

6G NETWORK AND AIR INTERFACE FOR MOBILE CONNECTED INTELLIGENCE

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5G JOURNEY

Main theme: eMBB and Verticals

2014

2020

Flexible numerology

Flexible frame structure

mmWave

Massive MIMO

URLLC

TSN

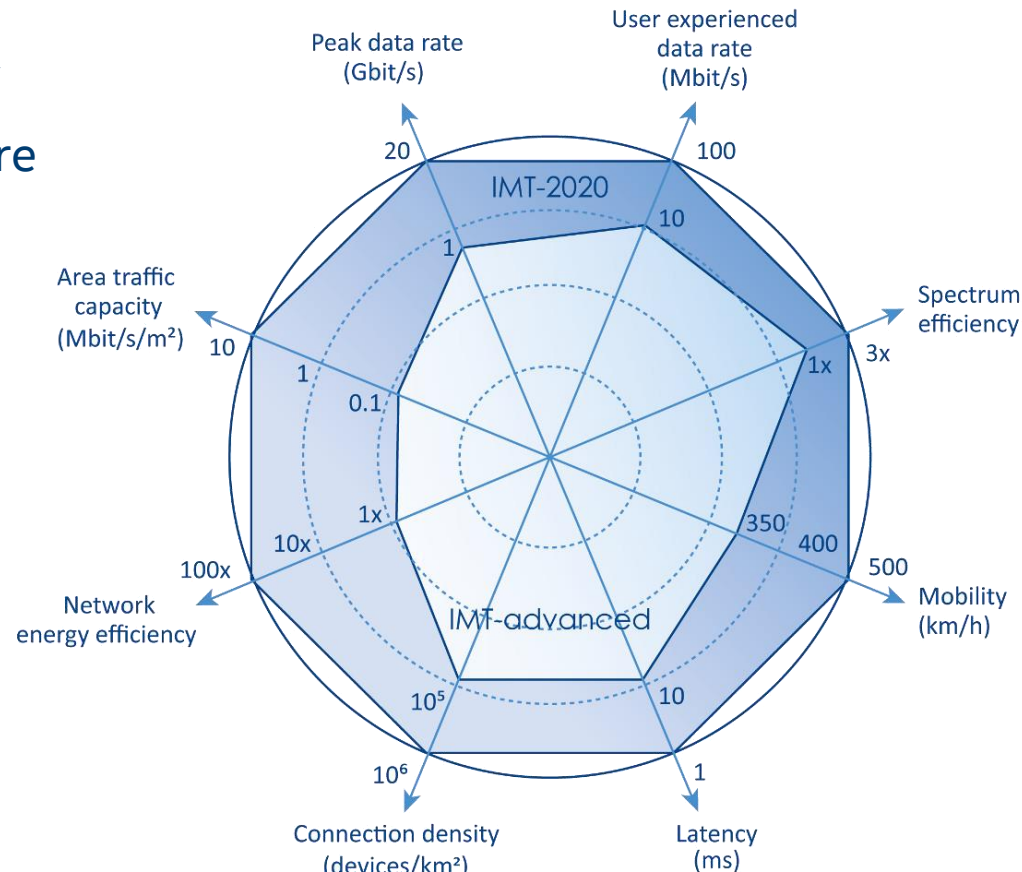
IAB

NR-U

NR V2X

Positioning

NTN



Source: <https://www.etsi.org/technologies/5g>

Service based architecture

SA, NSA deployment options

CU-DU split

CP-UP split

Network slicing

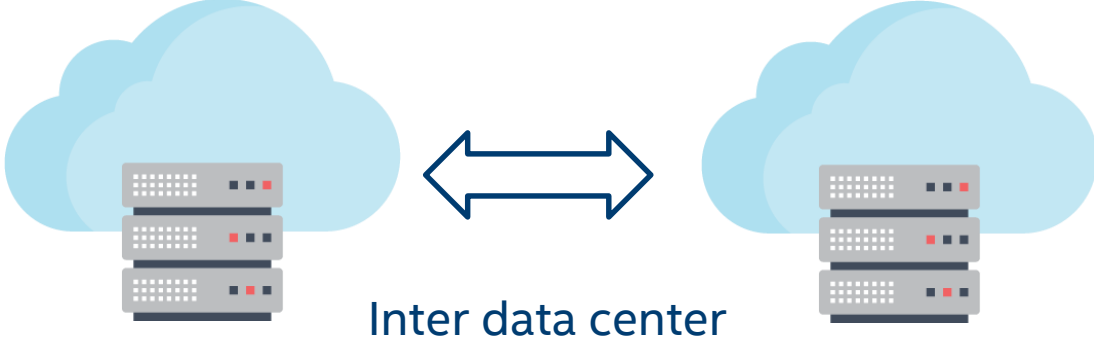
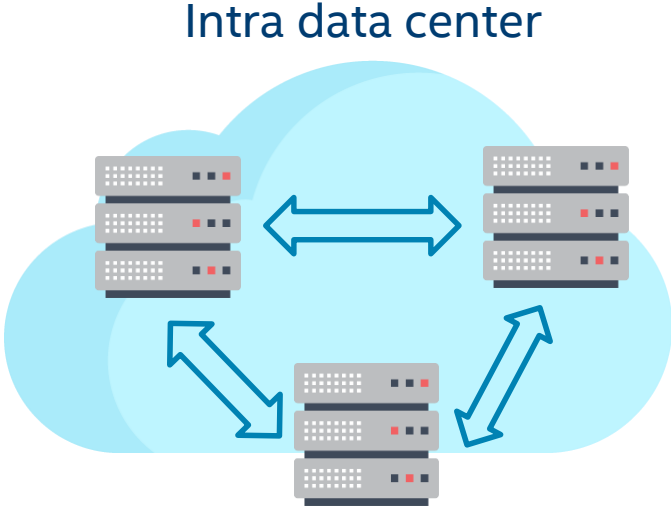
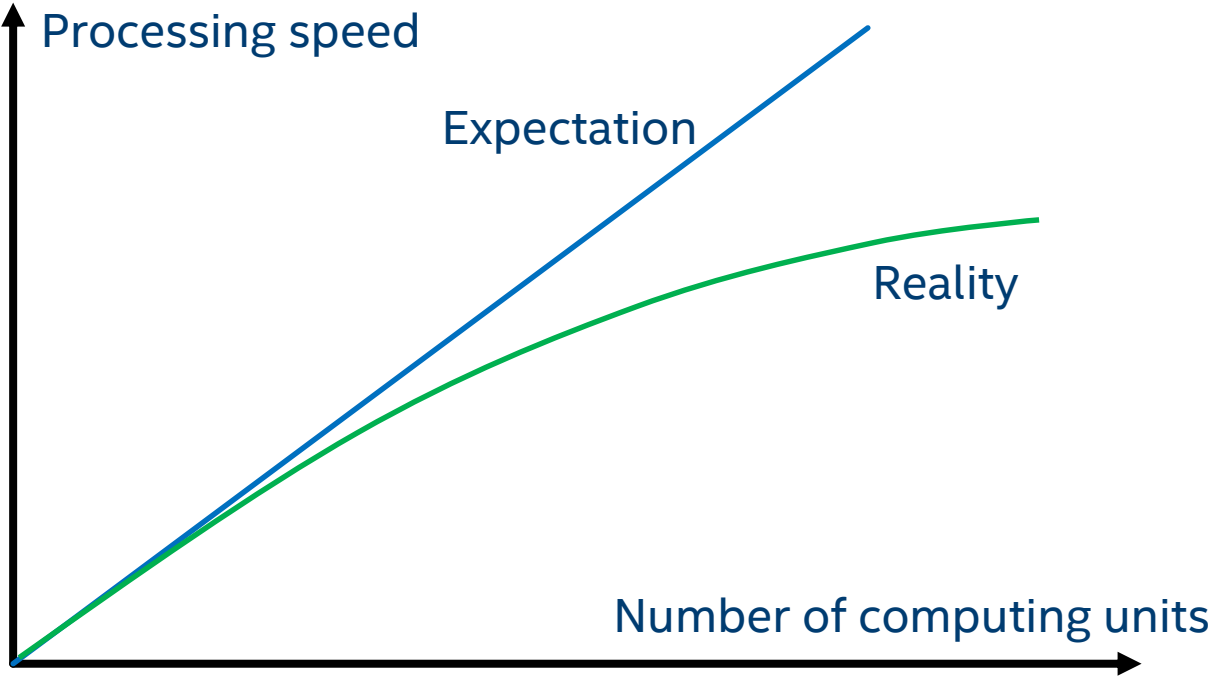
Wireless-wireline convergence

Non public network

ATSSS

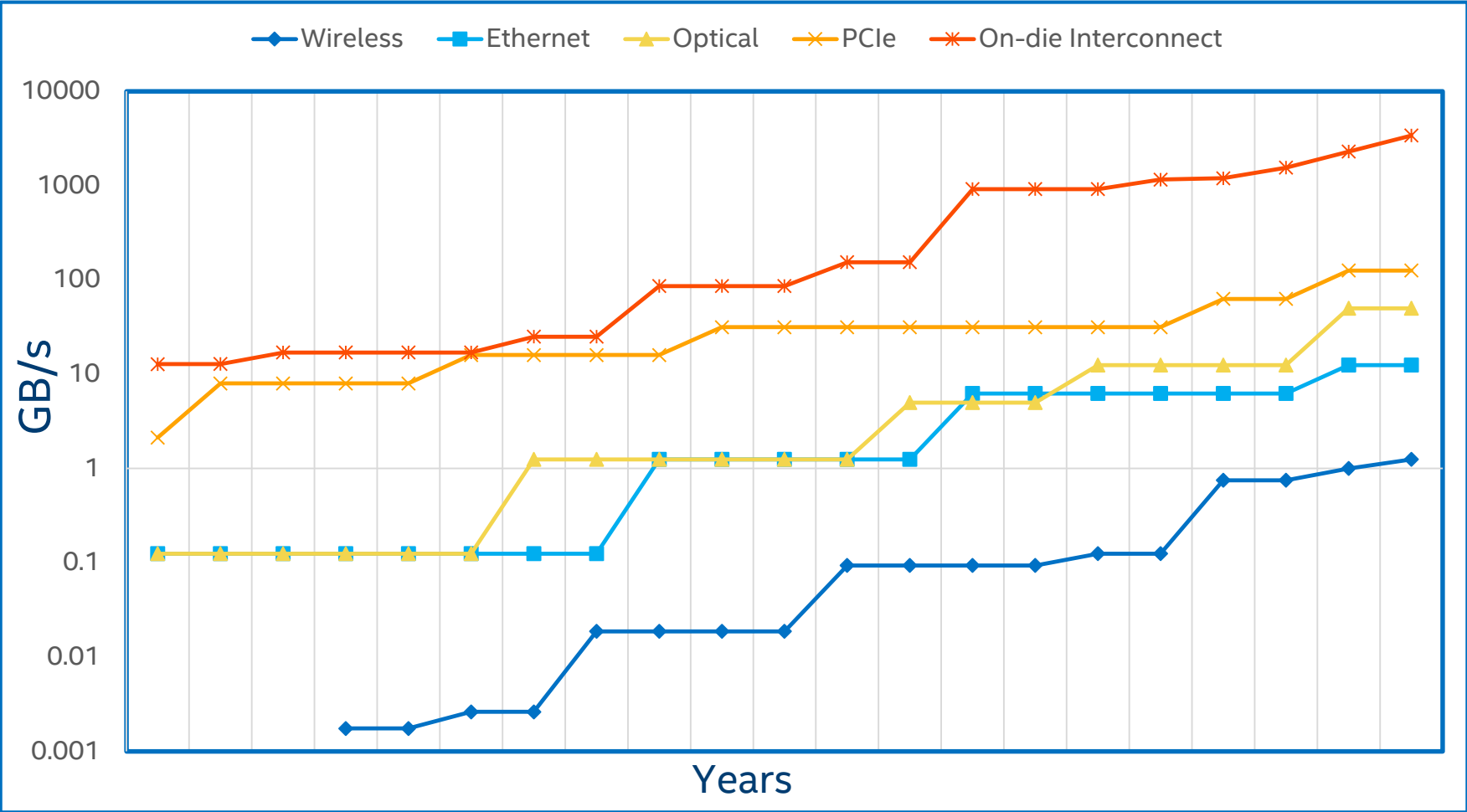
Edge computing

CHALLENGE #1: COMPUTING SCALING IS OFTEN I/O BOUNDED



COMMUNICATION TO ADDRESS COMPUTING SCALING ISSUE

Benchmark with communications for on-die inter-connect



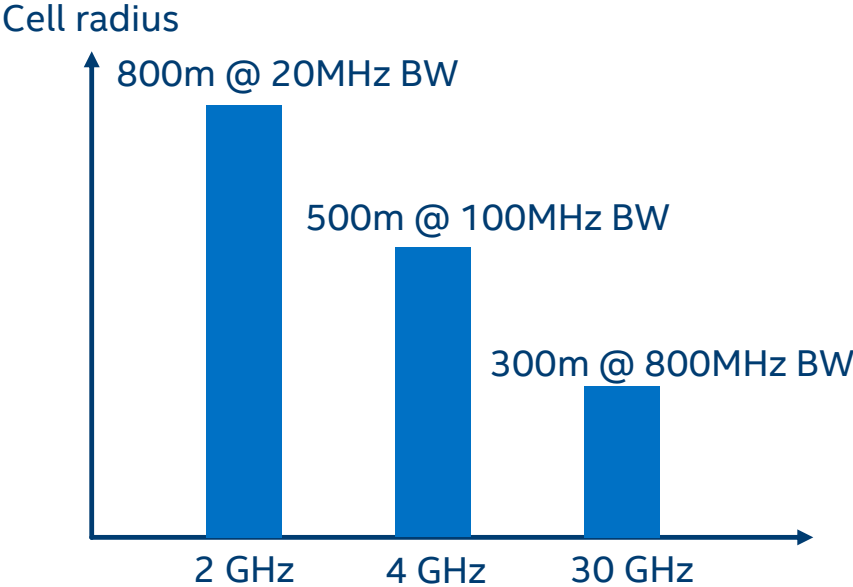
1000X Gap

CHALLENGE #2: NETWORK COMPLEXITY IS EVER INCREASING

	# of bands/band combinations
LTE	1713
5G NR	1802

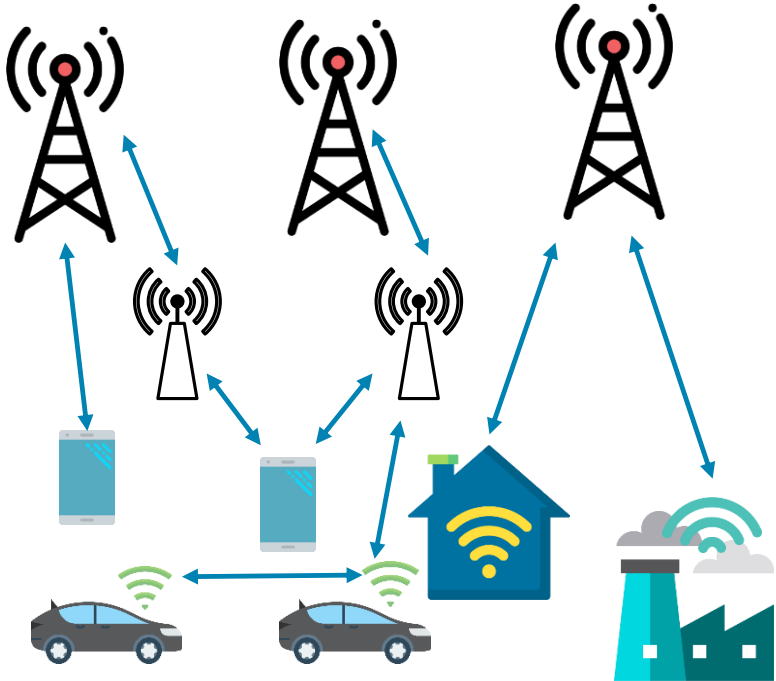
* As of July 2018

Large number of bands/band combinations



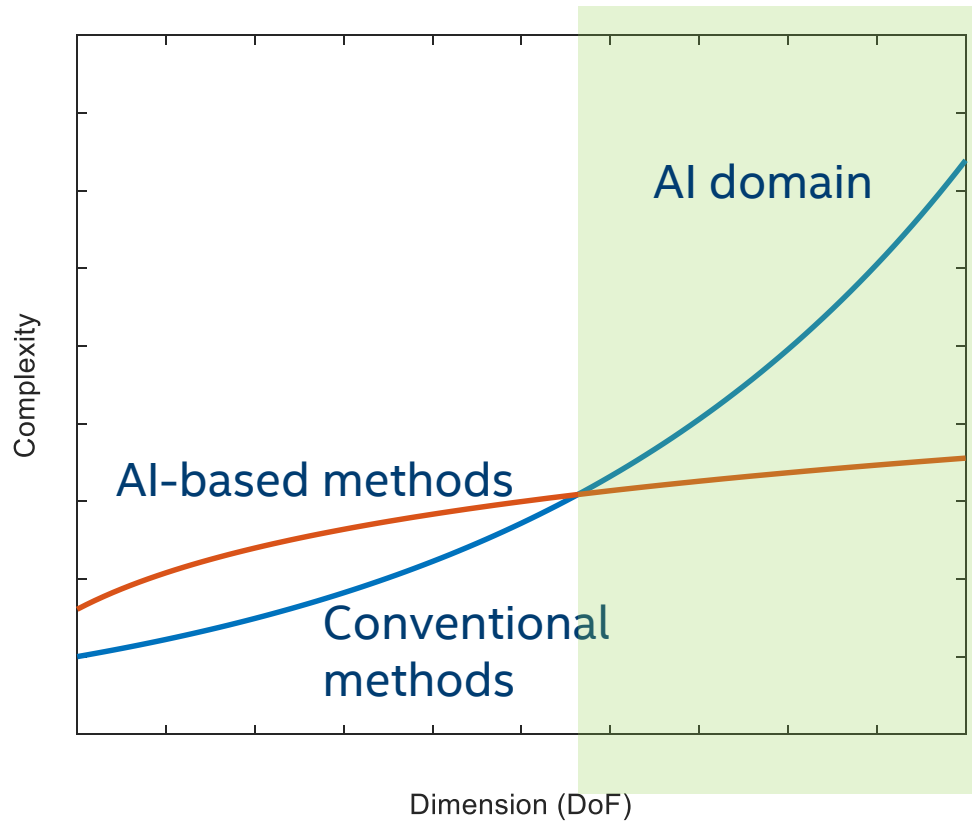
* Assume NLOS channel

Cell density increases as carrier frequency increase



Diverse types of links, traffics, services, network nodes/devices, interference scenarios

COMPUTING TO ADDRESS COMMUNICATION CHALLENGES



AI/ML can be used to address communication problems of high complexity

NSF/Intel Partnership on Machine Learning for Wireless Networking Systems (MLWiNS)

PROGRAM SOLICITATION NSF 19-591



National Science Foundation

Directorate for Computer and Information Science and Engineering
Division of Computer and Network Systems
Division of Information and Intelligent Systems
Division of Computing and Communication Foundations

Directorate for Engineering
Division of Electrical, Communications and Cyber Systems

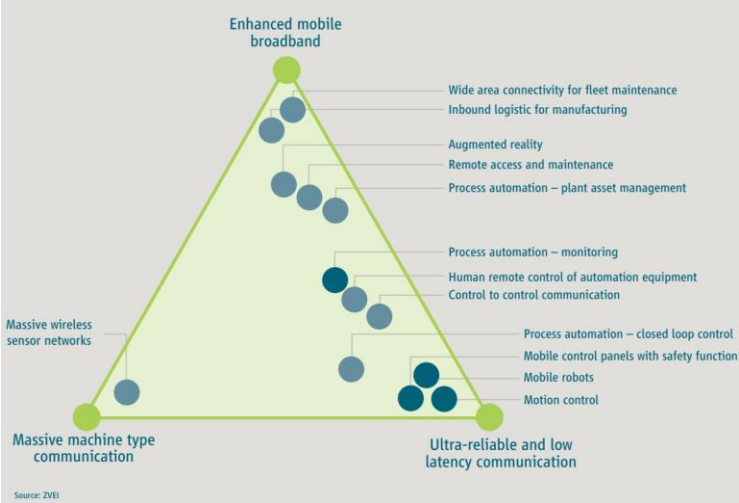


Intel Corporation

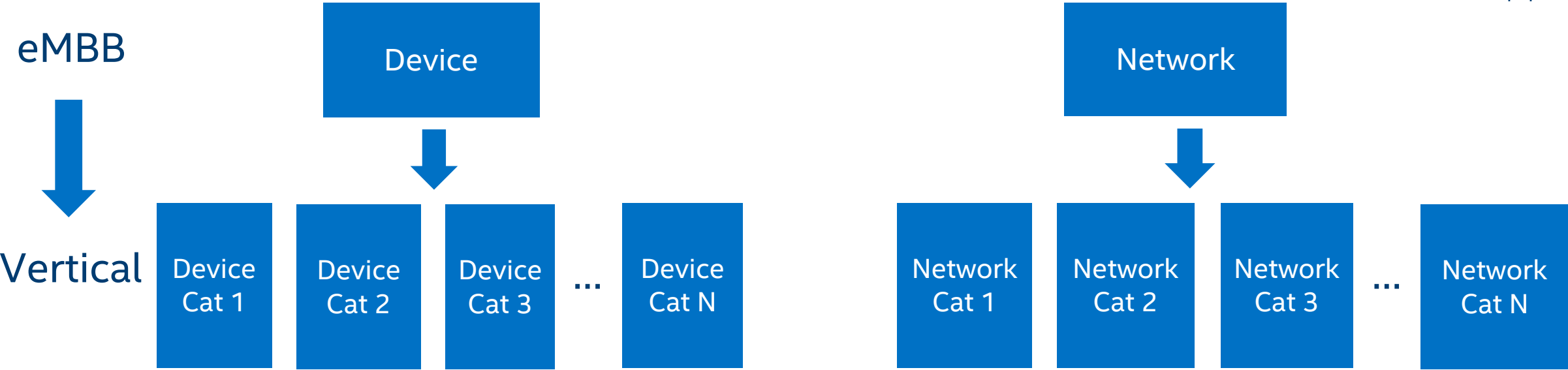
<https://www.nsf.gov/pubs/2019/nsf19591/nsf19591.htm>

CHALLENGE #3: COST-EFFICIENT NETWORK AND DEVICE FOR VERTICALS

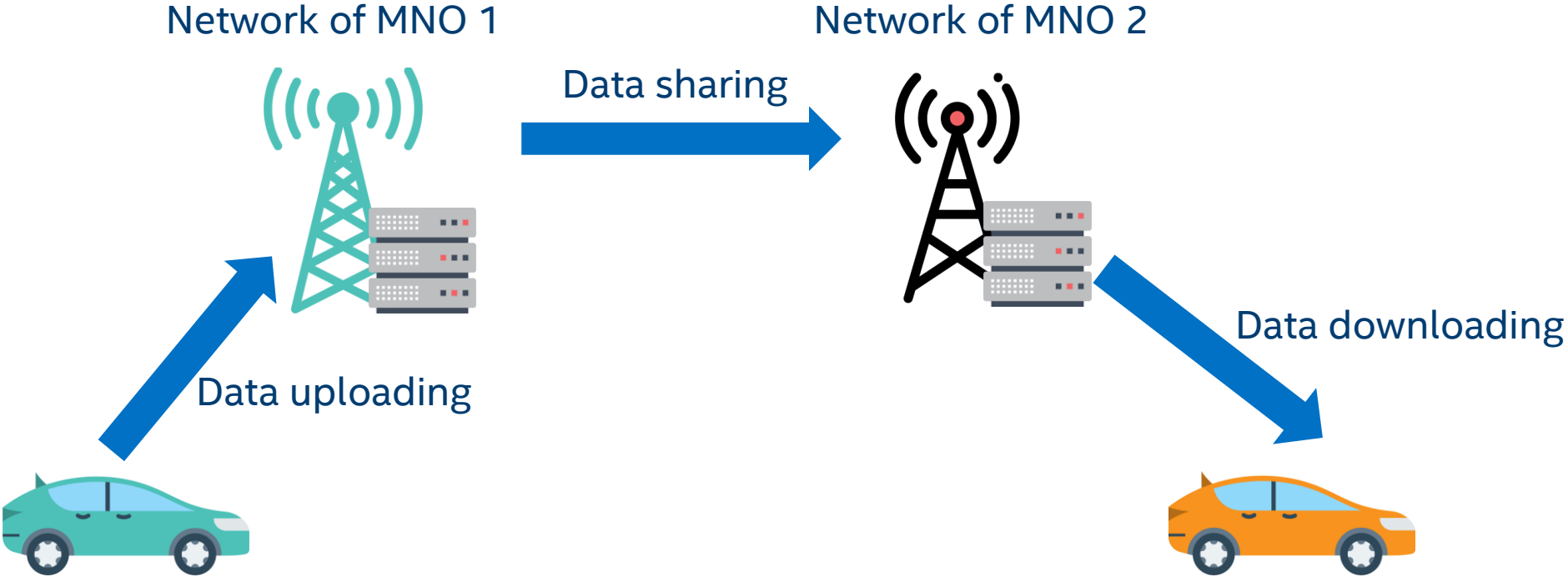
<p>3GPP WI/SIs related to verticals</p>	<p>RAN1: URLLC, V2X, NTN, LTE-M, NB-IOT RAN2: IIoT SA1: CAV, UAS, 5GS, 5GS-vertical, EAV, eCAV, AVPROD, 5GLAN, 5GMSG, FRMCS2, MARCOM, 5GSAT, MED, Asset Tracking SA2: Vertical_LAN, eV2XARC, ClIoT_5G, 5G_URLLC, 5WWC, FS_eNPN, FS_5WWC_Ph2, FS_IIoT, FS_5G_AIS, FS_5G_ProSe, FS_ID-UAS, FS_5GSAT_ARCH, FS_eV2XARC_Ph2, FS_5GLAN_enh</p>
<p>Industrial forums</p>	<p>5G ACIA, 5GAA, AECC, AVCC, etc.</p>



Source: 5G ACIA white paper

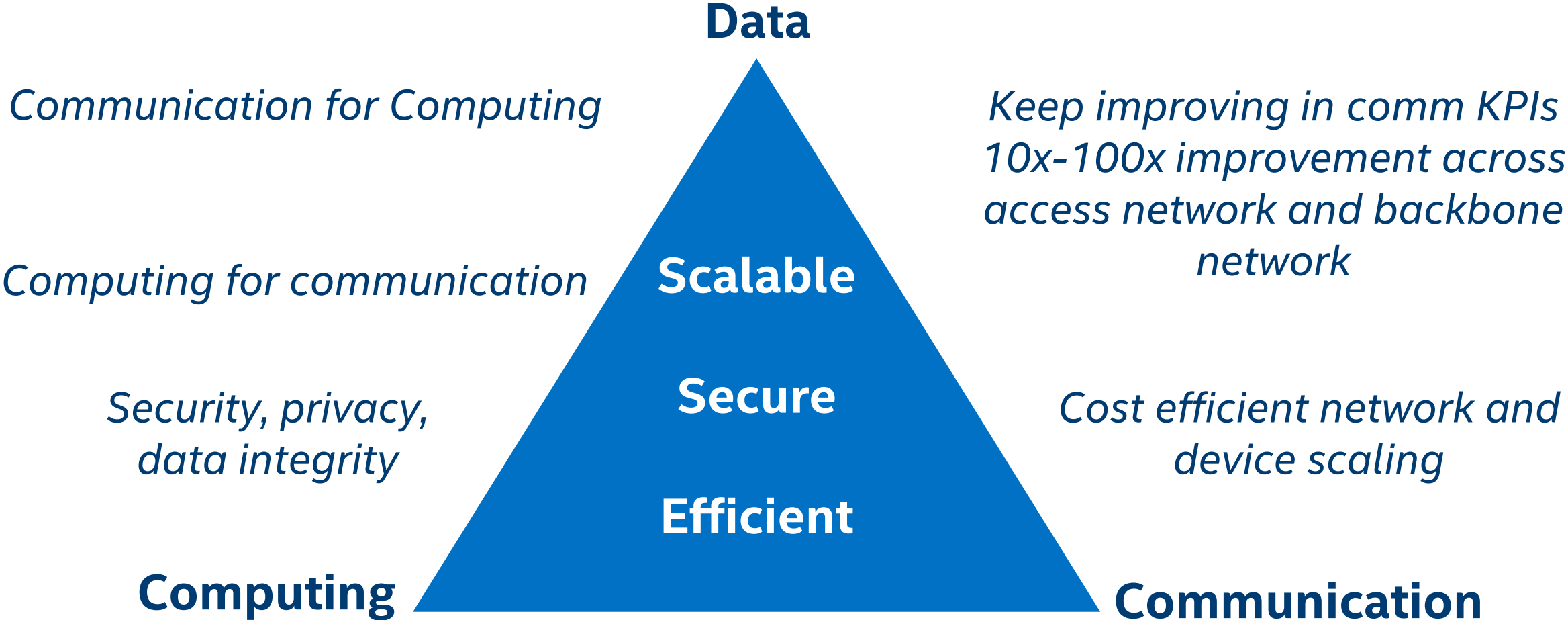


CHALLENGE #4: DATA INTEGRITY AND DATA SHARING ACROSS SECURITY DOMAINS



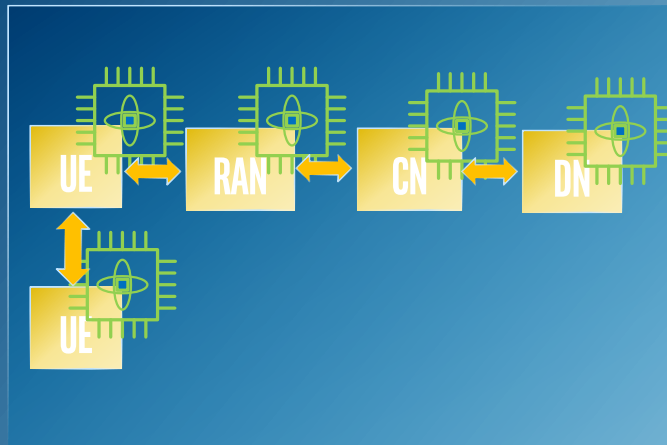
**TACKLING THESE CHALLENGES
REQUIRES A SYSTEMS VIEW**

FUNDAMENTAL CAPABILITIES NEEDED IN THE NEXT GEN



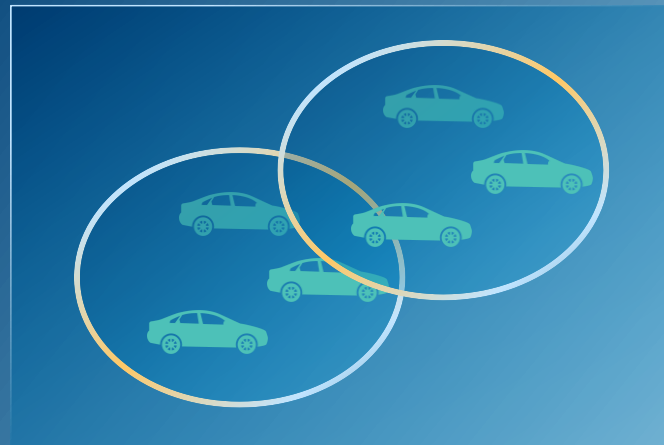
INTELLIGENT, FLEXIBLE AND PROGRAMMABLE NETWORK

NEW ARCHITECTURE FOR "DATA EFFICIENCY"



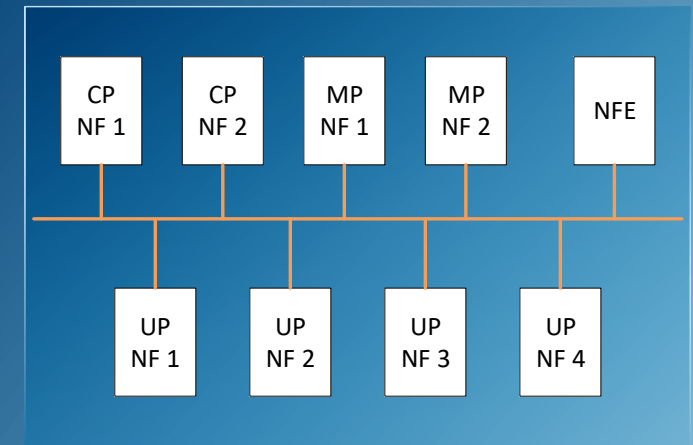
- Computing as network resource
- Computing in CN, RAN, moving nodes and devices

ARCHITECTURE FOR FLEXIBILITY



- Ad-hoc networking and group maintenance
- Autonomous network management and optimization

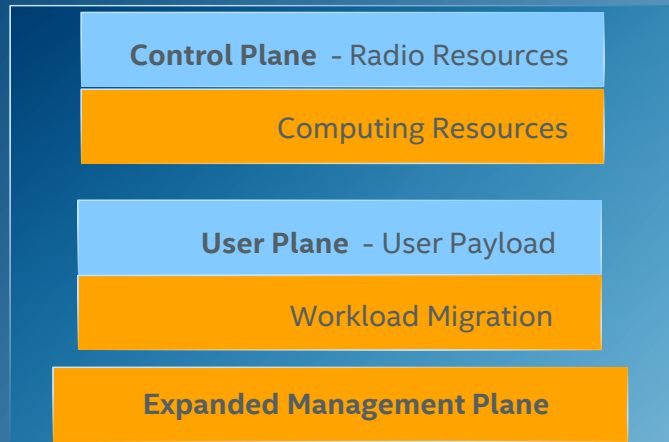
ARCHITECTURE FOR SERVICE



- Serviced based RAN/CN architecture with function exposure
- Programmability inherent in and supported by network

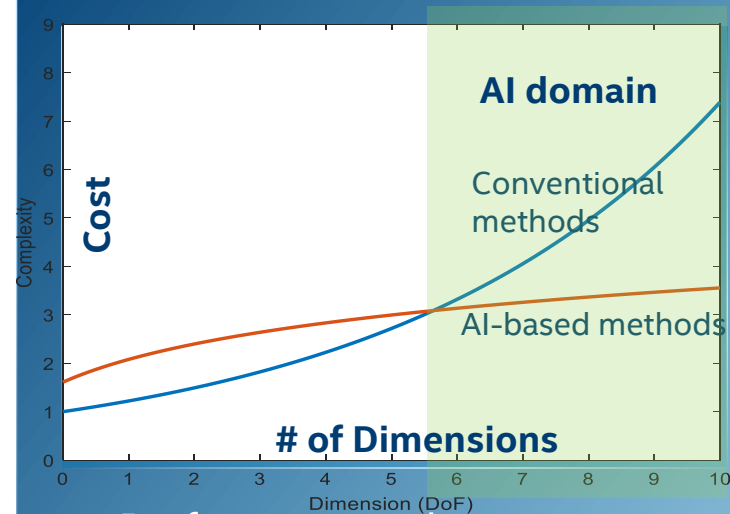
AIR INTERFACE WITH EMBEDDED COMPUTING

AIR INTERFACE FOR COMPUTING



- Workload distribution and migration in radio CP/UP
- Extending Mgmt Plane for e2e orchestration

AIR INTERFACE POWERED BY COMPUTING



- Performance enhancement to existing solutions
- Higher-dimension new types of radio link design

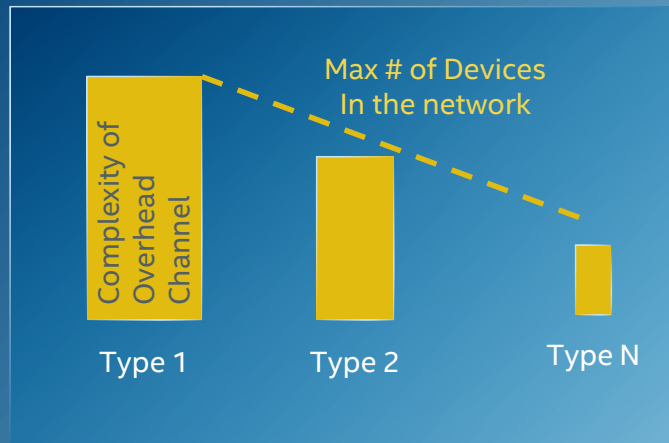
AIR INTERFACE FOR OPPORTUNISTIC ACCESS



- Fast link establishment (session-based or session-less)
- System framework for capacity and coverage layers

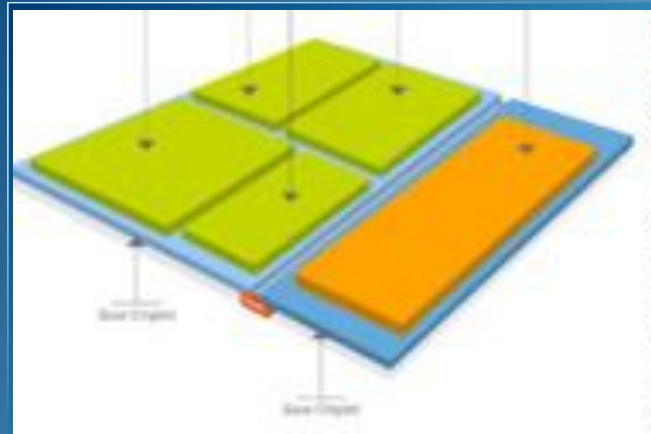
EFFICIENT DEVICE, NETWORK AND COMPUTING SCALING

SCALABLE NETWORK TYPES FOR DEDICATED NETWORKS



- Low complexity overhead channels for simple networks
- Potentially mobile node-centric overhead channels

SUMMABLE AIR INTERFACE FOR DEVICE SCALING



- Enable low-volume and/or low-end applications
- Open mobile node/device functional architecture

NEXT GEN PERFORMANCE OPTICAL AND WIRELESS NETWORK



IOWN Global Forum
Innovative Optical and Wireless Network

- 10x KPI improvement in access and backbone networks
- Computing scaling with new Data + Computing + Communication models

SECURITY, PRIVACY AND DATA INTEGRITY

SECURITY IMPOSED IN ALL LAYERS

Application Security

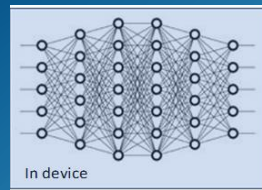
Network Security

Platform Security

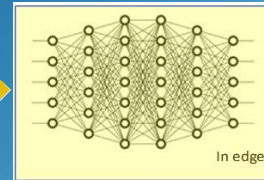
- Security in platform, network and application
- Security solution with scalability as one key target

LOCALIZED DATA SHARING/USAGE AND FEDERATED LEARNING FOR PRIVACY

In device

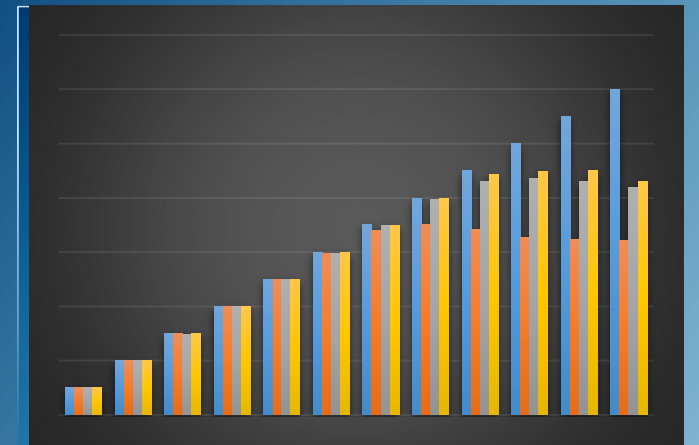


In network



- Locally share, process, and distribute data
- Federated learning with data preprocessing at the source

TRUSTED DATA SHARING ACROSS SECURITY DOMAINS



- Incorporate Blockchain technology in the RAN and CN
- Enable cross security domains data sharing

WE NEED TO CREATE NEW FUNDAMENTALS

