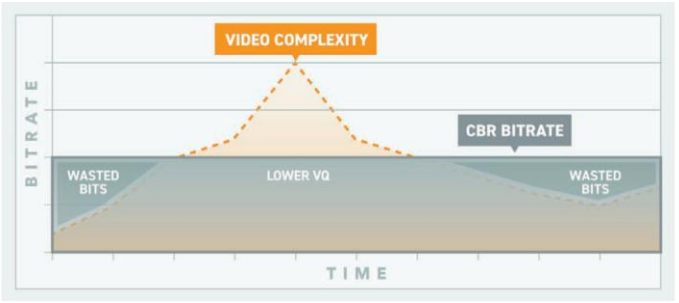
720p, average person starts noticing pixelization at around 11 inches in a 4.7-inch 720p phone

1080p, average person starts noticing pixelization at around 7.8 inches in a 5-inch 1080p phone

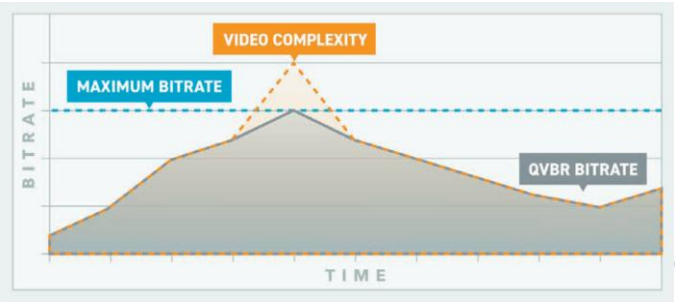
Quad HD, average person starts noticing pixelization at around 6.44 inches in a 5.5-inch 1440p phone

GBR QoS?

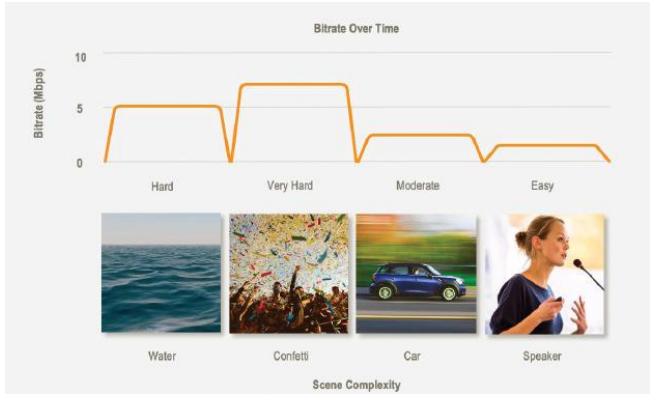
CBR



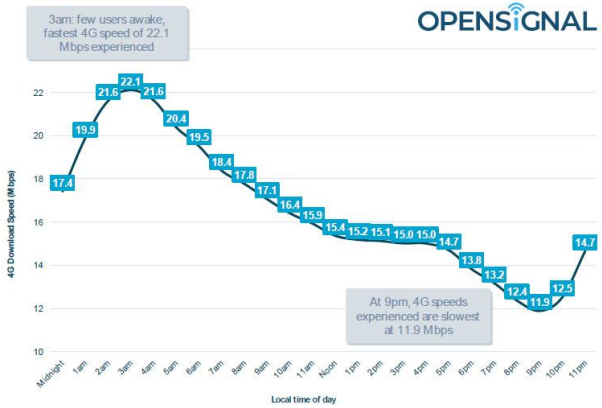
CVBR
CAE



Content Complexity



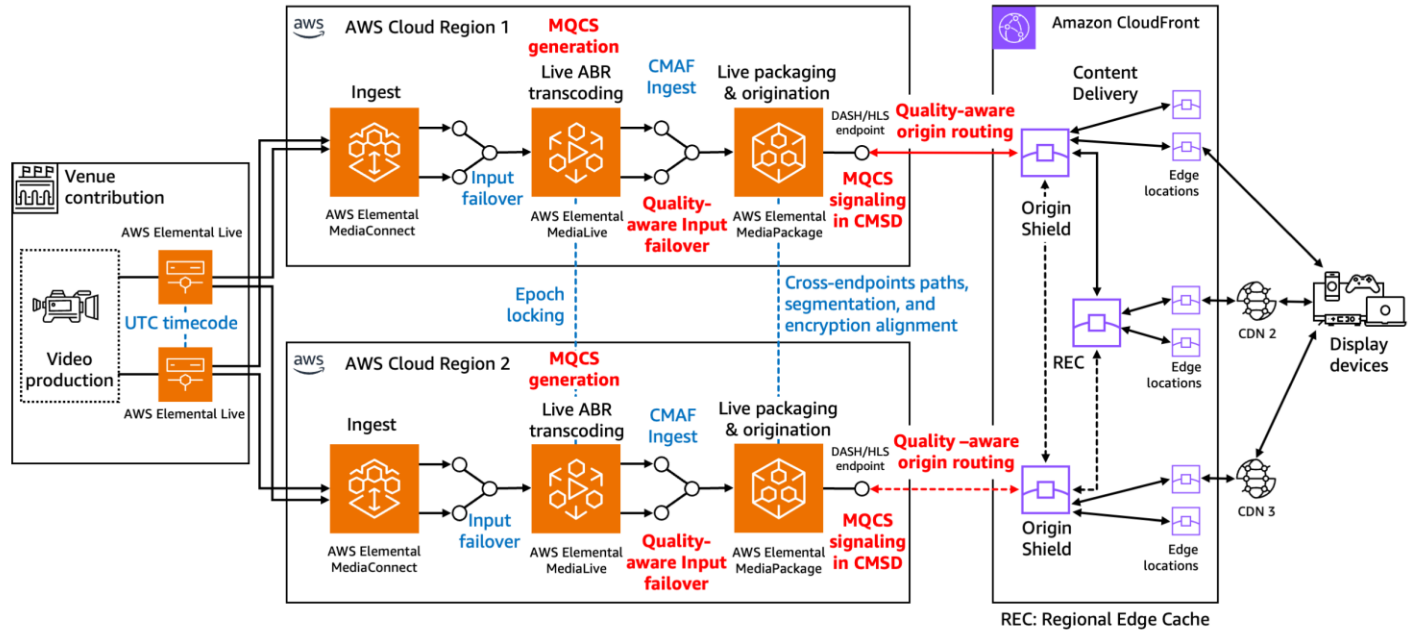
Radio Resources



Advanced Media Delivery ➔ Media Delivery Architecture

How can 5G/6G networks be integrated and combined with modern media delivery systems

Example: Amazon Delivery System architecture



https://aws.amazon.com/blogs/media/improve-your-viewers-live-streaming-experience-with-media-quality-aware-resiliency/

3GPP, 5G and 6G should be compatible with modern media delivery
Collaboration with media organizations (SVTA, DVB?)
5G-MAG should be a facilitator to connect the media industry

Based on our initial input we look forward to collaborate on shaping an input of 5G-MAG into 3GPP for 6G

Thank you

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