SESSION 2: To Infinity and Beyond with 5G-Advanced
**SESSION 2 AGENDA**

### Session 2 Speakers
- **Alex Sinclair**, CTO, GSMA
- **Bernard Despres**, Vice-President Core Network, Automation, Security, E2E services, Orange
- **Dr Xiaodong Xu**, Principal Researcher at China Mobile, and currently Vice Chair of 3GPP TSG RAN 1, China Mobile *(video)*
- **Alan Loh**, Executive General Manager, Zain KSA
- **John Gao**, 5.5G General Manager, Huawei
- **Tingfang Ji**, VP R&D Group at Qualcomm

### Session 2 Panel
- **Sibel Tombaz**, Head of 5G RAN, Business Area Networks, Ericsson
- **Dr. Mahmoud R. Sherif**, Head of Technology & IT Strategy, DU
- **Sheldon Yau**, Head of Wireless & Core Network Engineering, Hongkong Telecom
- **Ronnie Vasishta**, SVP Telecom from NVIDIA

### Photograph
- Join GSMA for a 5G-Advanced community photograph at the end of the session
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Introduction
5G-Advanced

Alex Sinclair
CTO
GSMA
To Infinity and Beyond with 5G-Advanced

Alex Sinclair – CTO, GSMA
5G-Advanced Promises Step Change for Extended Reality

Cross-layer collaboration tech could enable fivefold increase in simultaneous XR users.

Tests of 5G-Advanced cross-layer collaboration technology have demonstrated that forthcoming cellular networks will be able to deliver highly immersive extended reality (XR) experiences. Conducted in Hangzhou, Zhejiang province, China, the tests explored how 5G-Advanced networks could support very high-resolution virtual environments generated by computer technologies and wearable devices.

5G Advanced Could Turbocharge Video Uploads

Field tests of UCBC tech achieve uplink of more than 1 Gbps for a single user.

Huawei and China Mobile have conducted field tests that demonstrate that 5G Advanced can provide uplink capacity and throughput to support the fast and efficient transmission of high-resolution videos from anywhere with network coverage.

5G Advanced to Support Self-Powered Sensors

Passive IoT tech promises to improve coverage tenfold compared with RFID.

Huawei and China Mobile have conducted field tests of a passive Internet of Things (IoT) solution, which enables large numbers of sensors to transmit data without the need for batteries. Conducted in Chengdu, Sichuan province, China, the tests used a prototype 5G-Advanced network.
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5G-Advanced Experience

Bernard Després
VP Core Network, Automation, Security
Orange
5G advanced experience

MWC 2023 5G Futures Summit

Session 2 – from infinity and beyond with 5G advanced
March 1st 2023

Bernard Després VP Core network, automation, security
5G in Orange commercially available since 2019

**5G NSA**

5G Radio access
4G core network

*Except Poland: commercialised on 4G spectrum in DSS (Dynamic Spectrum Sharing)*

**5G SA**

5G Radio access
5G core network

February 13, 2022

Orange first operator to launch 5G SA (5G+) on the Spanish market

Available in
Barcelona
Madrid
Sevilla
Valencia

Botswana 2022
5G labs to coinnovate with partners

France, Europe (Belgium, Poland, Romania)
3 in Middle-East and Africa (Ivory Coast, Jordan, Senegal)

> 2000 companies or
public entities accompanied

176 co-innovation projects

Main business sectors:
• Entertainment
• Smart City
• Industry 4.0
• E-Health

Orange 5G Lab worldwide

17

Will to be opened in
H1 2023

4
5G advanced will enable network hyper automation

**Disaggregation**
from proprietary and closed solution, towards totally decoupled and open components which are re-combined to form a complete solution, with orchestrators

- Proprietary router App
- Proprietary OS
- Custom hardware
- vRouter
- Linux OS
- On the shelf hardware

**Virtualization**
and cloudification allow pooling of hardware resources (compute, storage, I/O) and economies of scale

- vRouter
- vApp1
- vApp2

**Cloud Infrastructure**
- Linux OS
- On the shelf hardware

**Continuous automated delivery** (leveraging on Ci/Cd, DevSecOps and Telco cloud, Gitops)

Autonomous networks involve closed loops automation assisted by machine learning & AI

Network services become ‘As a Service’ in a real **On demand** mode. **APIs** are key enablers for this transformation
5G Mobile Private Networks

1. Full private solution
   With/without RAN depending on B2B spectrum conditions

2. Hybrid-LBO (Local Break Out)

3. MPN-Virtual
   when large scale slicing ready

UPF = manages user traffic
SMF = manages signalling

Orange

Main 4G/5G core network

B2B SMF

B2B Customer

Enterprise premises

B2B Customer

Enterprize premises

B2B compact Core (+ RAN)
Pikeo is Orange Cloud Native, full software, automated and AI-driven 5G SA experimental network

Offering a dedicated slice on demand over a shared 5G SA infrastructure

A network supporting several logical subnets for different use cases

5G SA
- Slice: Internet service
- Slice: Corporate service
- Slice: Emergency service
- Slice: Connected car
- Slice: Industry 4.0

Showcased at MWC
We are only at the beginning of the 5G+ journey

- 6 GHz licensed
- Reduced Capability 5G IoT
- Extended reality XR
- Network Power Saving
- UpLink perf
- Ambient Power IoT
- Satellites Drones
- AI
  - Artificial intelligence
  - ML Machine learning
Thank you
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Accelerating 5G-Advanced Adoption

Dr Xiaodong Xu
Chief Specialist
China Mobile
Good morning, everyone

Accelerate 5G-Advanced Adoption

Dr. Xiaodong Xu
Chief Specialist of China Mobile
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5G-Advanced Empowering AI Innovation

Alan Loh
Executive General Manager
Zain KSA
5G-Advanced Empowering AI Innovation

Alan Loh
Innovation and Solutions Executive General Manager
5G-Advanced and AI
Zain KSA Contact Center AI (Now)
# Autonomous Optimization (Coming)

<table>
<thead>
<tr>
<th></th>
<th>Human Brain</th>
<th>AI Brain (Deep Learning)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data required to learn</td>
<td>Few data points</td>
<td>Huge amount of data</td>
</tr>
<tr>
<td>Quantitative optimization</td>
<td>Hard</td>
<td>Easy</td>
</tr>
<tr>
<td>(picking the best parameters combination out of a million)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customizing for each situation (showing each customer a different QoS to maximize CX)</td>
<td>Hard</td>
<td>Easy</td>
</tr>
<tr>
<td>Abstract concepts, analytical reasoning, common sense and insight</td>
<td>Easy</td>
<td>Hard</td>
</tr>
<tr>
<td>Creativity</td>
<td>Easy</td>
<td>Hard</td>
</tr>
</tbody>
</table>
AI Brings Dead Back to Life (Future)
AI Generated Pictures
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Accelerate 5G-Advanced Industry, Build A Better Intelligent World

John Gao
President of 5.5G Domain
Huawei

MWC™
GSMA
As 5G Reaches Maturity, New Trends Emerge

New Service Trends

- ToC/toH: From Content Centric To Experience Centric, From Best Effort To Deterministic Experience;
- IoT: From Partial Scenario To Full Scenario;
- ToB: From Auxiliary Process To Mandatory Process;
- ToV: From Internet Service To Assisted Smart Driving.
Multi-Dimension and Deterministic Experience Becomes More Significant

**To Consumer:**
* From Content Centric To Experience Centric

- Online Video/Gaming
- XR/Cloud Gaming
- AI Push Information
- AI Content Generation

**To Home:**
* From Best Effort To Guaranteed Experience

- More Operators Start To Offer Speed Based Package
- Volume Based
- Up to Speed
- Guaranteed Speed

### Fiber Like Experience

<table>
<thead>
<tr>
<th>Resolution</th>
<th>DL THP</th>
<th>UL THP</th>
<th>Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>8K</td>
<td>400Mbps</td>
<td>20Mbps</td>
<td>20ms</td>
</tr>
<tr>
<td>16K</td>
<td>1Gbps</td>
<td>~100Mbps</td>
<td>10ms</td>
</tr>
<tr>
<td>32K-64K</td>
<td>5-10Gbps</td>
<td>1Gbps</td>
<td>5ms</td>
</tr>
</tbody>
</table>

### Guaranteed Speed

- Connect your home at up to 1 Gbps/day and surf at very high speed, without limits and with all the stability of the FastWeb network.

* XR Requirement
Higher Requirements Appear in IoT/Campus/Vehicle Connections

**IoT:**
- **From Partial Scenario to All Scenario**
  - RedCap
  - eRedCap
  - LPWA
  - Passive IoT

**Campus:**
- **From Auxiliary to Mandatory**
  - Manufactory
    - Remote Control: 20ms@99.99%
    - Factory Automation: 5~10ms@99.99%
  - Positioning
    - Personnel Positioning: 1 meter@1 month
    - Flow Monitoring: 0.5 meter@1 year
  - Machine Vision
    - Local AI: 100Mbps UL
    - Edge AI: Gbps UL

**Vehicle:**
- **From Internet Service to Assisted Smart Driving**
  - Unmanned Delivery
  - L2/L3 Smart Driving
  - Situational Awareness
  - Traffic Management

- **Speed**
  - ≤100Mbps
  - ≤200kbps
  - ≤100kbps

- **Connections**
  - ~3Bln
  - ~3Bln
  - ~100Bln

- **Speed**
  - ≥100Mbps UL
  - ≥3Gbps UL
5.5G Enhances 10x Capability and Opens New Opportunity

<table>
<thead>
<tr>
<th>Category</th>
<th>5G</th>
<th>5.5G</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DL</strong></td>
<td>Gbps</td>
<td>~10Gbps</td>
</tr>
<tr>
<td><strong>UL</strong></td>
<td>~Mbps</td>
<td>~Gbps</td>
</tr>
<tr>
<td><strong>RTBC</strong></td>
<td>~x00Mbps</td>
<td>~x00Mbps</td>
</tr>
<tr>
<td><strong>mMTC</strong></td>
<td>NB-IoT, RedCap</td>
<td>Passive IoT</td>
</tr>
<tr>
<td><strong>URLLC</strong></td>
<td>20 ms level</td>
<td>4 ms level</td>
</tr>
<tr>
<td><strong>Positioning Accuracy</strong></td>
<td>Meter level</td>
<td>cm level</td>
</tr>
<tr>
<td><strong>Sensing</strong></td>
<td>NA</td>
<td>Distance Speed</td>
</tr>
<tr>
<td><strong>HCS</strong></td>
<td></td>
<td>...</td>
</tr>
</tbody>
</table>

UCBC: Uplink Centric Broadband Communication
RTBC: Real-Time Broadband Communication
HCS: Harmonized Communication and Sensing
ELAA-MM Technique Enables DL 10Gbps Capability In Live Test

ELAA Improves Coverage For Higher Frequency Bands

10Gbps Capability Are Approved by U6GHz and mmWave

U6GHz Provides 10Gbps Peak Data Rate
- Spectrum: U6GHz 400Mhz
- RAN: ELAA-MM 1000+
- Terminal: 4T8R

mmWave + Sub6GHz Provides 10Gbps Peak Data Rate
- Spectrum: mmWave 800Mhz, Sub-6GHz 200Mhz
- RAN: mmWave ELAA-MM 4T4R, Sub-6GHz 64T64R
- Terminal: mmWave 2T2R, Sub-6GHz 4T4R

* ELAA: Extremely Large Aperture Array
Spectrum Decoupling and Smart Slicing Provide Deterministic Experience

**Spectrum Decoupling Improves Utilization Efficiency**

- **MBSC to Improve Spectrum Efficiency**
  - TDD 6GHz 200~400MHz
  - FDD 100MHz
  - FDD+TDD Co-Carrier
  - Co-Control Channel
  - Unified Scheduling

- **FSA For Uplink Experience Improvement**
  - UL@FDD SUL DL@TDD
  - UL Improvement
  - DL Improvement
  - Poor Coverage

  **Frequency Pooling**
  - TDD 3.5 2.6 2.3 GHz
  - 1.8GHz 2.1GHz
  - 700-900MHz

**Smart Slicing and Layered QoS Provide Elastic Performance**

- **Smart Slicing** for Elastic Resource Allocation
  - ToC/ToH/ToB/IoT/ToV
  - 10 + Bands
  - Various Channel States
  - 10000 + Parameters

- **Layered QoS for Guaranteed Experience**
  - Contents Source
  - Important frame
  - Guaranteed Terminal

* MBSC: Multi-Band Serving Cell

* FSA: Flexible Spectrum Access
5.5G As A Milestone To Support All Scenario IoT

5.5G Extends CIoT Into Passive Scenario

- 100 Billion Connections
- Scenarios: Medium-speed, LPWA, Passive Connection
- Connections: Billion-level, Ten billion-level, Tens of billions
- Technologies: RedCap Positioning / URLLC, NB-IoT, Passive IoT Positioning / Temperature / Humidity

Passive IoT Brings Extra Value To Industry

- 10x + Coverage Enables Indoor To Outdoor
- Asset Inventory
- Tracking Logistics
- Temperature and Humidity Monitoring
- More Efficient, Accurate And Cost Effective:
  - Automatic
  - 99.99% Accuracy
  - ~5x Less Expensive Compare With Tradition

Ultra-low Cost UE
Passive Tag
Dedicated Spectrum
Massive Connectivity
Harmonized Communication And Sensing Brings New Opportunities

Large BW mmWave Enables High Precision Sensing Capability

- **Integrated Sensing And Communication**
  - Communication Signal
  - Sensing Signal
  - eMBB Terminal
  - Objects to be Detected

- **Full Vision**
  - No Blind Zone

- **Full Time**
  - 7*24h

- **Full Convergence**
  - Sensing & Communication

HCS Enables Smart Transportation

- **Coverage**: 1000 m+
- **Speed Accuracy**: 0.5 m/s
- **Distance Accuracy**: Sub-meter level

- **Scenario 1**: Help Drivers Avoid Congested Lanes

- **To Driver**
  - Increased Safe
  - More Comfortable

- **To Authority**
  - Improve Management Efficiency
  - Reduce Traffic Accident

- **To Car Company**
  - Improve Autonomous
  - Driving Level
Further Cooperation Is Needed For Industry Acceleration

- Accelerate The New Spectrum Allocation (mmWave/U6GHz/2nd Carrier)
- Accelerate Legacy Spectrum Refarming

- End To End Trial and Commercialization With 5.5G Techniques:
  - ELAA;
  - MBSC, FSA, QoS Layer;
  - P-IoT, Redcap.

- Accelerate The IoT Test With R18 Chipset;
- Accelerate The mmWave/U6G Terminal Readiness;

- Further Exploring The Value Of 5.5G In Industry:
  - XR; FWA;
  - Campus Network;
  - IoT;
  - Vehicle.
“If You Want To Go Fast, Walk Alone;
If You Want To Go Far, Walk Together.”

Thank You
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Reaching for New Heights with 5G-Advanced

Tingfang Ji
Vice President, Engineering
Qualcomm Technologies, Inc.
Reaching for New Heights with 5G Advanced

Dr. Tingfang Ji
Vice President, Engineering
Qualcomm Technologies, Inc.
To scale efficiently, AI processing is expanding towards the edge

Qualcomm is leading the realization of the connected intelligent edge

Convergence of:
- Wireless connectivity
- Efficient computing
- Distributed AI

Unleashing massive amount of data to fuel our digital future
Driving digital transformation across industries

5G will enable $13.1 Trillion in global sales activities in 2035

Source: The 5G Economy, an independent study from IHS Markit, commissioned by Qualcomm Technologies, Inc., November 2020
5G Advanced on the path to 6G

- Foundational research
- Vision forming
- Service requirements
- Study Item (proposals)
- Work Item
- Trials
- IoT
- 6G

- 3GPP 6G Workshop
  - Rel-20
  - Next technology leap for new capabilities and efficiencies

5G Advanced
- 2nd wave of 5G innovations

- Rel-18
- Rel-19
- Rel-20

- 5G
  - A unified platform for innovations

- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
- 2024
- 2025
- 2026
- 2027
- 2028
- 2029
- 2030+
Driving a balanced 5G Advanced evolution across key technology areas

Mobile broadband evolution and further vertical expansion
Deliver enhanced mobile broadband experiences and extend 5G's reach into new use cases

Immediate commercial needs and longer-term 5G vision
Drive new value in commercialization efforts and fully realize 5G's potential with future deployments

New/enhanced devices and network evolution
Focus on the end-to-end technology evolution of the 5G system to bring new levels of performance

Release 18 starts the 5G Advanced evolution and it prepares for new and enhanced features coming in subsequent releases
3GPP Release 18 sets off the 5G Advanced Evolution

Strengthen the end-to-end 5G system foundation
- Advanced DL/UL MIMO
- Mobile IAB, smart repeater
- AI/ML data-driven designs

Enhanced mobility
- Evolved duplexing
- Green networks

Proliferate 5G to virtually all devices and use cases
- Boundless extended reality
- Expanded sidelink
- Drones & expanded satellites comm.

- NR-Light (RedCap) evolution
- Expanded positioning
- Multicast & other enhancements

Learn more about 3GPP Release 18
5G NR Release 18 Scope

AI/ML-enabled air interface design

- Use cases: Enhanced CSI feedback, beam management, and positioning accuracy

AI/ML models

- Collaboration models, life cycle management, and algorithms

Evaluation methodology

- Existing 3GPP framework and field data to assess performance and identify KPIs

Impact assessment

- Spec changes needed to support identified use cases, covering multiple aspects

AI/ML framework for next-gen RAN

Network optimization

- Data collection and signaling support for energy saving, load balancing, mobility optimization

Future study

- New use cases (e.g., AI/ML for slicing, QoE), network functionality and interface procedures

5G Advanced evolution will expand wireless ML to the end-to-end system across RAN, device, and air interface

Network architecture enhancements

- ML to run over different HW/SW and future RAN function split to improve flexibility and efficiency

AI/ML procedure enhancements

- Model management, training (e.g., federated and reinforced learning), and inference

Data management enhancements

- ML data storage/access, data registration/discovery, and data request/subscription

New and expanded use cases

- Traffic/mobility prediction, optimized coverage/capacity, massive MIMO, SON, CSI, beam management, ...
5G NR: A unified, scalable air interface allowing coexistence of a wide range of 5G device classes

1. Ultra-reliable low-latency communication; 2. Time sensitive networking; 3. Data rate of 150 Mbps DL / 50 Mbps UL, latency of 10-30 ms, 10-3 to 10-5 reliability, coverage MCL of 143 dB; 4. Wakeup signal; 5. Wakeup receiver; 6. Also including satellite access; 7. Data rate of 1 Mbps, MCL of 155.7 dB (eMTC) and 164 dB (NB-IoT)
5G Advanced in Release 18+
Improving performance, expanding to new devices and deployments

Release 16
Establishing foundation

- Achieving accuracy of 3m/10m (indoor/outdoor) for 80% of time
- Supporting RTT\(^1\), AoA/AoD\(^2\), TDOA\(^3\), single-cell positioning
- Including new evaluation scenarios, i.e., industrial IoT

Release 17
Enhancing performance

5G Positioning Evolution

- Meeting centimeter-level absolute accuracy requirement of down to 0.3m
- Reducing positioning latency to as low as 10 ms
- Scaling to higher capacity for millions of simultaneous devices (e.g., IoT, automotive)

Sidetlink positioning and ranging

- Defining reference signals, measurements, procedures for out-of-range, absolute and relative (e.g., ranging) sidelink positioning

Improved positioning performance

- Specifying higher layer solutions for RAT\(^4\) dependent positioning techniques, accuracy improvement based on PRS/SRS\(^5\)
bandwidth aggregation, carrier phase measurements, and positioning accuracy in heavy NLOS\(^6\) with AI/ML

NR-Light\(^7\) positioning

- Setting performance requirements, evaluating performance for R17 positioning procedures, and identifying potential enhancements

Snapdragon® Platforms and Reference Designs

Snapdragon XR1 Mobile Platform

Snapdragon 5G XR2 Mobile Platform

$100M Snapdragon Metaverse Fund

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Staggering UE packet arrivals at gNodeB
Improves scheduling more users

HARQ enhancements
Improved ACK feedback to optimize retransmissions.

QoS and delay-aware schedulers
Use Packet Delay Budget (PDB) information to improve UE and flow multiplexing

SPS/CG enhancements
Improvements to DCI signaling efficiencies
UL skipping with gNB notification

Network coding
Outer coding between PDCP and RLC layers to improve reliability and reduced latency

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Release 18 capacity enhancement proposals

Further improving XR experience with 5G Advanced

Refer to 3GPP contribution1, 3GPP contribution2, and TR 38.838 for details.
Continued technology evolution on the path to 6G

Building a stronger, more capable wireless system foundation

- AI-enabled end-to-end communication
- Expanding into new spectrum bands
- Cellular air interface innovations
- Precise positioning and RF sensing

Taking 5G to new, more diverse verticals and use cases

- Powering the metaverse
- Wide-area IoT evolution
- Private network innovations
- Advanced automotive connectivity
Thank you
Sylwia Kechiche
Principal Analyst, Enterprise
Ookla

Dr. Mahmoud R. Sherif
Head of Technology & IT Strategy
DU

Sibel Tombaz
Head of 5G RAN, Business Area Networks
Ericsson

Sheldon Yau
Head of Wireless & Core Network Engineering
Hong Kong Telecom

Ronnie Vasishta
SVP Telecom
NVIDIA
5G FUTURES SUMMIT

THANK YOU

Join us from 5:45pm today at the Industry City stage for networking drinks - see you there!
Accelerate 5G-Advanced Adoption

5G Futures Community