MWC
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5G FUTURES SUMMIT

Welcome

GSMA Programme

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5G Futures Summit

Session 2: Unlocking the value of 5G-Advanced

Session moderator

Terence Wong
Head of APAC 5G Industry & IoT
GSMA

Agenda

Session 2: Unlocking the value of 5G-Advanced

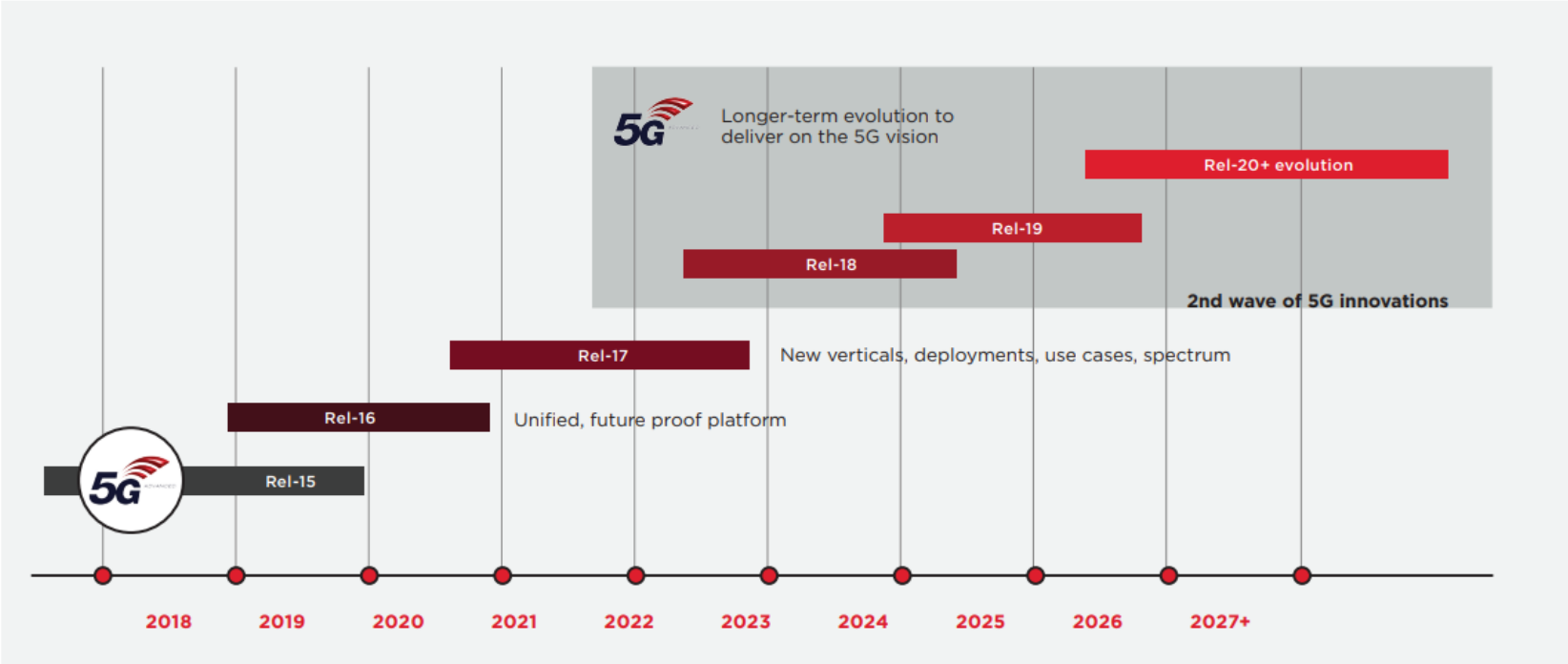
Keynote speakers

- **Dr. Nan Hu,** Vice Director Department of Wireless and Terminal Technology Research, China Mobile Research Institute
- **Dr. Gen Cao,** Principal Researcher of China Unicom Research Institute
- **Sheldon Yau,** Head of Wireless & Core Network Engineering, HKT
- **John Gao,** President of 5.5G Domain, Huawei
- **Dr. Hao Xu**, Head of Qualcomm Research China, Qualcomm

Panel discussion

- **Sheldon Yau,** Head of Wireless & Core Network Engineering, HKT
- **John Gao,** President of 5.5G Domain, Huawei
- **Dr. Hao Xu**, Head of Qualcomm Research China, Qualcomm

5G-Advanced roadmap



Some 5G Advanced features

5G ADVANCED RELEASE 18

PERFORMANCE IMPROVEMENTS

Advanced DL/UL MIMO

Enhanced multi-carrier operation & Enhanced mobility

Enhanced sidelink, sidelink relay enhancement and UE aggregation

Mobile integrated access/backhaul (IAB), network-controlled repeaters

Evolved duplexing

Time Sensitive Communication

BETTER MANAGEMENT AND GREATER EFFICIENCY

AI/ML data-driven designs

Operation & Maintenance Architecture and Management Functions

Autonomous Networks

ENHANCEMENT FOR SPECIFIC USE CASES

Edge computing

Expanded positioning

Extended Reality (XR)

NR<5MHz & Additional spectrum bands

Personal IoT Network

Vehicle mounted relay

RedCap Evolution

Drones & enhanced satellite connectivity

Multicast

Non public networks

Enhanced support for IoT, industrial IoT and URLLC

Mission-critical services

[Advancing the 5G Era – Benefits and Opportunity of 5G-Advanced Whitepaper]

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5G Futures Summit

Keynote #1

Accelerate 5G-Advanced Adoption Steadily

Dr. Hu Nan
Vice Director
Department of Wireless and Terminal Technology Research China Mobile Research Institute

Accelerate 5G-Advanced Adoption Steadily

Dr. Nan Hu

CMCC

China Mobile has Built the World's Largest 5G SA Network

New infrastructure construction

	No. of gNBs	5G package customers	C-IoT customers
2023Q2	1.6 million + >30%	698 million +	1 billion +

Large Network means Large Investment…

Leverage Existing is the key for sustainable evolution

Bridge Gap

Seize Opportunity

Reduce Cost

Key technologies of 5G Evolution: based on 5G-Advanced

Define 5G-Advanced 3 key directions and 10 key technologies, and work together to create a sustainable 5G future network.

Capability of current network

DL exp. rate : ~100Mbps

UL exp. rate:~10Mbps

Connectivity density: 10^6/km^2

Positioning accuracy: sub-meter level

Advanced Intelligent System

5G+AI

Advanced Energy Efficient Industry

Energy saving

Reduce Cost

Advanced Network

Cell Edge enh

Deterministic Network

UDD

X-Layer

Bridge Gap

NTN

ISAC

e-IoT

VoNR+

Seize Opportunity

Requirement of future network

DL peak rate: 10Gbps

UL peak rate: 1Gbps

DL exp. rate: 1Gps

UL exp. rate: ~100Mbps

Hundreds of billions of connection

Deterministic SLA

Tenfold energy efficiency

5G-A Dual-Chain Convergence Action Plan Builds a Prosperous Ecosystem

Released the 5G Wireless Technology Evolution White Paper, the industry's first doc on 5G Evolution.

Feb, 2021

5G-A Innovation Industry Summit

Aug-Oct,2021

Released the 5G-A New Capabilities and Industry Development White Paper & Innovation Achievements

Jun,2022

Release 5G-A Independent Innovation R&D and Test Platform with CMCC-Beijing

May, 2023

Aug, 2021

Released the 5G-A dual-chain convergence action plan for the innovation chain and industry chain.

Dec, 2021

Release the first-phase achievements of the prototype, first in industry

Dec, 2022

Release *5G-Advanced Dual-Chain Convergence Yearbook 2022*

Advanced Network: UDD Initiate a new Paradigm for Spectrum Utilization

中国移动 China Mobile

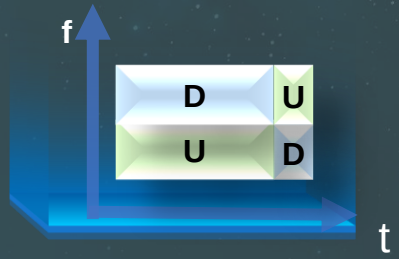
CMCC Duplex innovation constantly breaking the TDD performance ceiling

Requirements

Industrial internet scenarios require:

- **Low latency:** 10 ms for E2E services and less than 4 ms for some services
- **Large uplink:** Massive data upload

The transformation of duplex mode has become one of the core points of further expanding the application of industrial Internet.



Challenge

- **Meet the coexistence requirements of differentiated services.**
- **Overcome self-interference and cross-link interference.**

Key technologies

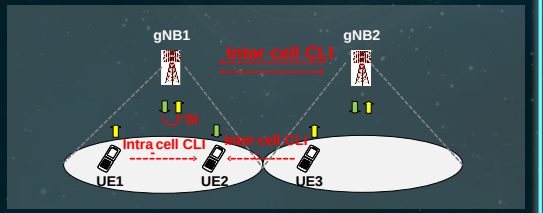
Unified time&frequency Division Duplex

➢ **Multi-carrier UDD**

- SUL supplementary uplink
- Dual Carrier Aggregation with Complementary TDD Frame Structure

➢ **Single-carrier UDD**

- BS Tx/Rx self-interference cancellation
- Inter-BS/inter-UE Cross Link Interference Suppression



Industry Progress

Prototype Verification

Dec, 2022

- E2E 4 ms@99.9999%
- UL: **1.4 Gbps**

Single-carrier UDD prototype (4.9 GHz 100 MHz)

May, 2022

- Improve the UL capability by 10 times in industry scenarios
- UL: 3 Gbps for the first time.

50 MHz SUL (2.3G) +100MHz (4.9G) TDD

Dec, 2021

- E2E 4 ms@99.9999%

2.6 GHz+4.9 GHz complementary TDD prototypes

Advanced Network: Extended-IoT enables billions of new connections

5G cellular e-IoT to solve the bottleneck of conventional RFID

Requirements

- RFID has a huge market in retail, industry, logistics and other industries. RFID Market Expected to reach $35.6 Billion by 2030
- Cellular e-IoT can overcome the disadvantages of traditional RFID: limited coverage due to backscattering communication, not supporting wide area deployment, not supporting positioning


Warehourse


ETC


Retail


Smart grids


Medical instruments

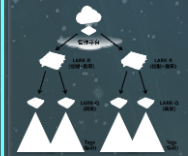

Livestock

Challenge

- To increase communication distance
- To reduce power consumption and cost
- Meter-level positioning
- Wide area cellular deployment

Key technologies

The extended IoT enables base stations to communicate with battery-less devices, in both indoor/outdoor scenarios.



➢ **Networking Architecture**

- One single network to support 4 key techniques, i.e., 5G, e-IoT, Industrial-IoT, cellular positioning
- Support Outdoor deployment based on cellular technologies, extra-low power consumption protocols, and end-to-end architecture.

➢ **Air-interface enhancement**

- Support ambient energy collection, ultra-low-power communication, temperature and humidity sensor data reporting
- Coverage enhancement based on Self-Interference Cancellation and Joint Interference Cancellation
- Improve receiver sensitivity and achieve more than 200 meters communication range.

Industry Progress

3GPP has started study item on ambient IoT in SA1 and RAN plenary.

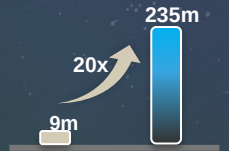
Typical scenarios

logistics, smart manufacturing, power grids, medical instruments, animal husbandry, and smart home.

- China Mobile Information Port
- Guangzhou Mingluo
- Foshan Shunwei
- …

e-IoT Prototype

Outdoor prototype trial



20x RFID coverage

Advanced Network: Integrated Sensing and Communications (ISAC)

中国移动 China Mobile

Build a low-cost, high precision, and seamless ISAC network to facilitate V2X and UAV Economic

Requirements

- Scenarios such as V2X (Vehicle-road collaboration and self-driving) and UAV (route planning, obstacle avoidance and supervision) require real-time communication and sensing.
- 5G implements low-cost and high-precision outdoor sensing through software and hardware upgrades, creating 10 billion-level economic and industrial value.

Challenge

- Integrated air interface and architecture, enabling multiple functions on one network
- Improved sensing precision and expanded application scenarios

Key technologies

The integrated air interface signal and diversified sensing design enable distance, speed and angle sensing besides communication.

➢ **Integrated sensing signal design**

- Flexible air interface multiplexing for communication and sensing signals

➢ **Diversified-sensing working mode**

- The self-sending, self-receiving, and inter-node collaboration sensing methods are used to match different sensing application scenarios and improve sensing precision.

➢ **Flexible awareness network architecture**

- Localized, independently deployed, and lightweight network architecture, reducing the delay for sensory signals

Industry Progress

The 3GPP SA1 scenario requirement SI will be closed in Q2 2023. In the future, 3GPP RAN and SA2 R19 projects will be initiated.

High-frequency (26 GHz) prototype verification for Traffic scenario

Coverage	>1000m
Angle accuracy	0.2 degree
Distance accuracy	Sub-meter level
Speed accuracy	0.5m/s

Mid-frequency (4.9 GHz) prototype verification for UAE scenario

Coverage	>1400m
Angle accuracy	1 degree
Distance accuracy	Sub-meter level

Advanced Intelligent System: 5G+AI Builds a New Form of Autonomous Network

AI opens a window for solving complex problems in communications systems.

Requirements

- Differentiated 5G requirements, diversified deployment scenarios and frequency bands, and flexible networking modes pose great challenges to providing optimal experience on 5G networks.
- AI technology implements model training, inference, and continuous iteration based on massive data, achieving optimal decision-making and improving automation and intelligence of 5G networks.

Challenge

- AI-based Intelligent Network Function Architecture Design
- High-quality data acquisition, feature extraction
- Powerful computing support and communication + AI algorithm design

Key technologies

Design a functional architecture that supports AI data collection, model training and derivation, and performance feedback, explore typical use case solutions, and build a bridge between 5G and AI convergence from theory to application.

➢ **Intelligent Network Architecture**

- **Proposes a "three-layer and four-dimensional" hierarchical distributed intelligent architecture to provide intelligent enablement for service and management domains.**

➢ **intelligent access network**

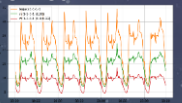
- **AI-based load balancing, network energy saving, and mobility management**

➢ **Intelligent air interface**

- **AI-based beam management, CSI feedback, and positioning**

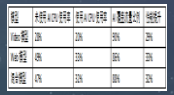
Industry Progress

- Focus on three types of key services. (large uplink service, small data service, and cloud mobile phone) , and two key NEs (intelligent paging and SPI-based charging) are tested and verified.



Intelligent paging

The paging signaling volume: **- 60% ~ 70%.**



SPI-based charging

UPF performance **+ 32%**

- The i-Detection anomaly detection based on the AI VAE algorithm is used to monitor 5G wireless network exceptions.
  - Accuracy rate: **88%**
  - Work order missing rate: **- 21%.**
- Intelligent interference identification based on image recognition and semantic recognition is used to check radio interference types.
  - Accuracy in coverage scenarios: **90%**
  - Identification efficiency: **1100 cells/s**

Advanced Energy Efficient Industry: Build a Green Network to Achieve the Double Carbon Target

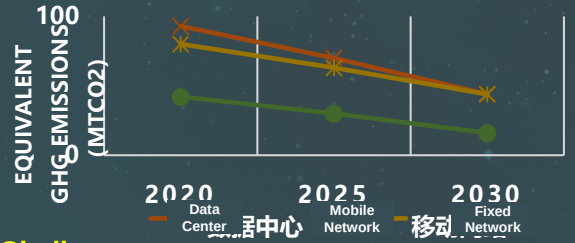
中国移动 China Mobile

Continuously reduce network energy consumption through innovative technologies

Requirements

- Implement the national double carbon strategy to achieve sustainable 5G deployment
- Reduce operating expenses, reduce costs, and increase efficiency
- ITU Requirements: Reduce the Carbon Emission of Mobile Communication Networks by 45% in the Next Ten Years

Carbon emission targets of each ICT domain



Challenge

- Diversified 5G requirements: Balance between Network energy saving and communication quality stability
- Design a comprehensive network energy efficiency evaluation mechanism.

Key technologies

New technologies are introduced to implement dynamic network energy saving based on service characteristics, air-liquid cooling to reduce equipment room PUE, and multi-dimensional energy efficiency evaluation mechanism to achieve refined energy saving.

➢ **New technology**

- Flexible switching between time, frequency, space, and power states to implement dynamic switching between energy saving modes, matching network and service characteristics, and implementing refined energy saving
- Propose the flexible cell architecture and promote the introduction of standards step by step.

➢ **New heat dissipation**

- High-concentration CRAN: Research the air-liquid cooling technology of the BBU to reduce the energy consumption of air conditioners in the equipment room.

➢ **Energy efficiency assessment**

- Comprehensively consider 5G network energy efficiency from multiple dimensions, such as network services and performance.

Industry Progress

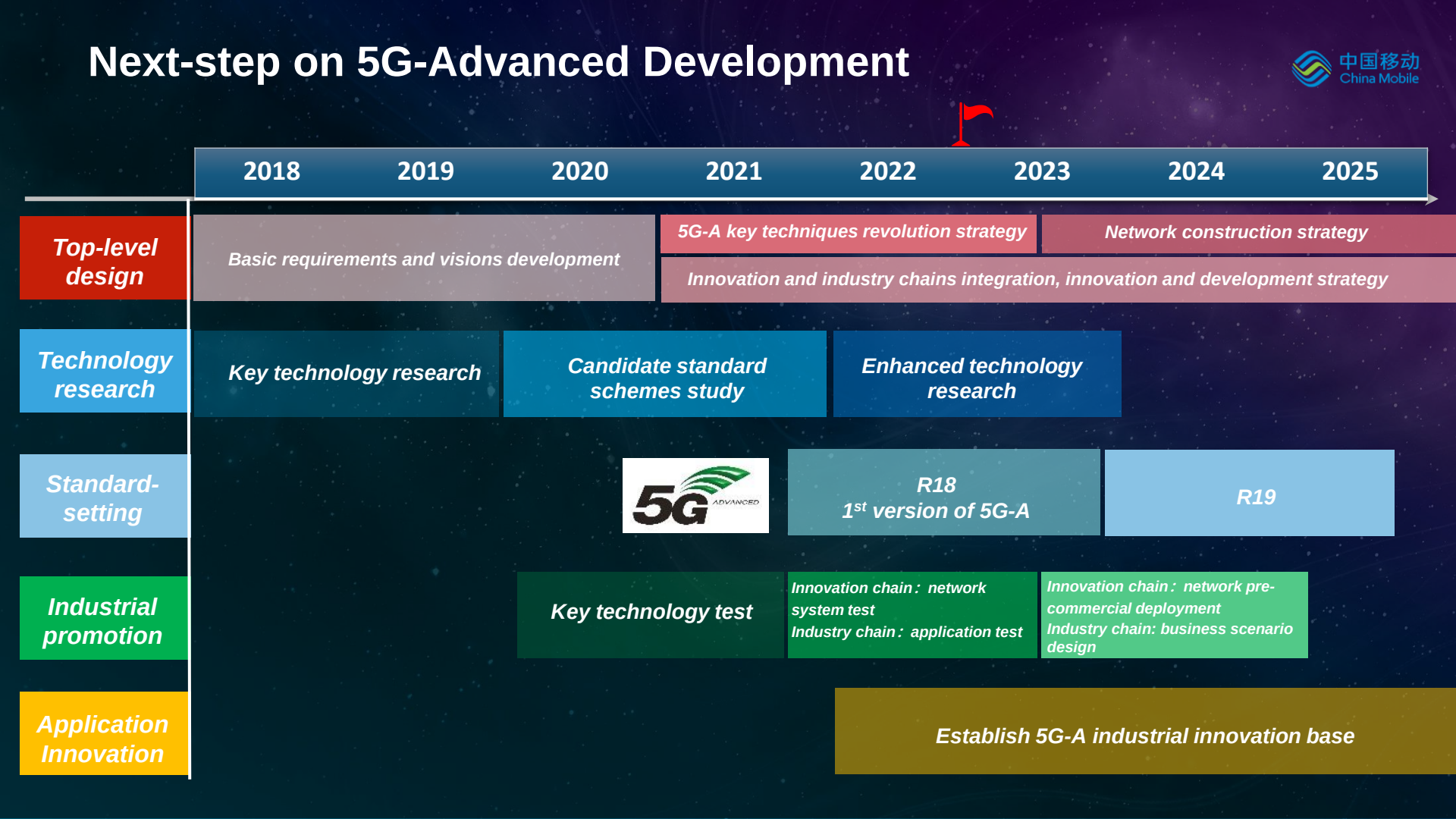
R18 Network Energy Saving WI is expected to be completed in early 2024

- Flexible cell prototypes improve the carrier shutdown rate and achieve energy saving gains of more than 10%.

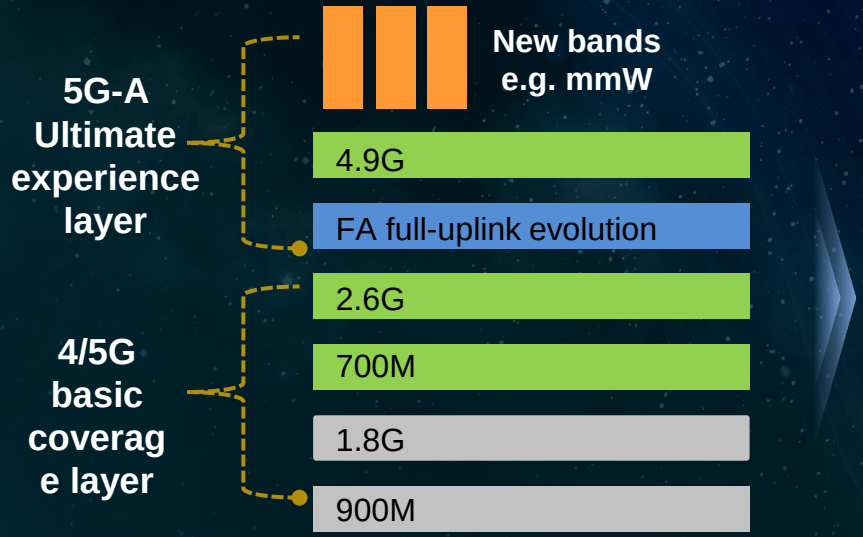
- Pilot verification of the BBU air-liquid mixed cabinet reduces the overall power consumption of the equipment room by more than **11%.**
- Released the network energy efficiency white paper 1.0 and proposed the energy efficiency evaluation correction factor.

Next-step on 5G-Advanced Development

中国移动 China Mobile



Stride to 5G-A to Accelerate Business Success



Deterministic Experience
Glass free 3D/cloud XR

ISAC
V2X/Low-altitude/ocean

100 billion IoT
RedCap/eIoT…

Green Intelligent Network
Native AI/Green

3 key directions

Advanced network

Advanced intelligent system

Advanced Energy efficient industry


The best preparation for tomorrow is doing your best today!

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5G Futures Summit

Keynote #2

Accelerating 5G-Advanced Commercial Use & Opening up a New Blue Ocean for Digital Economy

Dr. Gen Cao
Principal Researcher
China Unicom Research Institute

Accelerating 5G-Advanced Commercial Use & Opening up a New Blue Ocean for Digital Economy

China Unicom
Dr. Gen Cao
2023.06.30

Rapid Development of 5G

Global 5G

Network	Terminal	Scenario
243	1798	ToC/ToH/ToB

5G in China

Connections	60%+
Penetration	33%+
Industry UC	50,000

Various Scenarios

Core Link

Massive Terminals

Thriving Ecosystem

China Unicom's Achievements in 5G Applications

New Strategy

- Network Capabilities
- Innovative Applications
- Open Ecosystem

Integration Capability

- Private Network
- Industry Equipment
- Platform application

Network

5G co-construction and sharing
1.17 million

DL Speed
4Gbps+

Mid-band BW
300 MHz

City&Town Coverage
100%

Application

private network customers
4,500+

5G UC
19,000+

Ecosystem

5G application innovation
500+

No. of Alliance Members
3,000+

Continuous Innovation of 5G-A New Specific Areas

	Intelligent New Vision	Smart Uplink	Intelligent Super Sensing	URLLC
				
				
Progress	XR service awareness + differentiated assurance Single user: **~500Mbps@20ms**	Virtual High Bandwidth UL speed: **+50%**	**1 km** distance + **sub-meter** accuracy UAV Sensing + perimeter detection in Zhejiang Power Grid Substation	URLLC 4ms@99.999% with Complementary TDD Enable Flexible Production Line in EA Automation
Next	mmWave ultra-large BW + ELAA 10Gbps@5ms for Metaverse	Gbps Capability for UL Explore applications, e.g. industrial metaverse/holographic calls	Expansion Scenario: Cooperate with Shanghai Jiading Automobile City to Explore the V2X based on HCS	Promote URLLC high-density networking and URLLC modules. Flexible production to a large scale

ELAA: extremely large aperture array

5G-A 10Gbps Era, Building a Foundation for Metaverse

Promote the deployment of millimeter wave and innovative applications

Millimeter Wave Technical White Paper

2022.12

Standard promotion since R18.

Key capability verification

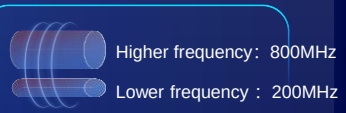
Innovative application exploration

5G-A 10Gbps is Ready, Lead the area of Intelligent New Vision

Test Result: **10.455 Gbs**

2023.3

Ultra-large bandwidth

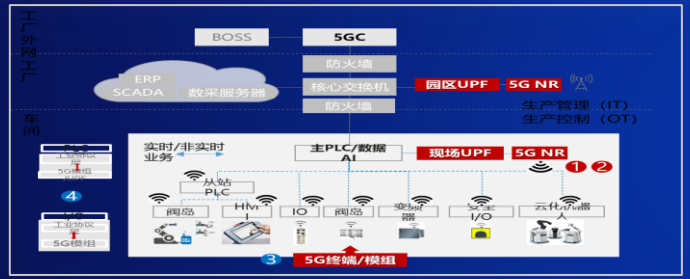


ELAA

Terminal

5G-A URLLC, Building a Benchmark for Smart Manufacturing

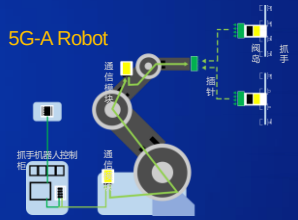
5G-A Opens New Spaces in the Smart Manufacturing Field



Solution Innovation

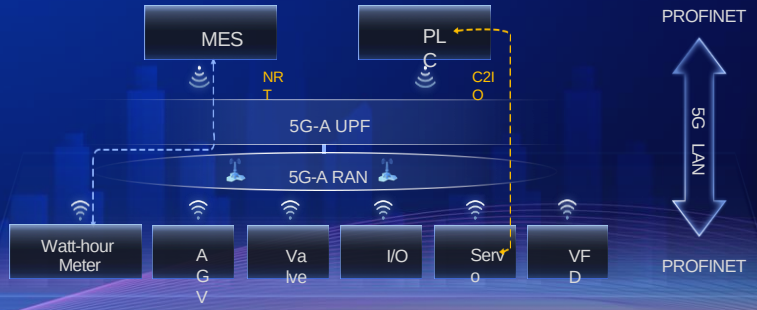
1. Complementary TDD and inter-carrier HARQ technologies are used to achieve industry-leading 4 ms latency.
2. Through URLLC capacity enhancement, the capacity is increased by 10 times, reaching to1000/5000m^2.
3. Module innovation, industrial protocol loading functions aligned with traditional wired modules
4. URLLC+industrial protocol cross-layer adaptation achieves the optimal performance

5G-A on-site OT networks to enable flexible production



Business Value

- 4ms@99.999%
- Wireless replaces wired, reducing downtime.
- Increase revenue, and save costs.
- Both RT and NRT services are supported, reduce network investment



5G-A ISAC Support Sensing, beyond Communication

One 5G-A Network supporting for Communication and Sensing

Various Application Scenarios for 5G-A Sensing

Foggy or Night Driving

Safer driving

(Independent sensing vs. Networked sensing)

High-speed rail perimeter

Instant Response

(vs. manual inspection)

UAV low-altitude economy

Efficient Assurance

(Reuse existing base station)

Industry Progress

First Release

Industry Promotion Initiative: Intelligent Super Sensing

China Unicom 5G-A Technical White Paper: Convergence of Communications, Sensing, and Computing

Joint Promotion

3GPP R19: ISAC SI/WI promotion

CCSA、IMT2020、IMT2030: Project initiation and Special Research

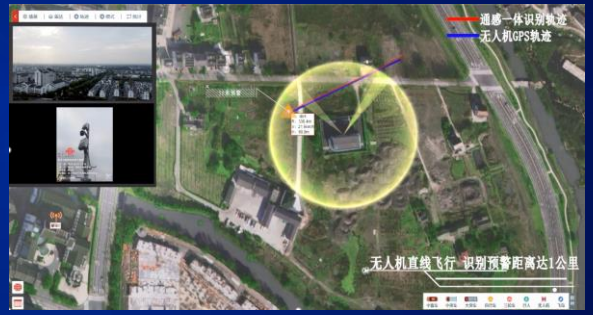
ISAC: Integrated Sensing and Communication

5G-A ISAC: V2X and UAV Practice

5G-A V2X Practice

ISAC V2X Innovation Pilot
The Sensing distance and accuracy are **3~5 times higher** than those of industry radars.

5G-A UAV Practice in Zhejiang State Grid



>1000m
Distance

Sub-meter
Distance Accuracy

0.5m/s
Speed Accuracy

Monetize New Network Capabilities through NaaS

5G-A IoT: RedCap Industry Promotion

Standard Promotion

- Lead 2 international standards
- Jointly lead 3 industry standards
- Released 2 community standards, 2 white papers

Pilot Network

Shanghai

Deploying continuous coverage areas of more than **40 cells**

Guangdong

160+ sites have been deployed, the largest pilot area in China.

Industry Application Demonstration

2022

the world's first pilot project for RedCap in the electric power/V2X industry

2023

Build RedCap's three key industry benchmark projects

Industrial Internet

Video Surveillance

V2X

RedCap Ecosystem

- **RedCap Module/Terminal**
- **RedCap Industry Ecosystem**

First RedCap commercial module: NX307

50%
Cost reduction
Compared with the existing R15/R16 modules

20%
Power consumption reduction
Compared with LTE Cat.4 modules of the same size

5+
Target Scenario
Industrial manufacturing, electric power, video surveillance, V2X, wearables, etc.。

Engineering Sample

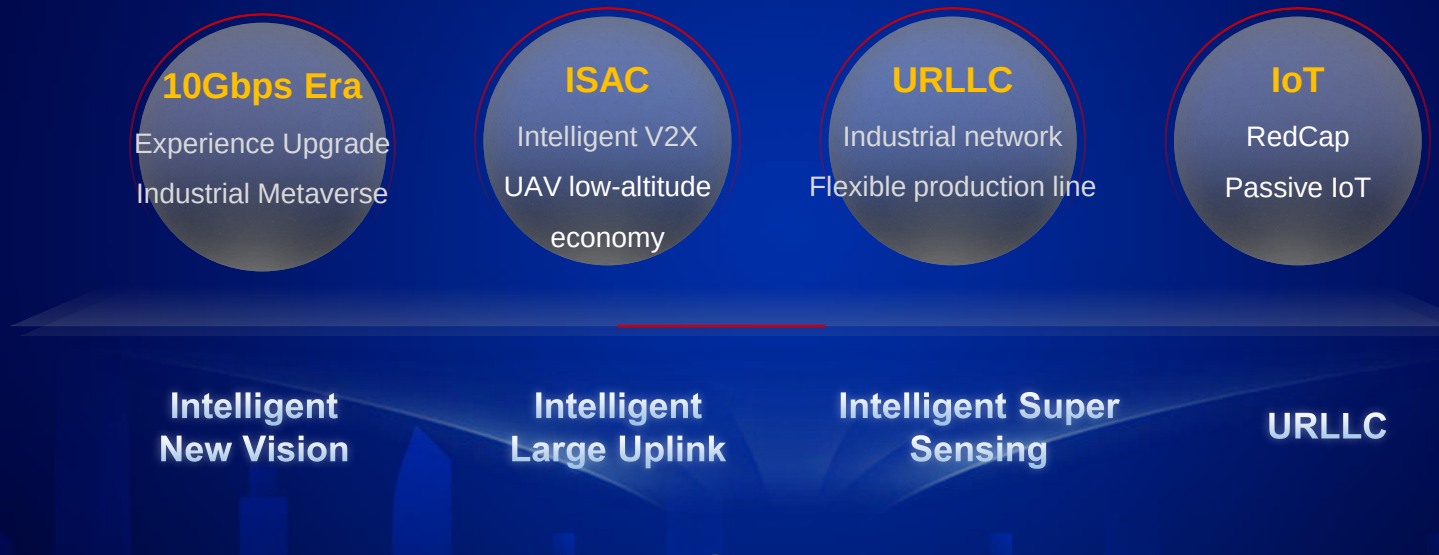
Superior performance

- Peak rate: 226Mbps(DL)/120Mbps(UL)
- uRLLC: 20ms latency & 99.99% Reliability
- Modulation: 64QAM/ 256QAM
- Slicing, 5G LAN, and high-precision timing

Customized Features

- Device management platform SDK integration
- 5G industry private network PLUS integration
- Customizing the AT Instruction Set
- eSIM platform LPA integration

5G-A Opening up a New Blue Ocean for Digital Economy



中国联通
China unicom

Join hands to create a new journey of 5G-A

GSMA

5G Futures Summit

Keynote #3

Future Smart City by 5G-A

Sheldon Yau
Head of Wireless & Core Network Engineering
HKT


HKT
Future Smart City by 5G-A

Best Network

Extreme Throughput

Enhanced Spectral Efficiency

Energy Optimization

eMBB
enhanced Mobile BroadBand

Extended Coverage

5G-A

mMTC
massive Machine To Compute

High Connection Density

Ultra-low Latency

URLLC
Ultra Low Latency Communications

Ultra-low Complexity

Ultra-high Reliability

Location Precision

5G-A Application

Live Streaming

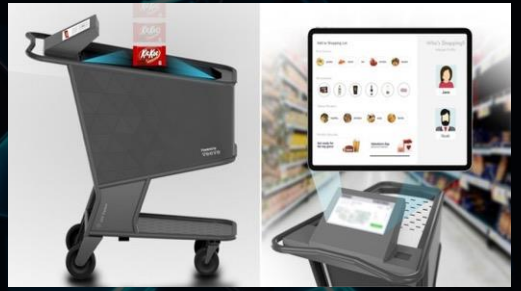
AI Video/ Voice Analytics

Web 3.0
Decentralised data architecture

Naked Eye 3D Entertainment

5G-A Application

Smart Transportation



Smart Checkout

Warehouse Management

Logistic Control

5G-A Application

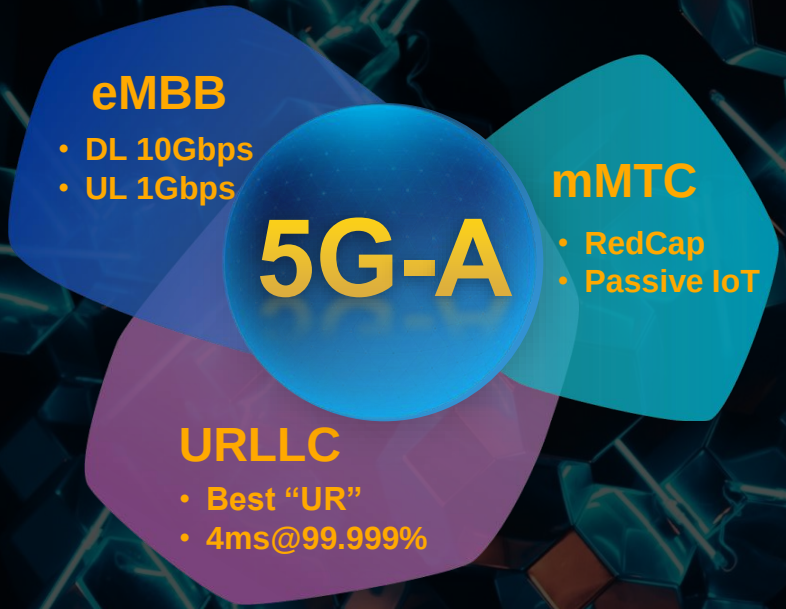
Medical Applications

Financial Transaction

Autonomous Driving

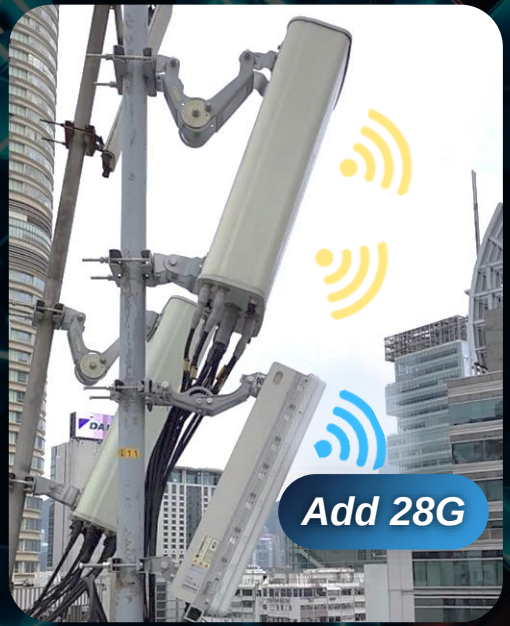
Gaming

How to realize 5G-A?

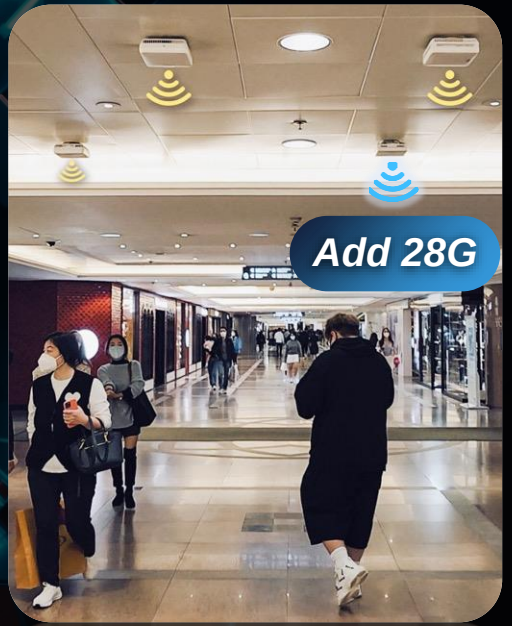


Require new spectrum with extremely wide bandwidth, such as mmWave

Outdoor Solution



Indoor Solution



5G-A in HK

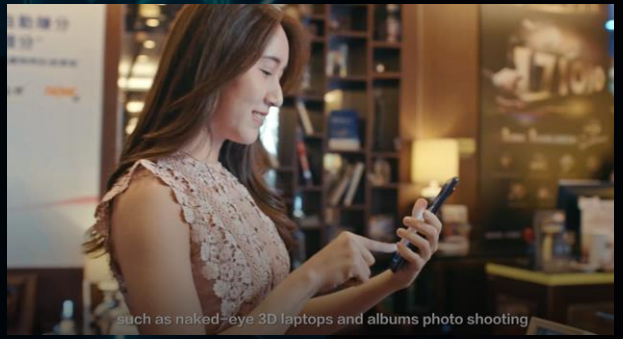
10Gbps Business Circle

Hotspots

Continuous eMBB experience in city center

Shopping Mall

Continue 5G-A experience in indoor environment



5G-A Showroom

Early 5G-A experience for general publics

5G-A in HK


PCCW HKT
HKT uses 400MHz mmWave bandwidth and 1:1 construction


Thank You

GSMA

5G Futures Summit

Keynote #5

Setting off the 5G Advanced Evolution

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Qualcomm


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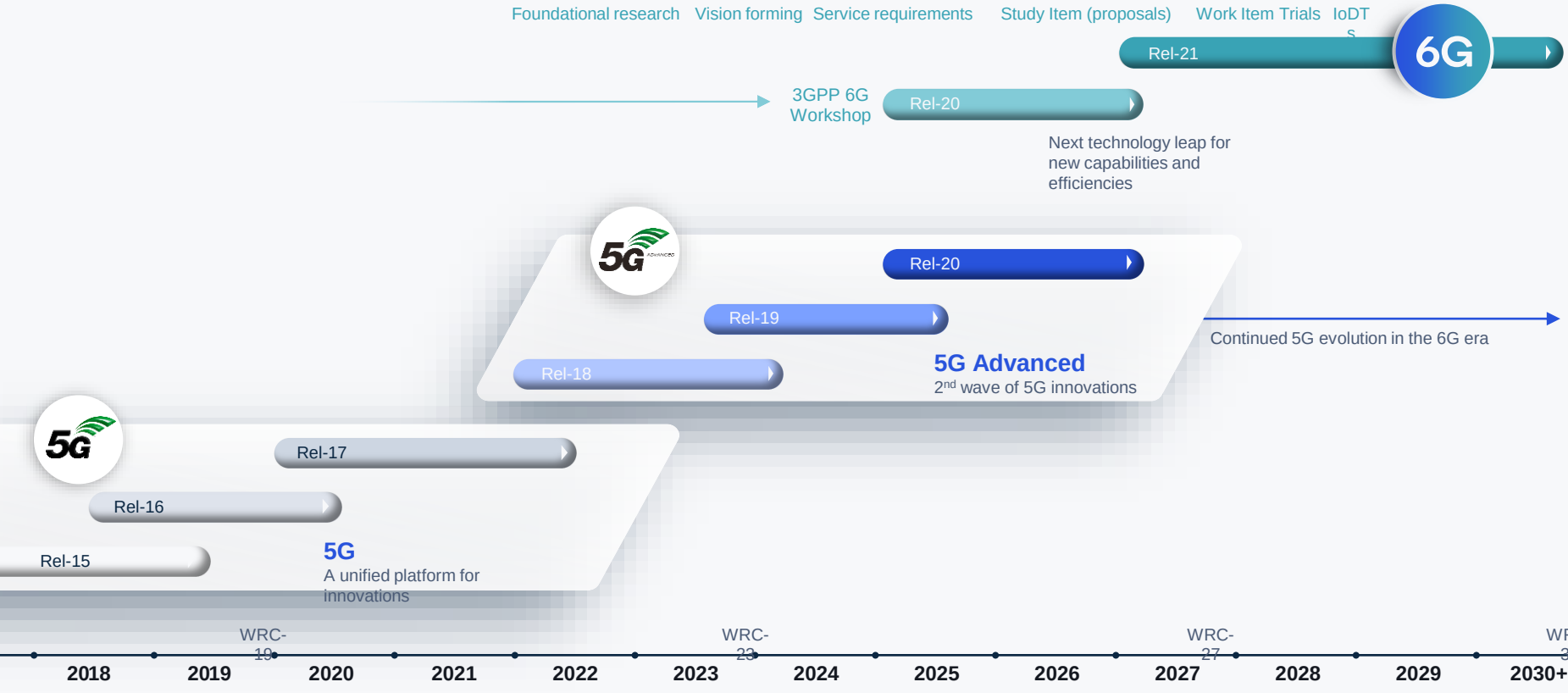
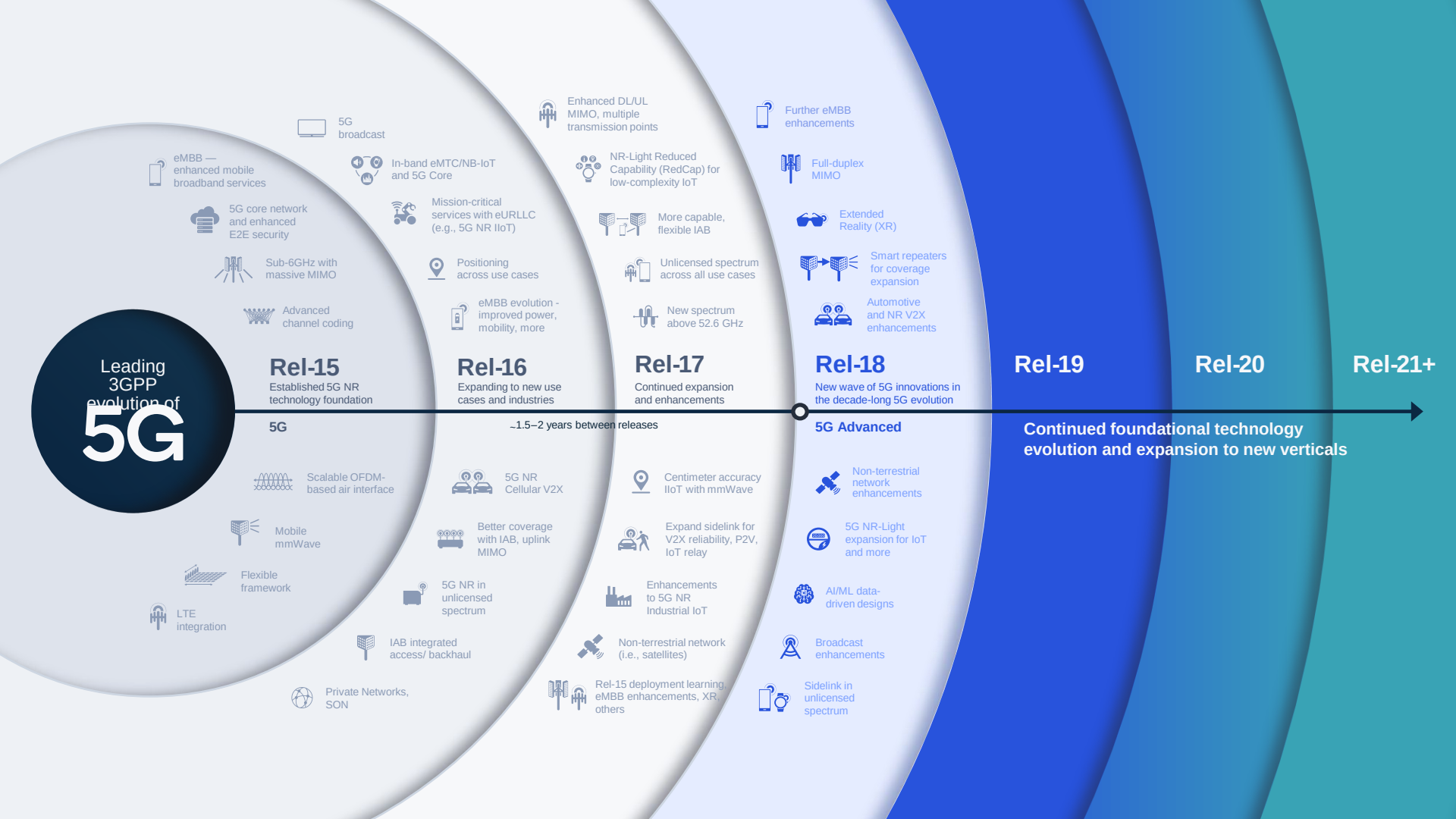
5G Advanced unlocking the 2nd wave of 5G innovations




Leading 3GPP evolution of 5G
Rel-15
Established 5G NR technology foundation
5G
Rel-16
Expanding to new use cases and industries
Rel-17
Continued expansion and enhancements
Rel-18
New wave of 5G innovations in the decade-long 5G evolution
5G Advanced
Rel-19
Rel-20
Rel-21+
~1.5–2 years between releases
Continued foundational technology evolution and expansion to new verticals
eMBB — enhanced mobile broadband services
5G core network and enhanced E2E security
Sub-6GHz with massive MIMO
Advanced channel coding
Scalable OFDM-based air interface
Mobile mmWave
Flexible framework
LTE integration
5G broadcast
In-band eMTC/NB-IoT and 5G Core
Mission-critical services with eURLLC (e.g., 5G NR IIoT)
Positioning across use cases
eMBB evolution - improved power, mobility, more
5G NR Cellular V2X
Better coverage with IAB, uplink MIMO
5G NR in unlicensed spectrum
IAB integrated access/ backhaul
Private Networks, SON
Enhanced DL/UL MIMO, multiple transmission points
NR-Light Reduced Capability (RedCap) for low-complexity IoT
More capable, flexible IAB
Unlicensed spectrum across all use cases
New spectrum above 52.6 GHz
Centimeter accuracy IIoT with mmWave
Expand sidelink for V2X reliability, P2V, IoT relay
Enhancements to 5G NR Industrial IoT
Non-terrestrial network (i.e., satellites)
Rel-15 deployment learning, eMBB enhancements, XR, others
Further eMBB enhancements
Full-duplex MIMO
Extended Reality (XR)
Smart repeaters for coverage expansion
Automotive and NR V2X enhancements
Non-terrestrial network enhancements
5G NR-Light expansion for IoT and more
AI/ML data-driven designs
Broadcast enhancements
Sidelink in unlicensed spectrum

A new era of

connected intelligent devices

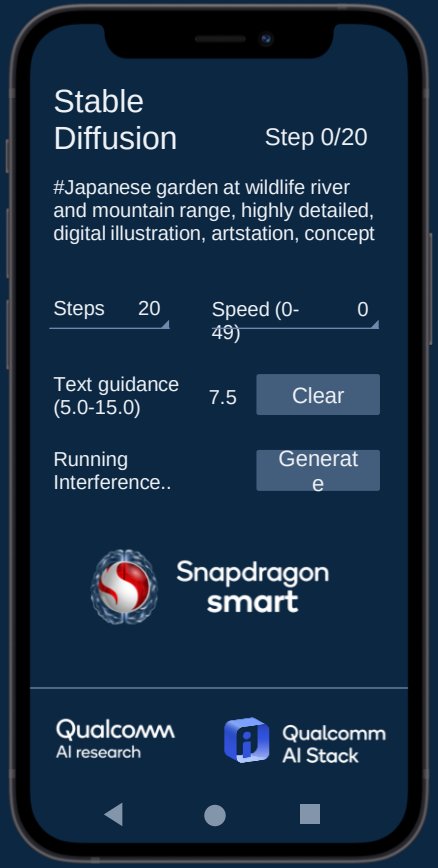
Firstly demonstrated at MWC 2023

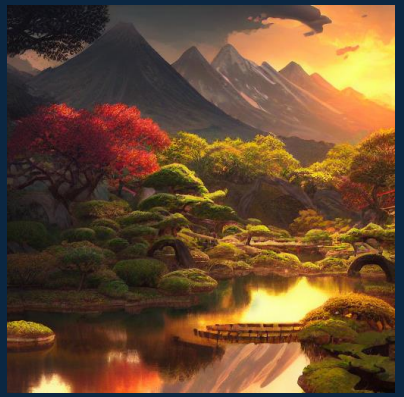
World's first on-device demo
generative AI model (Stable Diffusion) running on an Android phone

1B+ parameter
generative AI model

Full-stack AI optimization to achieve
sub-15s latency for 20 inference steps

Leading AI engine, AI stack and tools
make it happen





Note: Stable Diffusion images generated with the prompt: "Japanese garden at wildlife river and mountain range, highly detailed, digital illustration, artstation, concept art, matte, sharp focus, illustration, dramatic, sunset, hearthstone, art by Artgerm and Greg Rutkowski and Alphonse Mucha"

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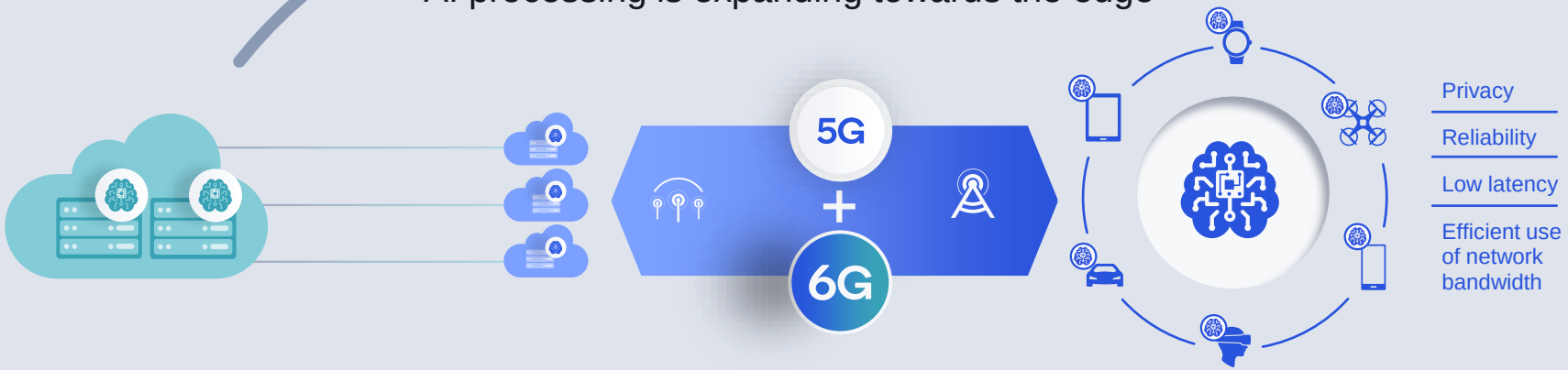
To scale efficiently,
AI processing is expanding towards the edge



- Privacy
- Reliability
- Low latency
- Efficient use of network bandwidth

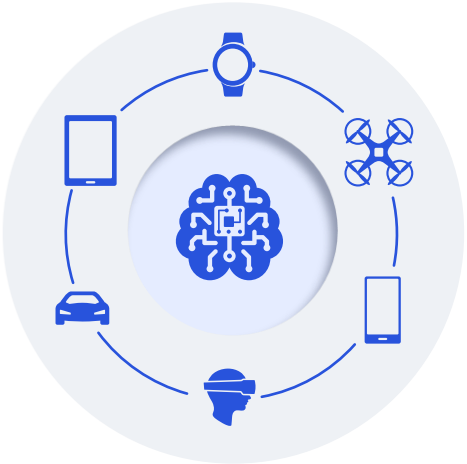
The future of AI is hybrid

Convergence of:

- Wireless connectivity
- Efficient computing
- Distributed AI

Unleashing massive amount of data to fuel our digital future

On-device AI improves the 5G end-to-end system



Radio awareness

Environmental and contextual sensing that reduces access overhead and latency

Enhanced device experience

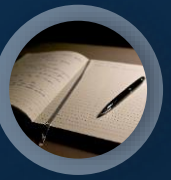
More intelligent beamforming and power management improve throughput, robustness, and battery life

Improved system performance

On-device inference reduces network data traffic for more efficient mobility and spectrum utilization

Better radio security

Detecting and defending against malicious base station spoofing and jamming with fingerprinting



2D

Spatial

The screen disappears and the world becomes your home screen

Latency[1]

M2R2P latency < 70ms
5G RTT < 20ms
M2P latency < 20ms

Frame rate

2kx2k per eye
at 90 frames per second

Throughput[1]

Reliable downlink throughput of 50~100Mbps
Reliable uplink throughput of 1~2Mbps, 90Hz pose

Immersive VR

Photorealistic visuals
6-DoF mobility
Highly reliable

1: Lower latency and higher throughput may be required, depending on use cases.

Achieves initial KPIs for at-scale 5G boundless XR deployments

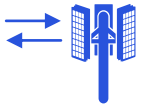
5G ADVANCED

Release 18

3GPP Release 18

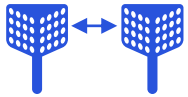
sets off the 5G Advanced Evolution

Strengthen the end-to-end 5G system foundation



Advanced DL/UL MIMO

Enhanced mobility



Mobile IAB, smart repeater

Evolved duplexing

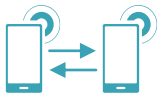
AI/ML data-driven designs

Green networks

Proliferate 5G to virtually all devices and use cases

Boundless extended reality

NR-Light (RedCap) evolution



Expanded sidelink

Expanded positioning

Drones & expanded satellites comm.

Multicast & other enhancements

5G ADVANCED

5G AI

Working together across the Connected Intelligent Edge

5G NR Release 18 Scope

AI/ML-enabled air interface design

Use cases
Enhanced CSI[2] 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[1]), 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, …

Source: RP-213599 (AI/ML for NR Air Interface), RP-213602 (AI/ML for NG-RAN)

1 Quality of Experience; 2 Channel State Information

Release 18 lays the foundation for the future of full duplex

Identify and evaluate potential enhancements to support duplex evolution for 5G NR TDD spectrum

Identify applicable and relevant deployment scenarios and use cases

Develop evaluation methodology for duplex enhancement

Study subband non-overlapping full duplex and potential enhancements on dynamic TDD

Future study may include partial overlapping and full overlapping subband

Study inter-gNodeB, inter-device CLI[1] management and impact on RF requirements considering adjacent-channel coexistence with legacy operation

Source: RP-213591 (Evolution of duplex operation)

1 Cross-link Interference

Pushing forward with the 5G positioning technologies

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 10ms

Scaling to higher capacity for millions of simultaneous devices (e.g., IoT, automotive)

5G Advanced in Release 18+

Improving performance, expanding to new devices and deployments

Sidelink 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

Source: RP-211660 Expanded and improved Positioning. 1. Roundtrip Time; 2. Angle of Arrival, Angle of Departure; 3. Time Difference of Arrival; 4. Radio Access Technology; 5. Positioning Reference Signal, Sounding Reference Signal; 6. Non-line of sight; 7. aka. RedCap

AI/ML	Air interface (cross-node channel state feedback, beam management, positioning) Study Item in **Rel-18** and Work Item in **Rel-19+**	
Full Duplex	Full Duplex in TDD bands, sub-6/mmWave, enhanced crosslink interference, coexistence with legacy and other operators Study Item in **Rel-18** and Work Item in **Rel-19+**	
Network Power Savings	**Rel-18:** Techniques on the gNodeB and device side to improve network energy savings in terms of both transmission and reception	**Rel-19+:** Further enhancements for system power saving
XR	**Rel-18:** Application-aware RAN (frame-level QoS, multi-streams), power enhancements, capacity enhancements	**Rel-19+:** Further enhancements for capacity and power
Enhanced RedCap/IoT	**Rel-18:** Reduced complexity/cost (5MHz devices), power savings, sidelink support, enhancements for narrow band positioning	**Rel-19+:** Low-power Wake Up Signal, passive IoT (energy harvesting)
Enhanced Non-terrestrial network	**Rel-18:** Coverage enhancements, deployment above 10GHz bands, mobility and service continuity enhancements, enhancements for IoT-NTN	**Rel-19+:** Possible further enhancements
Sidelink/V2X	**Rel-18:** Enhancements for unlicensed, mmWave enhancements, device-to-device relay, coexistence of LTE/NR V2X, enhanced CA	**Rel-19+:** Enhancements for sidelink MIMO, enhancements for power savings, etc.
eMBB enhancement	**Rel-18:** Rel-18: MIMO enhancements, enhanced uplink coverage, smart repeater, enhanced mobility, network energy savings	**Rel-19+:** MIMO enhancements (CSF time domain compression, etc.), enhancements for network energy savings

Release 18 is just the start of the 5G Advanced evolution

Further 5G NR enhancements in R19, R20, and beyond

Key longer-term research vectors

enabling the path towards 6G

AI-native E2E communications

Data-driven communication and network design, with joint training, model sharing and distributed inference across networks and devices

Scalable network architecture

Disaggregation and virtualization at the connected intelligent edge, use of advanced topologies to address growing demand

Expanding into new spectrum bands

Expanding to THz, wide-area expansion to higher bands, new spectrum sharing paradigm, dynamic coordination with environmental awareness

Air interface innovations

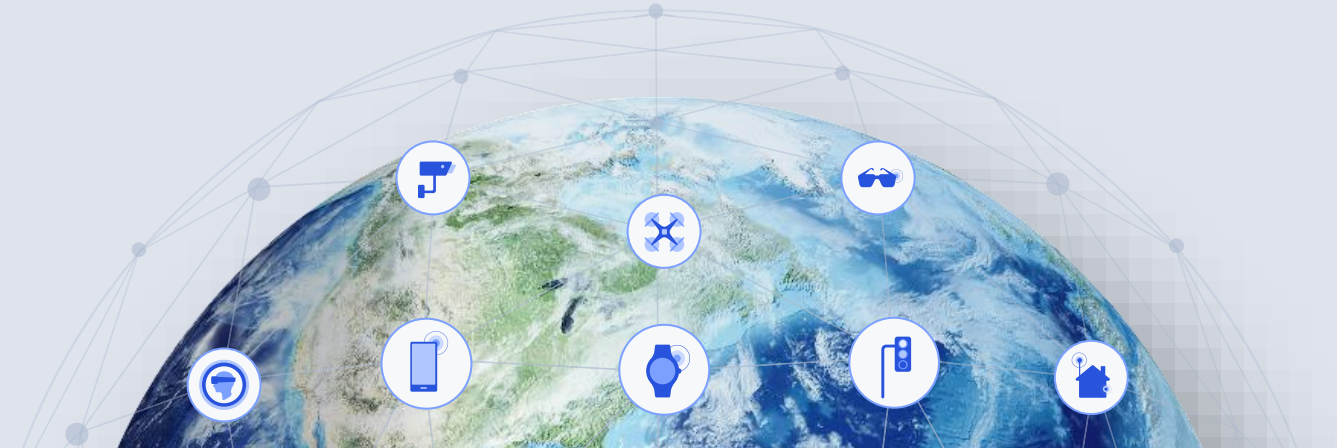
Evolution of duplexing schemes, Giga-MIMO, mmWave evolution, reconfigurable intelligent surfaces, non-terrestrial communications, waveform/coding for MHz to THz, system energy efficiency

Merging of worlds

Physical, digital, virtual, immersive interactions taking human augmentation to next level via ubiquitous, low-power joint communication and sensing

Communications resiliency

Multifaceted trust and configurable security, post quantum security, robust networks tolerant to failures and attacks



Driving the next wave of evolution and rollout of 5G technology and devices

Snapdragon X75 5G modem-RF

World's first 5G Advanced-ready modem-RF system

- 1st Tensor accelerator for 5G – 2.5x AI processing power
- 1st Converged mmWave and Sub-6 architecture

Designed to drive the 5G Advanced in all key verticals

Snapdragon X35 5G modem-RF

World's first 5G NR-Light modem-RF system

- Optimized architecture
- Superior power efficiency
- Incredible location accuracy
- Supports new 5G use cases – smartwatches, entry-level IoT, PCs, XR, more

Innovating to pave the path to 6G

A unified connectivity fabric for this decade

Next technology leap for new capabilities and efficiencies

Continued evolution

Historically 10 years between generations

Strong 5G momentum sets stage for global expansion

Thank you

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PANEL DISCUSSION

GSMA Programme

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Panel members

Panel moderator

Terence Wong
Head of APAC 5G Industry & IoT
GSMA

Sheldon Yau
Head of Wireless & Core Network Engineering
HKT

John Gao
President of 5.5G Domain
Huawei

Dr. Hao Xu
Head of Qualcomm Research China
Qualcomm

APAC 5G Industry Community

Accelerating the 5G & IoT adoption in industries and enterprises

OUR VISION: Strengthen operator and industry partnerships to accelerate the 5G & cellular IoT

INTEREST INDUSTRY GROUP (2022-2023): Welcome companies, govt/agencies and industry organizations with interest or passionate on 5G to join as community member

- Manufacturing
- Logistics, Port & Transportation
- Healthcare
- Energy, Mining & Utility
- Smart City & Public Sector

INDUSTRY LEADERSHIP:

Contributor members & Ecosystem partners

AIS Business 5G, axiata, bridge alliance, depa, DHL Innovation Center, EABC The European Chamber of Commerce Thailand, Globe Business, Holomedicine Association, Infocomm Media Development Authority, Joint Foreign Chambers of Commerce in Thailand JFCCT, HUAWEI, Ministry of Communications and Informatics Republic of Indonesia, maxis, MDEC, Life Is On Schneider Electric, 大灣區5G產業聯盟 The Greater Bay Area 5G Industry Alliance, viettel

APAC 5G Industry Community

Welcome to join the community with benefits

Receive regular newsletter with latest 5G Industry development and insights

Access to the Industry Interest Group activities

Raise interest and support request to the contributor members i.e. Proof of Concept

Speaking and show case chances in GSMA 5G activities including webinar, conference and 5G tour, etc

Business matching opportunities for innovators, SI, enterprises and mobile operators

Potentially contribute to 5G industry report and case study

Application the Global Mobile Award (GLOMO) and Asia Mobile Award (AMO)

APAC 5G INDUSTRY COMMUNITY

Register here to join the community

Up Next

Session 3 - 5G-Advanced – Intelligent Networking

12:50 – 14:20 CST

Keynote speakers

- **Xie Fang,** Principal Researcher, Technical Manager, China Mobile
- **Riping Wu,** Head of Network Portofolio, North East Asia, Ericsson
- **Calvin Zhao,** Vice President of Wireless MAE Product Line, Huawei

Panel discussion

- **Zhiyi Luo,** Project Manager on OSS planning, Network Department, China Mobile
- **Xinzhou Cheng,** Director of Network Intelligent Operation Center, China Unicom Research Institute, China Unicom
- **Kevin Xu,** Head of APAC, TM Forum

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Thank you

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Session 3: **5G-Advanced - Intelligent Networks**

12:50 – 14:20

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