

5G New RAT, an Unified Air Interface (UAI)

- ❖ UAI Design Philosophy
- ❖ UAI Vision and Characters
- ❖ UAI Enabling Technologies
- ❖ 5G Timeline (Release 14 and onwards)

5G, A Single UAI targeted Diverse Requirements

UAI
(Unified Air Interface)
to meet the diverse requirements

Diverse Applications

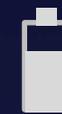


Voice Web Video Verticals.....

Diverse QoE



Data Rate Latency Connections



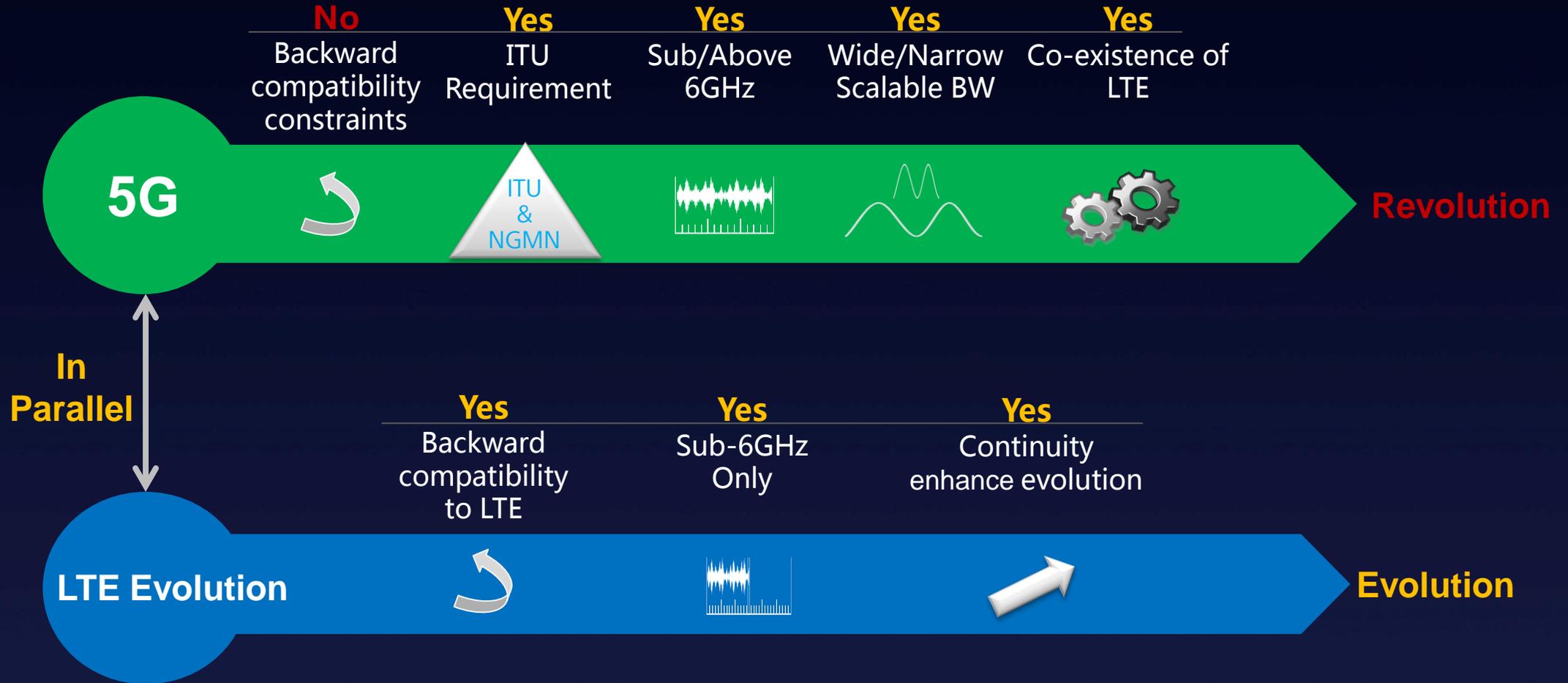
Battery Life

Diverse Adoption

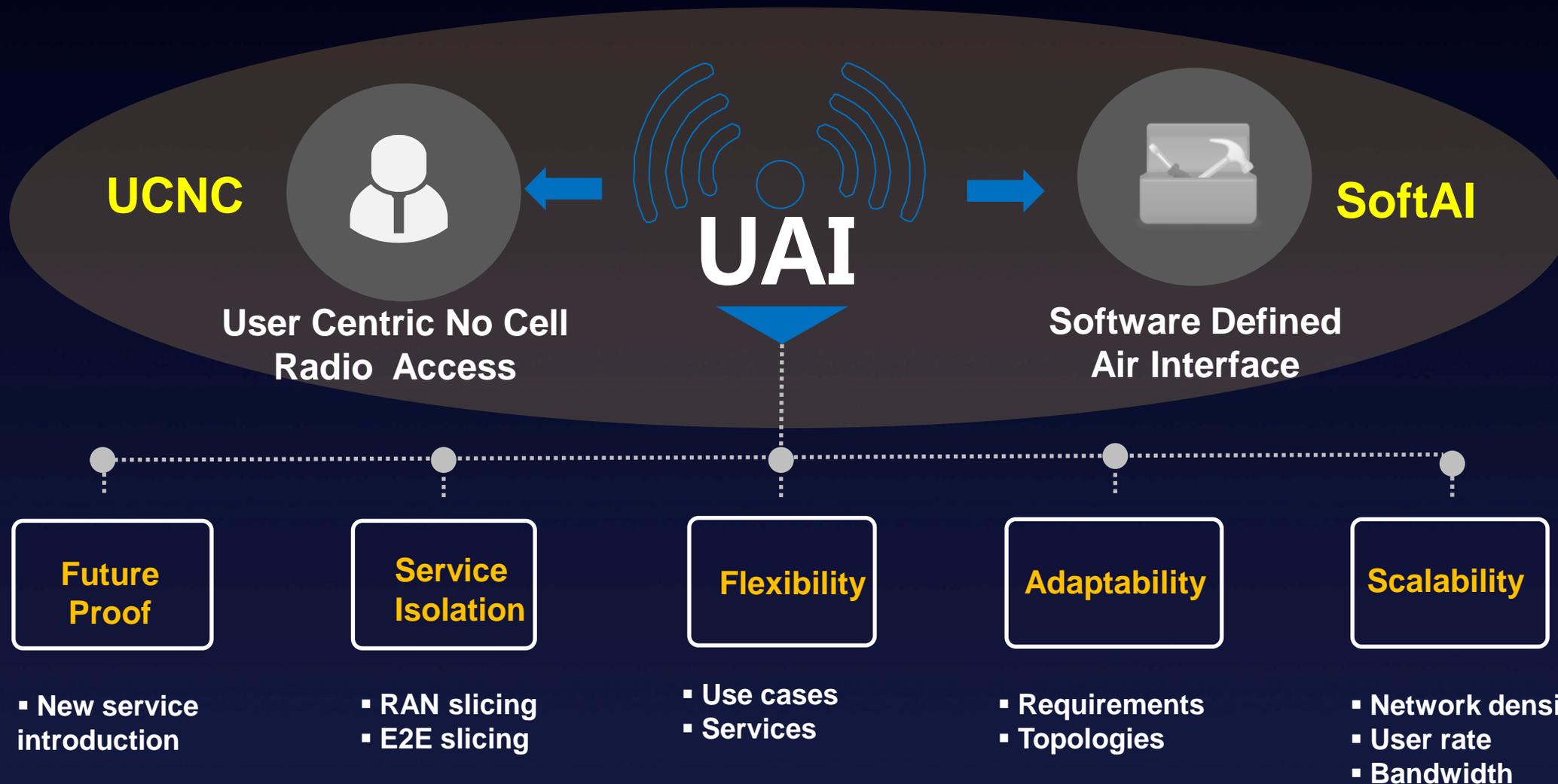


Outdoor/indoor Wide/Deep coverage Low/High band Wide/Narrow Bandwidth

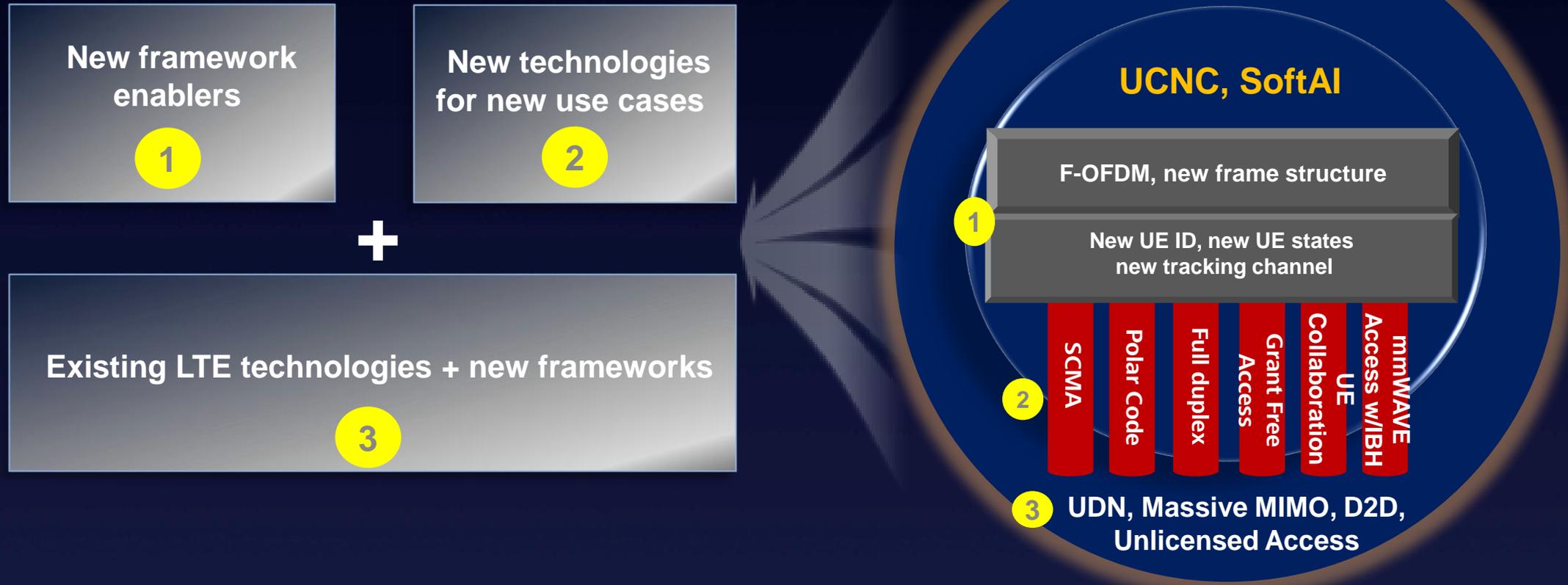
5G UAI Design Philosophy



UAI Framework and Characters



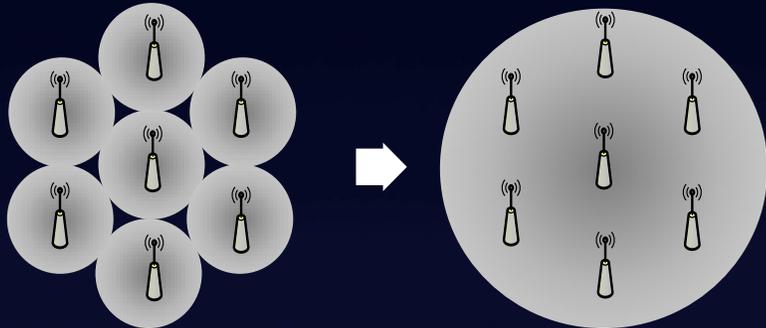
UAI Three Technology Categories



UCNC - UE Centric No Cell Radio Access



Cell centric cellular to UE centric non cell



C-RAN based UE centric TP Optimization



D2D enabled UE Cooperation



- Abstraction of the UE radio access with virtualized the cell concept to enable RAN slicing to enable RAN slicing by

- Decoupling the UE from physical cell-site
- Decoupling DL/UL
- Decoupling Control/Data
- Decouple physical topology with services
- Simplifying the heterogeneous nodes deployments

- New UE and network transmit node association mechanism enabled by "Hyper cell ID" and "Dedicated UE connection ID"
- CRAN and D2D enabled UE centric transmission point (TP) cooperation and device cooperation to eliminate "cell edge"
- New UE state supports massive connected devices with low signaling overhead and energy consumption
- Seamless mobility transparent to UE with simplified procedural and reduced latency

SoftAI to Integrate all Use Cases

Enable radio interface primitives agility

One size fits all (LTE) → AI Adaptation (5G)

- Optimized RAT for each application/use case
- Dynamic or semi-static or static configurable
- Across frequency carriers or within the same frequency carrier
- Forward compatible: easy to add future-proof new service/use case
- **Smooth migration of LTE**

Soft AI

Waveforms and MA

- f-OFDM
- SCMA
- Ultra NB WF

Access Protocols

- Scheduled
- Grant-free
- Adaptive HARQ
- LBT

Coding Modulation

- Polar
- Turbo
- Network Coding

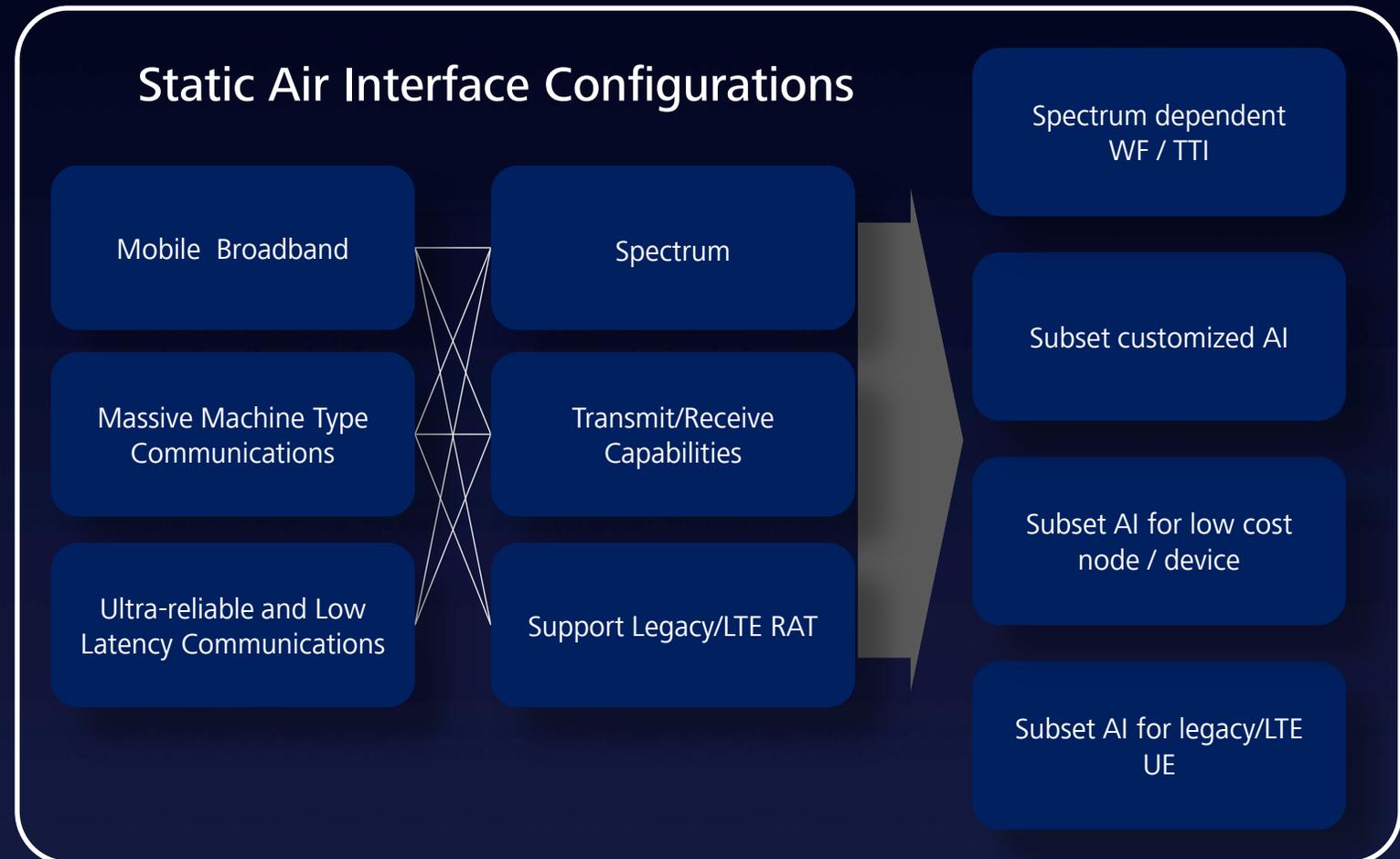
Frame Structure

- Flexible TTI
- Flexible Numerologies
- Flexible Duplex
- Full-Duplex

SoftAI Adaptation Characteristics

Co-existence of Multiple AI configurations

- **Static Configuration for new and legacy RAT**
 - Support phased deployment and standard releases for future-proof
- **Content-aware Dynamic Configuration**
 - Traffic/QoE classification
 - Adaptive Waveform, Multiple Access, TTI, Protocol
 - New FEC for small packet and lower power consumption optimization
 - Polar Coding



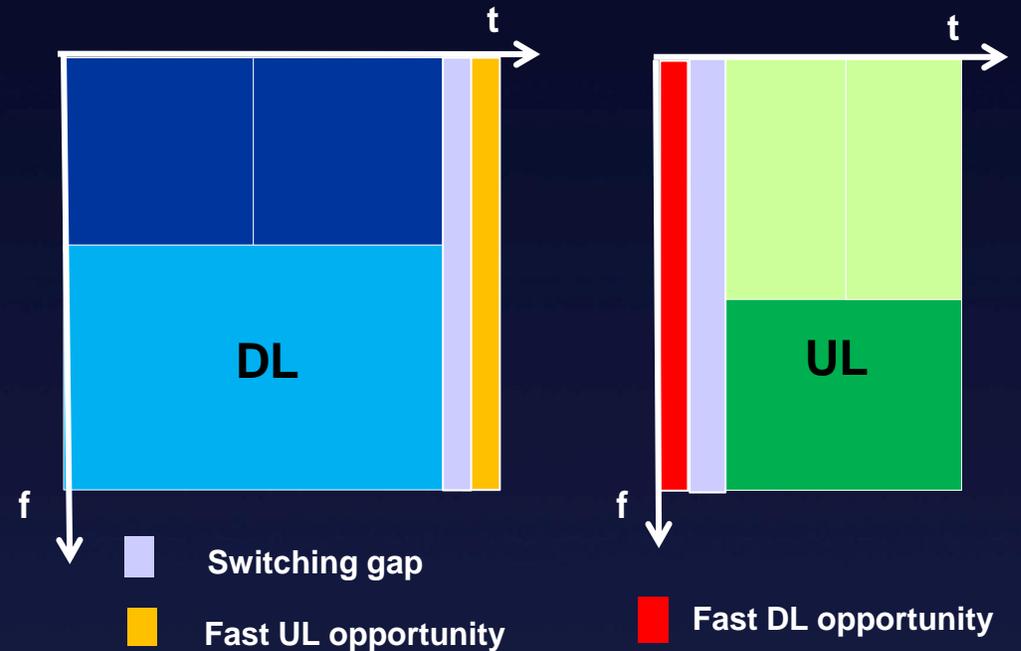
Adaptive Frame Structure: provide flexibility

- Co-existence of different TTI and numerologies
- Decouple DL TTI with UL control channel timing
- Self Contained
- Support low latency traffic with configurable switching overhead and configurable HARQ timing

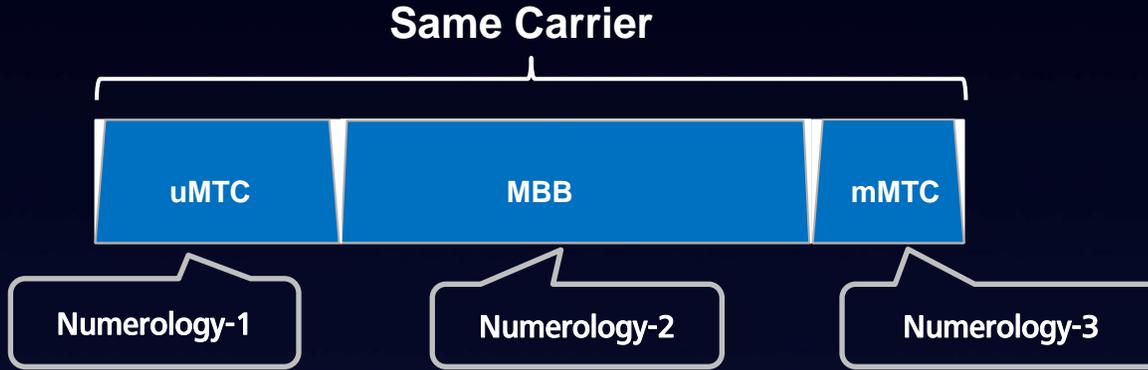
FDD Example



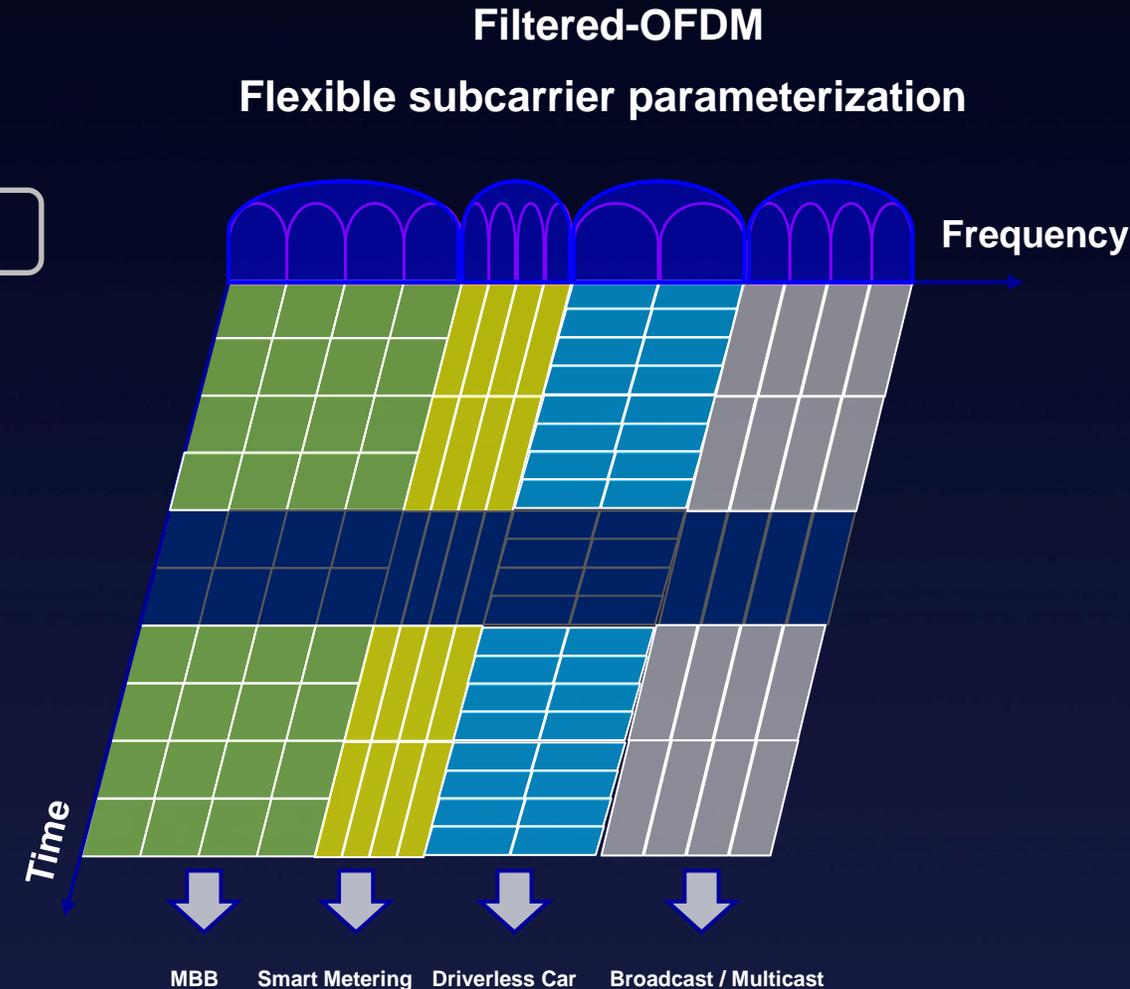
TDD Example



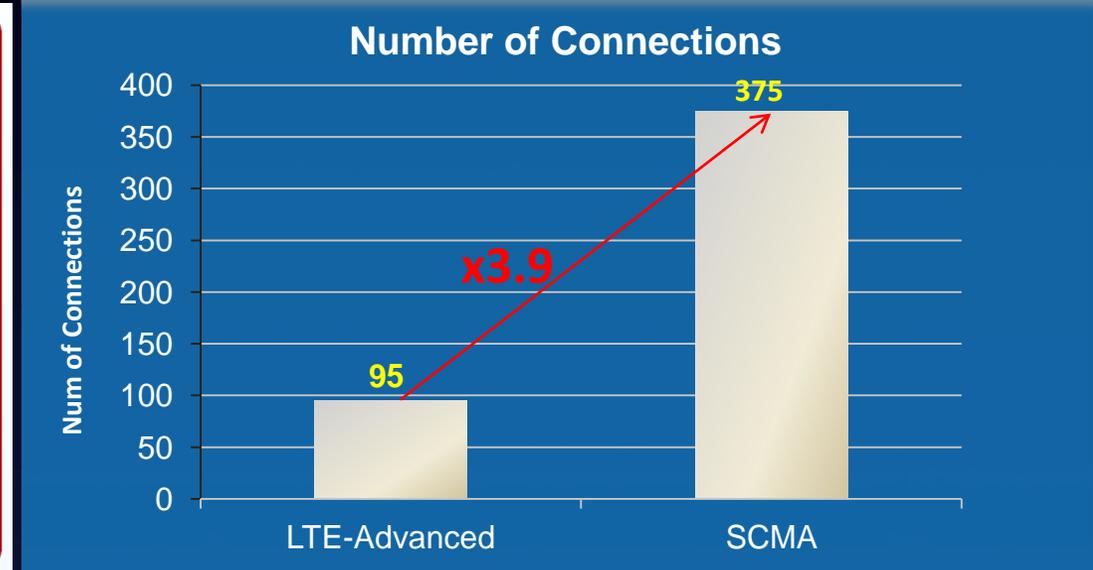
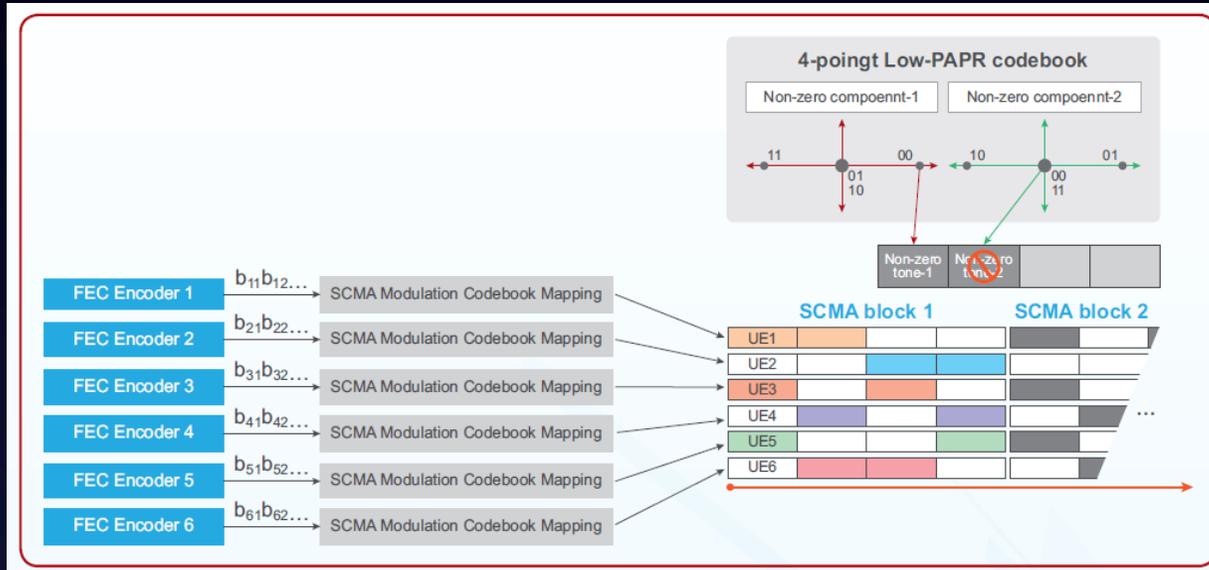
f-OFDM: Enable Future Proof Design and RAN Slicing



- Enable future proof design and RAN slicing by allowing independent co-existence of multiple services within the same carrier
- Sub-band digital filter to control inter-block interference (spectrum localization)
- Orthogonal Intra block to maintain OFDM benefits
- Non-orthogonal to enable co-existence of multiple numerologies without guard band



SCMA: Sparse Code Multiple Access

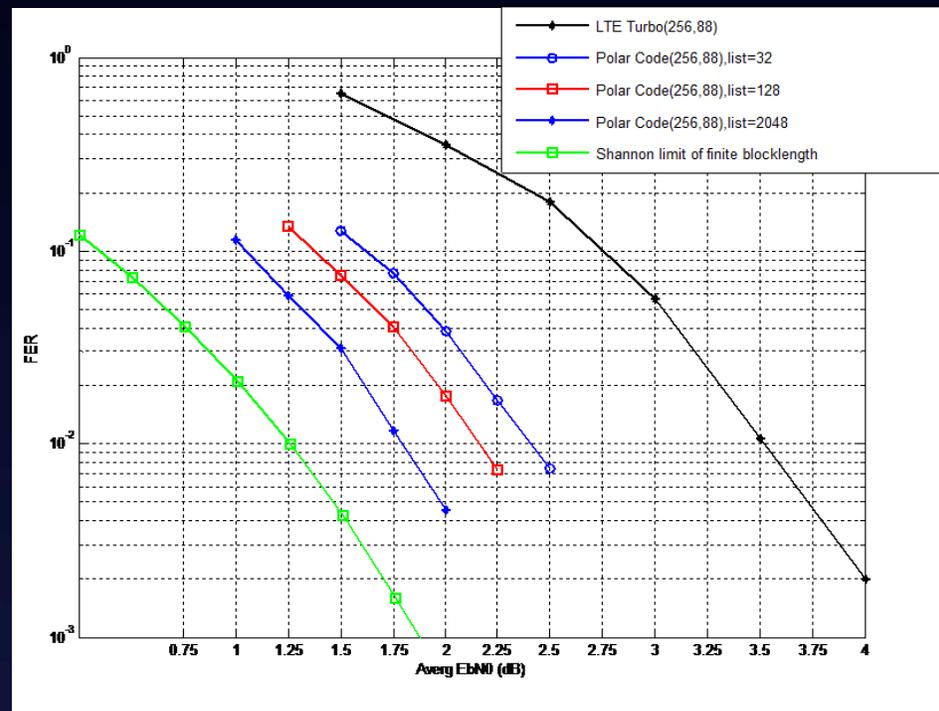
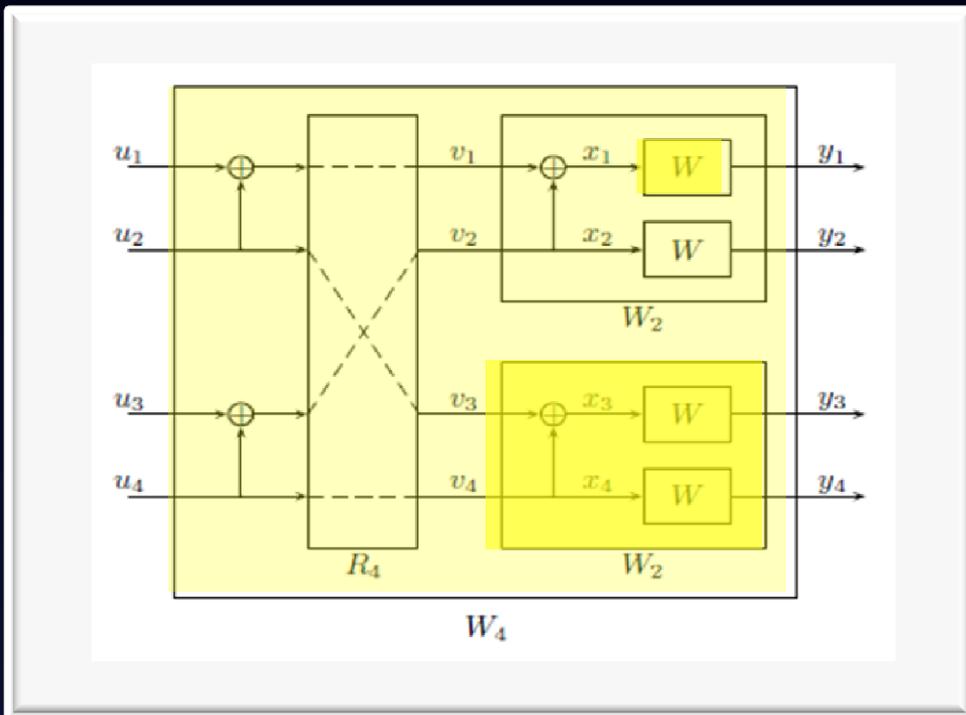


- **Non-orthogonal** multiplexing of layers
- **Overloading** to increase overall rate and connectivity
- **Sparsity** to limit complexity of detection
- **Multi-dimensional codewords** with shaping gain and better spectral efficiency
- **Spreading** for robust link adaptation
- **Grant-free access** for reduction of both latency and signaling overhead

From LTE Global Orthogonality to Dual Non-Orthogonality

- **Inter-block non-orthogonality**
 - Enable the co-existence of eMBB, mMTC and uMTC with individual customized WF within the same carrier
 - WF numerology optimized to different applications (Different CP, sub-carrier spacing, TTI)
 - Flexible resources partition
 - Flexible WF numerology configuration to meet the requirements of different eMBB services
 - Subband based WF numerology configuration within eMBB band
- **Intra-block non-orthogonality**
 - Overloaded superposing multiple access for supporting massive connectivity
 - Non-orthogonal multiple access for capacity enhancement

Polar Code for reliability and low energy consumption

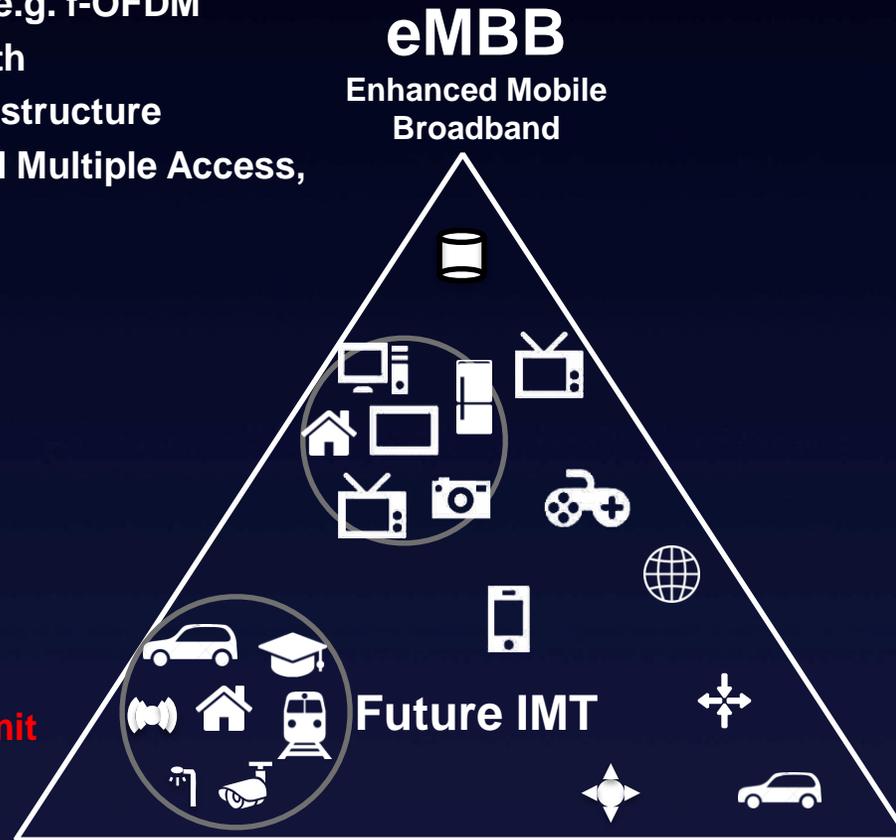


- For small packet (e.g. IoT, control channel), Polar Codes have 0.5-2dB gain comparing with Turbo Code used in LTE, the gain is significant.
- No error floor, suitable for ultra-reliable transmission
- Low energy consumption

Potential Technologies to Meet ITU Requirements



- New waveform e.g. f-OFDM
- Wider Bandwidth
- Adaptive frame structure
- Non-Orthogonal Multiple Access, e.g. SCMA
- UCNC
- Massive MIMO
- Polar Code



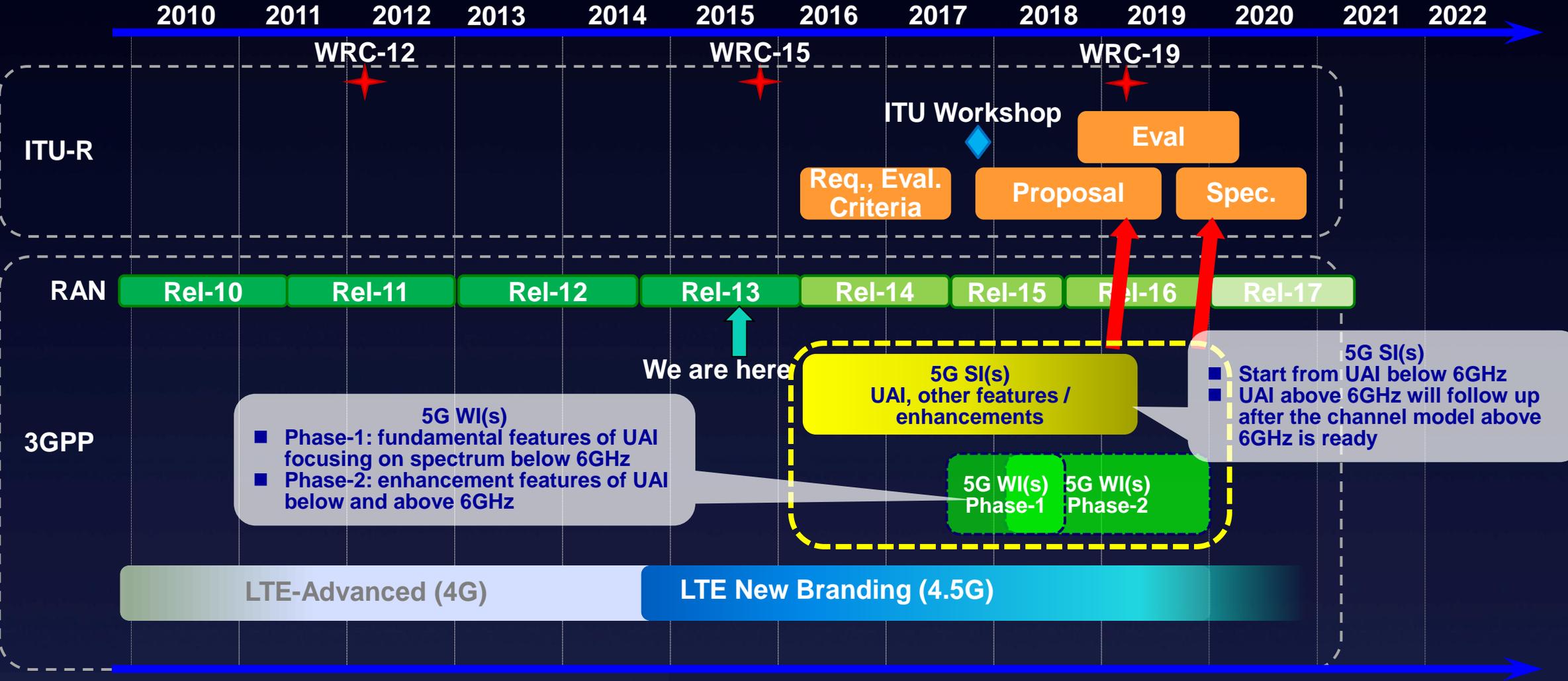
- Shorter TTI
- SCMA based grant-free Tx
- Configurable TDD DL/UL switching point and HQAR
- Fast system re-entry scheme
- ACK/NACK less re-transmission
- UE cooperation diversity
- New data notification scheme
- Polar Code

- Grant-free multiple access
- Narrow band SCMA
- Asynchronous (TA-free) Transmit
- UE dedicated connection ID
- Polar Code for small packet

mMTC
Massive Machine Type
Communications

uMTC
Ultra-reliable and Low-latency
Communications

5G Timeline (Release 14 and onwards)



Notes:

- * Proposal submission to ITU no later than June 2019
 - * Spec submission to ITU no later than February 2020
- Huawei proprietary

Phased Approach

- 5G SI(s) should consider the key enabling technologies for eMBB, mMTC and uMTC.
- 5G Phase-1 should address all ITU requirements to differentiate with LTE evaluation, focused on lower 6GHz spectrum
 - May place emphasis on eMBB for early deployment
- 5G Phase-1 should define the framework to support mMTC and uMTC.
 - Such as waveform, numerology and frame structure
- 5G Phase-1 should not take up the most standardization time
 - The launch of Phase-2 WI should **NOT** wait for the completion of Phase-1
- Phase-2 is a comprehensive 5G for global main stream deployment of 5G

Thank you

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