5G Enabling Technologies

An Unified Adaptive Software Defined Air Interface

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5G World

Everything on Mobile

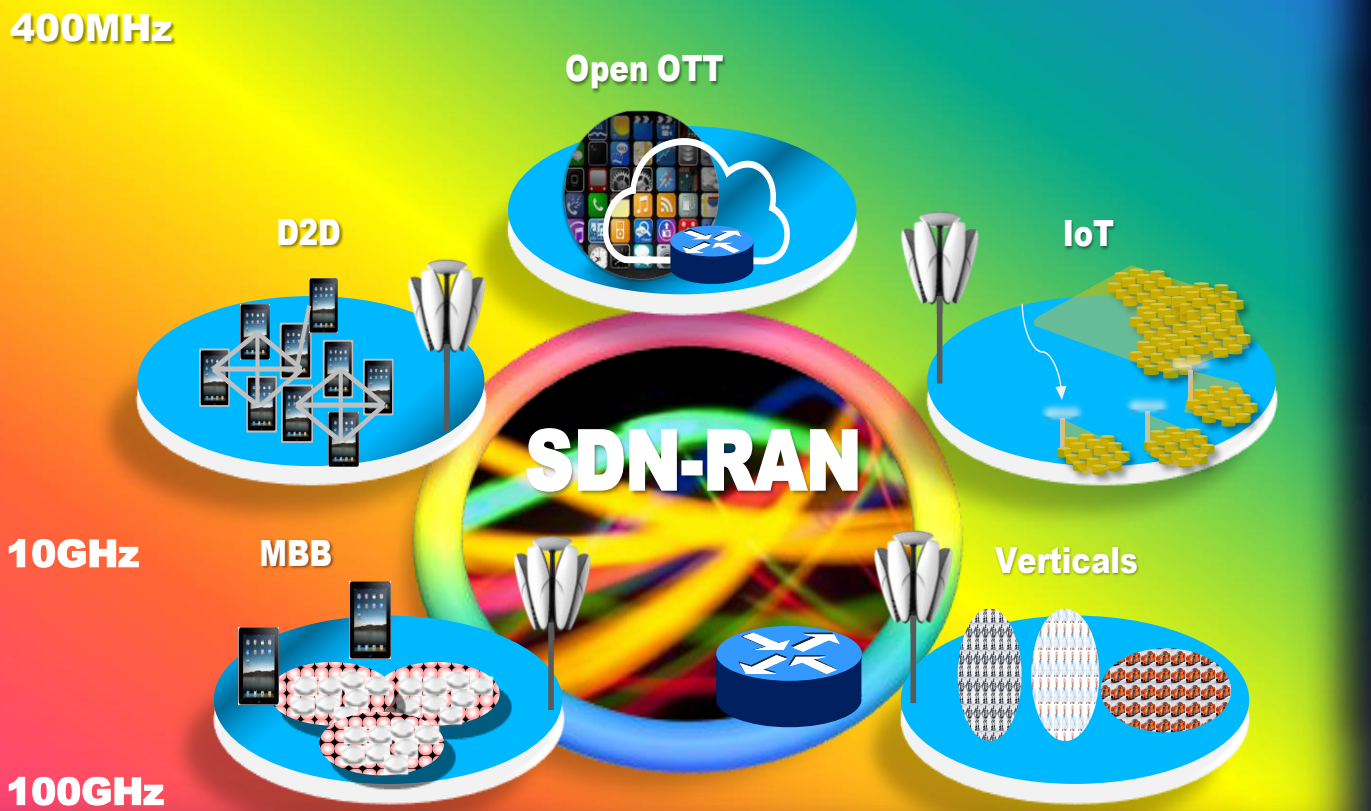
Everything Connected

Everything Virtualized

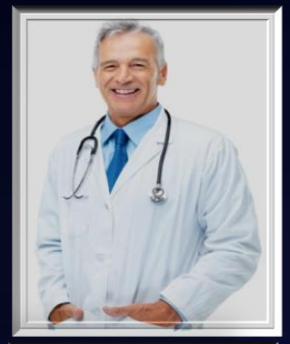
5G (Beyond Smartphone)

HUAWEI

Transform the Industry Verticals



Auto-drive



Medicare

Robots

Meters
Sensors

Capacity	Speed	Latency	Links	Energy
1000X （Capacity/km^2）	100X （10Gbps）	Less than 1ms	100x	1000X Reduce

5G (Beyond Internet Access and APPs)

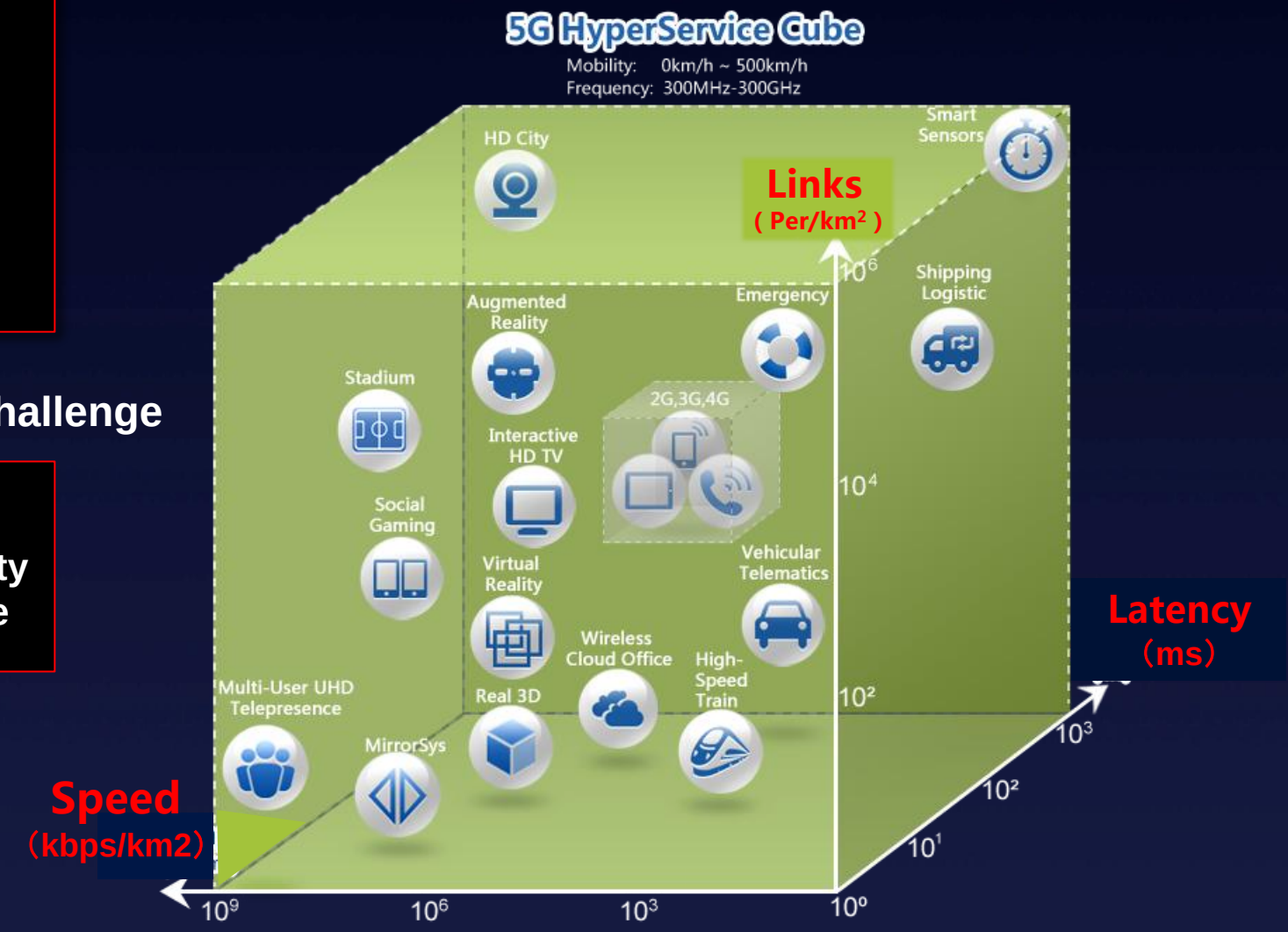
Unprecedented Performance Challenge

Stretched in 3 Dimensions
- Speed
- Links
- Response

Spectrum Efficiency
All Spectrum Access

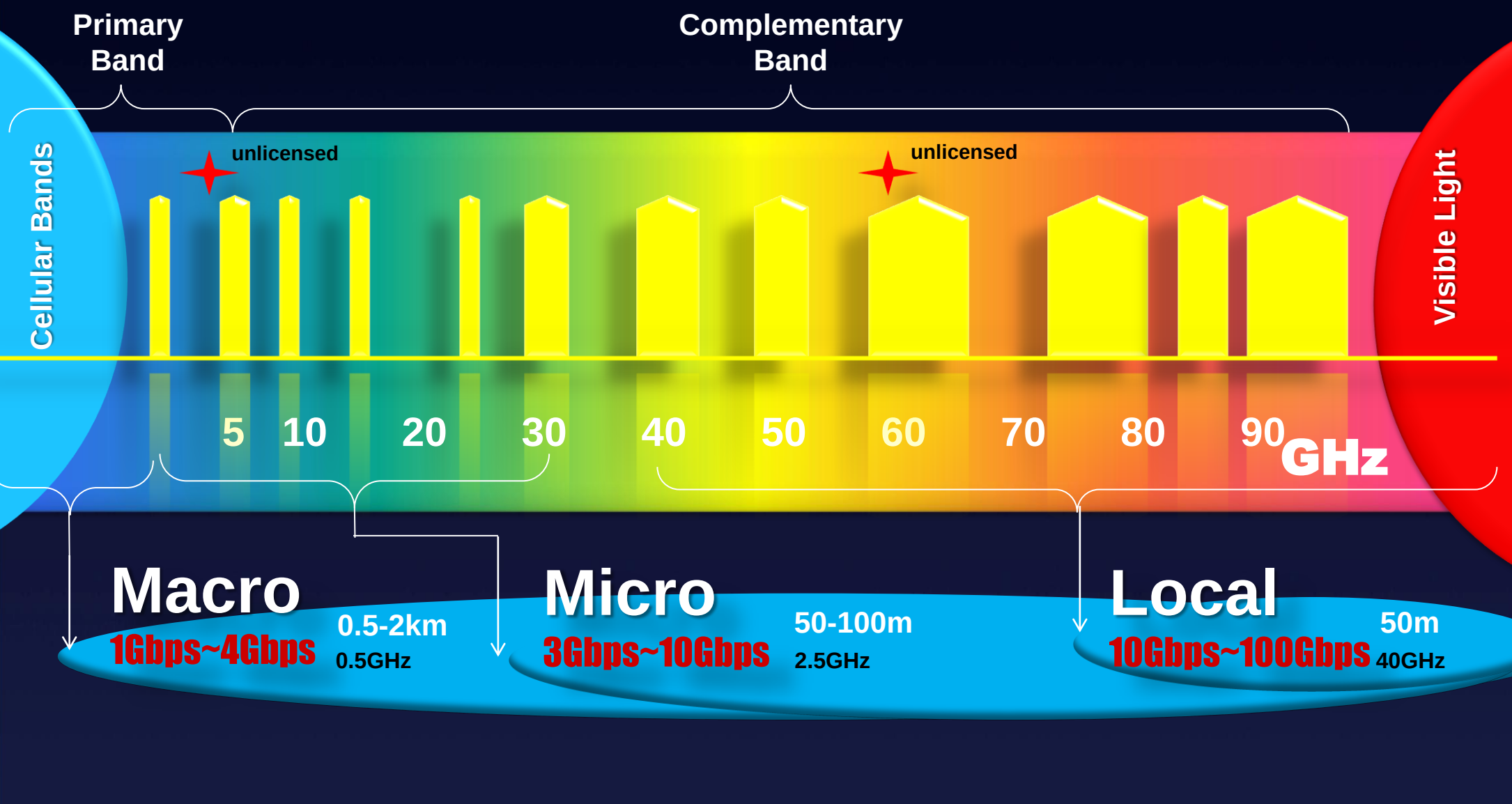
Networks Re-Architect Challenge

No-Cell Virtual RAN
Software Defined &Simplicity
Service Aware and Monetize

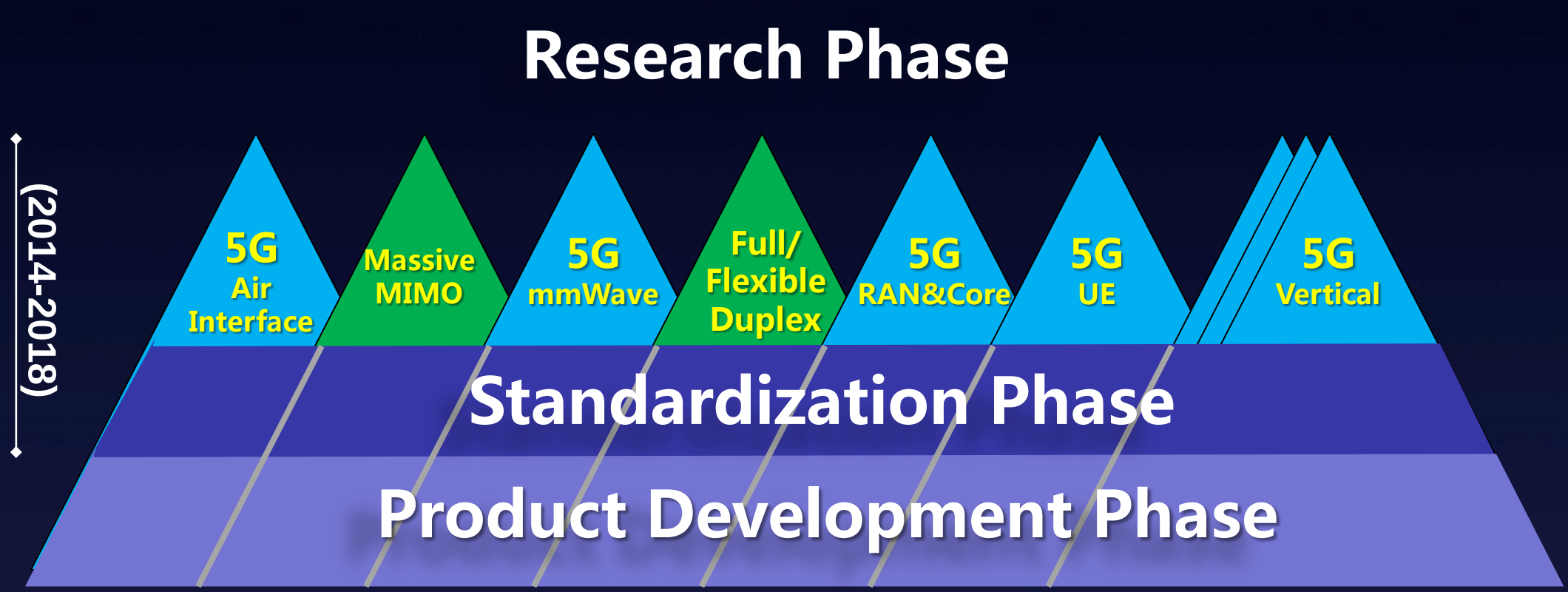


Single & Unified Air-Interface

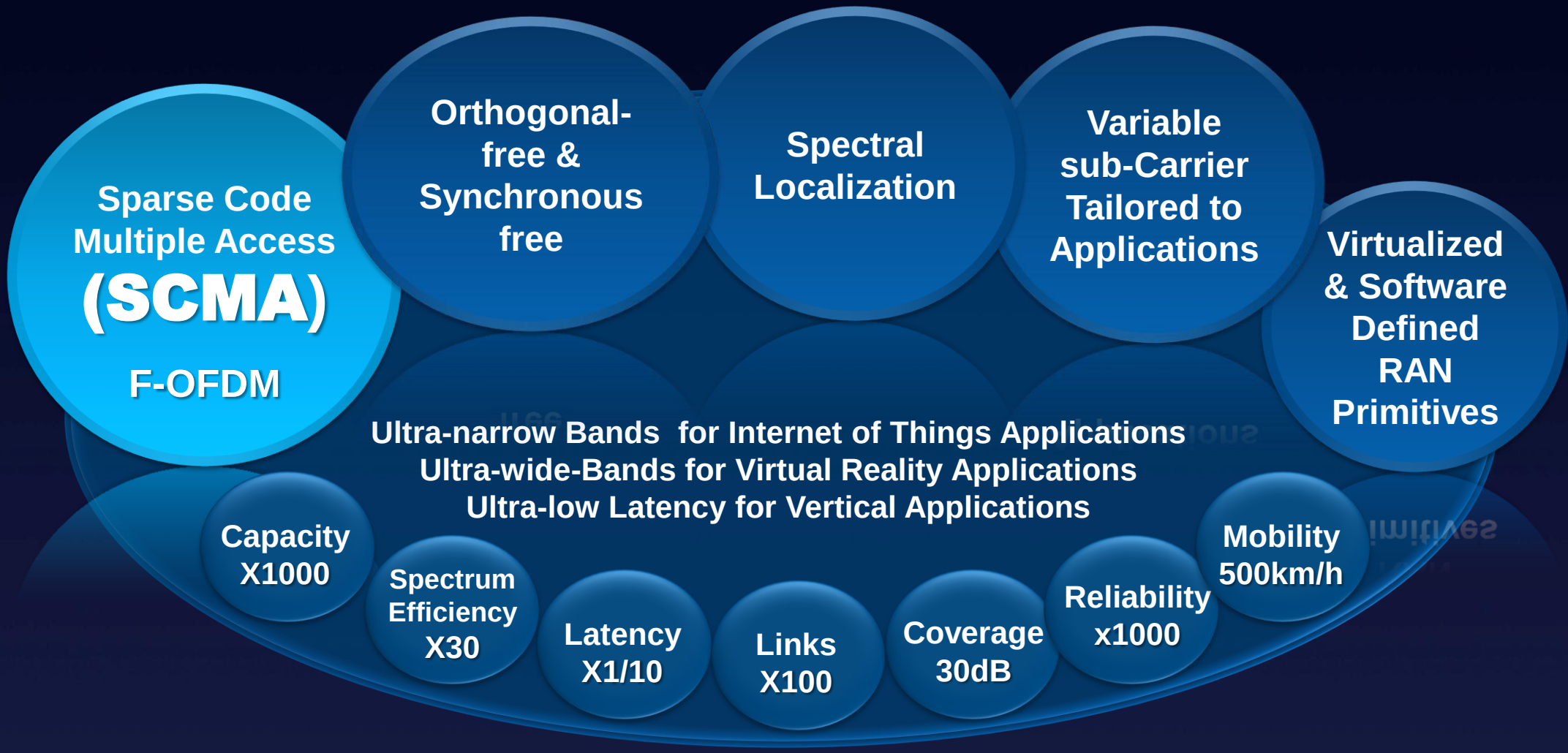
for All Spectrum Access



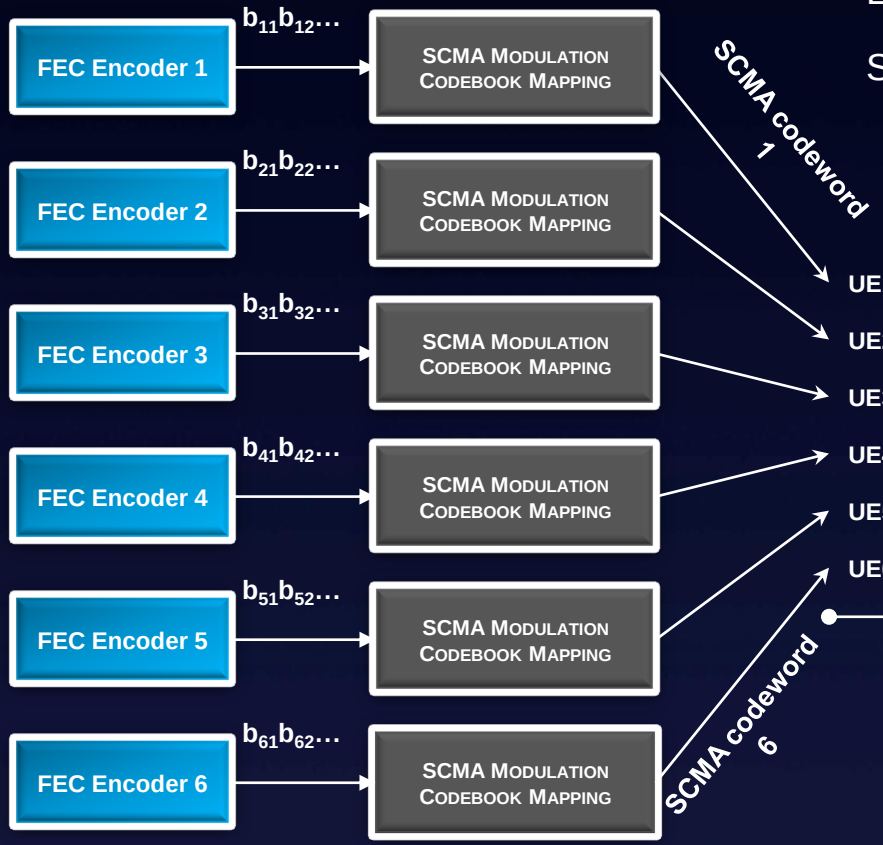
Foundational Technologies



Air Interface Characteristics

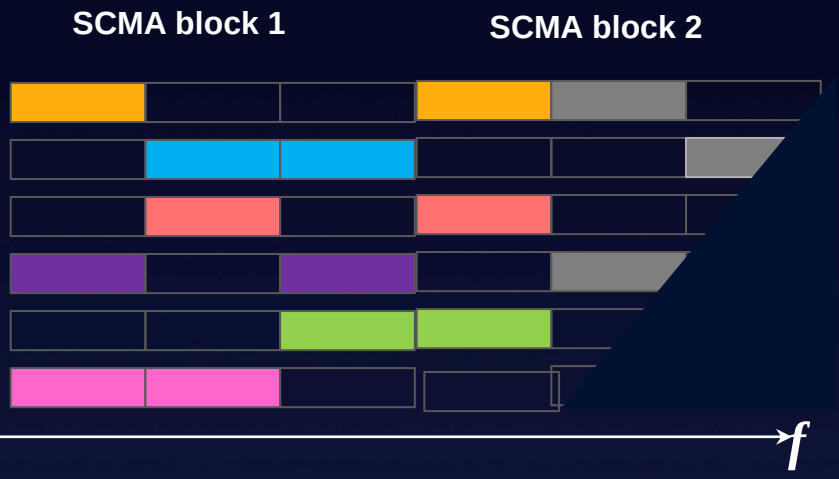


SCMA (Sparse Code Multiple Access)



LTE: K (4) symbols mapped to K (4) sub-carriers

SCMA: N (6) symbols mapped to K (4) sub-carriers (N > K, overloading)

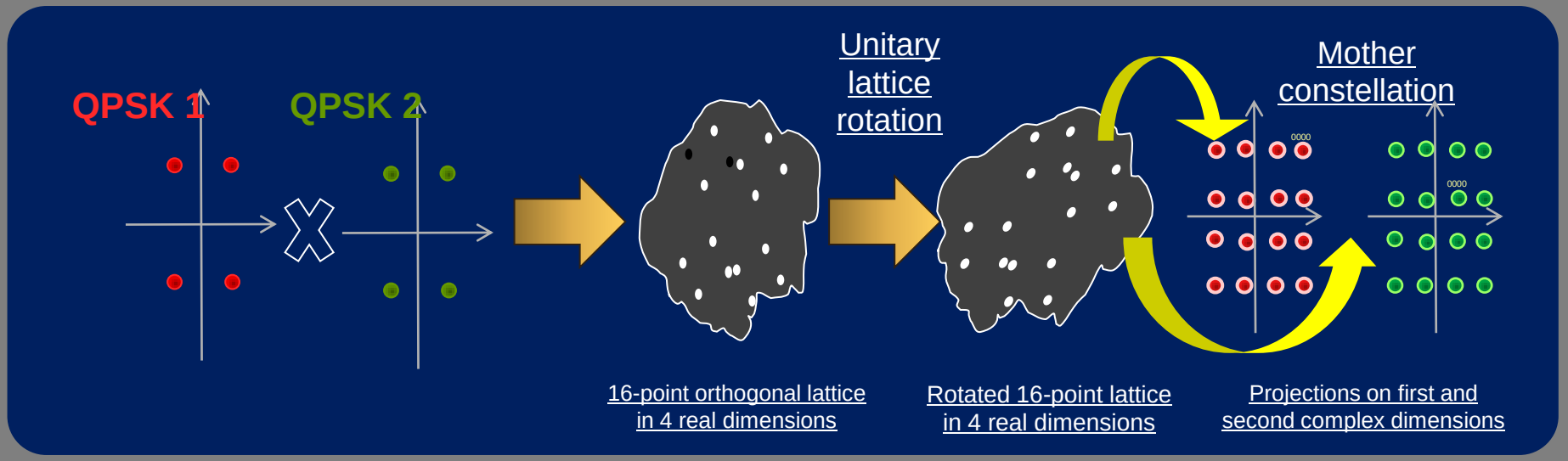


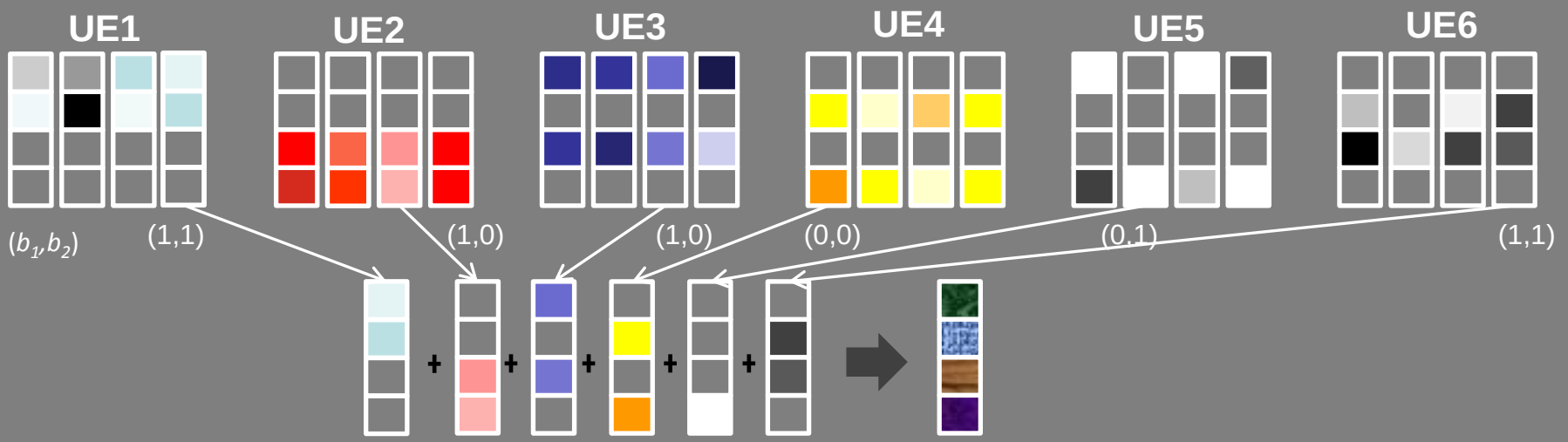
- ***Non-orthogonal*** multiplexing of code layers
- ***Over-Dimension*** to increase overall rate and connectivity
- ***Sparsity*** to limit Rx complexity for detection
- ***Multi-dimensional*** codewords with shaping gain
- ***Spreading*** for robust link-adaptation, coverage

A new frequency domain non-orthogonal waveform

- Input bits are directly mapped to codewords and spread over multiple sub-carriers
- Codewords can be assigned to same UE (SU-SCMA) or different UEs (MU-SCMA)

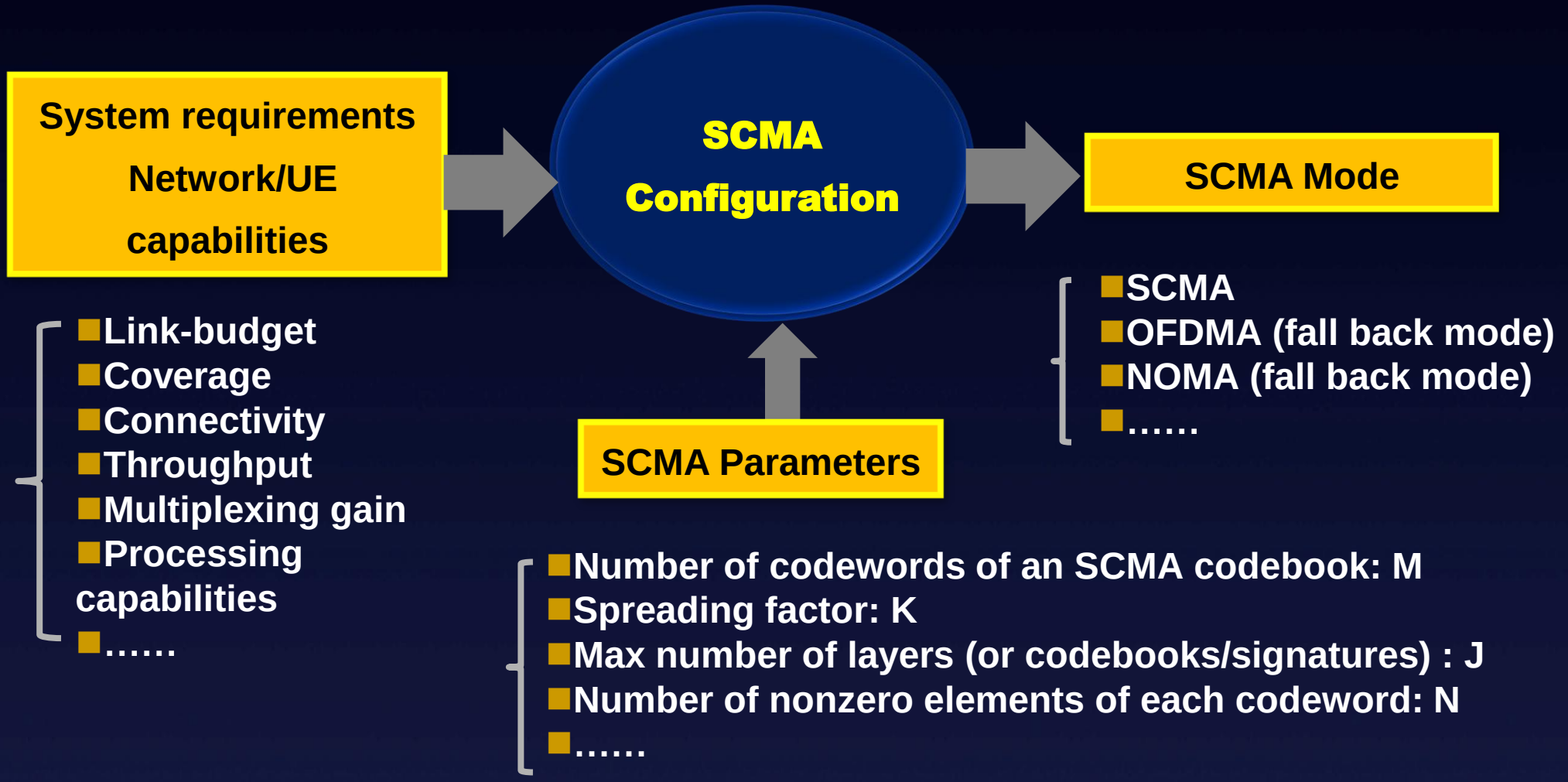
SCMA Code Book





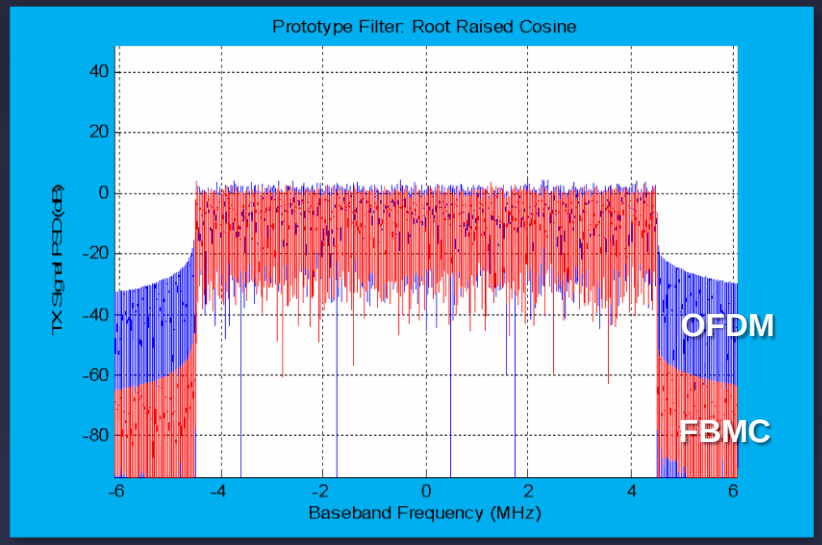
- SCMA codebook based on Multi-dimensional Lattice Constellation to exploit shaping gain and coding gain
- Each UE/layer stores a unique codebook
- Binary input data is mapped to a codeword of the corresponding codebook
- Low PAPR and low projection codebooks possible

Scalable SCMA
with Adaptive System Parameters

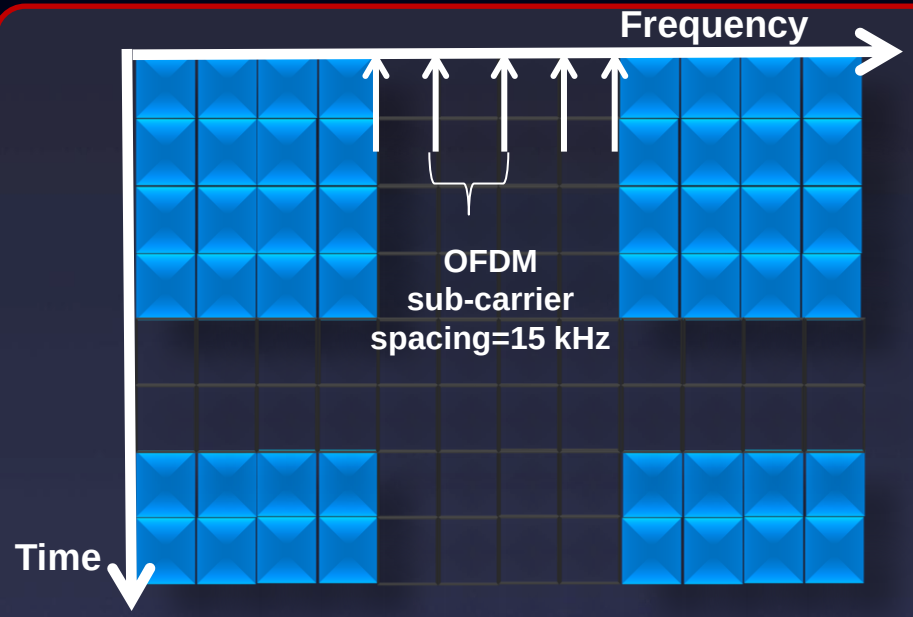


Flexible and scalable SCMA based access scheme which can compromise among spectral efficiency, coverage, detection complexity, connectivity, and link budget to adapt to different application scenarios

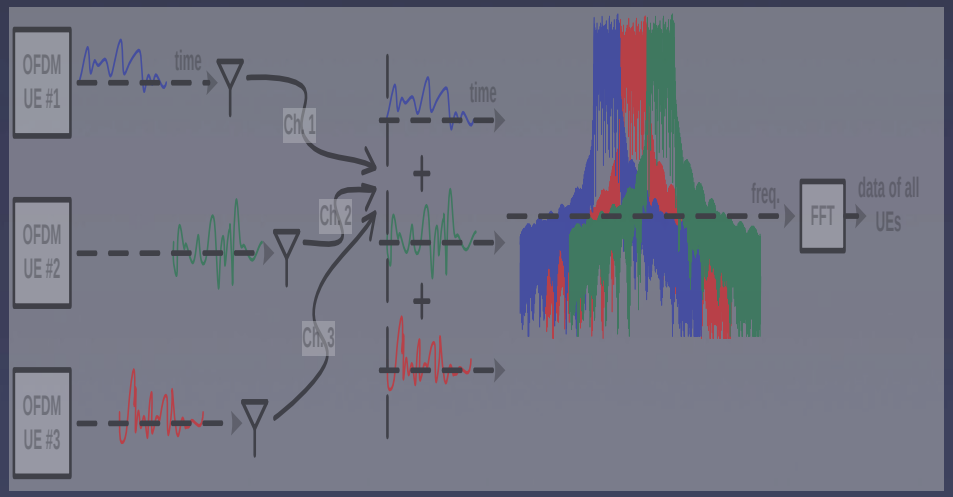
Issues for OFDM Waveform



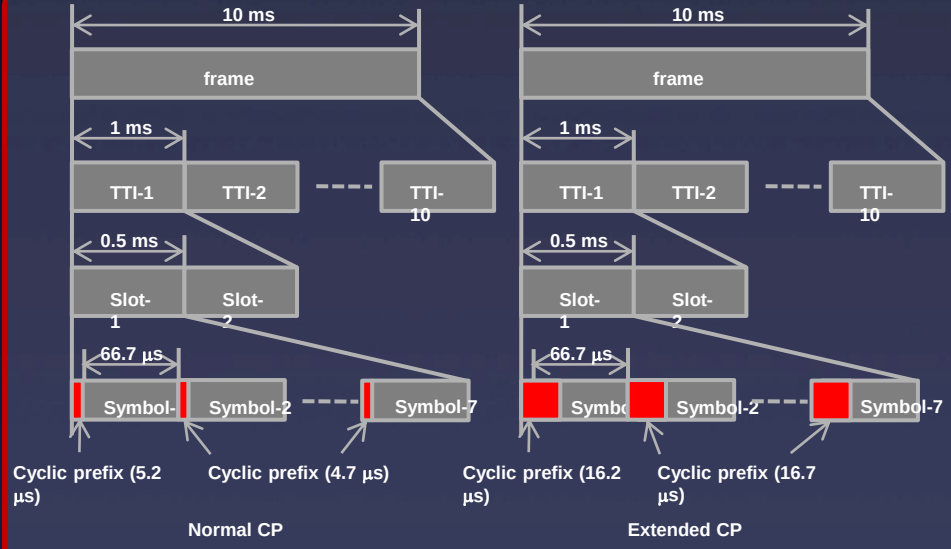
Spectrum not localized, need guard band



Not flexible to change sub-carrier spacing in Frequency



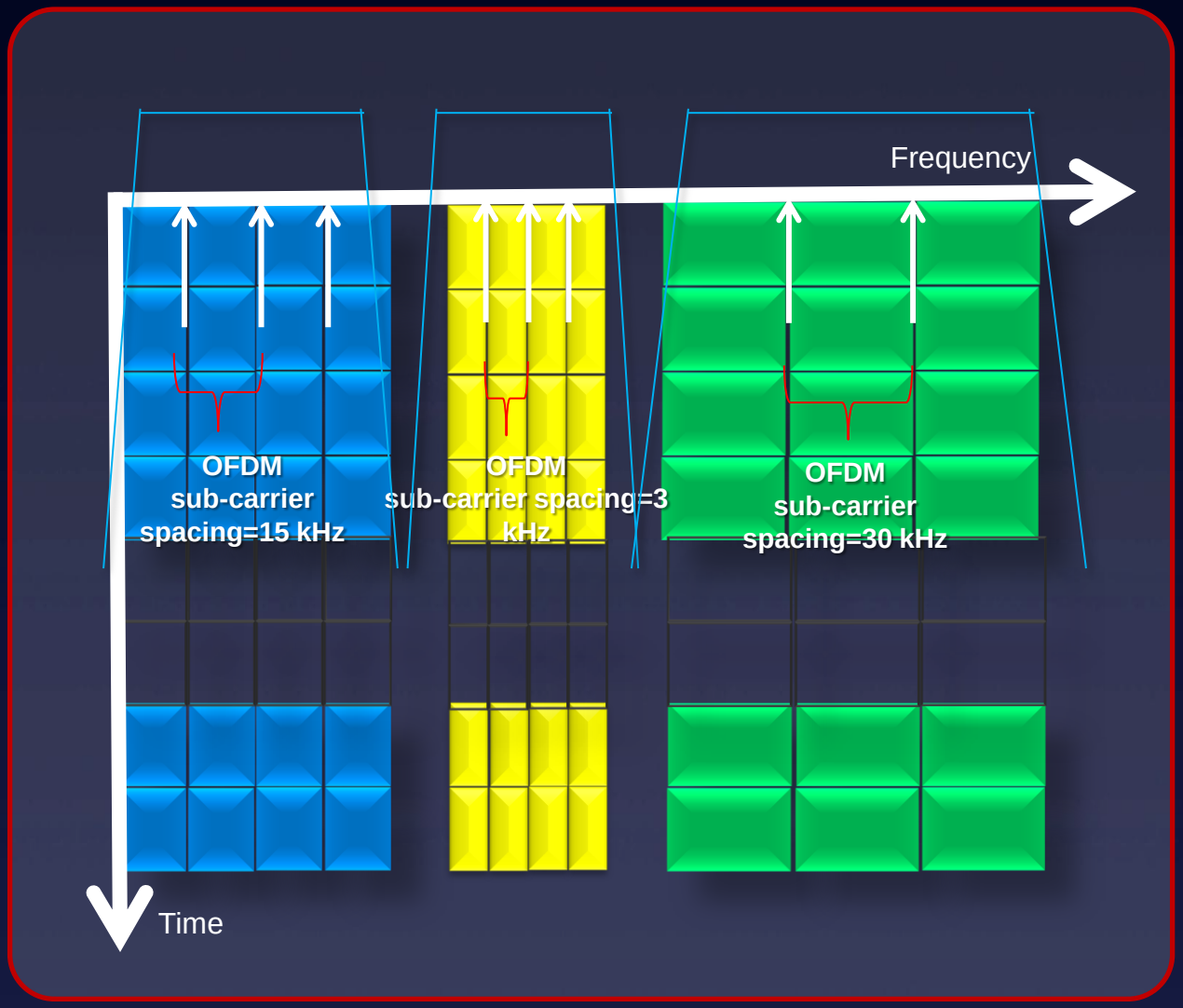
Synchronous Tx, large overhead for time alignment



Fixed symbol duration, not flexible to change CP

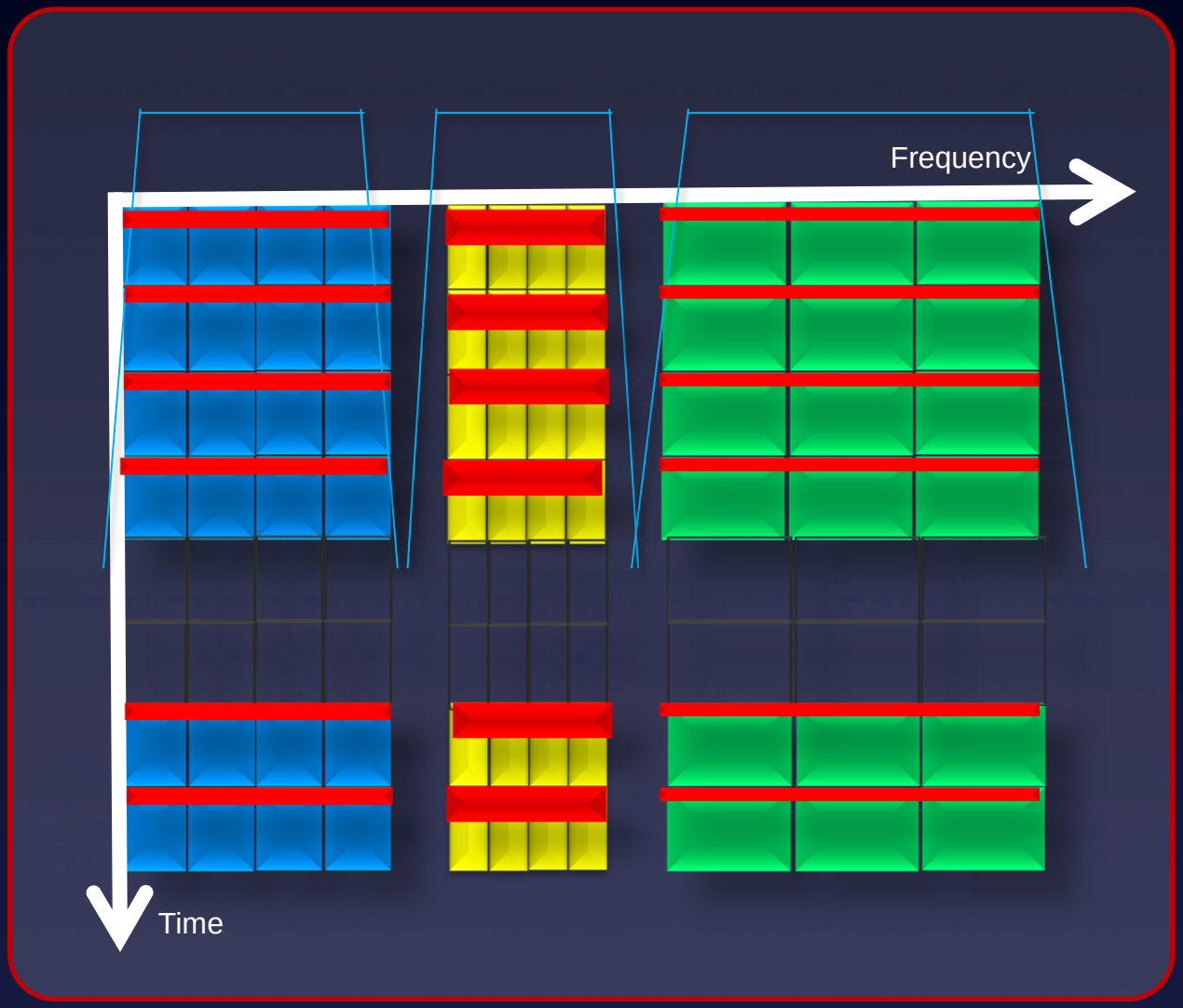
Spectrum Filtered OFDM (f-OFDM)

1. Sub-band digital filter is applied to shape the spectrum of subband OFDM signal.
2. Orthogonal subcarriers within each subband
3. Allow co-existence of waveforms with different OFDM Primitives



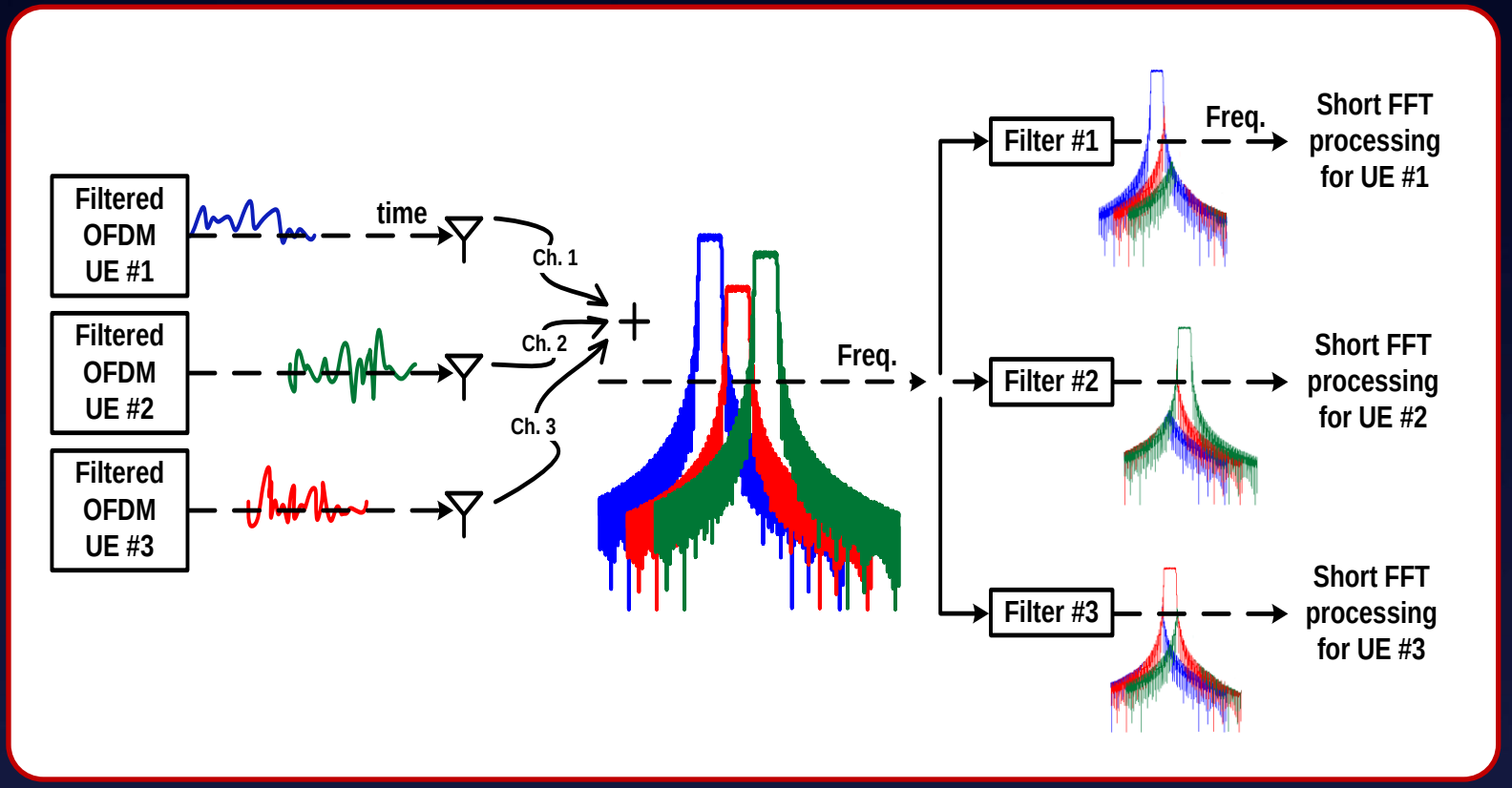
Spectrum Filtered OFDM (f-OFDM)

1. Sub-band digital filter is applied to shape the spectrum of subband OFDM signal.
2. Orthogonal subcarriers within each subband
3. Allow different cyclic prefix for each specific sub-band



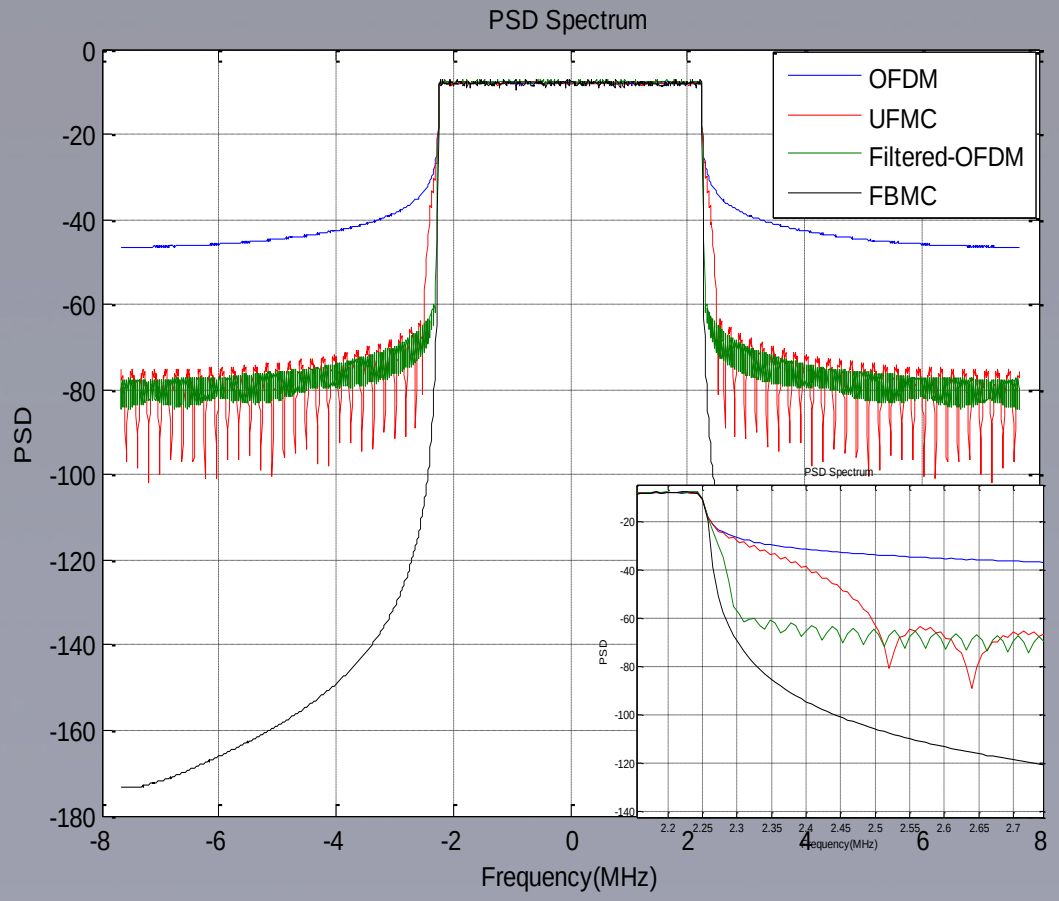
F-OFDM Supports Asynchronous OFDMA

1. Support asynchronous OFDMA transmission
2. Non timing advance signal needed



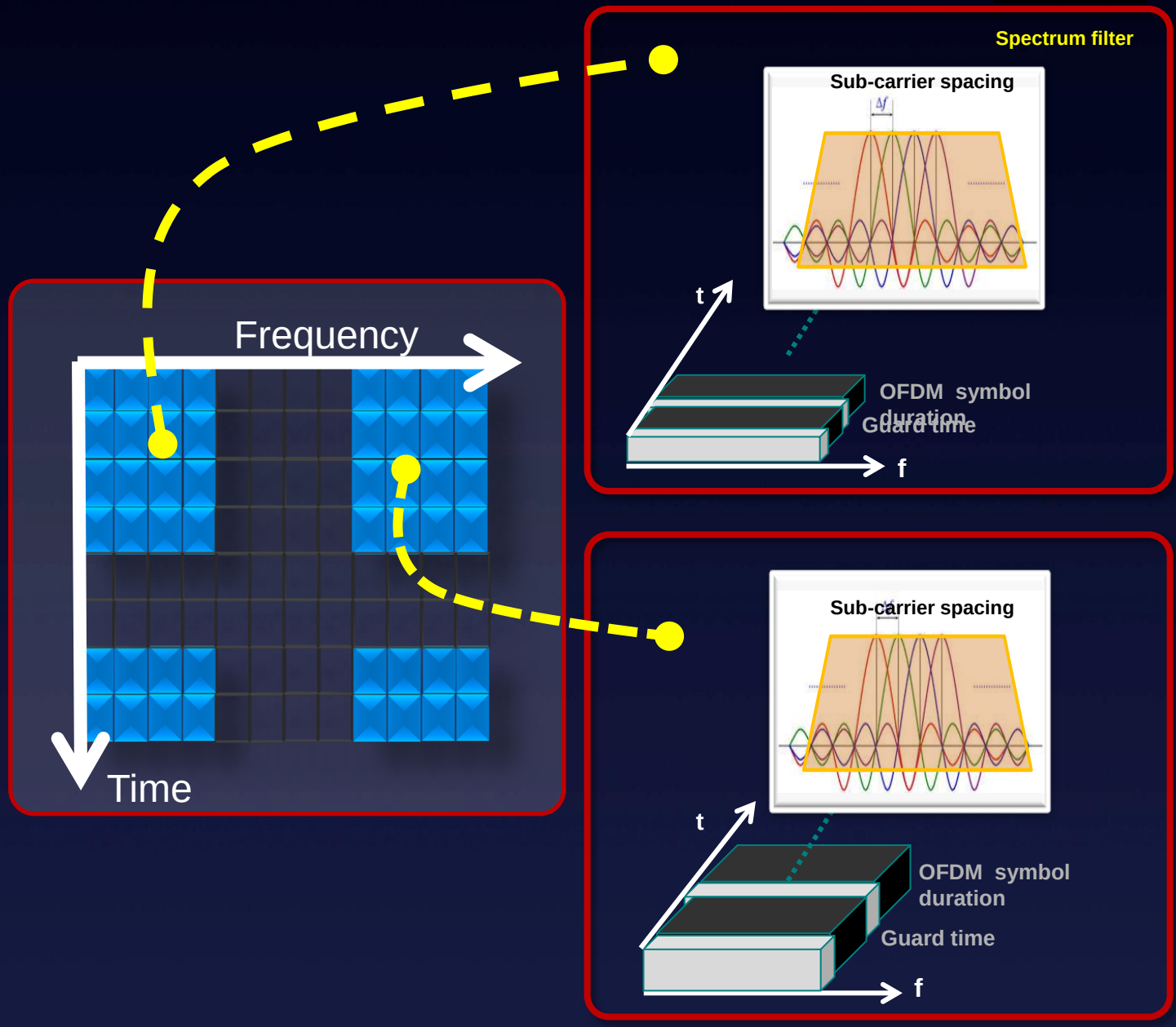
Spectral Filtered OFDMA Characteristics

1. Good out-of-band leakage rejection
2. Similar spectrum localization performance compared to FBMC
3. Maintain all the benefits of OFDM
4. Easy for m-MIMO



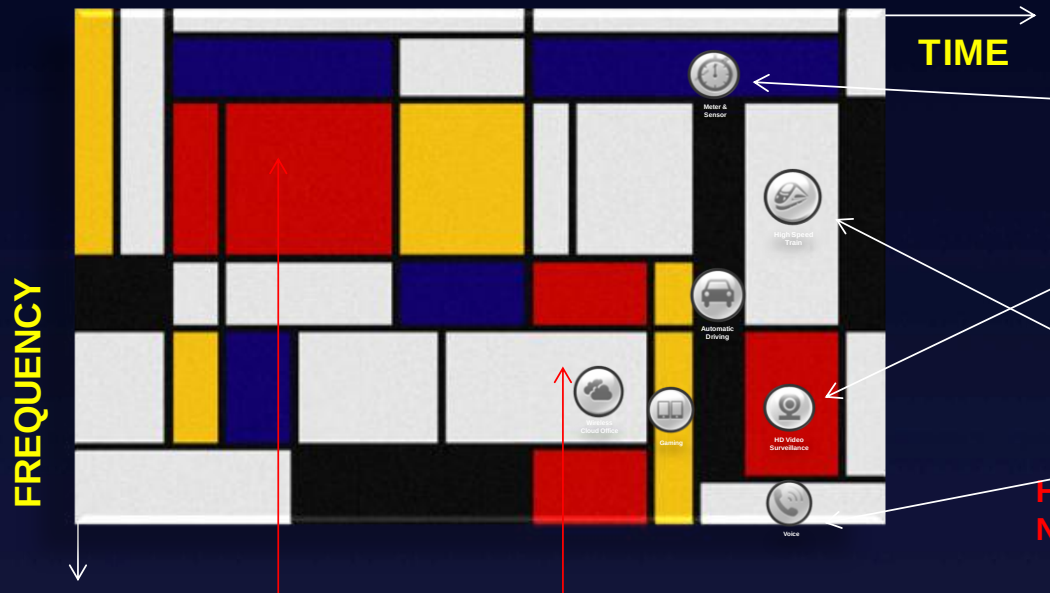
Flexible Time-frequency Lattice

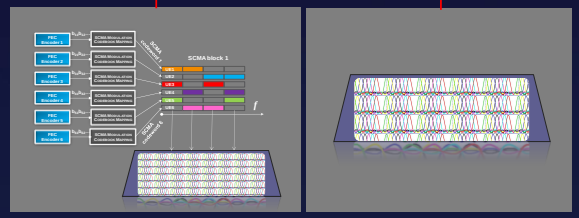
1. Co-existence of different time-frequency granularities
2. Waveform optimized for different transmission condition and applications
3. Regional broadcasting, high speed train, fixed devices,……
4. Subband spectrum filter to control inter-block interference

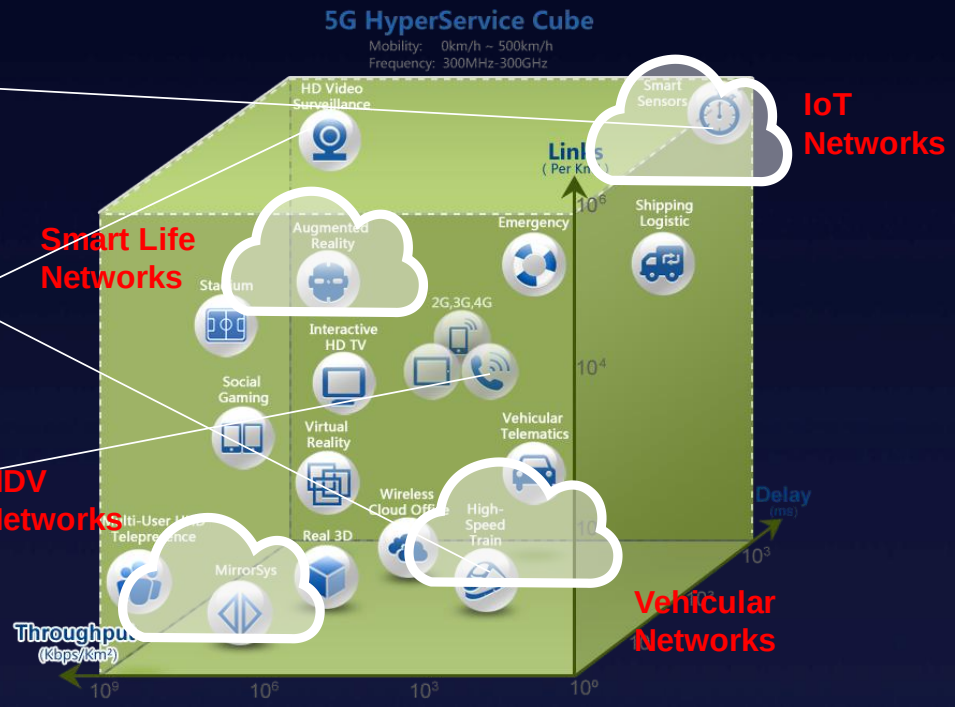


An Unified Adaptive Software Defined Air Interface to Meet Diverse Services Demand

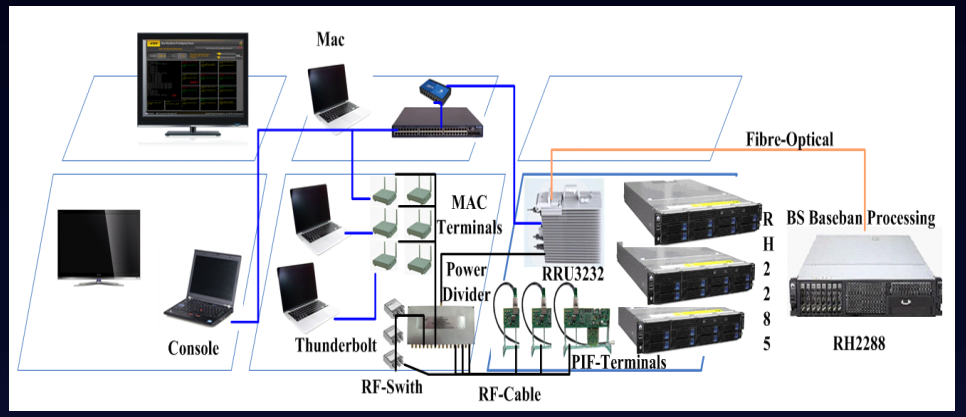
- Unified air interface to support
- different waveform / multiple access schemes / flexible TTI

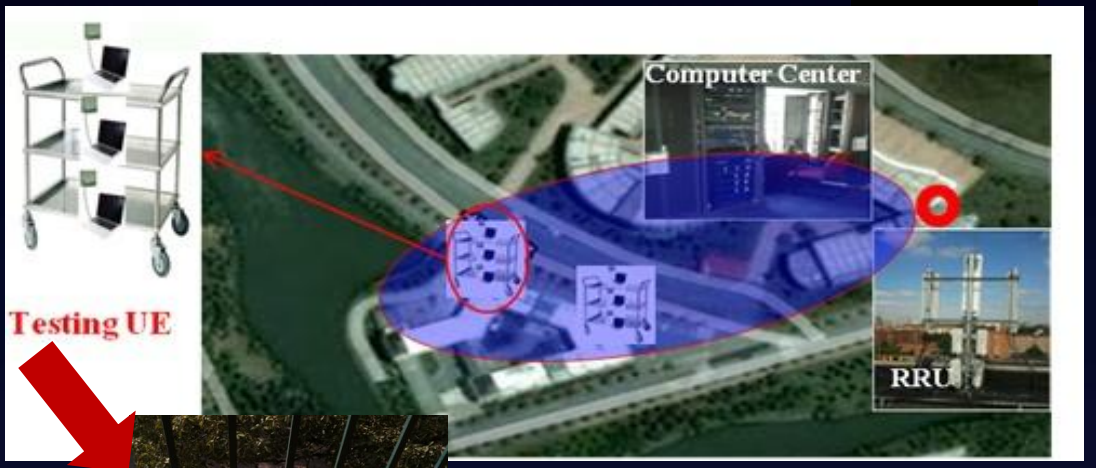


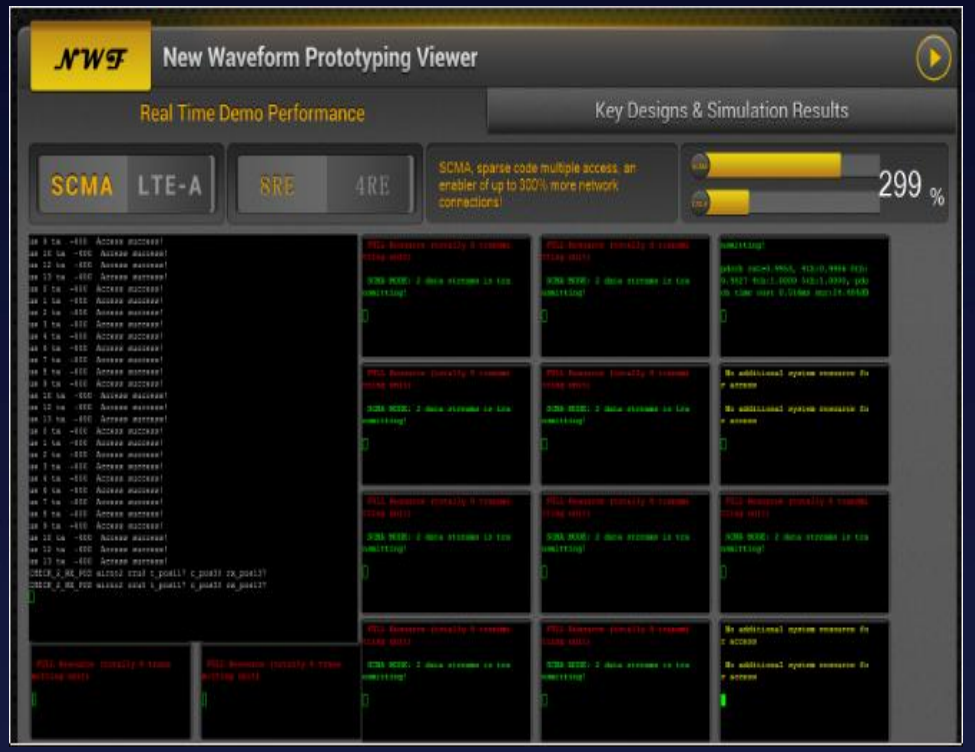




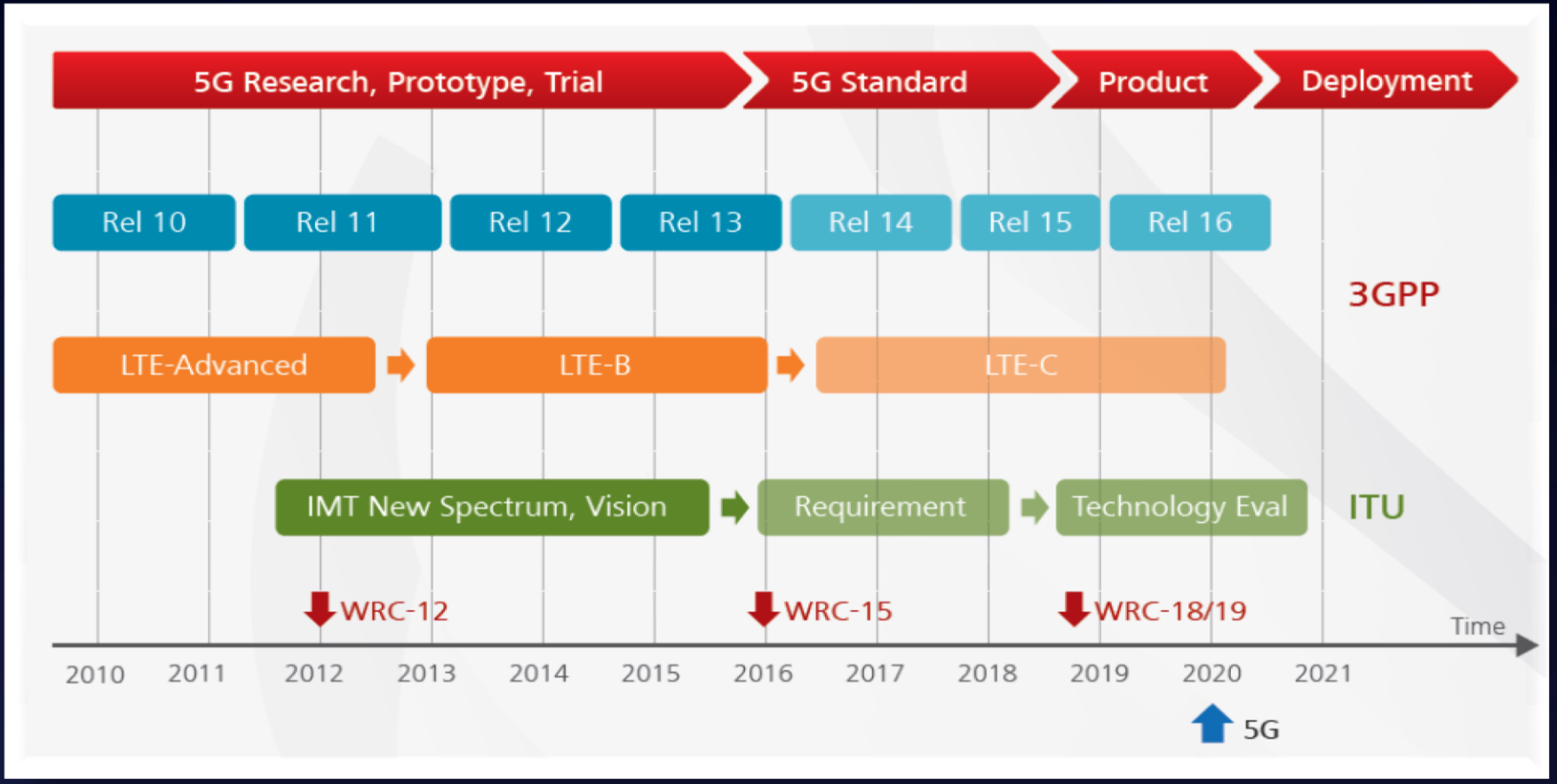
SCMA Prototype and Field Trial







5G Timeline


5G Research, Prototype, Trial
5G Standard
Product
Deployment
Rel 10
Rel 11
Rel 12
Rel 13
Rel 14
Rel 15
Rel 16
3GPP
LTE-Advanced
LTE-B
LTE-C
IMT New Spectrum, Vision
Requirement
Technology Eval
ITU
WRC-12
WRC-15
WRC-18/19
Time
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
5G

THANK YOU

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