5G – Beyond speed into a new paradigm

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Alex Jinsung Choi
CTO, EVP and
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SK Telecom

SK Telecom's View on 5G Values and Technologies

Dr. Alex Jin-sung Choi

CTO & Head of Corporate R&D Center

SK Telecom, Korea

5G promises differentiated values in addition to being "just fast"

5G is more than "just fast" network. Key distinguished values are 1) customer experience enhancement, 2) new business opportunity, and 3) efficient & intelligent operation

Customer Experience Enhancement

VR/AR
UHD Multimedia
Immersive Displays

New Business Opportunity

Massive IoT
Mission-critical IoT
Autonomous Driving
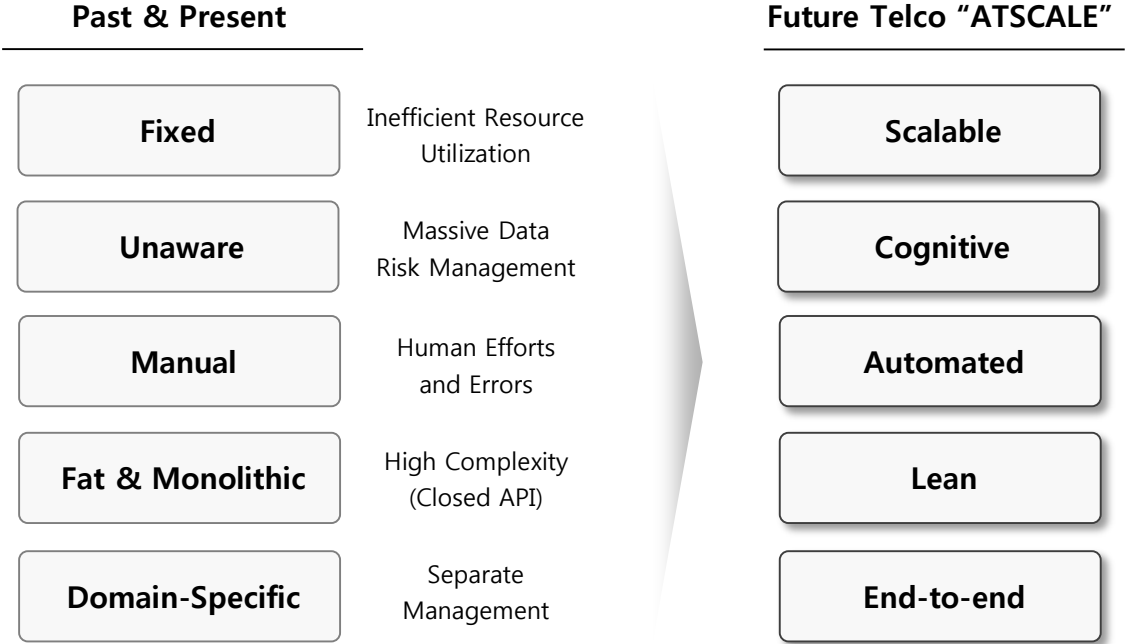Enterprise Solutions

Efficient and Intelligent Operation

Cognitive Operation
TCO Reduction
Green

Mobile network must be re-architected to offer distinguished values

Static and monolithic mobile network is no longer viable.
Distinguished 5G values can be efficiently offered via new Telco architecture at scale.

Past & Present		Future Telco "ATSCALE"
Fixed	Inefficient Resource Utilization	**Scalable**
Unaware	Massive Data Risk Management	**Cognitive**
Manual	Human Efforts and Errors	**Automated**
Fat & Monolithic	High Complexity (Closed API)	**Lean**
Domain-Specific	Separate Management	**End-to-end**

SK Telecom Proprietary 2016

Architecture design principles for mobile architecture ATSCALE

Monolithic functions shall be unbundled to smallest meaningful open s/w modules, which are intelligently orchestrated inside All-IT based cloudified environment

"Unbundling"

- Software/Hardware Decoupling
- Unbundled Function Blocks
- Control-/User-plane Separation

"Open"

- Open Source Software (OpenStack, ONOS)
- Open Hardware (OCP, TIP)
- Open Interface (Fronthaul, API)
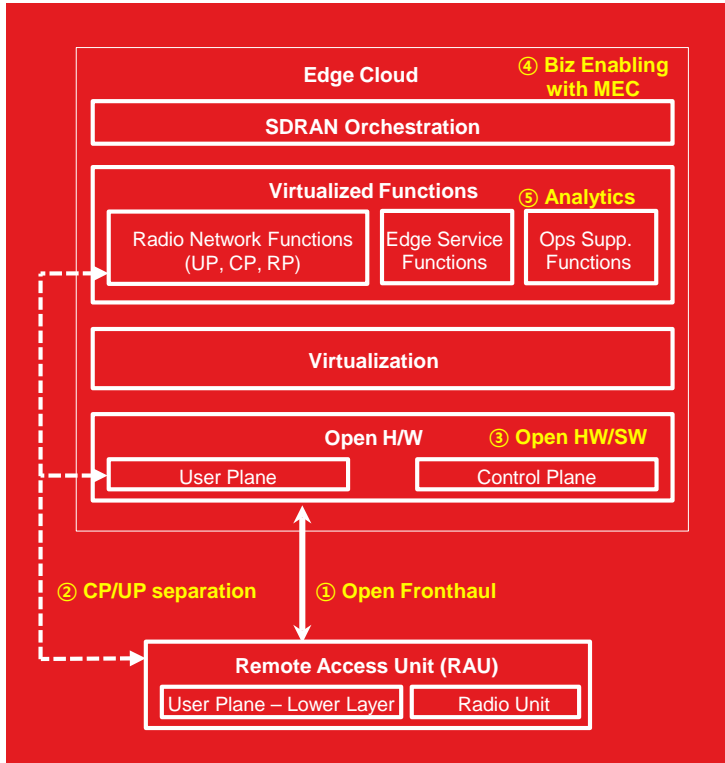
"Softwarization"

- NFV (Network Functions Virtualization)
- SDN (Software Defined Networking)
- Orchestration & Network Slicing (XaaS)

"Cloudification"

- Cloud-based "All IT" Infra
- SDN-enabled Fabric
- Re-architecting as a Data Center

SDRAN (Software-Defined RAN) - ATSCALE

To realize cost-effective telecommunication infrastructure offering differentiated 5G values, architecture must also evolve to be open and programmable

Edge Cloud

④ **Biz Enabling with MEC**

SDRAN Orchestration

Virtualized Functions

⑤ **Analytics**

- Radio Network Functions (UP, CP, RP)
- Edge Service Functions
- Ops Supp. Functions

Virtualization

Open H/W

③ **Open HW/SW**

- User Plane
- Control Plane

② **CP/UP separation**   ① **Open Fronthaul**

Remote Access Unit (RAU)

- User Plane – Lower Layer
- Radio Unit

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① Open Fronthaul and modular RAU
- Open fronthaul for flexible RAN function split
- Standard interface for RAU

② CP/UP separation through standard interface
- UP in dedicated H/W and CP in virtualized func
- Standard and open interface between UP/CP

③ Open H/W and S/W
- Whitebox, Bare-metal, OCP-based H/W
- Openstack-based S/W

④ MEC
- Proximity-based Mobile Edge Services
- E2E Network Slicing incl. RAN, Transport, Core

⑤ Analytics-based SON

Telecom Infra Project

Telecom Infra Project (TIP) started in February 2016 to Rebuild the telecom infrastructure together for a sustainable future
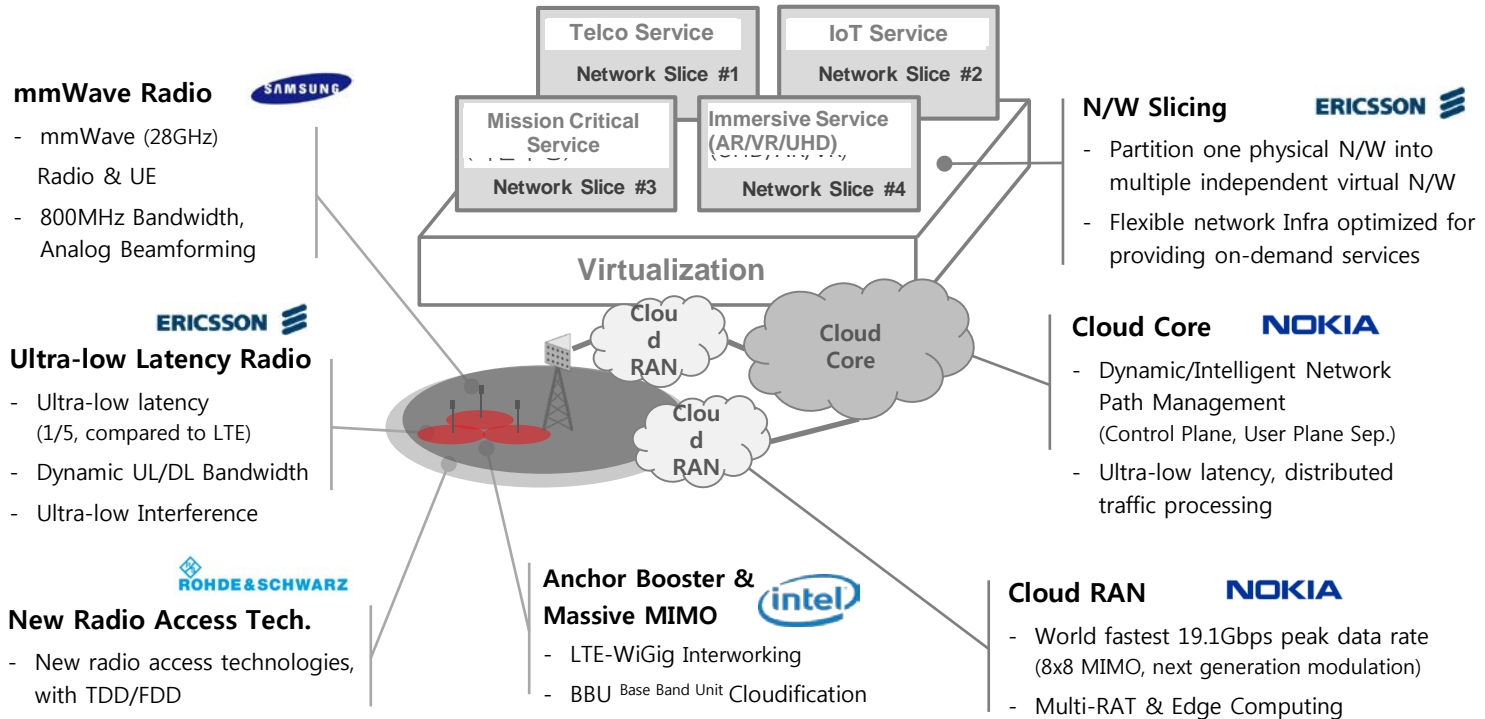
TELECOM INFRA PROJECT

Membership Momentum

facebook · Deutsche Telekom · SK telecom · intel · NOKIA · EE · Globe · axiata · Telefónica · vodafone · ACACIA · ADVA Optical Networking · BLUESTREAM · BROADCOM · Coriant · Deloitte · indosat ooredoo · JUNIPER · LUMENTUM · MTN

Project Groups

Access	Backhaul	Core & Management
System integration and site optimization	High-frequency automatic access	Core network optimization
Unbundled solutions	Open optical packet transport	Greenfield telecom networks
Media-friendly solutions		

SK Telecom

5G R&D activities

To maximize synergy across various global leaders and facilitate 5G R&D, SK Telecom founded 5G test-bed to be used as outpost for global 5G R&D and fostering ecosystem


mmWave Radio SAMSUNG

- mmWave (28GHz) Radio & UE
- 800MHz Bandwidth, Analog Beamforming

Ultra-low Latency Radio ERICSSON

- Ultra-low latency (1/5, compared to LTE)
- Dynamic UL/DL Bandwidth
- Ultra-low Interference

New Radio Access Tech. ROHDE&SCHWARZ

- New radio access technologies, with TDD/FDD

Telco Service
Network Slice #1

IoT Service
Network Slice #2

Mission Critical Service
Network Slice #3

Immersive Service (AR/VR/UHD)
Network Slice #4

Virtualization

Cloud RAN

Cloud Core

Cloud RAN

Anchor Booster & Massive MIMO (intel)

- LTE-WiGig Interworking
- BBU Base Band Unit Cloudification

N/W Slicing ERICSSON

- Partition one physical N/W into multiple independent virtual N/W
- Flexible network Infra optimized for providing on-demand services

Cloud Core NOKIA

- Dynamic/Intelligent Network Path Management (Control Plane, User Plane Sep.)
- Ultra-low latency, distributed traffic processing

Cloud RAN NOKIA

- World fastest 19.1Gbps peak data rate (8x8 MIMO, next generation modulation)
- Multi-RAT & Edge Computing

Innovative future services

Virtual experience room demonstrates and offers personal experiences on state-of-the-art AR/VR and innovative future devices and services including 5G

5G Based Live Production

Remote production of Sony's next generation 4K IP contents connected to 5G network
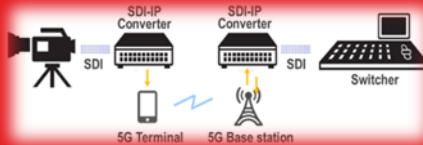
5G Robot

5G robot in action at disaster scene by remotely controlling the robot connected to 5G network

T-AR for Tango

3D space-awareness AR technologies, jointly developed by T-AR platform & Tango (Google)

Remote AR

Real-time AR-based workspace for remote work collaboration

Beyond Surface

World's first multi-user / multi-IO tabletop with optimized tabletop OS

Immersive Experience Room

Immersive services and entertainments based on ultra short throw projector

Magnus Ewerbring
Vice President, CTO Asia Pcific
Ericsson

2021 OUTLOOK

9B
mobile subscriptions

15B
IoT connections

28B
Connected devices

Source: Ericsson Mobility Report Jun 2016

5G
USE CASES

SENSORS EVERYWHERE

BROADBAND AND MEDIA EVERYWHERE

SMART VEHICLES, TRANSPORT

INFRASTRUCTURE, MONITOR AND CONTROL

CRITICAL CONTROL OF REMOTE DEVICES

INTERACTION HUMAN-IOT

5G
FOR
INDUSTRIES

Source: Scania

Source: ABB

Source: SKF

Source: Boliden

Dr. Hiroshi Nakamura
Senior Vice President and General
Manager of R&D strategy department
NTT DOCOMO
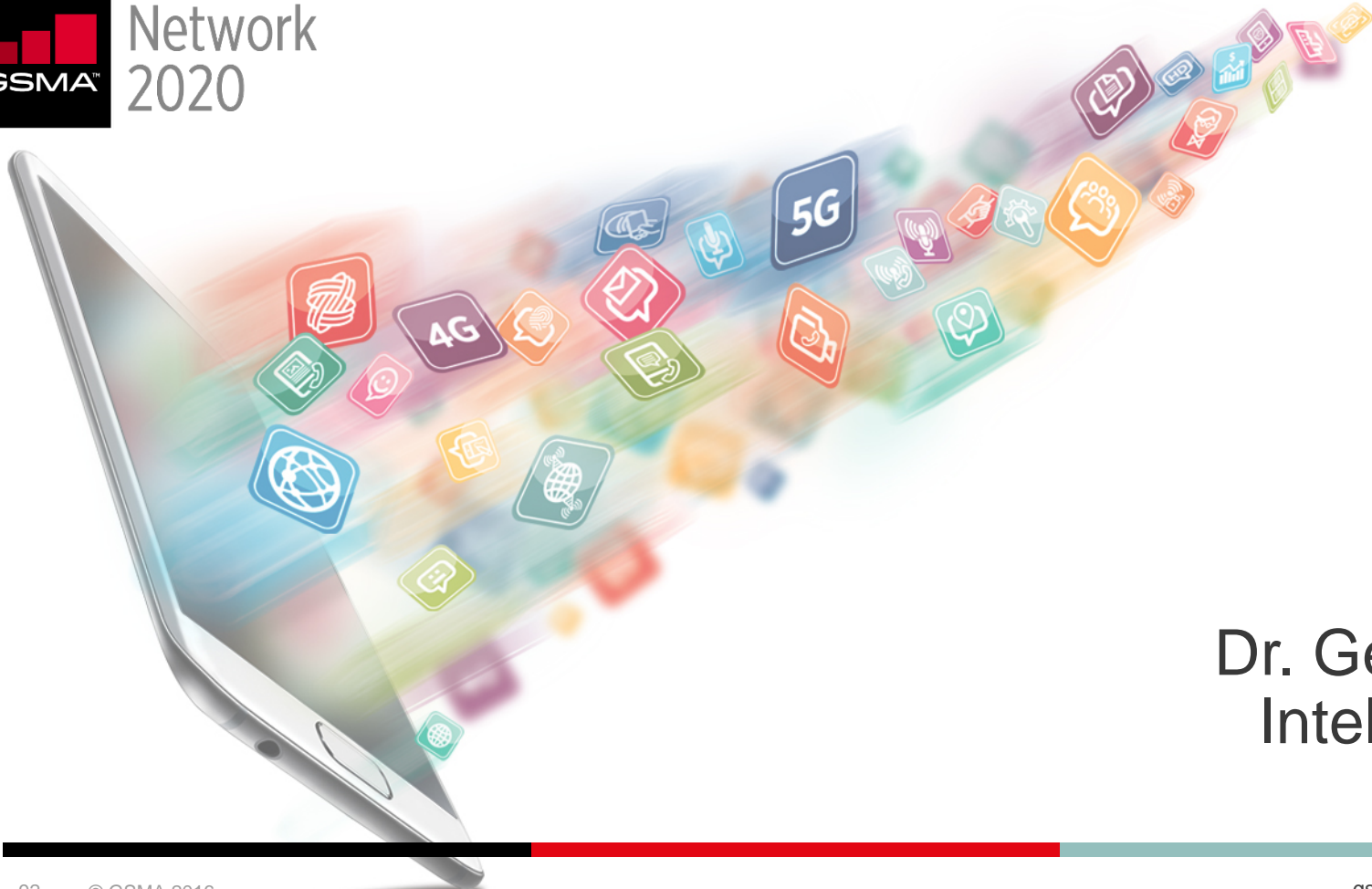
Dr. Geng Wu
Intel Fellow
Intel

THE ROAD TO 5G: FROM DEVICES TO NETWORKS

June 28th, 2016

Dr. Geng Wu, Intel Fellow

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Intel view of 5G

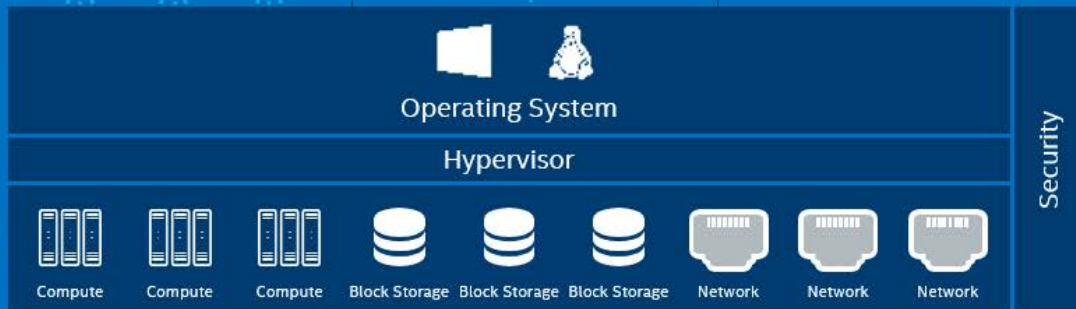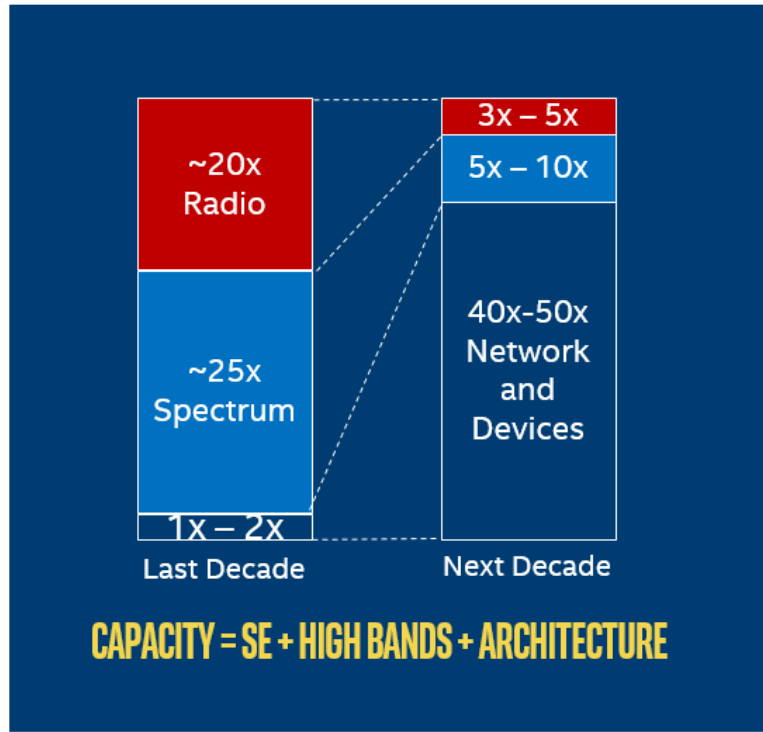| SMART DEVICES | RADIO ACCESS TECHNOLOGY | NETWORK INFRASTRUCTURE | CORE NETWORK | CLOUD |

Radio Access Technology
- 5G — Cellular* + WiFi
- 4G — licensed + unlicensed
- 3G/2G

Integrated heterogeneous connections

IoT

Network Infrastructure
- Small cells
- C-RAN (Remote Radio Heads)

Core Network
- Network function virtualization
- SDN

Operating System

Hypervisor

Compute   Compute   Compute   Block Storage   Block Storage   Block Storage   Network   Network   Network

Security

INTEL POWERS THE END-TO-END NETWORK FROM DEVICE TO CLOUD: UNLEASHING TOMORROW'S USE CASES

(intel)

Technology is at a turning point...

CAPACITY = SE + HIGH BANDS + ARCHITECTURE

~20x Radio
~25x Spectrum
1x – 2x
Last Decade

3x – 5x
5x – 10x
40x-50x Network and Devices
Next Decade

1x Smart Phones
10x – 100x Smart Things

DEVICES = PHONES + THINGS + MOVING NODES

(intel)

Future spectrum usage

| CELLULAR | HIGH FREQUENCY < 40GHZ | HIGHER FREQUENCY < 100GHZ |

Licensed + Unlicensed + Licensed–Shared

CARRIER + ENTERPRISE + INDUSTRY + HOME + CONSUMER

Demanding tasks for the industry

Applications
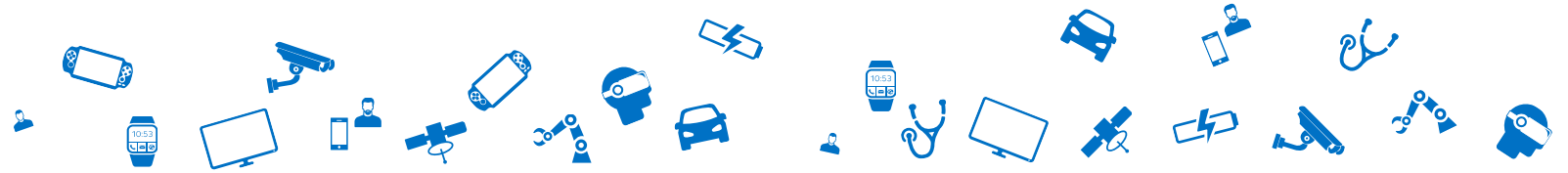
Network

Air interface

3. Business challenges e.g. business models for verticals and IoT

1. Higher performance e.g. enhanced mobile broadband

2. Technology challenges e.g. fundamental tech for mmWave

Expanding standardization models

New model
Cross industries
Open industry implementation
Virtualization technologies

Traditional model
Edge cloud/tight device coupling
New bands/new air interface
Underlay network clusters

Logos shown represent categories of common Internet content and are used for conceptual illustration only.

Intel 5G channel measurement and modeling

Focus on Temporal/spatial consistency and blockage model
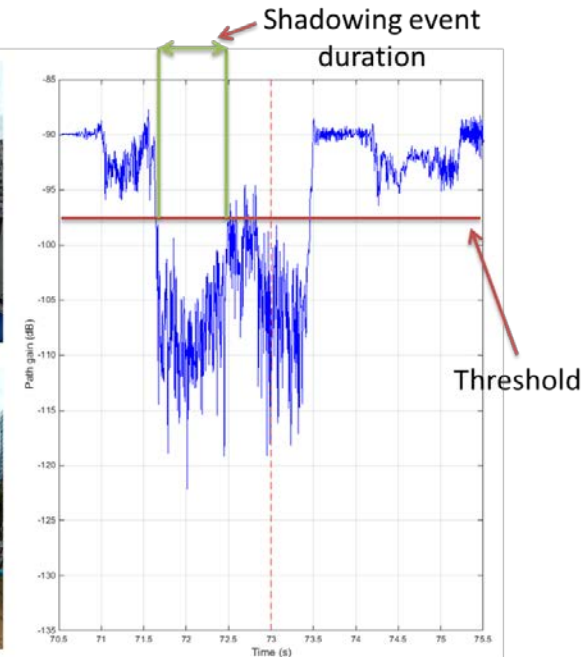
Intel mobile trial platform (4GHz/28GHz) for UE
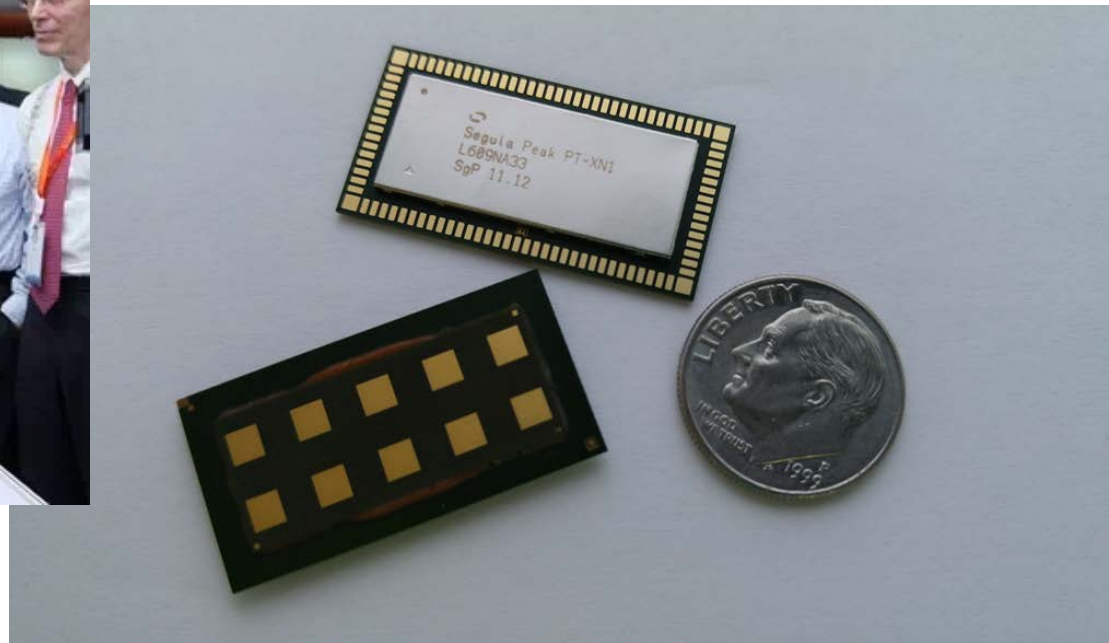
Intel modular RFEM (60GHz) for small cells

Antenna Side

Shield Side
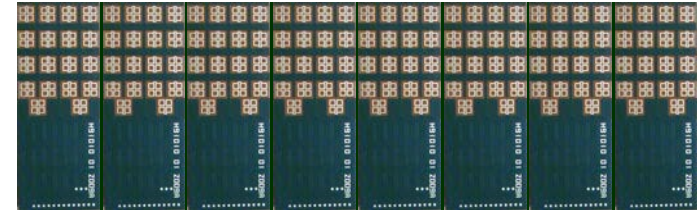
60GHz Operation

16 Elements

25.2 mm x 9.8 mm
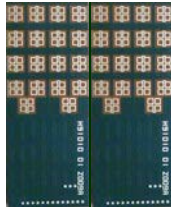
16 elements   **32 elements**   **64 elements**   **128 elements**   **128 elements**
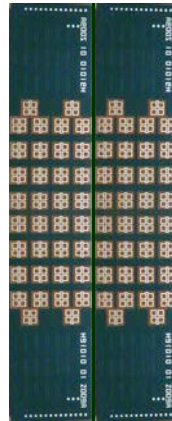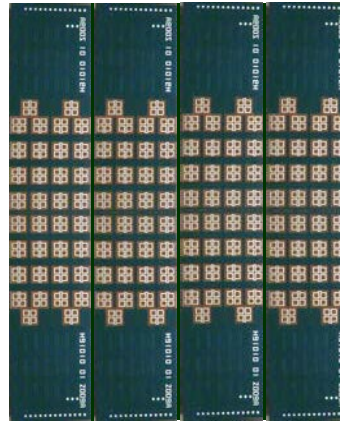
5G technology goals

Applications

Sliceable Application
New Applications and Unprecedented UX

Network

Sliceable Network
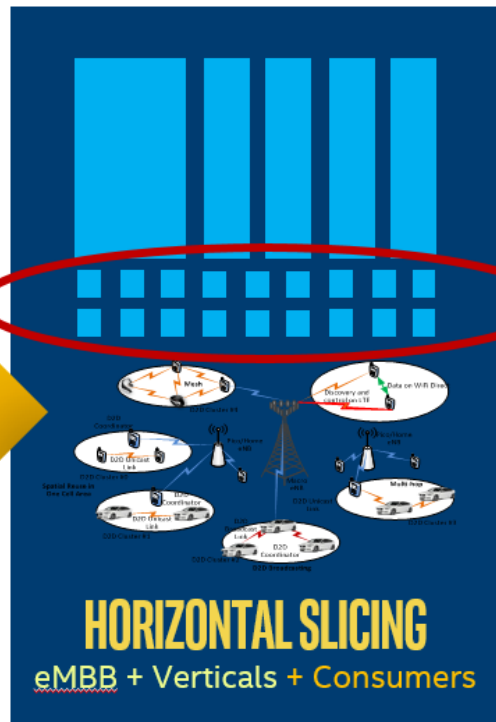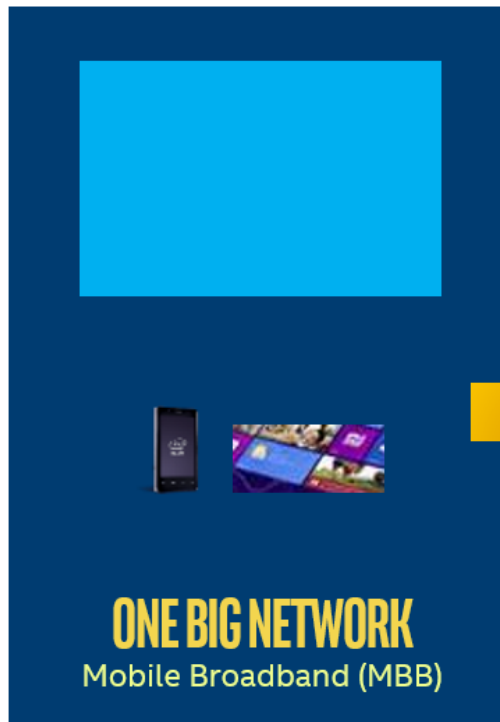Networking + Computing + Storage

Air interface

Sliceable Air Interface
eMBB + mMTC + URLLC

Future networks and devices

intel®

Thank You!

GSMA Network 2020

Shaping the next generation in mobile

Audience questions