Agenda

• 5G Vision and Use Cases
• Media Usages and Requirements for 5G
• Mobile Network Architecture for 5G
• 5G Media Opportunities
## 5G Vision & Use Cases (NGMN)

<table>
<thead>
<tr>
<th>Broadband access in dense areas</th>
<th>Broadband access everywhere</th>
<th>Higher user mobility</th>
<th>Massive Internet of Things</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERVASIVE VIDEO</strong></td>
<td><strong>50+ MBPS EVERYWHERE</strong></td>
<td><strong>HIGH SPEED TRAIN</strong></td>
<td><strong>SENSOR NETWORKS</strong></td>
</tr>
</tbody>
</table>

### Extreme real-time communications
- **TACTILE INTERNET**

### Lifeline communications
- **NATURAL DISASTER**

### Ultra-reliable communications
- **E-HEALTH SERVICES**

### Broadcast-like services
- **BROADCAST SERVICES**
5G Usages and Requirements

ITU-R vision on IMT-2020 and beyond

Enhanced Mobile Broadband

Massive MTC

Critical Communications

Network Operation

Network Slicing / Flexibility
Connectivity / Routing
Migration / Interworking

AR / VR
Train / Airplane
UHD / Hologram

Mobile broadband
Dense crowd of users

Very high data rate
Very high capacity
Massive number of devices
Reliability, resilience, security
Long battery lifetime
Very low latency

IoT sensor network
IoT control network

Ultra-reliable and low latency communications

Peak Data Rate
User Experienced Data Rate
Spectrum Efficiency
Mobility
Network Energy efficiency
Connection Density
Latency

RF
Processors
Communications
Connectivity
UX

BT IA
WiFi FMR
2G LTE
GNSS

- High Importance
- Medium
- Low

Enhanced Mobile Broadband
# 5G Design Principles (NGMN)

## Radio
- Leverage spectrum
  - Exploit higher frequencies and unlicensed spectrum
  - C/U-path split, UL/DL split, multiple connectivity
- Enable cost-effective dense deployments
  - Integrate third-party/user deployments
  - Automate configuration, optimization and healing
  - Enhance multi-RAT coordination
  - Support multi-operator/shared use of infrastructure
- Coordinate and cancel interference
  - Build-in massive MMO and CoMP
  - Exploit controlled non-orthogonal interference
- Support dynamic radio topology
  - Moving cells, relays, hubs, C-RAN, D-RAN
  - D2D (e.g., for latency, disaster relief)

## Network
- Create common composable core
  - Minimize number of entities and functionalities
  - C/U-function split, lean protocol stack
  - No mandatory U-plane functions
  - Minimize legacy interworking
  - RAT-agnostic core
  - Fixed and mobile convergence
- Support new value creation
  - Exploit big data and context awareness
  - Expose radio and network APIs
  - Facilitate XaaS
- Build in security and privacy
  - Extend C-plane security (e.g., HetNets)
  - Ensure location privacy and identity protection from (unlawful) disclosure

## Operations & Management
- Simplify operations and management
  - Automation and self-healing
  - Probeless monitoring
  - Collaborative management
  - Integrated OAM functionality
  - Carrier-grade network cloud orchestration

Embrace flexible functions and capabilities
- Network slicing
- Function variance
- Flexible function/service/application allocation
- Leverage NFV/SDN
- State-disintegrated functions
- Graceful degradation
5G Media Usages

Enhanced Mobile Broadband
- **UHD / 4K content delivery** anywhere anytime for unicast and broadcast
- **Interactive conferencing and telepresence** with ‘being there’ experiences
- **Virtual / augmented reality**, with immersive 360 degree / 3D video and content analytics capabilities, e.g., scene detection/ manipulation, 2D/3D object classification, voice recognition, metadata extraction, etc.

Mission Critical Comms, Internet of Things and Other New Verticals
- **Connected Drones**: Analyze, in real time, the video and infrared imaging of the fields that are streamed from the cameras and sensors. Broadcast live outdoor events like marathon, F1 auto racing.
- **Industrial Control**: Deliver uplink live video stream over a high bandwidth connection to a physical operator for real-time analytics and control
- **Remote control**: UAV (unmanned aerial vehicle) shoots real-time pictures or video along the road and sends the content back to the manipulator.
- **Bio-connectivity, telemedicine and remote health care**: Patient examination performed remotely supported by a video stream
- **Domestic home monitoring**: Video monitoring and surveillance for home security, where captured videos are delivered to an aggregation point
- **Cloud robotics**: Robot sends captured video/audio/data collected to the cloud in real time, receiving in return action instructions.
5G Media Requirements

User Requirements - Mobile Internet

- Higher user experienced data rate
- Zero latency experience
- Fiber-like access rate
- Comparable to local operations
- Consistent experience under diverse scenarios

Perfect service experience

- Immersive audio-visual experience
- Smooth control experience
- Varieties of personalized services

Service Requirements

- UHD
- 3D
- Virtual Reality

Continuous growth of video resolution
Require extremely high data rate (~16Gbps)

Augmented Reality
Online games
Cloud Desktop

Huge amount of data exchange in ms level latency

GSMA Intelligence whitepaper

Future IMT

Massive Machine Type Communications
Ultra-reliable and Low Latency Communications
## 5G Opportunity for Mobile Network Operators (MNOs)

<table>
<thead>
<tr>
<th>Role</th>
<th>Business Models</th>
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<tr>
<td><strong>Asset Provider</strong></td>
<td>XaaS: IaaS, NaaS, PaaS&lt;br&gt;Ability to offer and operate for a 3rd party provider different network infrastructure capabilities (Infrastructure, Platform, Network) as a Service.</td>
</tr>
<tr>
<td><strong>Connectivity Provider</strong></td>
<td>Basic Connectivity&lt;br&gt;Best effort IP connectivity in retail (consumer/business) &amp; wholesale/MVNO</td>
</tr>
<tr>
<td><strong>Partner Service Provider</strong></td>
<td>Operator Offer Enriched by Partner&lt;br&gt;Operator offering to its end customers, based on operator capabilities (connectivity, context, identity etc.) enriched by partner capabilities (content, application, etc..)</td>
</tr>
</tbody>
</table>

**Subscribers:** Access more content / videos with better quality and QoE, anywhere anytime

**Service / Content providers:** Enhance user QoE, generate new revenue, sell more content/service

**Mobile network operators:** Deliver content / videos more efficiently, differentiate mobile services, better network utilization and user QoE, monetize network and launch new services
Mobile Edge Computing (MEC), enables cloud-computing capabilities within the Radio Access Network (RAN) in close proximity to mobile subscribers.

- Applications reside at the base station, radio network aggregation point or the edge of the core network
- Goal: Reduce latency, ensure highly efficient network operation and service delivery
- Allows access to real-time radio and network information as well as ultra-low latency and high-bandwidth connections

ETSI MEC Industry Specification Group (ISG) established in Dec 2014:
- Goal: Create a standardized, open environment to allow the efficient and seamless integration of mobile edge applications across multi-vendor MEC platforms.
- The initial scope focuses on use cases; requirements and reference architecture,
- Work on platform services, APIs and interfaces to commence after initial specifications.
Video Processing at the Edge

1. Video Vault/OTT
2. Video Stream
3. Storage
4. Content Delivery Network
5. Transport Edge
6. Edge Caching
7. QoE-aware Prioritization & Resource Allocation
8. RAN-Aware Content Adaptation
9. Client Adaptive Transcoding
10. Content Analytics / Metadata
11. Client Feedback
12. Targeted ad insertion
13. Augmented reality

Video Vault/OTT

Video Stream

Storage

Content Delivery Network

Transport Edge

Edge Caching

QoE-aware Prioritization & Resource Allocation

RAN-Aware Content Adaptation

Client Adaptive Transcoding

Content Analytics / Metadata

Client Feedback

Targeted ad insertion

Augmented reality

Video surveillance

Visual data mining in volume

170+ MEDIA FORMATS

200+ DEVICES

Video encoding/transcoding

“Any device” display, connection efficiency, and cost avoidance vs batch encode

Video on demand

Personalized video services with real time device continuity, targeted ad insertion

Video indexing & search

Nirvana of Search given growth of video

Next Generation & Standards (PEG)
MPEG’s Server And Network Assisted Streaming (SAND)

- Specified in ISO/IEC 23009-5: SAND is Part 5 of MPEG DASH specification
- Defines message formats and interfaces among server, client, edge proxy and network elements toward enhancing streaming QoE.
- SAND messages describe real time operational characteristics of networks, servers, proxies, edge caches, CDNs as well as DASH client’s performance.

Industry Participants: Intel, Microsoft, Huawei, Ericsson, Cisco, Qualcomm, Samsung, Technicolor, TNO, Arris, Interdigital, etc.
Other Relevant Standardization Work on 5G Media Services

**MPEG**
- Omnidirectional Media Application Format (OMAF)
- Compact Descriptors for Visual Search & Video Analytics (CDVS / CVDA)
- Media-centric Internet of Things and Wearables (MIoTW)
- Augmented Reality Application Format (ARAF)
- Green Metadata for better Energy Efficiency
- Future Video Coding and Next Generation Video (incl. 360 3D video)
- Higher Dynamic Range / Wider Color Gamut (HDR/WCG)

**3GPP**
- Virtual Reality Study Item to enable relevant media formats, interfaces and delivery procedures in 3GPP services
- Multi-stream Multi-party Conferencing Media Handing (MMCMH)
- IMS Telepresence service for immersive ‘being-there’ media experiences
- Server and Network Assisted DASH (SAND) for edge media processing
- TV Video Profiles to align 3GPP service layer with broadcast formats (DVB, ATSC, HbbTV...)

- Many other media-related work in IETF, ITU, GSMA, W3C, NGMN, ETSI, etc.
For Questions:

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