Bringing 5G into Reality

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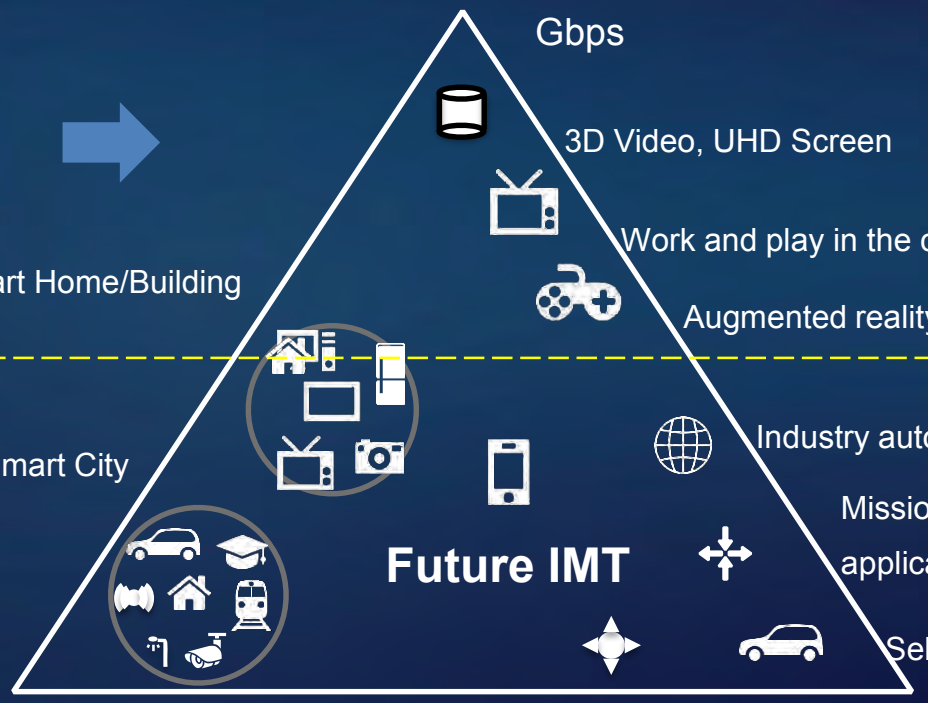
Wireless Network Product Line
2016.05.26

Contents

Embracing the Super Connected World in 2020s

People's Experience driven

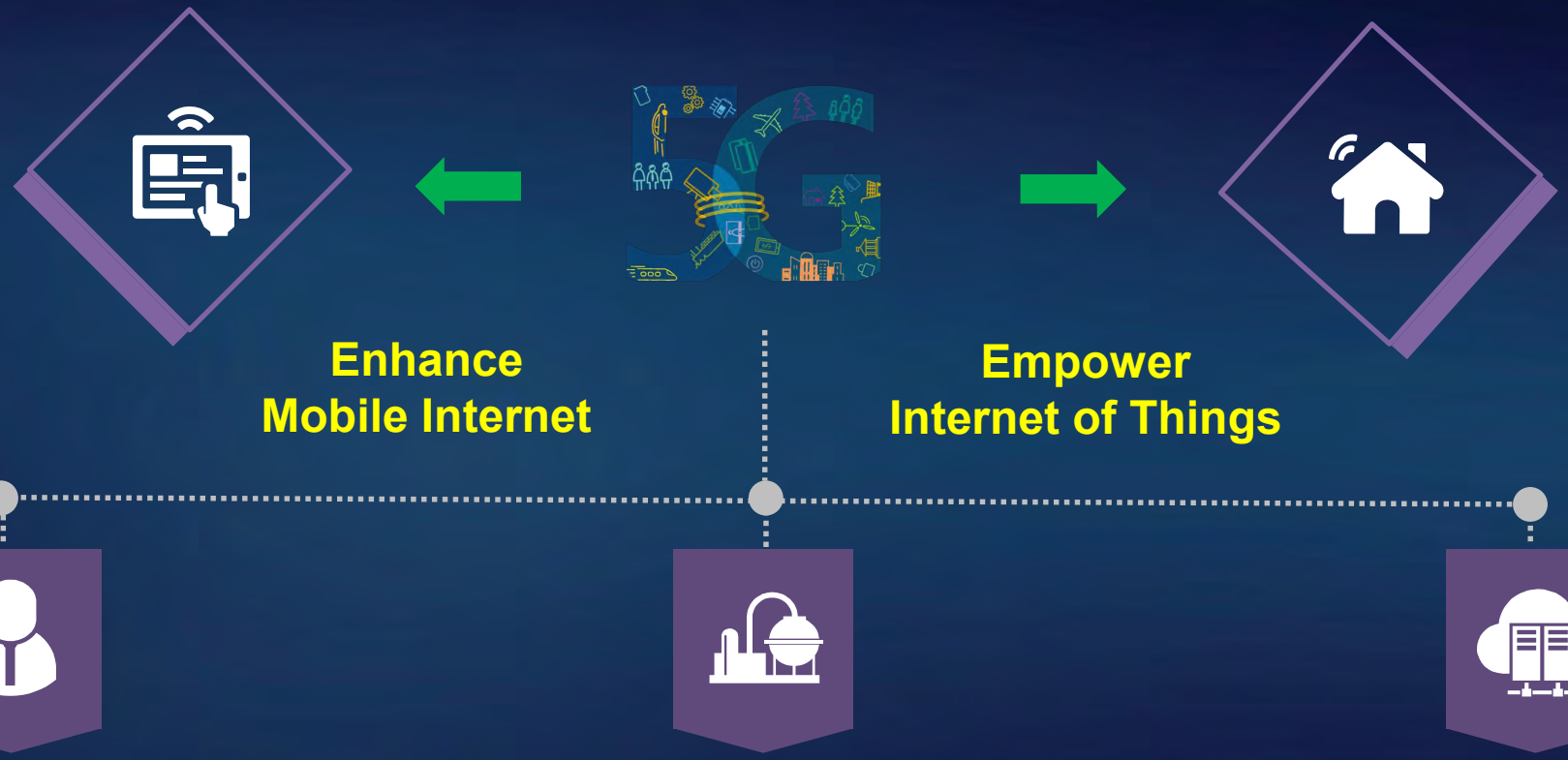
Machine's Connection driven



10Gbps Peak Rate
Anytime Anywhere 100Mbps
5ms Latency

10^6 Connections/km^2
100x Energy Efficiency
1ms Latency

5G Covers Many Industries and Stakeholder Benefits



Consumers

- Ubiquitous & consistent experience
- New services

Verticals

- Easy access to the common infrastructure of 5G
- Real-time, on-demand services

Operators

- Easy deployment and maintenance
- Network flexibility for multiple industries

Diversified Challenges and Gaps to Reach 5G

	Latency	Throughput	Connections	Mobility	Network Architecture
5G	1 ms Network Latency	10Gbps Peak Throughput	1,000K Connections Per km²	500km/h High-speed Railway	Slicing Ability Required
GAP	30~50x	100x	100x	1.5x	NFV/SDN
LTE	30~50ms	100Mbps	10K	350Km/h	Inflexible

5G Deep Innovation for the Future

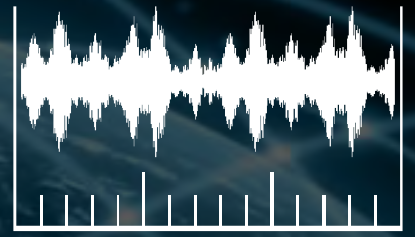
Industry Collaborations

- Cross-industry Communication & Collaboration
- Global Unified Standard

Technology Innovations

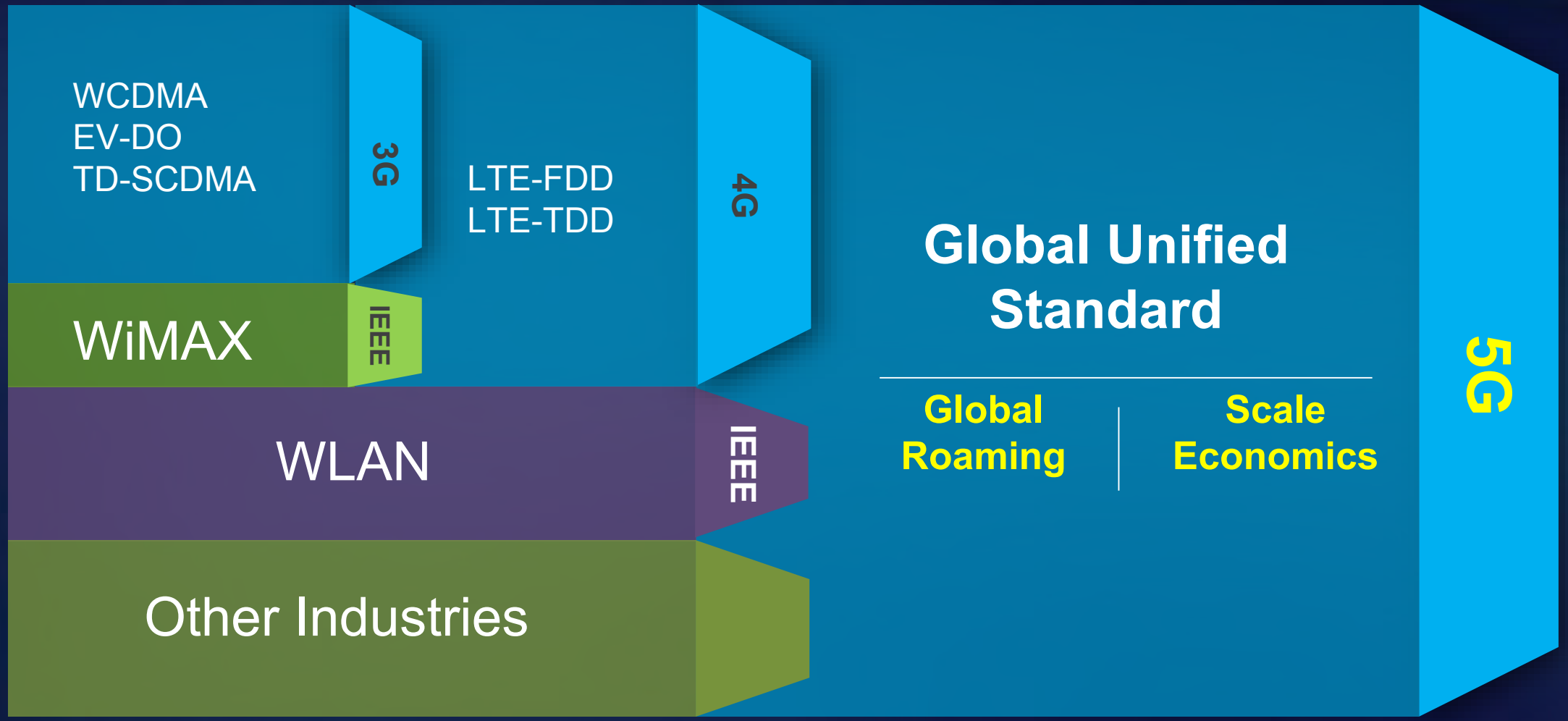
- Revolutionary Innovations
- Spectral Efficiency Improved by at Least 3 Times

Spectrum Support



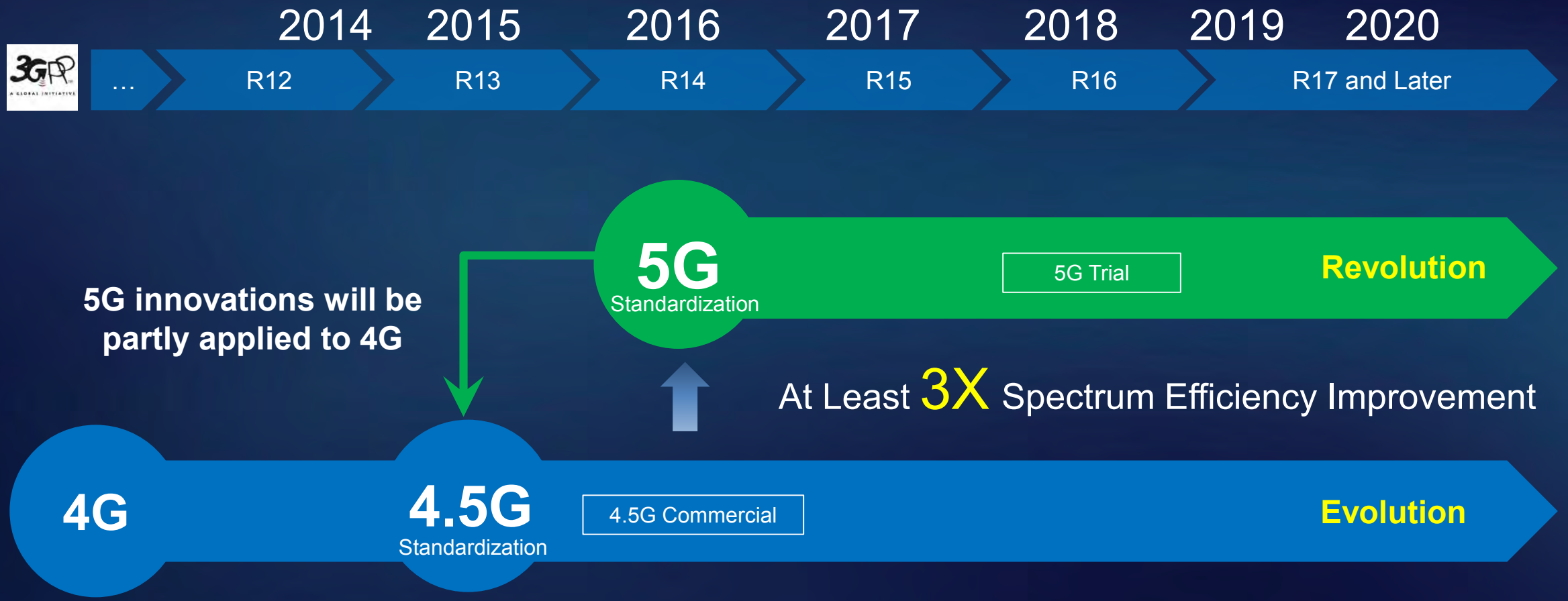
- Government & regulators open more spectrum resources
- Technology aggregates all available bands

5G Needs Global Unified Standard



Contents

5G Needs Revolutionary Innovation

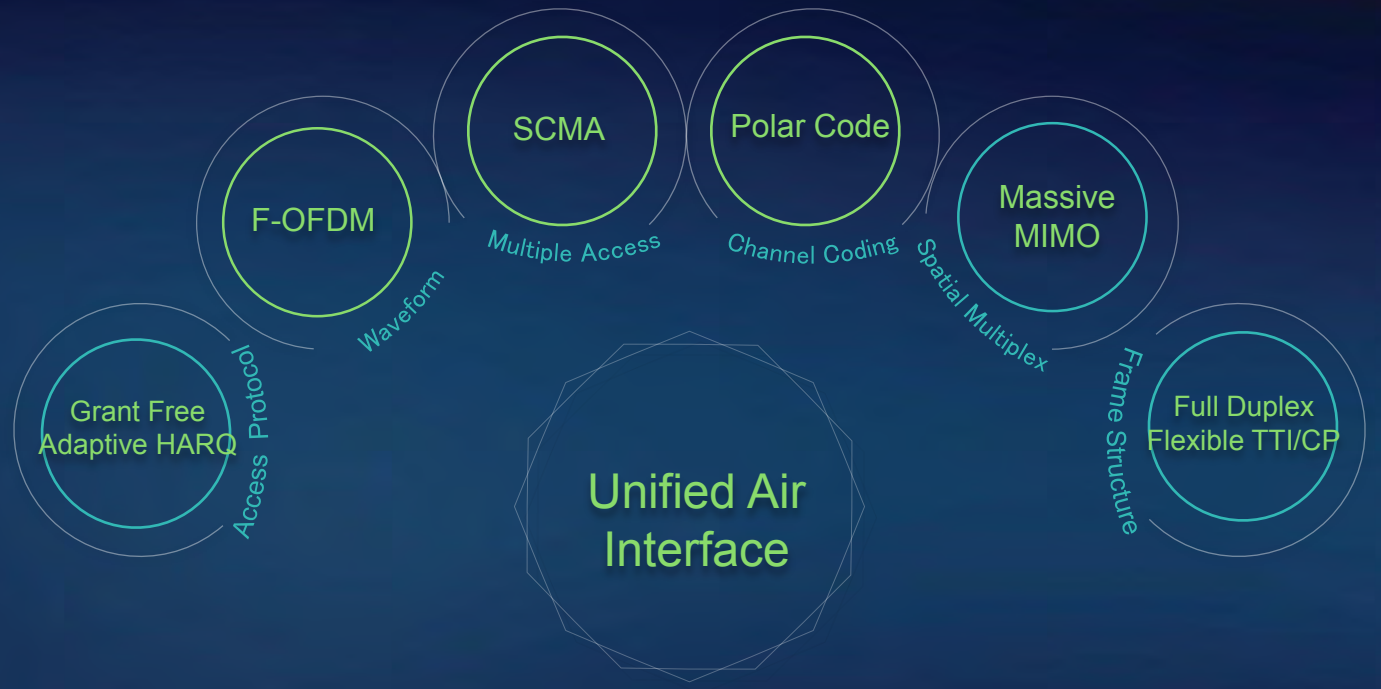


5G Revolutionary Road

	4G	4.5G	5G
Network Architecture	EPC	vEPC Virtualization + Cloudformation	5G NW Functions Cloud-Native Architecture
Air Interface	LTE	256QAM M-MIMO, LAA, NB-IoT, …… LTE Massive CA	Multiple Access Waveform, Duplex, Frame, …… NEW AIR Channel Coding
Spectrum	Existing + New allocated spectrum 6GHz – 100GHz	Existing + New allocated spectrum 6GHz – 100GHz	New spectrum + Existing refarming 6GHz – 100GHz

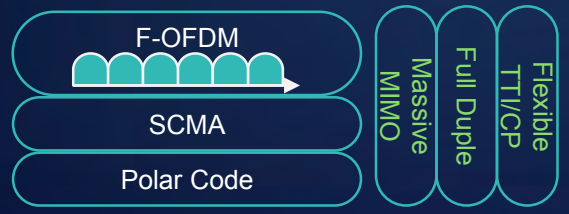
Unified New Air Interface for Diverse Applications

One Adaptable to All Applications

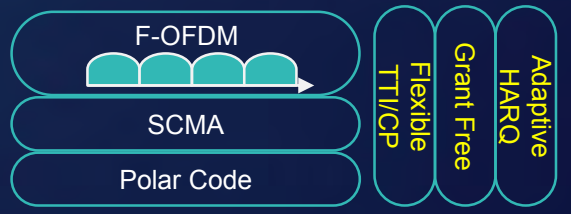


3X Spectrum Efficiency

eMBB



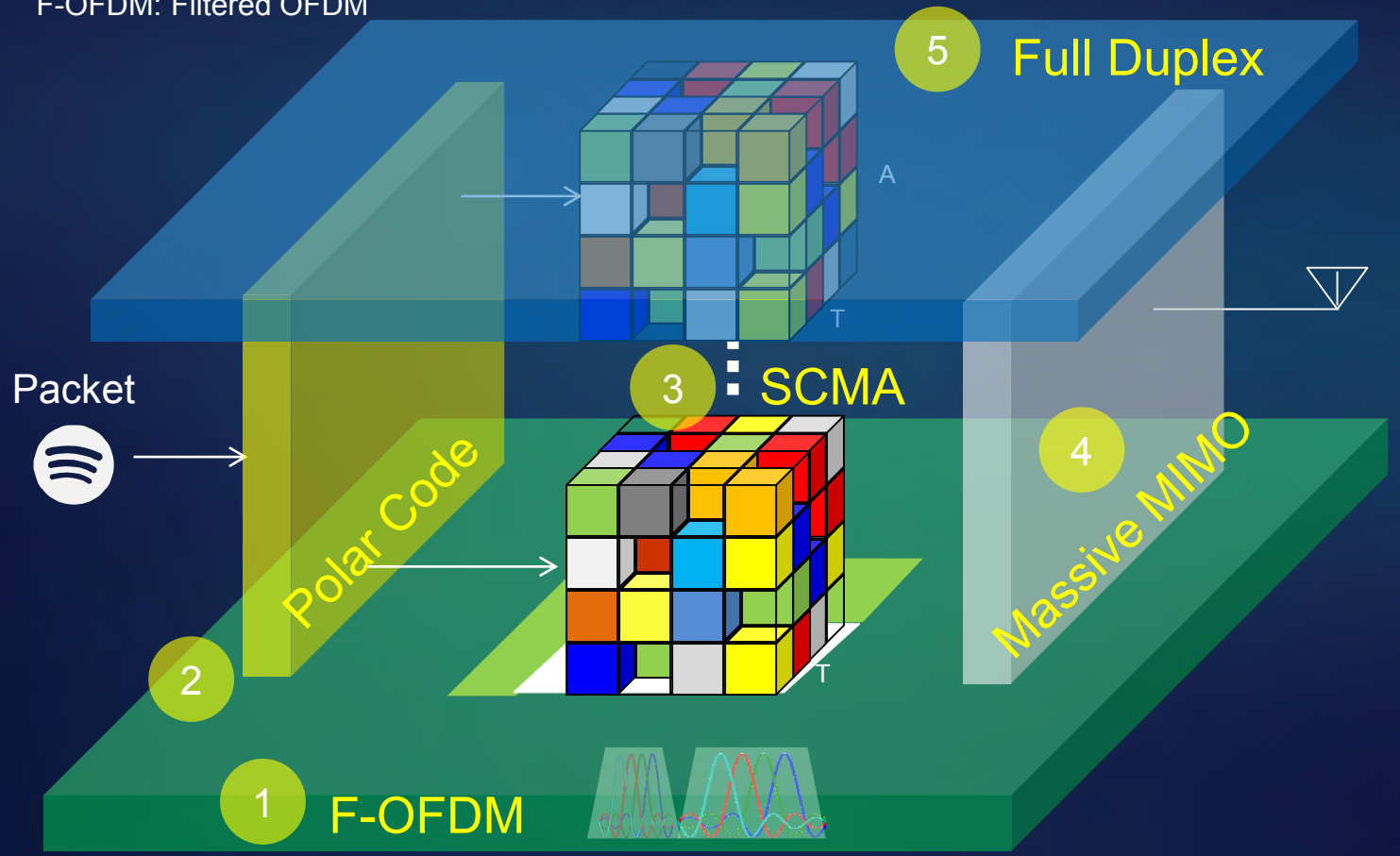
uRLLC



mMTC

5G New Air Key Enabling Technologies

SCMA: Sparse Code Multiple Access
F-OFDM: Filtered OFDM



1 F-OFDM

- Multi services co-existence in the same carrier
- Flexible numerology without guard band

2 Polar Code

- Approach Shannon Limit
- No error floor & High reliability
- Better gain compared with LTE Turbo Code

3 SCMA

- Overloading to increase overall data rate and connectivity
- Grant free to shorten latency
- Low PAPR code book for MTC power saving

Schedule Milestone of 5G Radio Test Bed

5G Radio Test Bed			
2014	Lab Test	• Low band: > 10Gbps • High Band: >115Gbps
2015~2016	Field Test	• New air interface field trial (F-OFDM /SCMA/Polar Code/MU-MIMO/Full Duplex) • High band field trial (70Gbps) • High band & low band hybrid networking
2017~2018	Pre-Commercial Trials	• Field Trial with strategic partners

5G Multi-User Field Trial

World's First Large Scale Trial

China • Chengdu

SCMA

UL 3X connections
DL >1.5X throughput

F-OFDM

Saving guard band
Asynchronous transmission

Polar Code

0.5~2dB gain compared with
LTE Turbo Code

MU-MIMO

24 layers
3.6Gbps Peak Rate

24 TUE

Sub6GHz

100MHz

NTT docomo

Deutsche Telekom & Huawei: Set New 5G Record @ mmWave

70Gbps

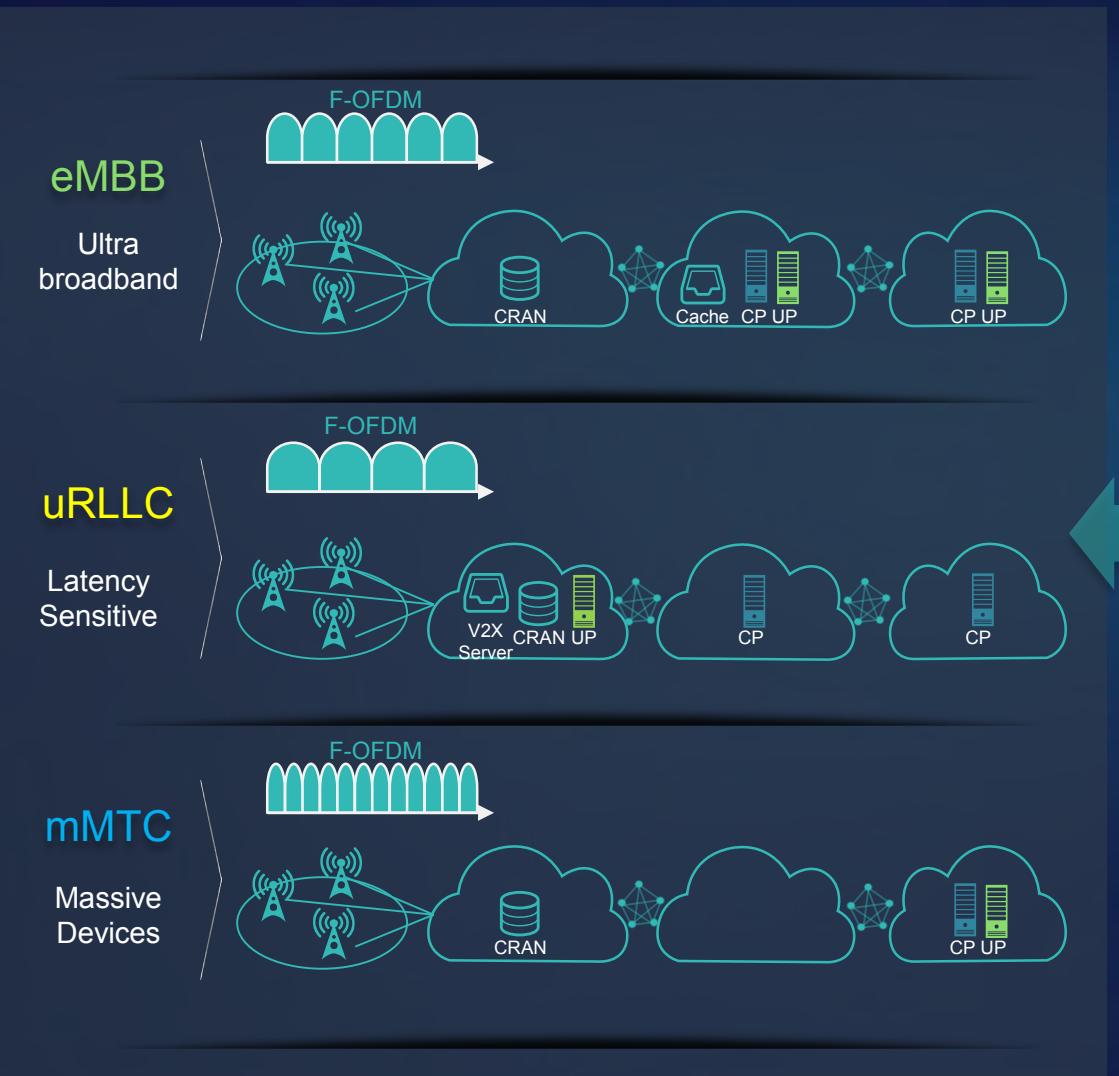
1.8GHz BW @ E-band

Multi-User MIMO

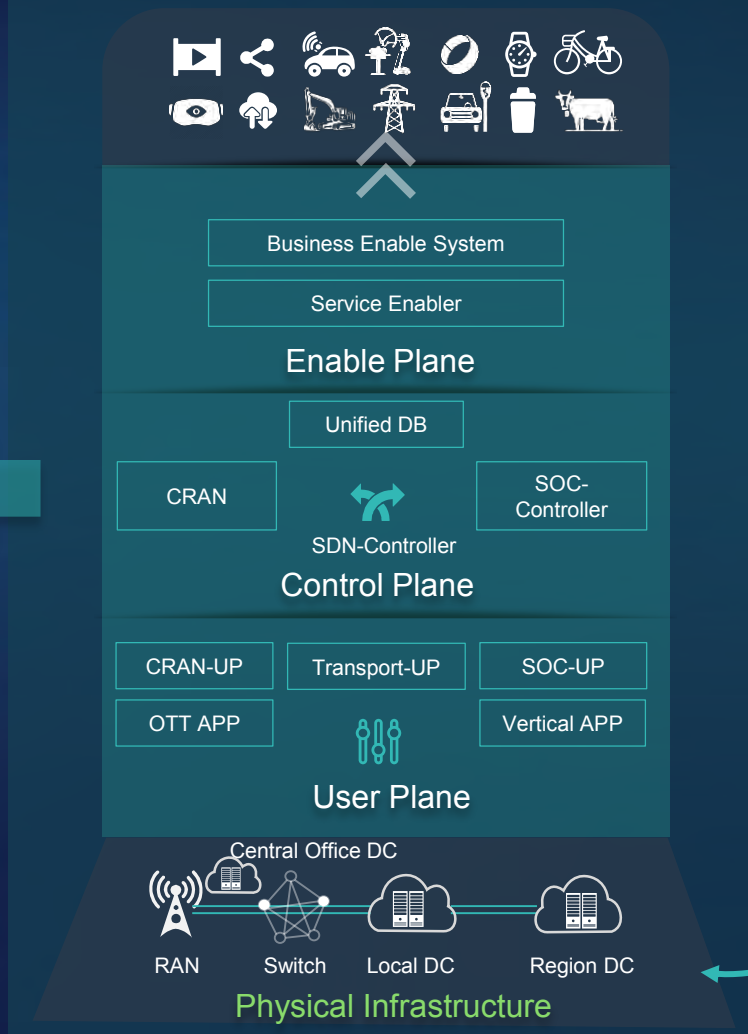
NLOS&LOS

Dynamic Beam Tracking

5G Network Architecture for E2E Network Slicing



Adaptive Radio as a Service



Cloud-Native Architecture

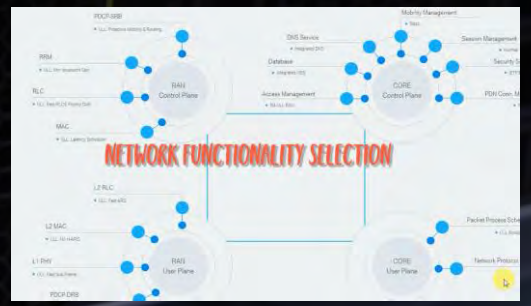
Self-Service Agile Operation

DT & Huawei: World's First 5G E2E Slicing Prototype

- **C/U decoupling**
- **Network functions programmable**
- **Ultra low latency & high throughput scheduling**

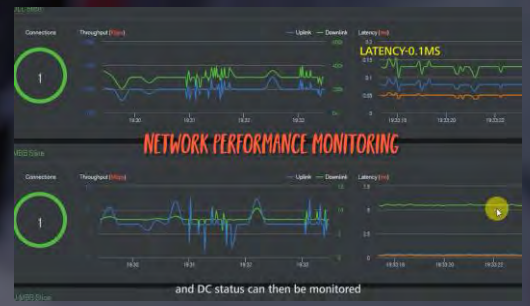
Ultra low latency & high throughput network slices

Purchasing



Orchestration

Deployment

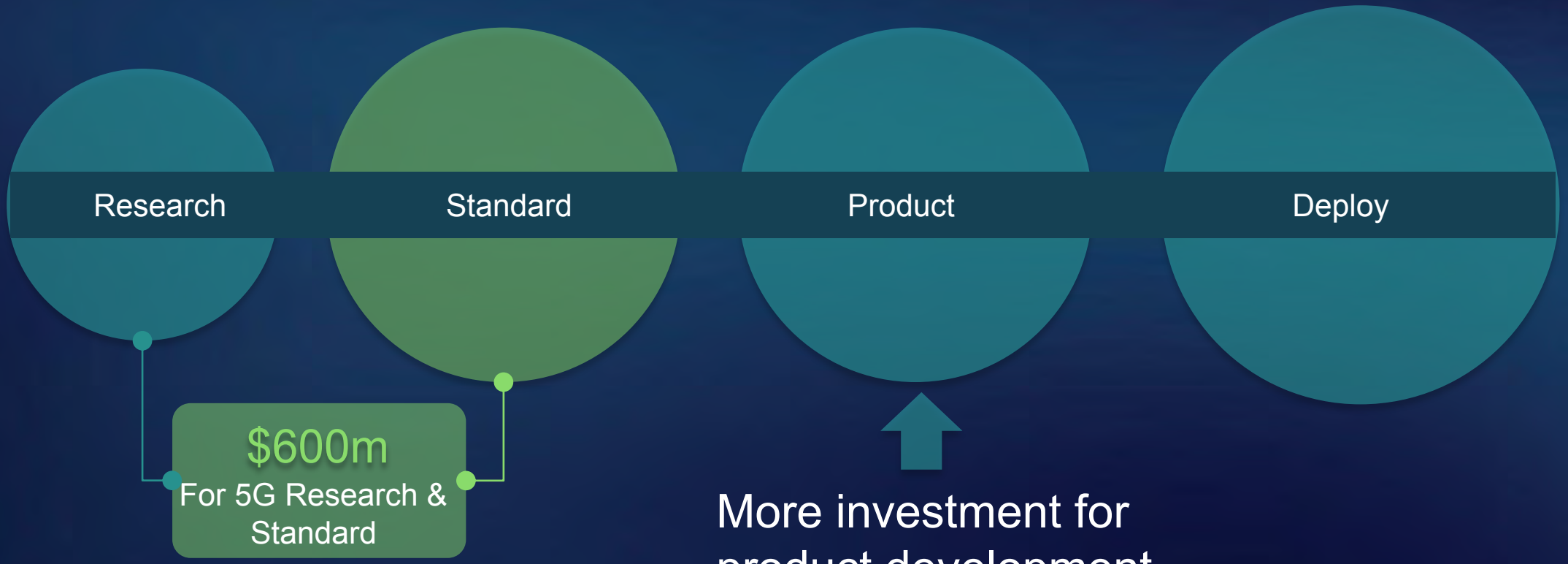


Monitoring

Contents

Huawei 5G Research Investment

Huawei began 5G research in 2009 at the launch of the world's first commercial LTE network



Open Collaboration for Global Unified Standard

Industry Collaborations

Europe

- 5G PPP — Board Member
- 5G Innovation Center — Key Founder
- 5G VIA — Key Founder

Asia

- IMT-2020 — Board Member (China)
- 5GMF — Leading R&D Partner (Japan)
- 5G Forum — Leading R&D Partner (Korea)

Operator Collaborations

- ngmn — Leading R&D Partner
- etisalat, NTT docomo, T-..., vodafone
- 中国移动 China Mobile, Telefonica, TeliaSonera
- LG U+, kt, Singtel, МегаФон
- ... 20+ operators

5G Research Centers (11)

- Stockholm, Sweden
  - •System Architecture
  - •Algorithms
- New Jersey, USA
  - •5G Transmission
- Paris, France
  - •Standardization
- Ottawa, Canada
  - •5G Radio
  - •Network Architecture
- Munich, Germany
  - •Verticals
- Moscow, Russia
  - •Fundamental Algorithms
- 5G Research Centers in China
  - •Shenzhen
  - •Shanghai
  - •Cheng du
  - •Beijing
  - •Hangzhou

Contributions to 5GPPP Flagship Program

METIS-II :
Mobile and wireless communications Enablers for 2020 Information Society-II

FANTASTIC-5G :
Flexible Air interface for scalable service delivery within wireless communication networks of the 5th Generation

mmMAGIC:
Millimeter-wave based mobile radio access network for Fifth Generation Integrated Communications

5G-Xhaul:
Dynamically reconfigurable optical-wireless backhaul/fronthaul with cognitive control plane for small cells and cloud-RANs

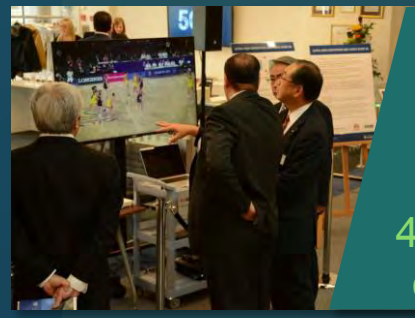
5GEX:
5G Exchange

Founding 5GIC with UK Top Operators

5G Innovation Center

Together with UK Top Operators

Largest- scale 5G Air Interface Field Trail in Europe



15th Sep, 15

4K Video over 5G

London

SCMA for IoT

Huawei Won the World's First 5G Award

Jun, 2015

"Biggest Contribution to 5G Development"

"Huawei is spending considerable effort and funds for 5G and is making significant advances in R&D, particularly in air interface and test bed developments. This award recognizes Huawei's continuous efforts for innovation and R&D excellence and acknowledges the vendor's standardization activities."

—Dimitris Mavrakis, Principal Analyst at Ovum and one of this year's award judges commented

Thank you