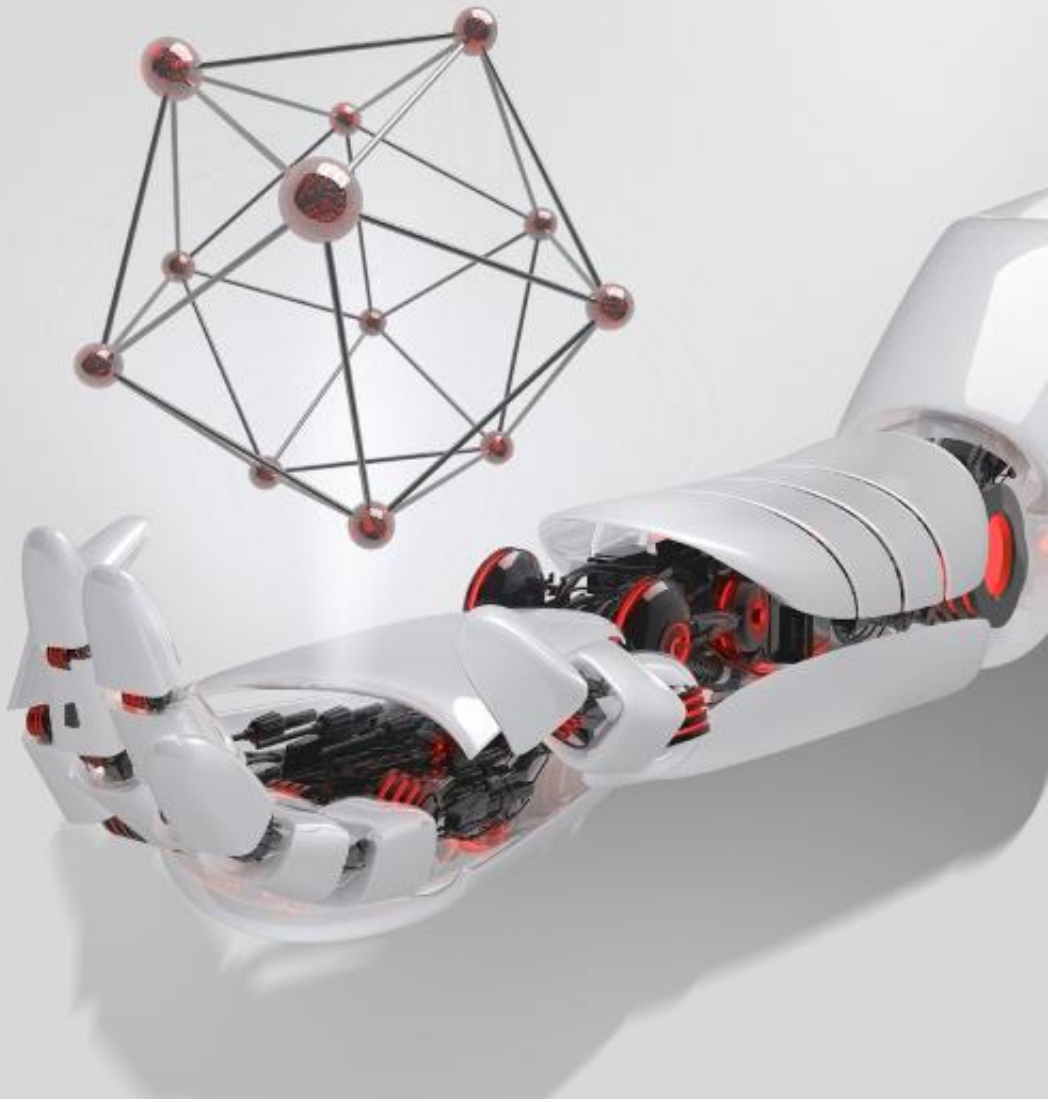
From Network to Compute Inter-Connection

The Customer Access Network is Your (Distributed) Data Centre

Dirk Trossen
Huawei Research



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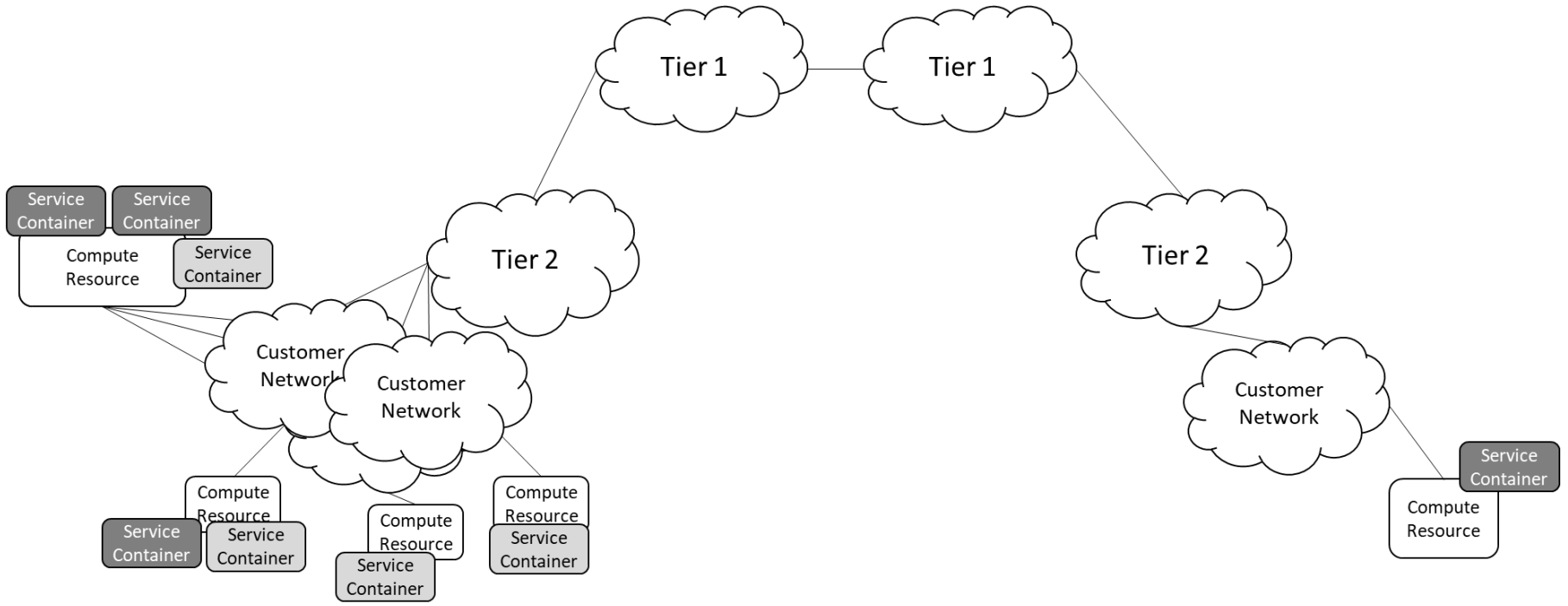
Accommodate Today's Transit Evolution…



- Most computational tasks are **localized** in customer access network(s)
- Transit still provided, i.e., not dead yet, unlike Geoff Huston's view [1]
- But unlike CDNs, compute resources may be **highly distributed**

[1] "Internet Centrality and its Impact on Routing", Geoff Huston, IETF112 side meeting on "Service Routing & Addressing", https://github.com/danielkinguk/sarah/blob/main/conferences/ietf-112/materials/Huston-2021-11-10-centrality.pdf

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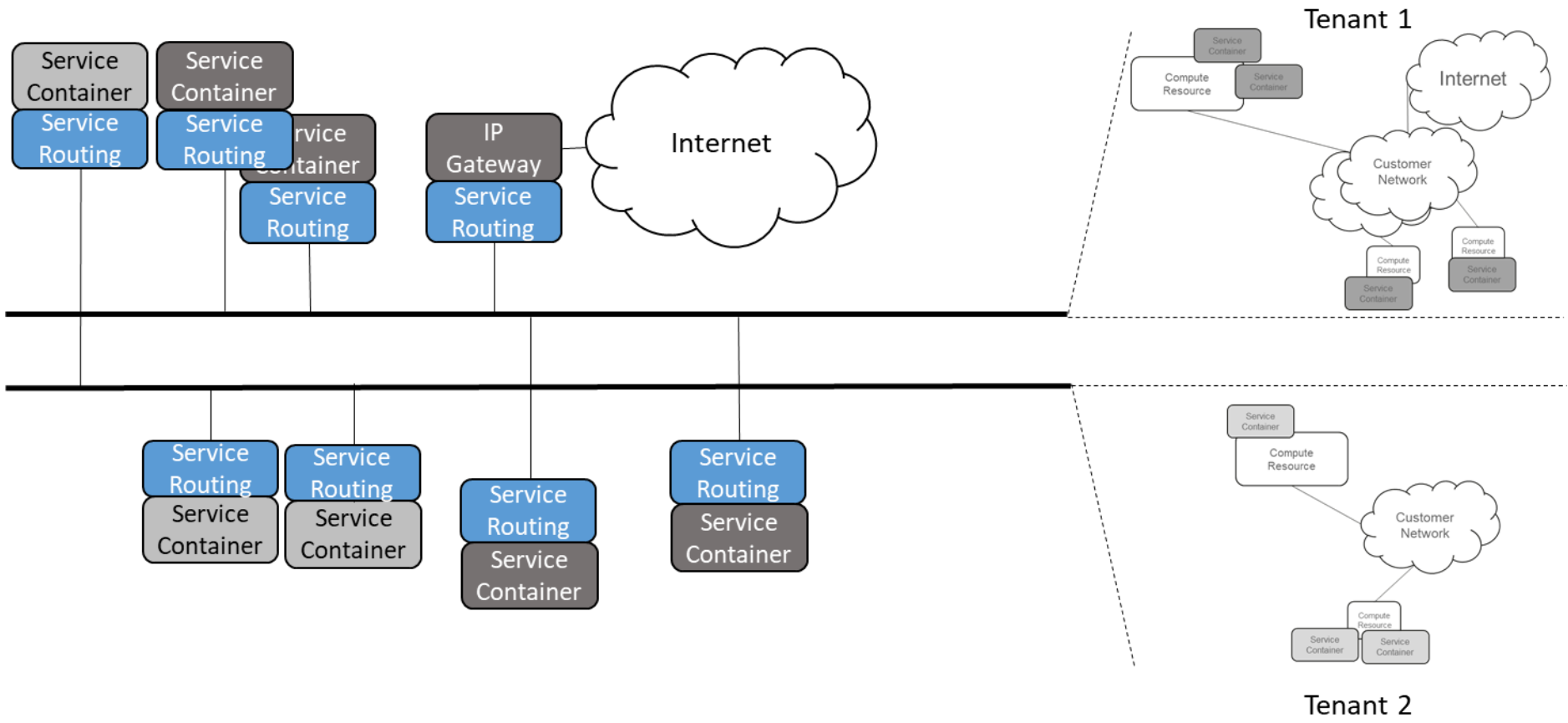
…to Form a Multi-Tenant Distributed Data Centre



Key enabler here:
5GLAN to extend localized, e.g., WiFi, to quasi-pervasive DC

-> the world becomes your oyster from an application perspective!

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Application Use Case

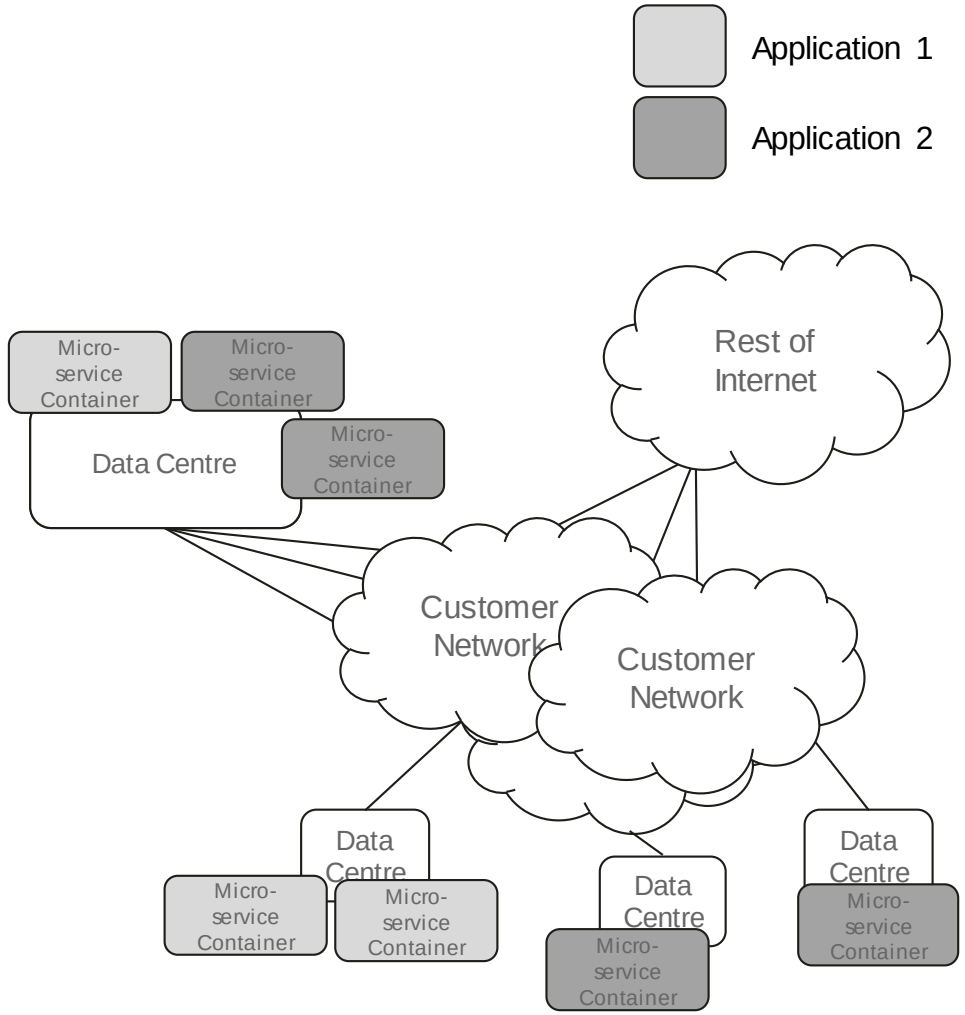
Evolution of Mobile Applications

Vision

Push towards *ubiquitous computing* through distributing mobile applications via a micro-service based design, linking into COIN RG and similar activities

Examples

Any mobile app really, e.g., (1) multi-viewing experiences (2) multi-user gaming (3) localized tourist experiences



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Network Service Use Case

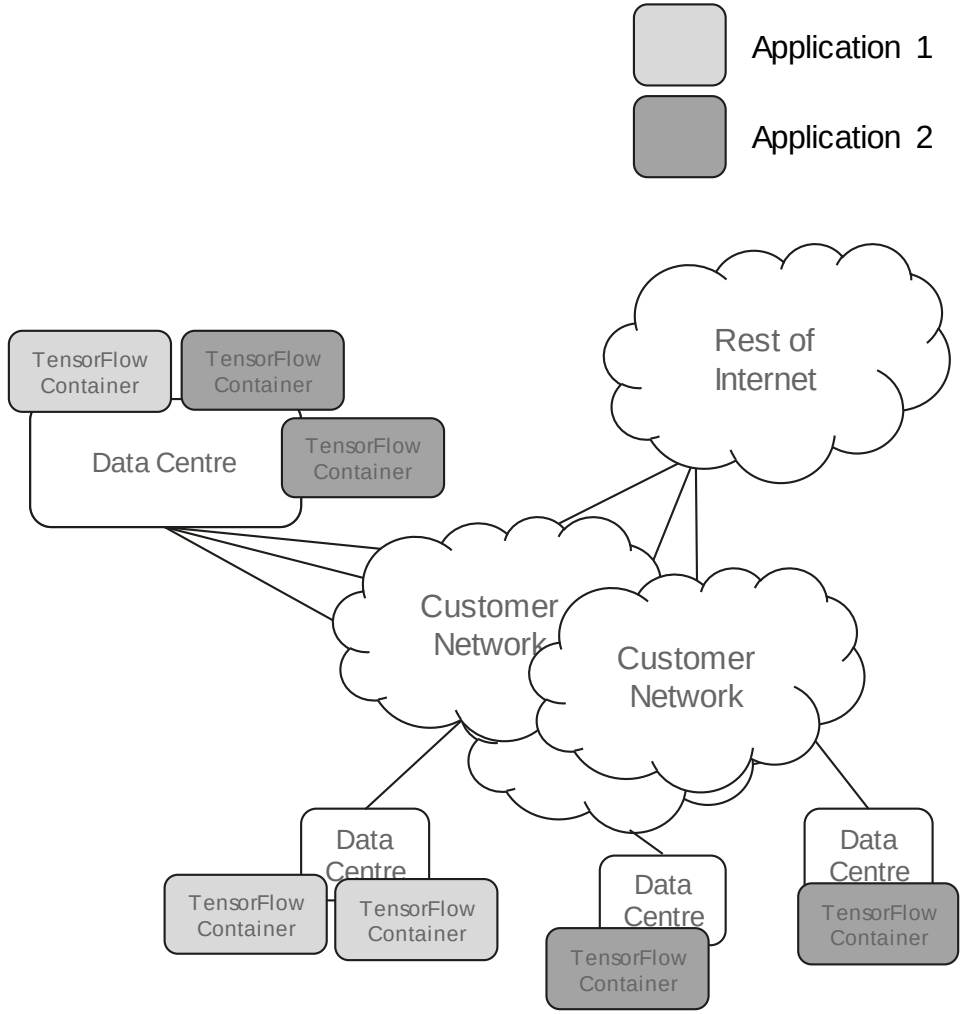
Distributed Learning, particularly for B5G/6G

Vision

Utilize distribute computing power to increase compute capabilities as well as utilize localized data & reasoning

Examples

(1) RAN processing (2) RADAR like applications (3) Large-scale image recognition (4) V2X (5) smart energy



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Infrastructure-as-a-Service Use Case

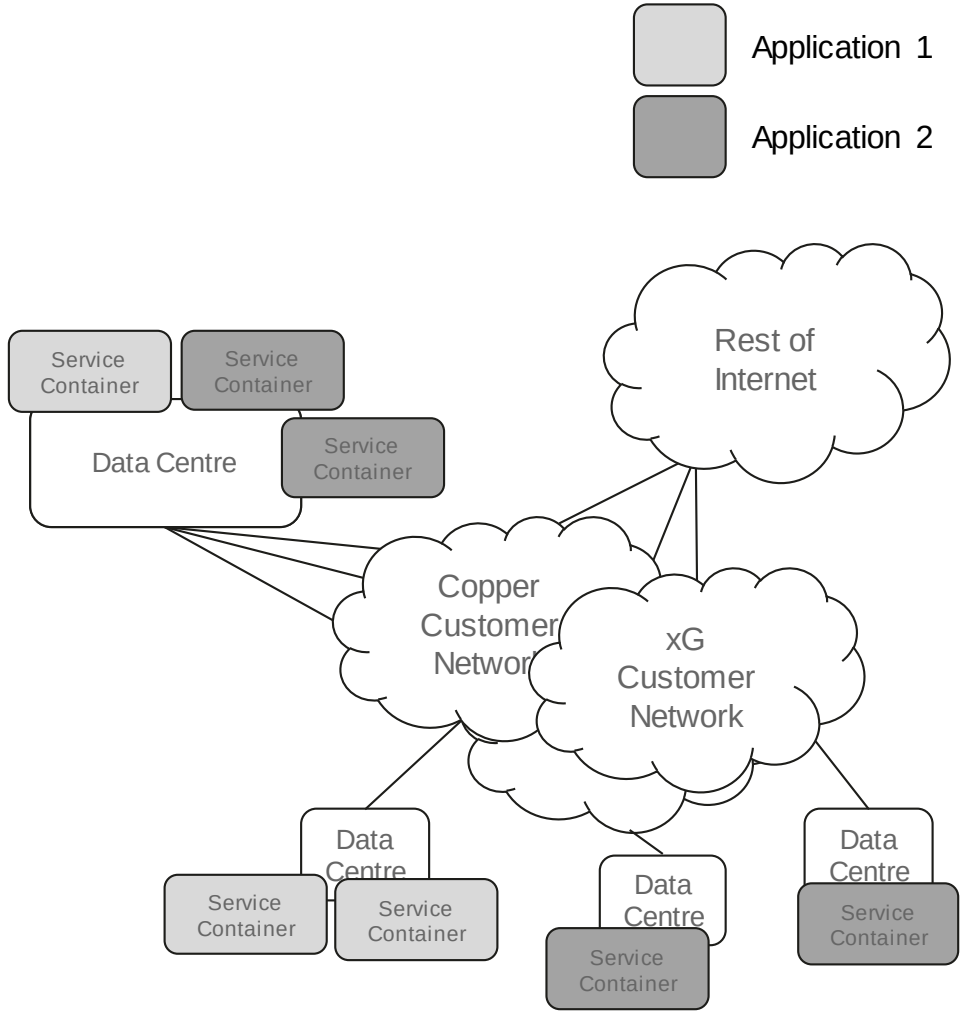
Cloud Infrastructure for Any Vertical

Vision

Build dynamic, multi-technology data centre connectivity across all access technologies as foundational proposition for other value-add use cases

Examples

Almost any vertical, e.g., (1) industrial IoT, (2) gaming (for consumer networks) (3) smart cities



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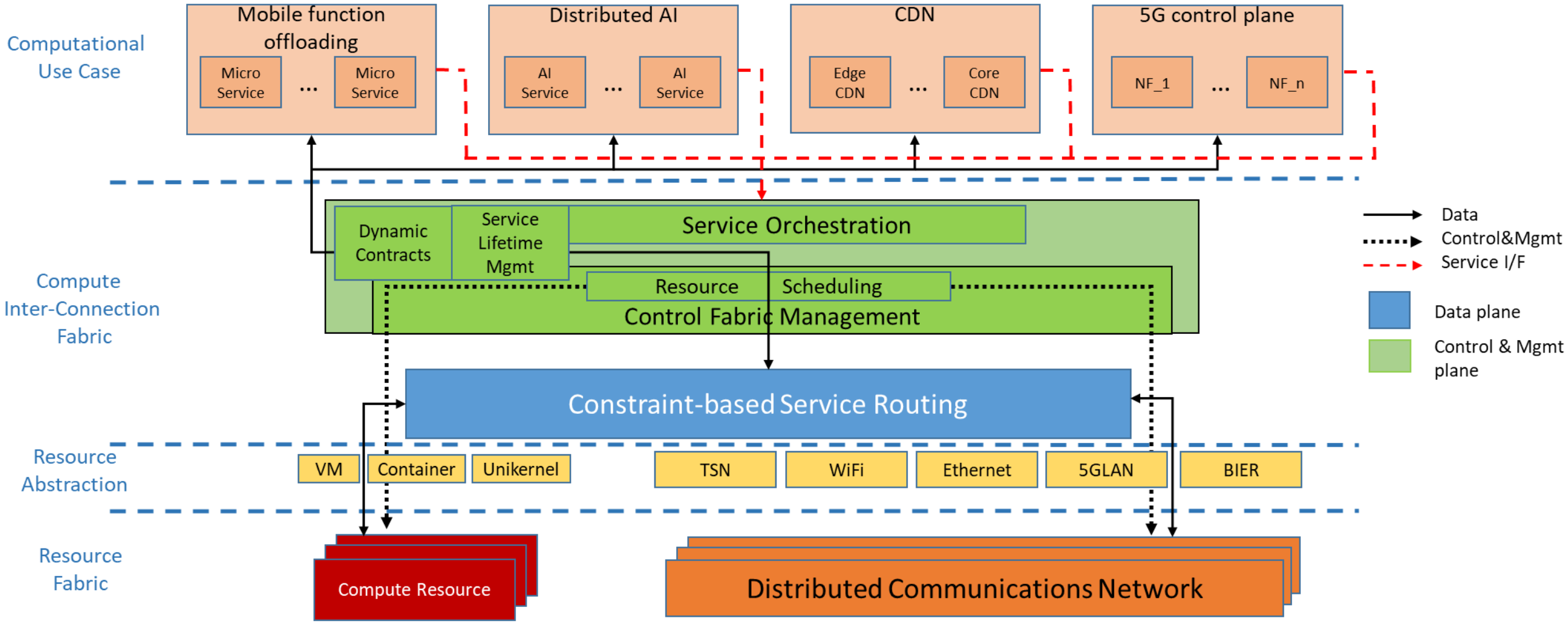
Key Enabler: The Compute Inter-Connection Fabric (CIC)



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Key Challenges: Enabling the CIC

- **Aligning objectives** across layers
  - > Service planning, management, control and steering

System

- Dynamically (re-)**forming** the forwarding plane
  - > Mobility
  - > Dynamicity of service assignments (through virtualization)
- **Steering** of service requests between distributed sites
  - > Multi-optimality routing

Control plane

  - > Resource scheduling
- **Collective** communications
  - > Dynamic forming of multicast groups

Data plane

  - > Diffusion mechanisms (e.g., for DLTs, security attestation, ...)
- **Programmable** forwarding planes
  - > Integration with, e.g., P4 and other INP evolutions

Forwarding plane

Conclusions

- Points-of-Presence are a key enabler for today's Internet

- Interpreting the customer access network as a distributed data centre consequently applies the PoP model while bringing the desired distribution
  > This includes end user devices!

- Key challenges are to be solved

-> need research, prototypes, trials, and experiments!

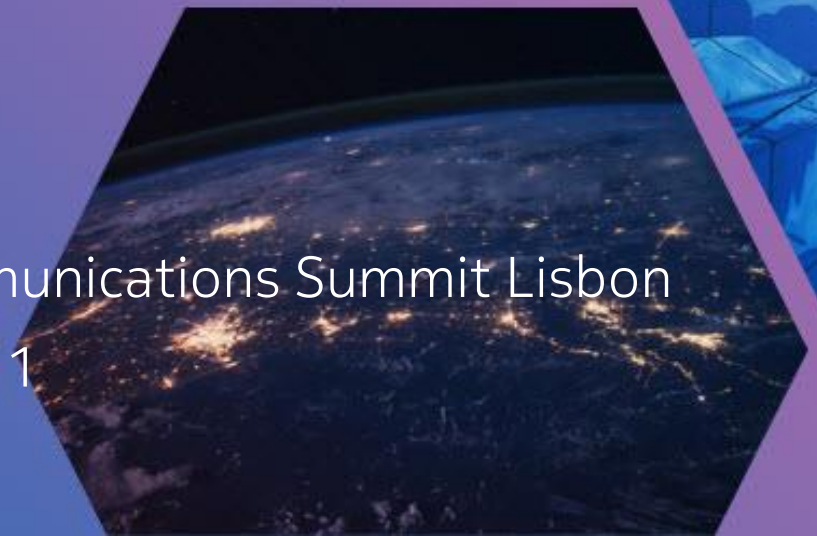
Building the future CIC is a key challenge for the SNS to address!

Thank you.

Bring digital to every person, home and organization for a fully connected, intelligent world.

Hexa-X
The European 6G Flagship Project



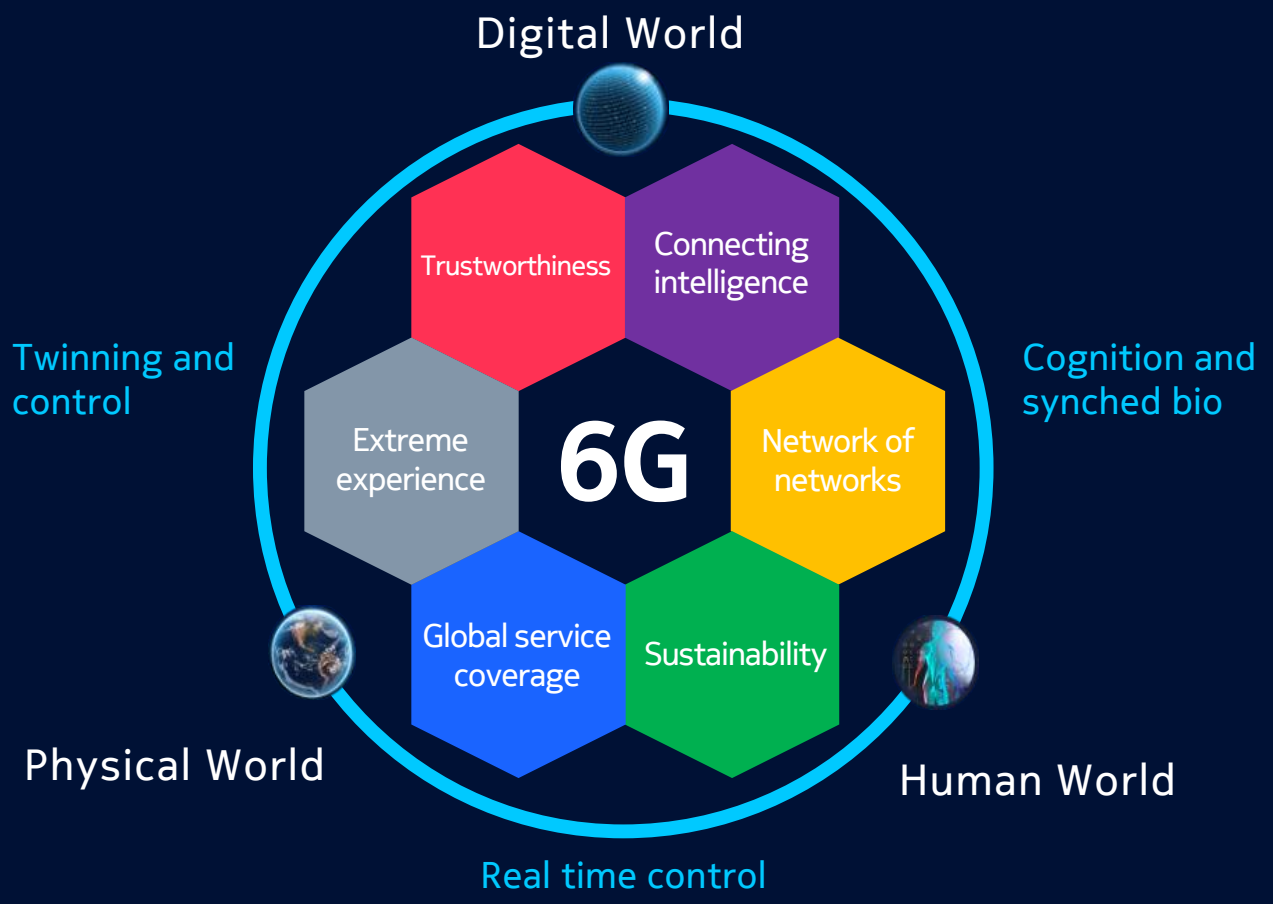

Dr Volker Ziegler

Nokia Bell Labs

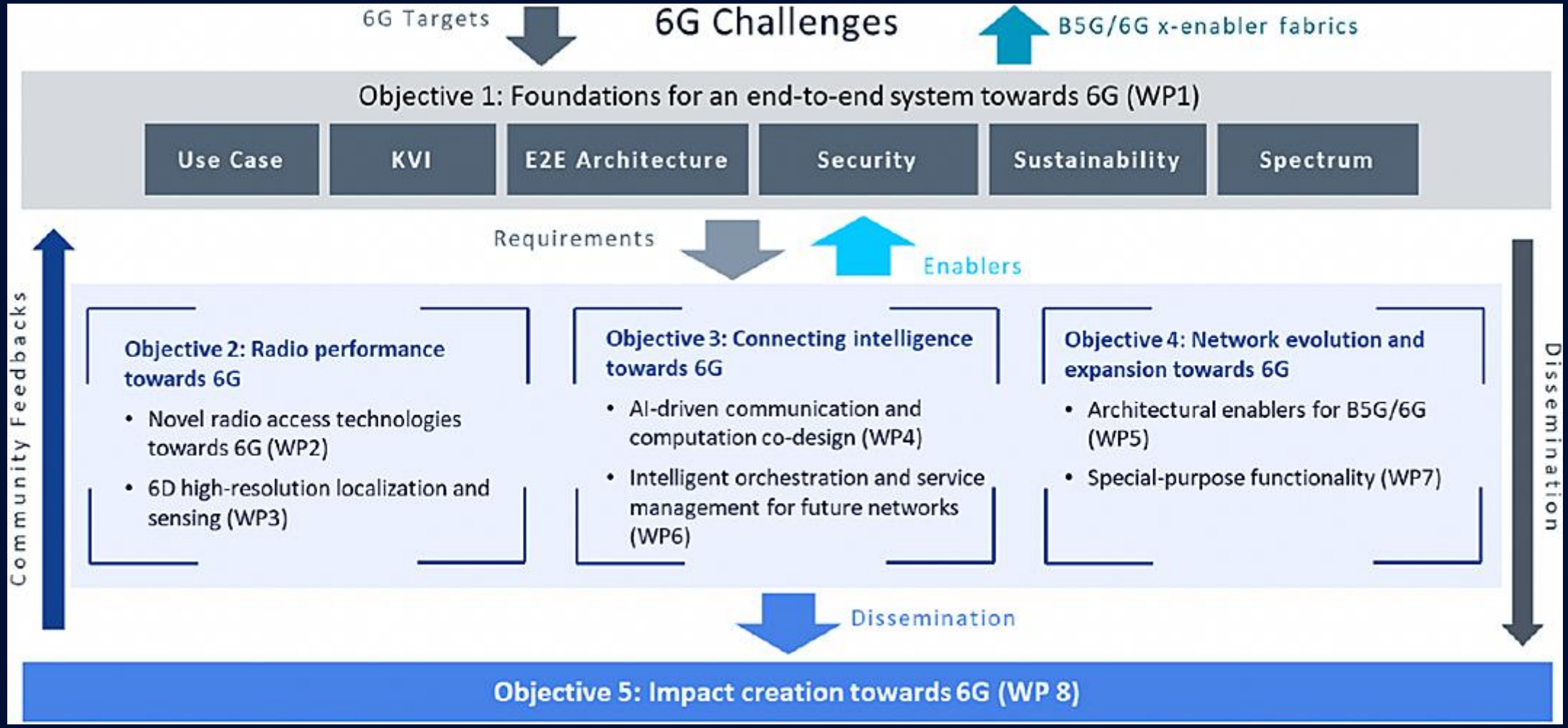
Vision of Future Communications Summit Lisbon

November 24-25, 2021

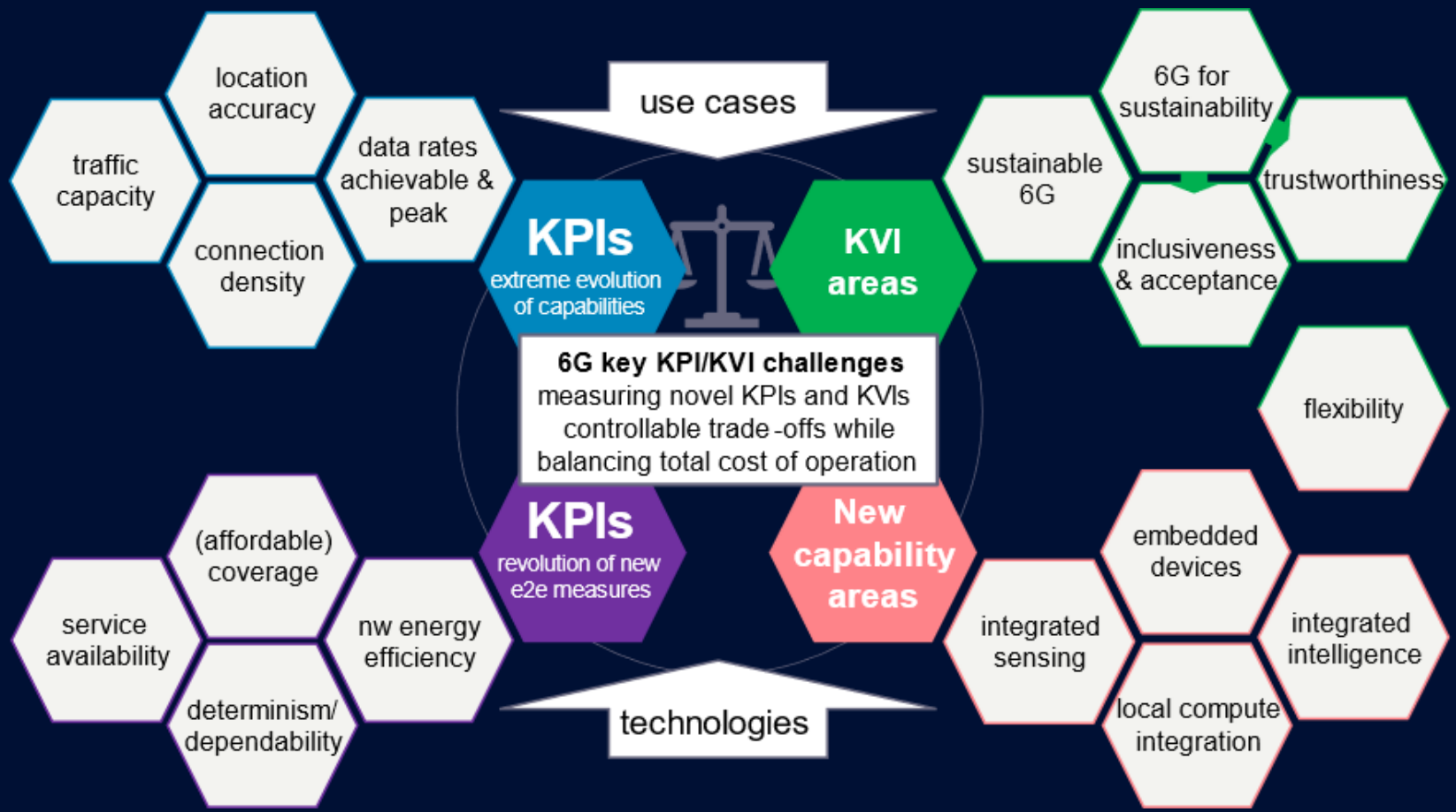
Vision & Challenges



Objectives



KVIs & KPIs

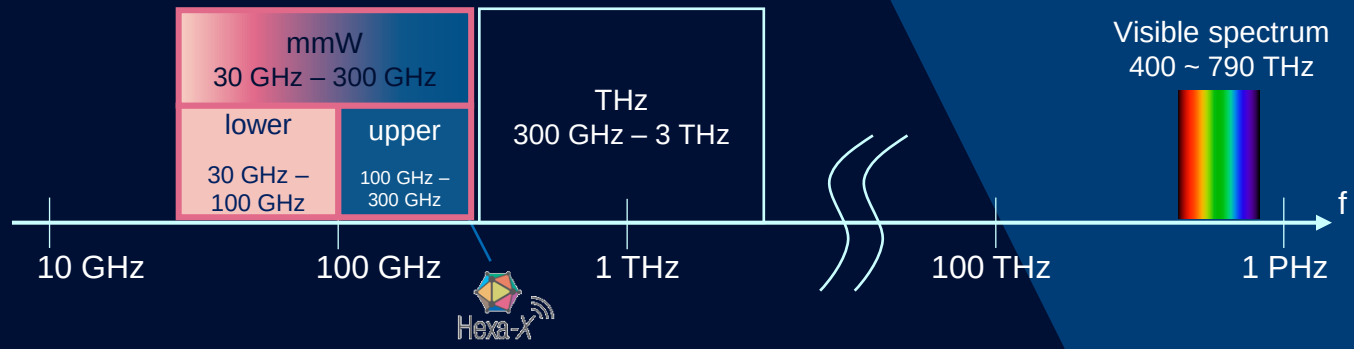

use cases
location accuracy
traffic capacity
data rates achievable & peak
connection density
KPIs
extreme evolution of capabilities
KVI areas
6G for sustainability
sustainable 6G
trustworthiness
inclusiveness & acceptance
6G key KPI/KVI challenges
measuring novel KPIs and KVIs
controllable trade-offs while
balancing total cost of operation
flexibility
KPIs
revolution of new e2e measures
New capability areas
(affordable) coverage
service availability
nw energy efficiency
determinism/ dependability
embedded devices
integrated sensing
integrated intelligence
local compute integration
technologies

Towards Tbps Communications Technologies

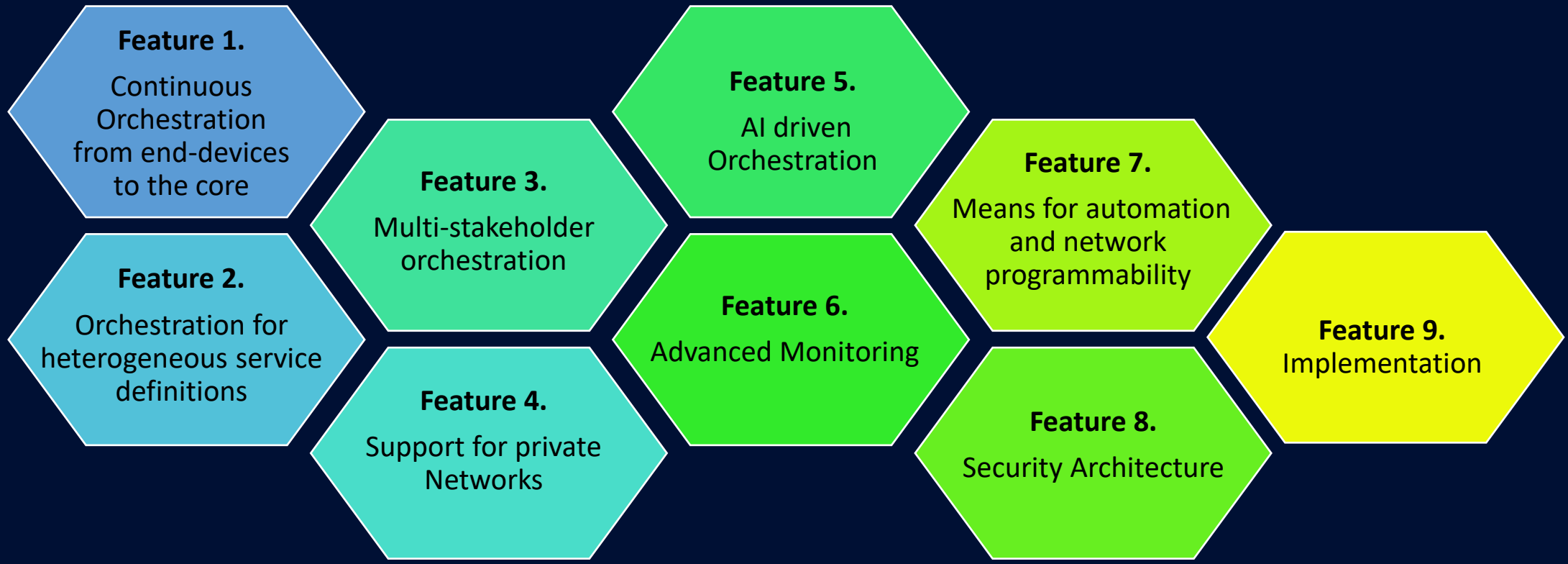
- exploring the upper mmW frequencies, while also considering improvements in the lower mmW range
- frequency agnostic solutions

Considered technologies

- Hardware
- Waveforms
- Beamforming
- Distributed MIMO
- Channel models



Service Management and Orchestration Goal State-Features



Special Purpose - key technology areas and targets

Sustainable coverage

- Energy- and efficiency-related aspects
  - EE low-EMF operation
  - Zero-energy devices
  - Collaborative beamforming, CSI-free strategies
  - Repurposing networks for rural coverage
- Topology and flexibility
  - Coexistence of non-3GPP and 3GPP networks
  - Intent-based wireless connectivity
  - D2D/D2I resource assignment

Dependability

- across multiple services (communication, computation, positioning)
- Cross-layer impacts
  - Communication-control-co design
  - energy consumption and performance
  - Error identification and failure-cause traceability as indicator/capability for trustworthiness and dependability
- Protocols for ultra-flexible and reliable private networks

Thank you!

HEXA-X.EU

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User-centric Communications

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Visions for Future Communication Summit
24/11/2021, Lisbon

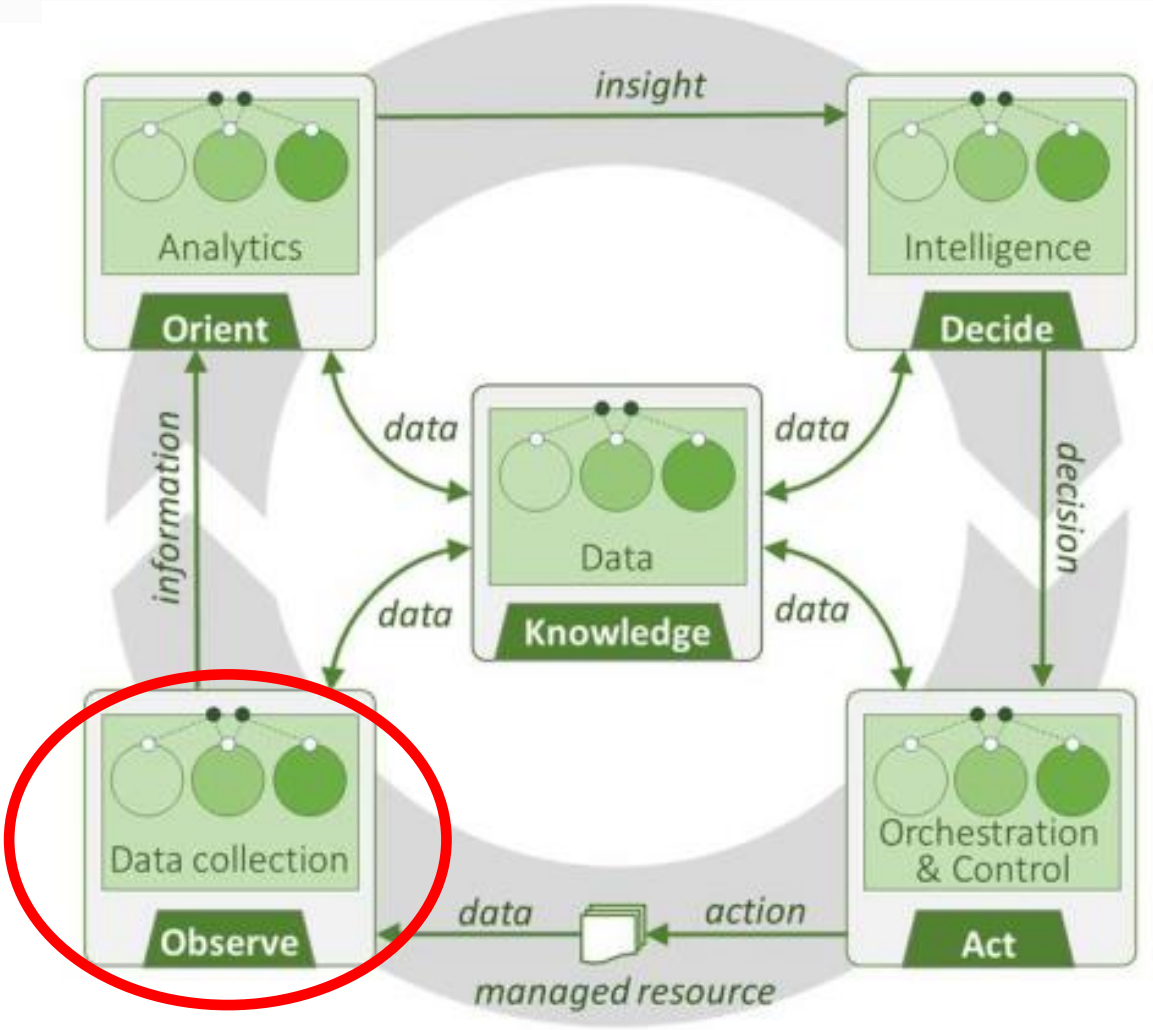
Motivations

- User-centric communications is intended here as a communications paradigm that has got as its main objective the satisfaction of the needs of the communications network users
- Next Generation Internet, places the citizen and humans at the very center of future communication network research [1]
- Among the future IMT megatrends
  - Simplified life [2]
  - Aging society must exploit tecnology in simple way
  - More intuitive and efficient interactions among humans, machines and the environment, and the networks will
  - Digital inclusion: Evolving towards 2030, connectivity will likely be regarded as a basic human right for accessing equal education, business and health opportunities.
- Quality of experience (QoE) is expected to become the most important performance parameter to be satisfied

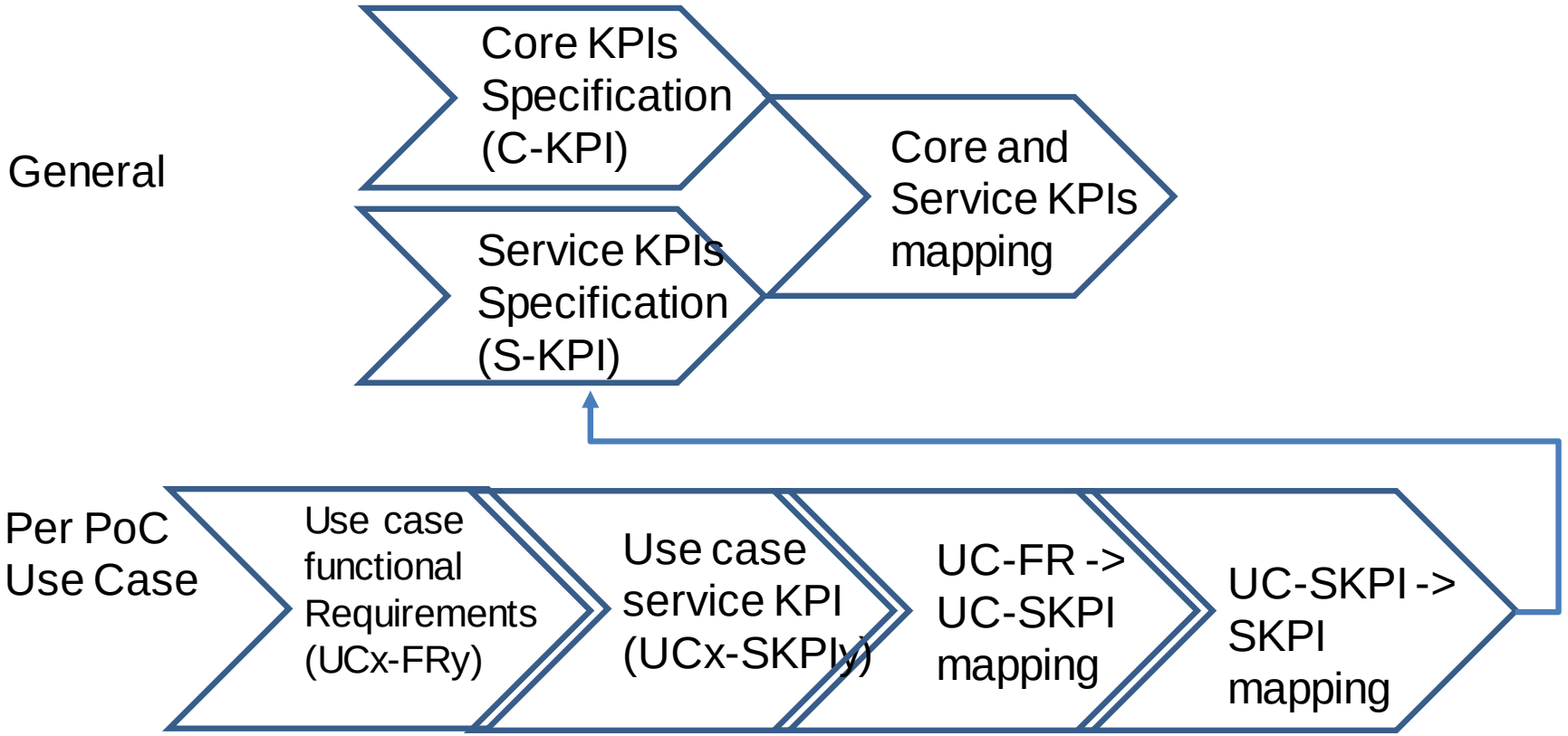
Scenario

- Slices are essentially the natural evolution of overlay networks/over the top (OTT) (including also computational resources)
- Techniques to guarantee the QoE
  - in the overlay/OTT network: in the given slice, methods shall be developed to meet the requested QoE
  - in the physical network hosting the slice: the network provides slices capable of guaranteeing the requested QoE
- Example: content delivery networks
  - if the network does not guarantee the requested QoE, methods are developed (e.g., specific encoding) to guarantee the requested QoE.
  - To provide a seamless user experience such techniques shall be transparent to the user, that is autonomous.

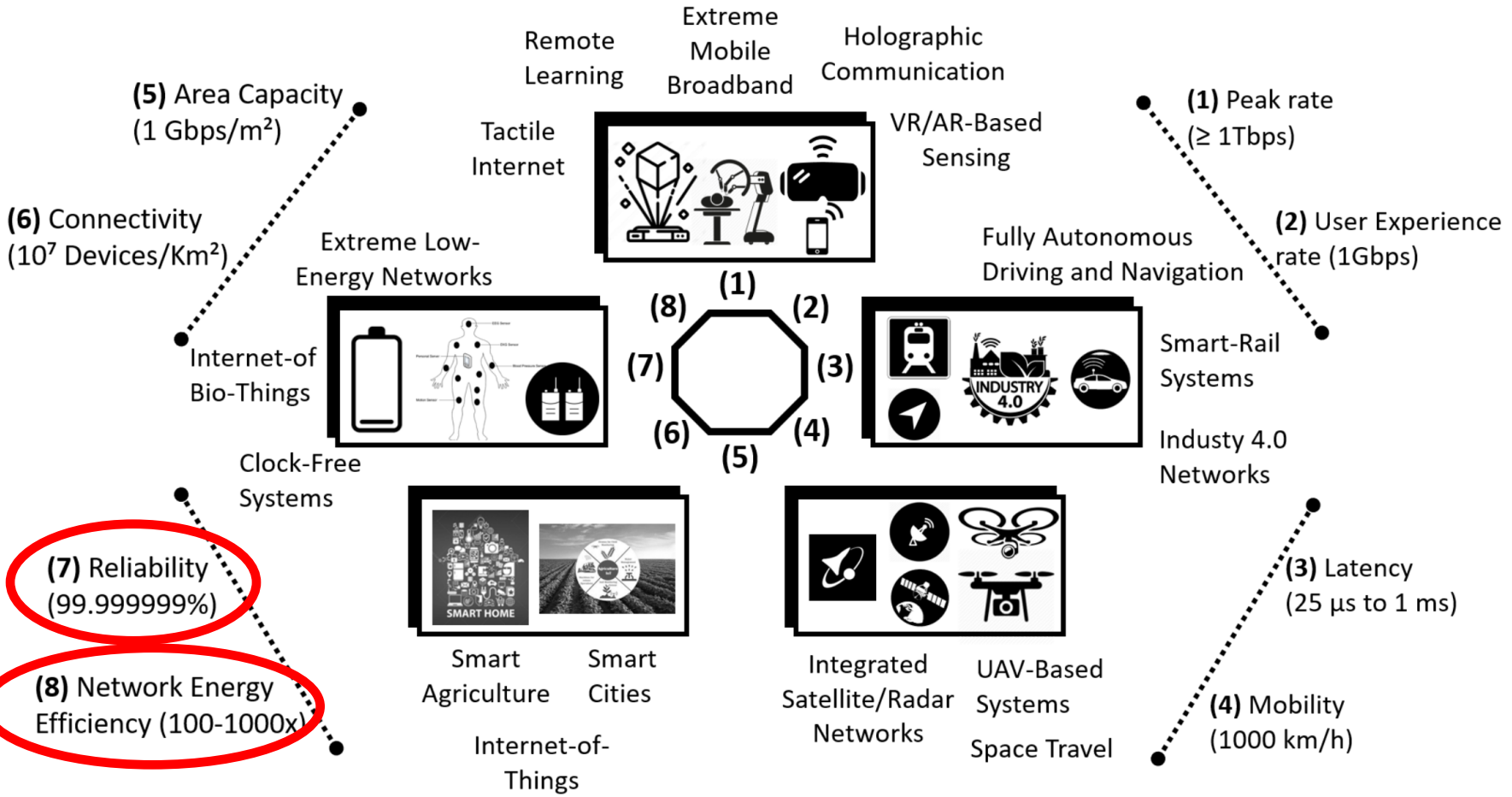
AI-based Closed Loop Control



How do we map user-related metrics to network KPIs ?



How do we measure them ?



Source [2]

Key Challenges to be addressed

- Methods for autonomously personalising services and guaranteeing the requested QoE with the minimal user involvement
- Methods of mapping the target QoEs to basic KPIs
- New measurement methodologies to verify the achievement of the requested KPIs.

References

1. https://www.itu.int/en/ITU-T/focusgroups/net2030/Documents/White_Paper.pdf
2. IMT.FUTURE TECHNOLOGY TRENDS TOWARDS 2030 AND BEYOND
3. "**Service performance measurement methods over 5G experimental networks – (May 2021)**", **5GPPP TMV, White paper (May 2021)**

Thanks

Thank YOU

Samsung Research

Research requirements for

End-to-End Network AI

Nov 2021

Dan Warren, SRUK

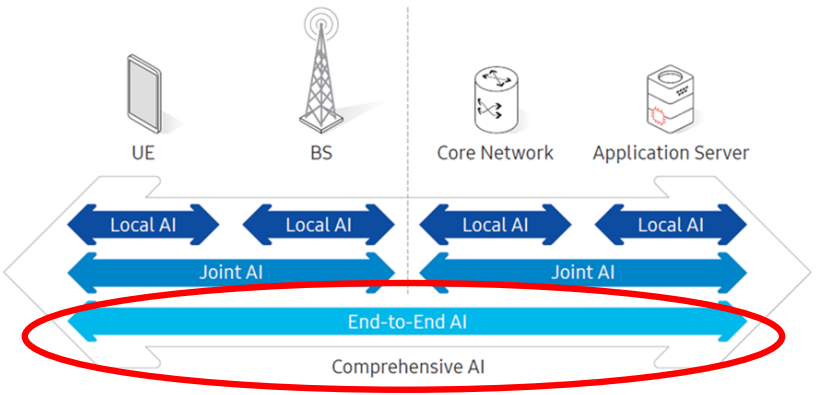
Samsung (and everyone else's) Strategic Direction

Comprehensive & Native AI

Slide Source – Samsung Corporate presentation on 6G Vision, accompanying Samsung 6G Vision Whitepaper

Current Applications
Network planning, e.g., optimization of site locations
Prediction, detection, and self-healing of network anomalies
Network management such as configuration automation, power consumption minimization
Performance improvement, e.g., handover optimization and scheduler enhancement

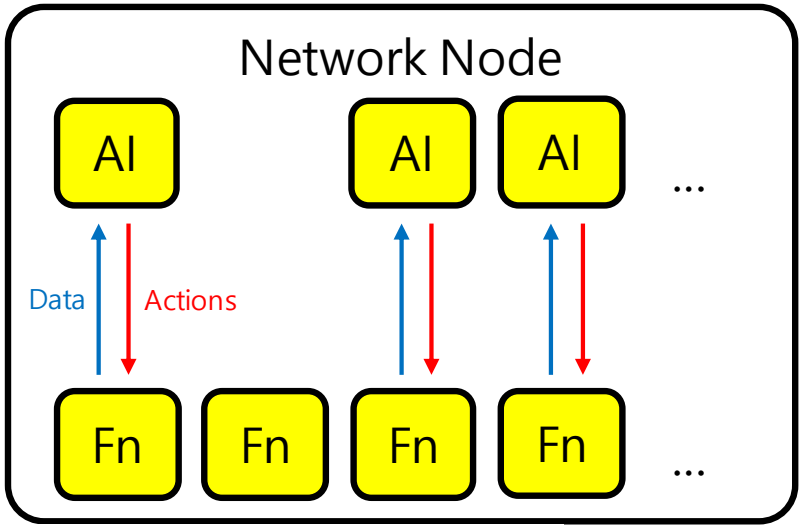
Comprehensive & Native AI
End-to-end optimization of the overall system performance and operation



Comprehensive AI as a 6G building block

Background – current SOTA implementation

Current implementation of AI limited to individual function level

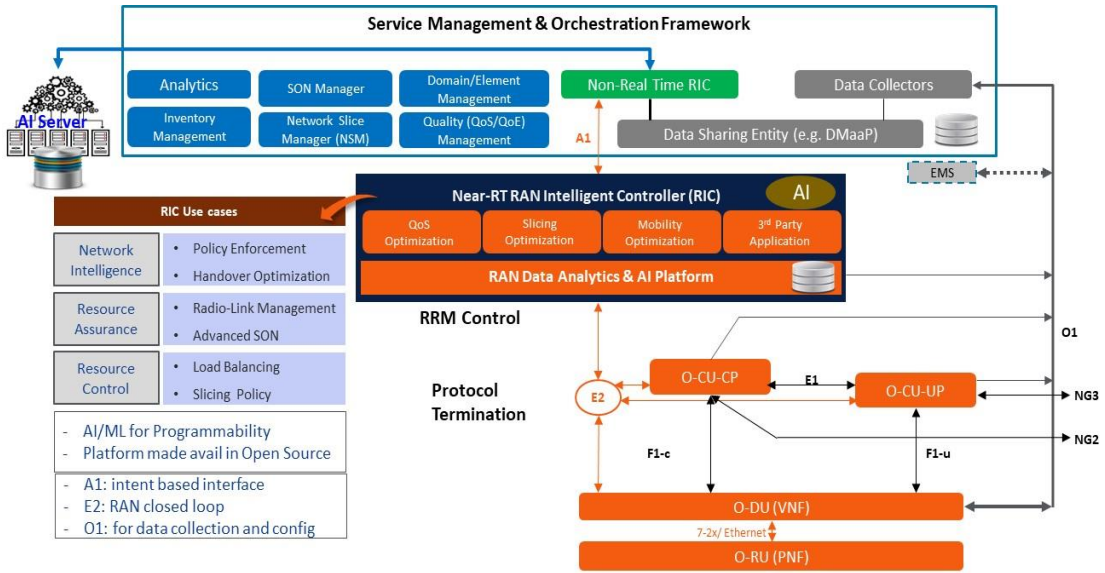


This is hyper-local AI – per function within eNodeB

- AI applied to products is on a **per function basis**
  - Simple to implement and can deliver immediate results but limited number of features are suitable
  - Feature must be wholly contained within a single network node.
  - Requires a simple dataset and standalone function
  - Example features – Cell On/Off, Load Balancing.
- Can create **internal conflicts** – optimisation of one function can lead to degradation of another
  - e.g Cell On/Off tries to unload RATs, Load Balancing tries to balance loads across RATs.

Background – ORAN Architecture

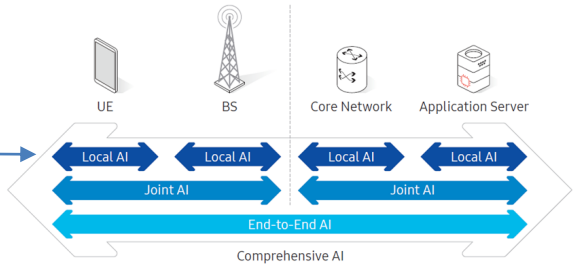
Application of Analytics and Intelligence separately from network node



- Disaggregates RAN management from network Control and User Plane functions
- Data to be sent over 'Open' interfaces – E2, O1, A1 – to be used for multiple purposes in RAN Intelligent Controllers (RICs)

- RAN domain specific implementation
  - Based on experience of per function implementation, can predict that optimising RAN will degrade some performance in Core and Management

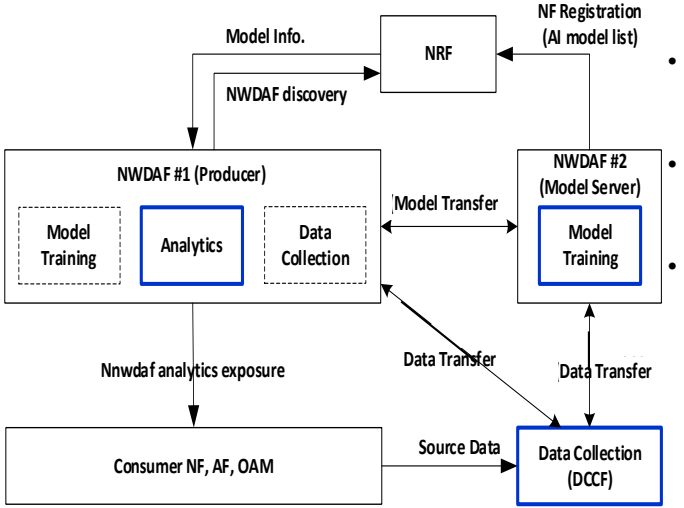
This is local AI – Data and actions all limited to RAN domain



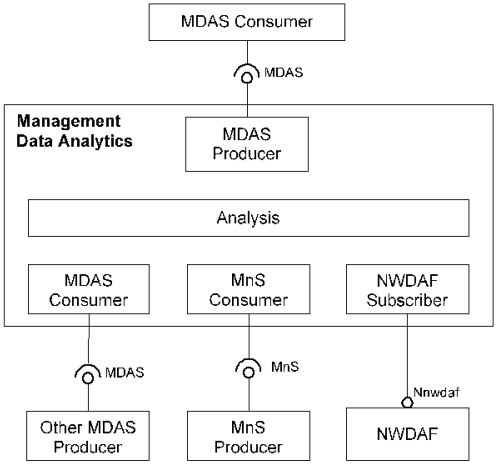
Background – 3GPP NWDAF and MDAS

R16, R17 and R18 increasing complexity in Network Analytics

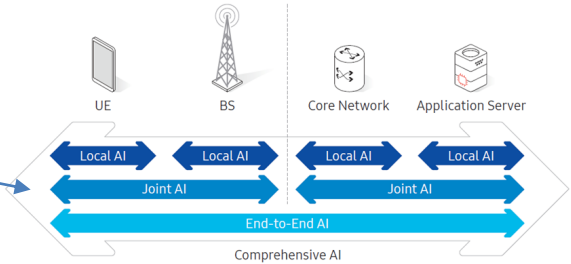
Diagram sources – SRUK Keynote presentation at ACM SIGCOMM'21 - FlexNets Workshop



- Both NWDAF and MDAS include Analytics within their functional make up meaning they are domain specific
- R18 definition likely to allow MDAS and NWDAF to exchange information and results.
- Still will only allow optimisation within one domain which will likely create conflicts on and end-to-end system level.



- R16, R17 NWDAF is Local AI.
- R17 MDAS is moving towards Joint AI (NWDAF can be data source)
- R18 likely to allow NWDAF to source data from MDAS – Joint AI



Problem Statement

Product Implementation and Standards definition do not allow for End-to-End AI to be achieved.

- Because Data and Analytics functions are tightly coupled to individual domains, it is not possible to optimise an end-to-end system or network slice fully.
- Each domain-specific Analytics function can only optimise their own domain

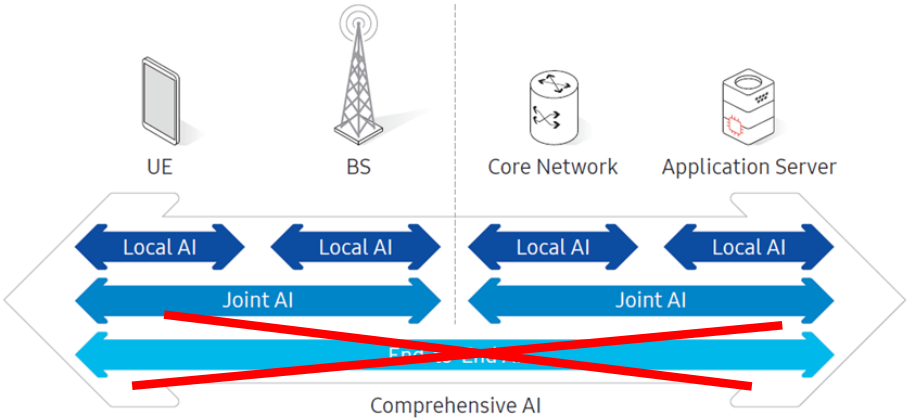
  RICS <->RAN

  NWDAF <-> Core

  MDAF <-> Management

- This results in conflicts and sub-optimal end-to-end outcomes – changes to optimise one domain may negatively impact the next.
- While this model is maintained, solutions cannot move beyond Local AI

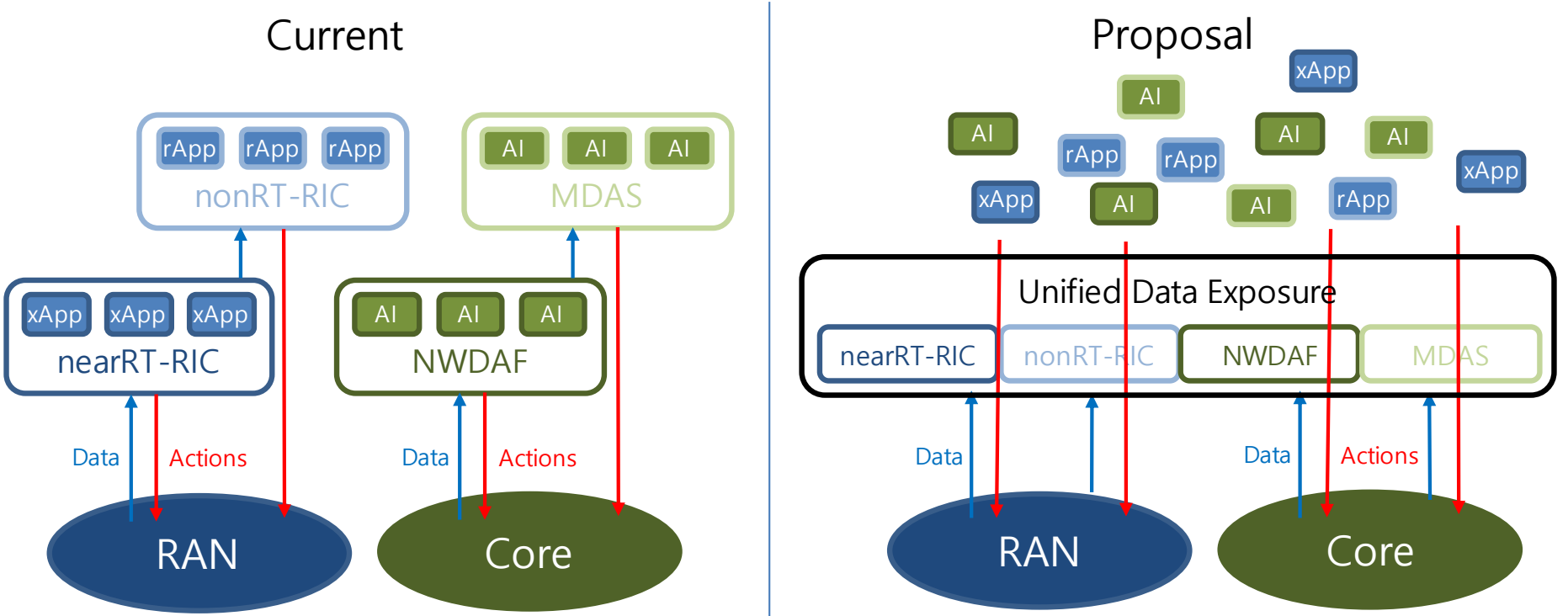
  Even when MDAS and NWDAF are linked in R18, optimisation will still only be achievable at local level.



6G Building Block of Comprehensive AI will not be achieved

What the goal implies

- Separation of AI/Analytics layer from domain-specific functions



Barriers to overcome

Research goals and changes to environment

Requirements for better application of AI/ML

- Availability of data
- Metrology to assess benefit vs effort
- Techniques for increased efficiency in application

Research agenda for achieving end-to-end AI/ML

- Unified data layer across network functions and domains
- Capability to chain applications
- Conflict mitigation in the AI/ML domain
- Reflection and recognition of hard-earned experience (and human intelligence)

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