



**KEYSIGHT
WORLD 2020**

Track A: 5G Test Tomorrow's Technology Today and Get a Head Start on 6G

General Manager, Greater China Wireless Application Engineering, Keysight Technologies

Jeffrey Chen 陳俊宇

Racing to Realize the Vision of 5G

WHERE WE HAVE BEEN AND WHAT'S NEXT?

5G PHASES

2010 - 2015

Research

2016 - 2019

Prototyping, Standards and Trials

2020 – 2025+

Commercialize, Deploy & Ramp



Enhanced Mobile
Broadband



— Gigabytes in seconds



— 4K Streaming



— Augmented Reality



— Industry Automation



— Mission Critical Applications



— Self Driving Car

Massive Machine
Type Communication

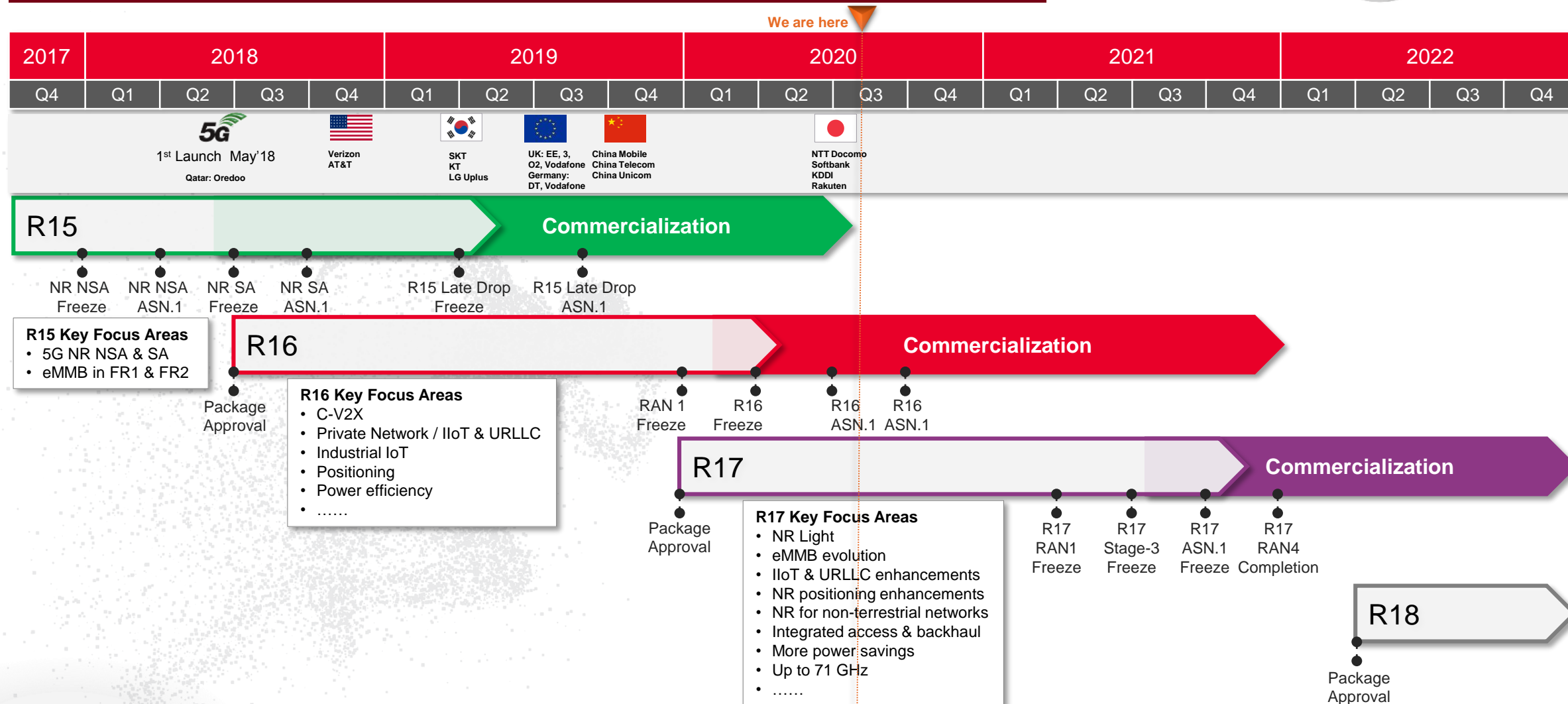
Smart
City

Smart
Home

Ultra Reliable & Low
Latency Communications

Deploying 5G NR as Standards Advance

COVID-19 DID CHANGED SOMETHING



3GPP 5G NR Release 16 Summary from 3GPP TR 21.916

FOCUS ON VERTICAL EXPANSION & EFFICIENCY

- Enhancement of Ultra-Reliable (UR) Low Latency Communications (URLLC)
- 5GS Enhanced support of Vertical and LAN Services
- Cellular IoT support and evolution
- Advanced V2X support
- 5G Location and Positioning Services
- UE radio capability signaling optimization
- Satellite Access in 5G
- Enablers for Network Automation Architecture for 5G
- Wireless and Wireline Convergence Enhancement
- Mission Critical, Public Warning, Railways and Maritime
- Streaming and TV
- User Identities, Authentication, multi-device
- Slicing
- Other cross-TSG Rel-16 Features
 - Single Radio Voice Continuity from 5GS to 3G
 - Access Traffic Steering, Switch and Splitting support in the 5G system Architecture
- Radio Features
 - NR-related Release 16 Features
 - Release 16 Features impacting both LTE and NR
 - LTE-related Release 16 Features
- All other Release 16 Features
 - Energy Efficiency of 5G
 - Usage of CAPIF for xMB API
 - OAM aspects of LTE and WLAN integration
 - Volume Based Charging Aspects for VoLTE
 - Charging Enhancement of 5GC interworking with EPC
 - Service Interactivity
 - RTCP Verification for Real-Time Services
 - Stage-3 SAE Protocol Development for Rel16
 - IMS Stage-3 IETF Protocol Alignment
 - Reliable Data Service Serialization Indication
 - Shared Data Handling on Nudm and Nudr
 - Remote Identification of Unmanned Aerial Systems

3GPP 5G NR Release 17 Plans

FROM RP-193216 RAN1, RAN2 & RAN3 ACTIVITIES



New Stuff & Verticals

- Study Items
 - NB-IoT/eMTC over NTN
 - NR Sidelink relay
 - NR Positioning enhancement
 - NR XR
 - RAN slicing
 - Study enhancements for 52.6 ~ 71 GHz with existing waveform
- Working Items
 - NR over NTN
 - Extending current NR operation up to 71 GHz
 - IAB
 - NR Sidelink enhancement
 - NR Multicast broadcast
 - Industrial IoT / URLLC
 - NB-IoT/eMTC enhancement

Fixing Things

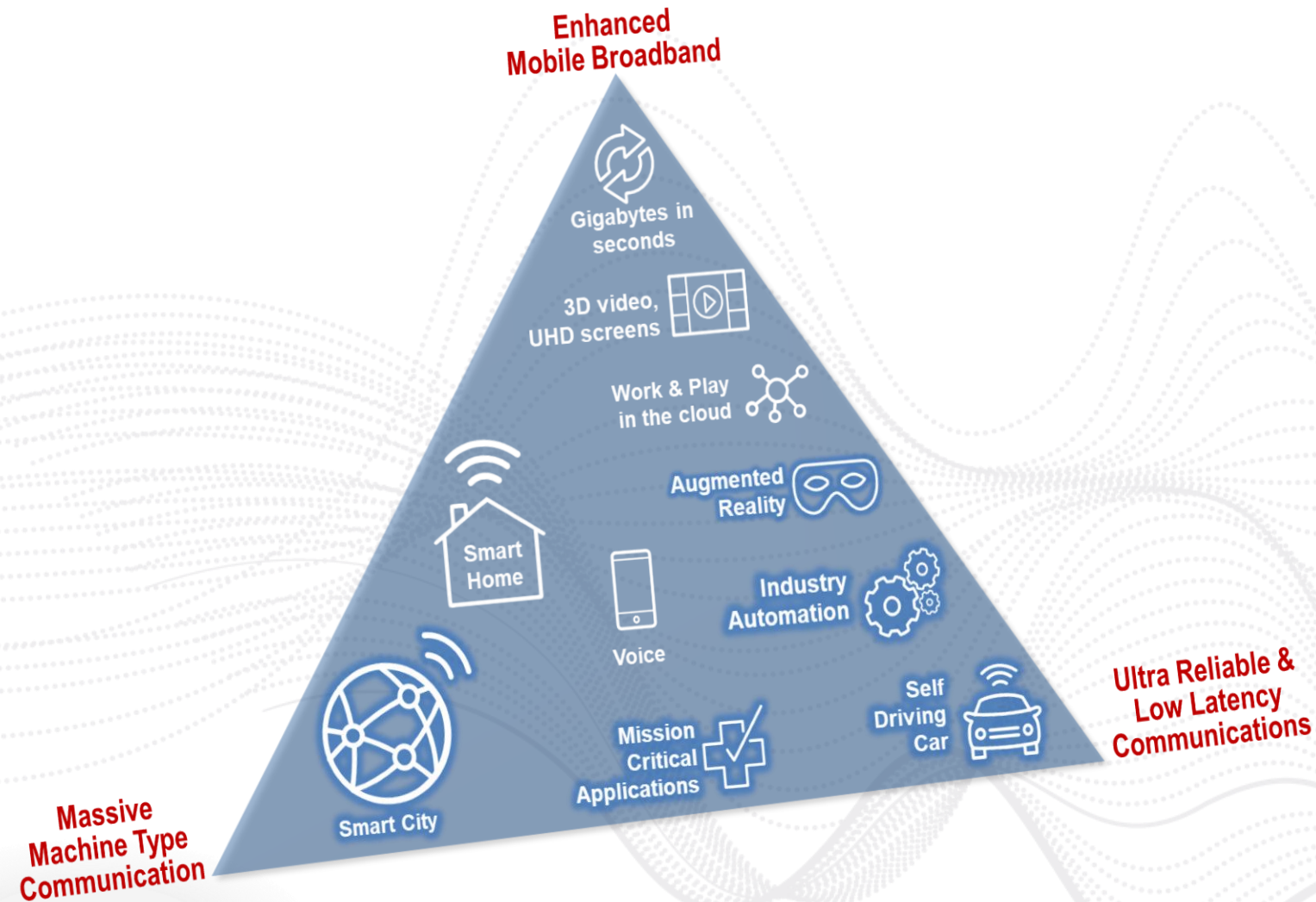
- Study Item
 - NR Light
 - NR MIMO
 - NR Coverage
- Working Item
 - UE Power saving
 - Multi-SIM
 - Small data
 - SON MDT

Others

- Study Item
 - NR QoE
- Working Item
 - Dynamic Spectrum sharing
 - Multi-radio dual connectivity
 - Enhanced eNB architecture

From 5G NR Release 15 Toward Release 16 & 17

IMT-2020 USAGE SCENARIO PERSPECTIVES



Operation Efficiency

Further improvement on capability of smarter 5G network operation & management with Big Data, Integrated access and backhaul, Non Public Private Networks,.....

Capacity Efficiency

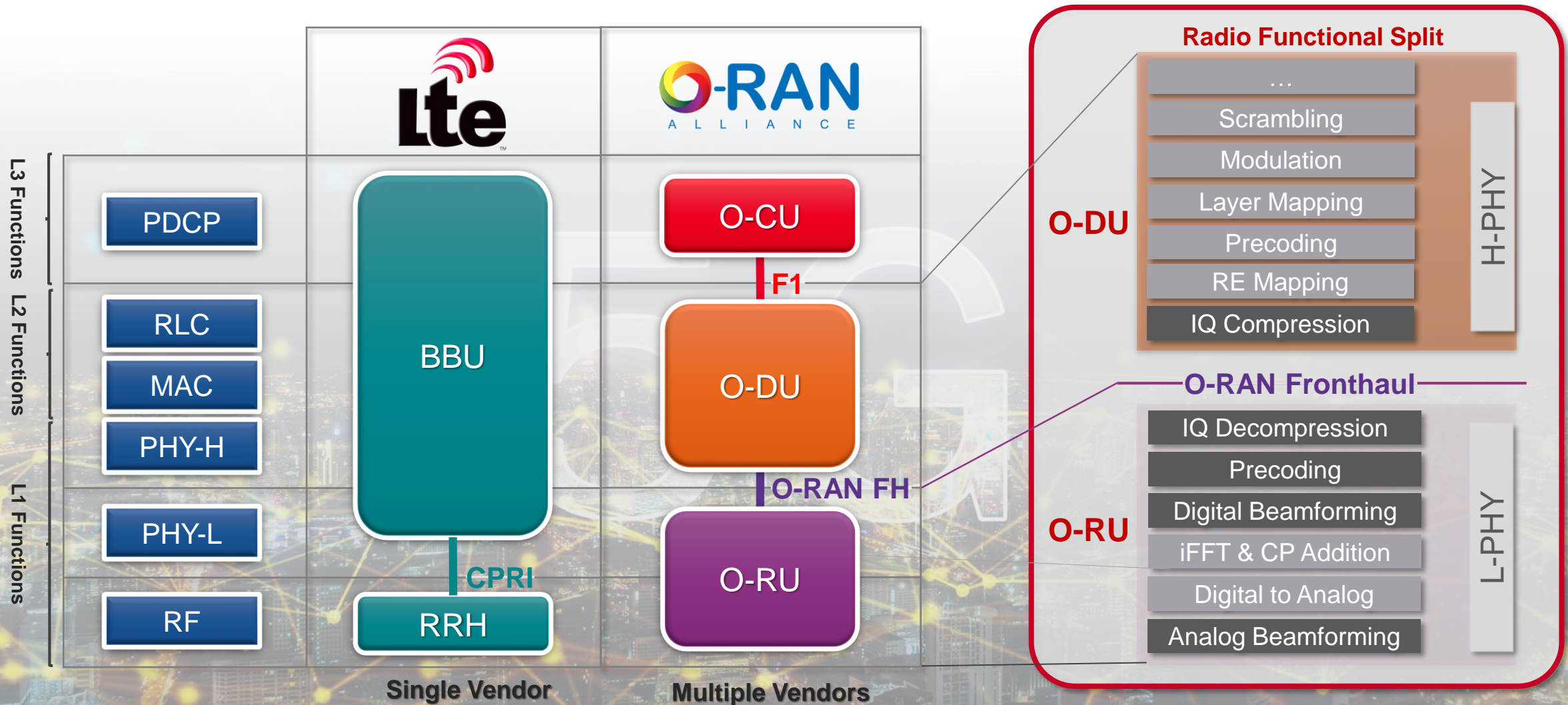
Further enhance and extend capacity, coverage and efficiency with more power saving, enhanced MIMO, multi-beam management, uplink coverage,.....

Vertical Expansion

More vertical expansion in Industrial IoT, Ultra Reliability, Low Latency, Positioning, Time-Sensitive Network, Vehicle to Everything, Unlicensed band,.....

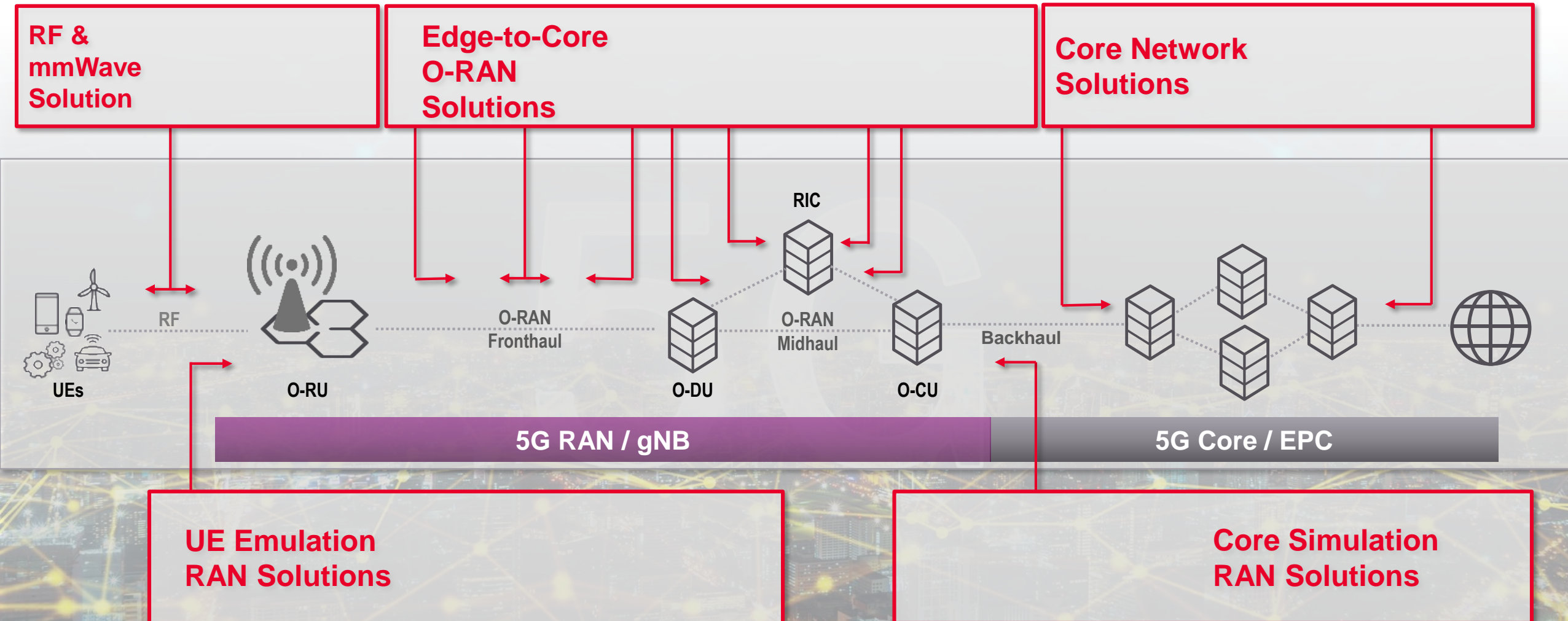
gNB Disaggregation with Functional Splits

OPEN RAN ARCHITECTURE









Keysight 5G Radio Access & Core Network Test Portfolio

ENABLING END TO END TESTING



“Cellular” Communications

EVOLUTION OF EXPECTATIONS

1980s	1990s	2000s	2010s	2020s	2030s
1G Carry your phone around the country	2G Carry your phone around the world & text	3G Check e-mail from anywhere	4G Surf the web & watch video from anywhere	5G Connect to the digital fabric from anywhere	6G H2M & M2M automation anywhere
					
Mobile Phone	Feature Phone	Smartphone	Smartphones, Hotspots, IoT Sensors	Smartphones, Hotspots, Cars, Robots, Drones, Mass IoT...	Intelligent Devices, Mass M2M
Mobile Voice Calls	SMS, MMS	Mobile Internet, Video Call	Streaming Video, Voice over IP	4K/8K Video, AR & 3D, AI	Holographic, Multi-sense Comms, Real-time Intelligence
Data Rates: 19.2 kbps Transmission: Analog RAT: NMT, AMPS, TACS Multiple Access: FDMA Switching: Circuit Core Network: PSTN Roaming: National	384 kbps Digital GSM, GPRS, EDGE, IS-95 TDMA, CDMA Circuit & Packet PSTN Global	43 Mbps Digital CDMA2000, UMTS CDMA Packet Packet Global	1 Gbps Digital LTE, LTE-A, LTE-A Pro OFDMA Packet Packet Global	20 Gbps Digital NR SA & NSA OFDMA Packet Virtual Global	1 Tbps Digital “ManyNets” Any approach is OK AI-Enabled IP Virtual Global

Carry my Phone

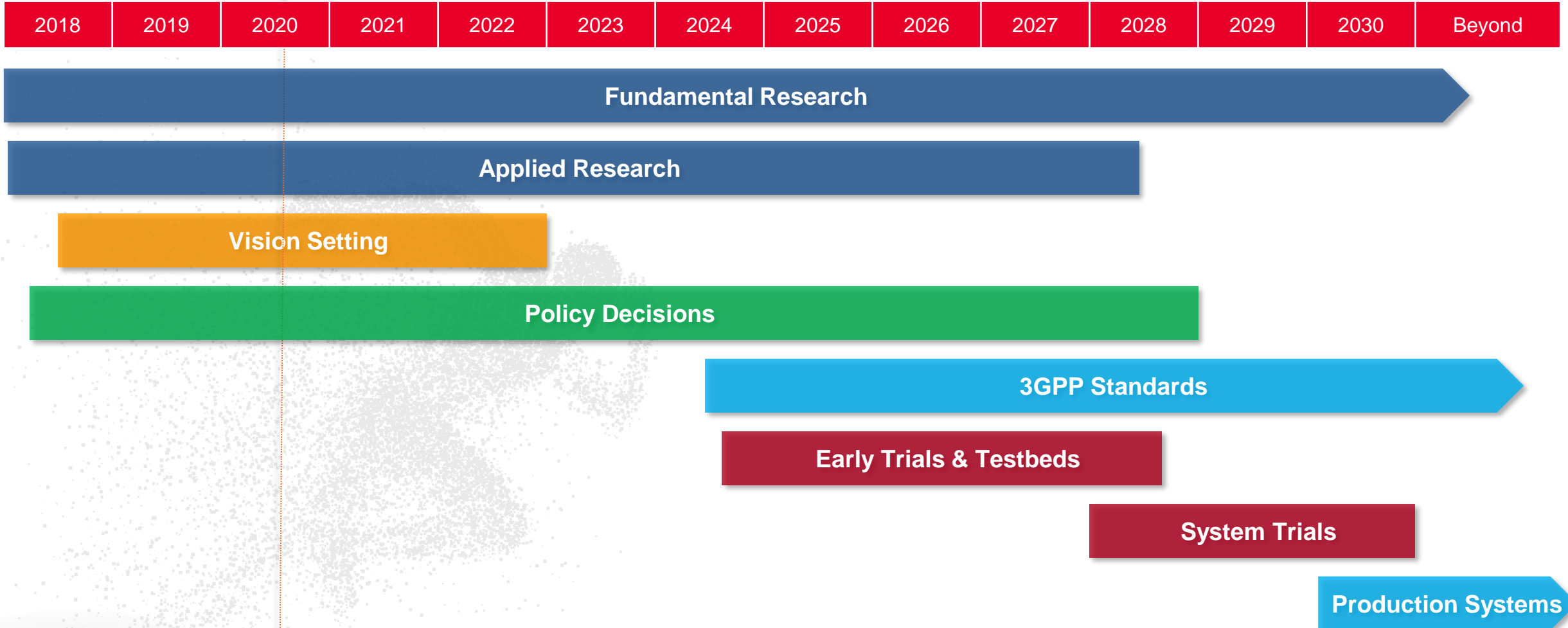
Carry My Office

Integral to Society

6G Timeline

GET A HEAD START ON 6G

We are here



6G Wireless

EVOLUTION OF MEASUREMENT REQUIREMENTS

> 1 Tbps / User



- Simulate/Design/Measure Sub-THz RF
- Baseband: extreme-speed, real-time
- Extreme-speed interconnect (board-to-board)
- Optical WiFi Communications
- Optical Networks: beyond 800G

**Physical
Measurements!**

**Complex Radio Systems
Design and Testing**



- Heterogeneous: WiFi, Cellular, FR1+FR2+FRN
- Test in simultaneous modes
- Design/simulate complex systems
- Extreme power efficiency

**Complex System
Interaction**

**E2E Network Design,
Validation, Optimization**

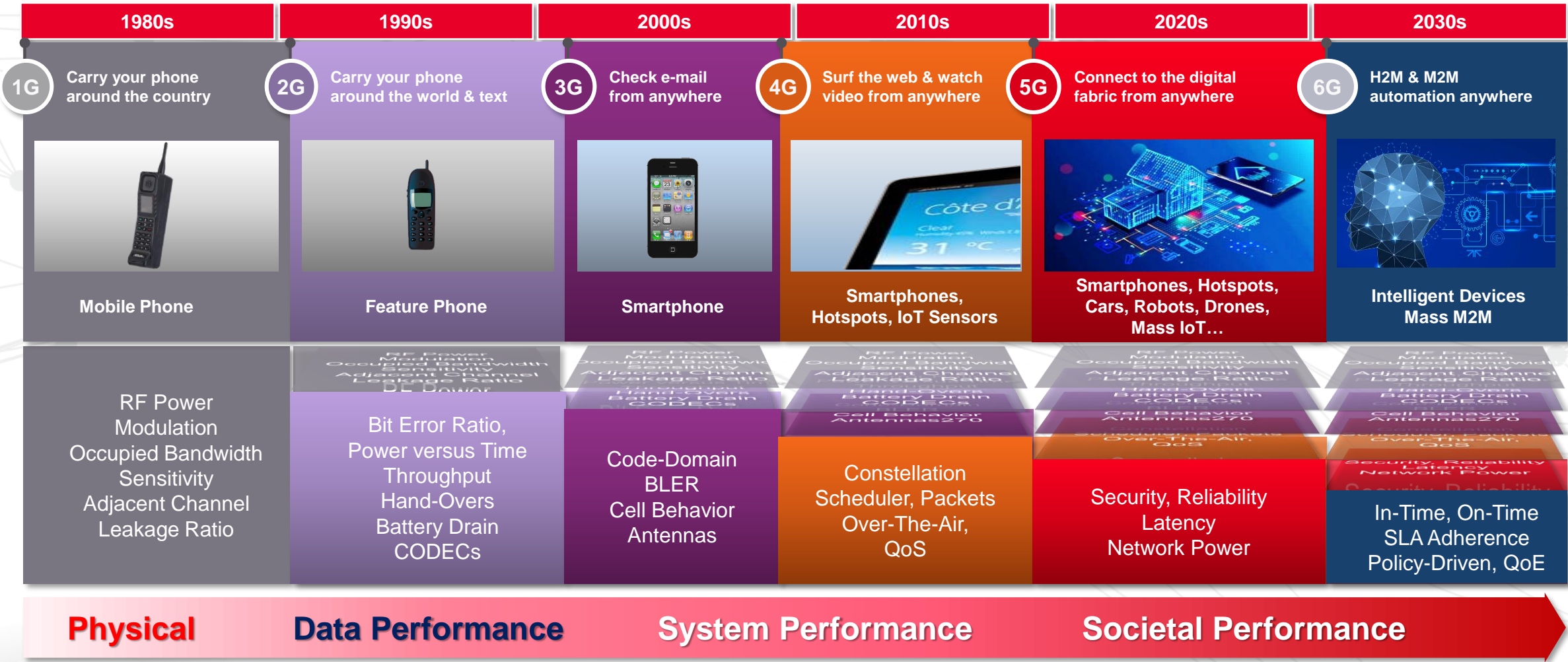


- QoS (quantitative) — Validate SLA
- QoE (qualitative) — Validate SLA
- Security--All facets

**System ↔ Society
Interaction**

Evolving Expectations and Measurement

FROM MEASURING PHYSICS TO MEASURING SYSTEM BEHAVIOR





KEYSIGHT
WORLD 2020

