Drivers, Goals, and Innovations for the 6G System Architecture

26. VDE/ITG Fachtagung Mobilkommunikation

Gerald Kunzmann

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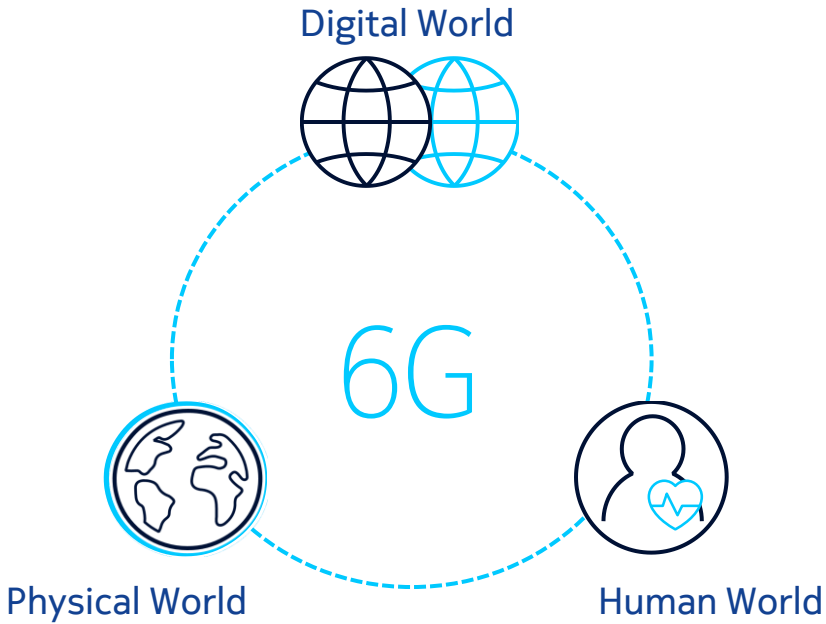
NOKIA

Unleash human potential



Connect digital, physical and human worlds to unleash the innate potential of human beings

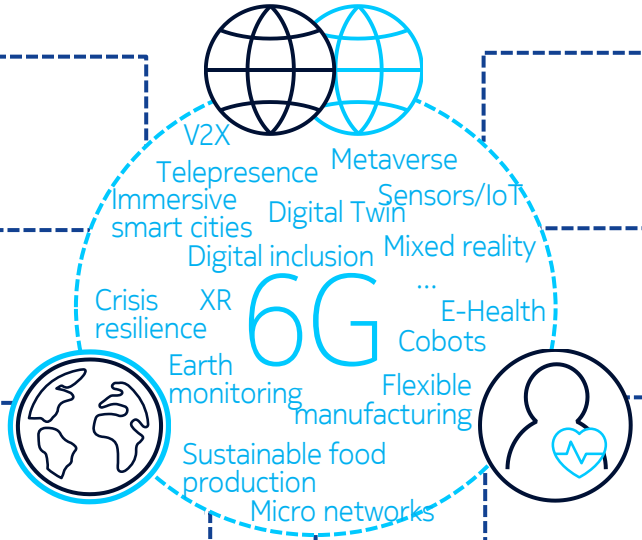
6G system architecture
Drivers and principles

New applications trends, e.g., requiring increased application awareness and adaptive QoS/QoE

New technology trends, e.g., joint communication and sensing

Architecture to suit ultra-dense and macro deployments

Privacy, Security, Trust and Resiliency.
Quantum safe design.
Ensure full protection for UE and network



Sustainability as integral part of 6G architecture design

Native AI/ML support

Cognitive Network and autonomous management for cognitive NFs

Leverage full potential of Service Based Architecture (SBA)

Radio Network disaggregation

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6G system architecture
6 design goals

Specialization
- tailored features and functions
- subnetworks
- extreme networking

Simplification and sustainability
- minimize number of protocols
- minimize/simplify interfaces
- automation

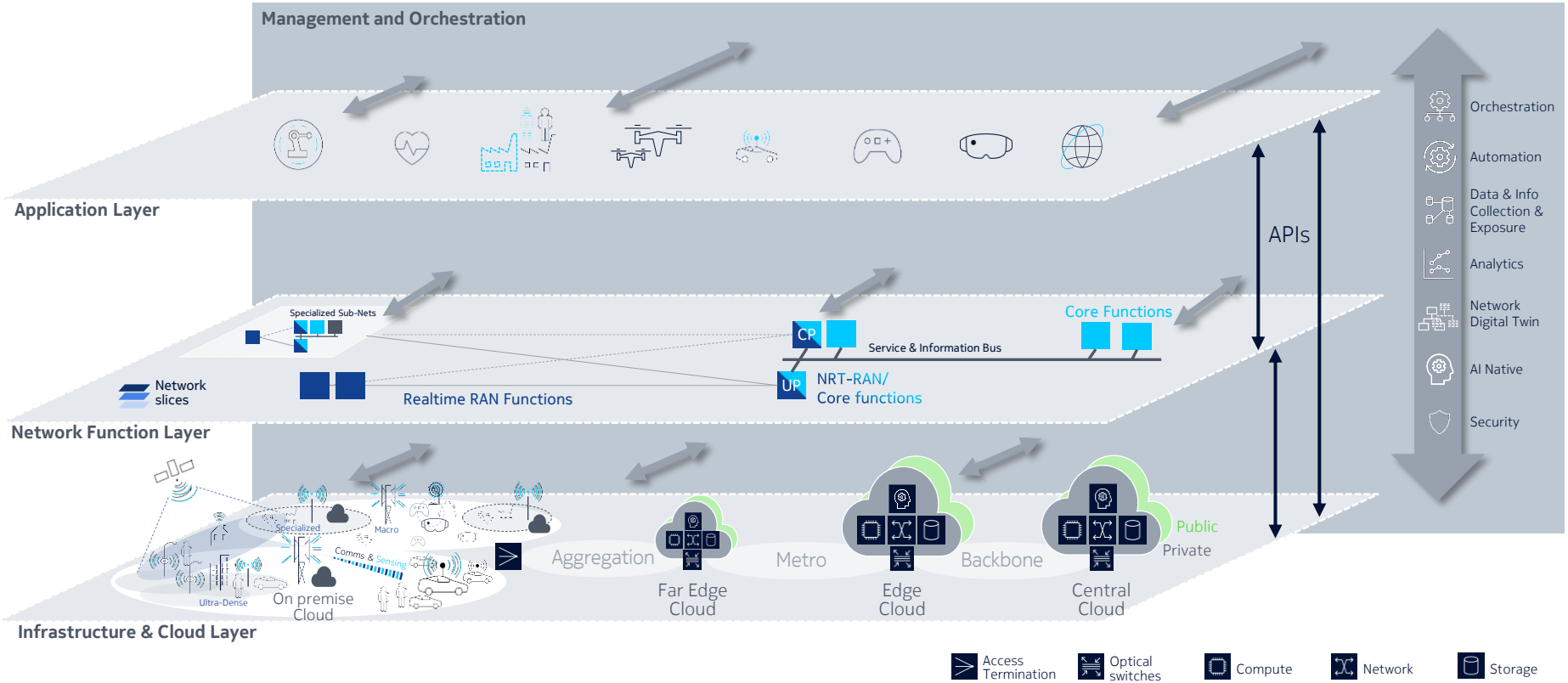
Programmability
- micro-services
- cloud agnostic
- programmable hardware

Cloud platform
- public/private/hybrid
- on-prem/(far-)edge/metro/core
- acceleration

Flexibility
- function placement
- scalability
- topologies

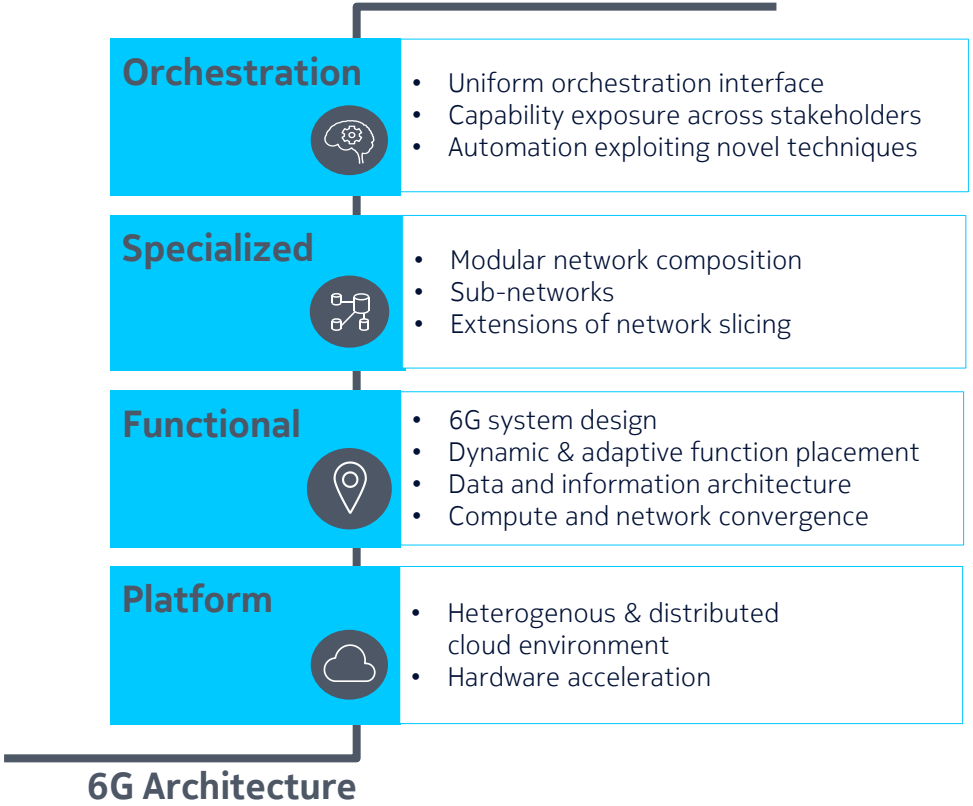
Robustness and security
- full coverage
- multi-connected
- trust, privacy and resiliency

6G system architecture concept

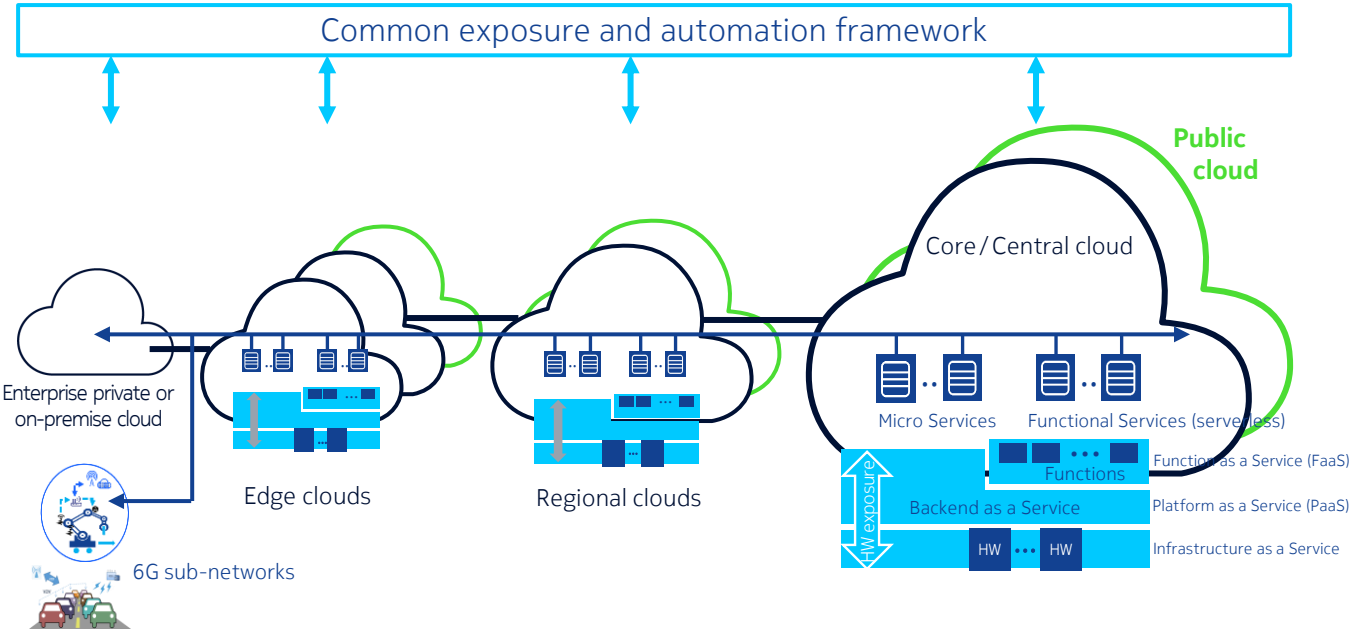


6G architecture innovations

6G architectural innovations



Heterogenous (Het-Cloud) platform



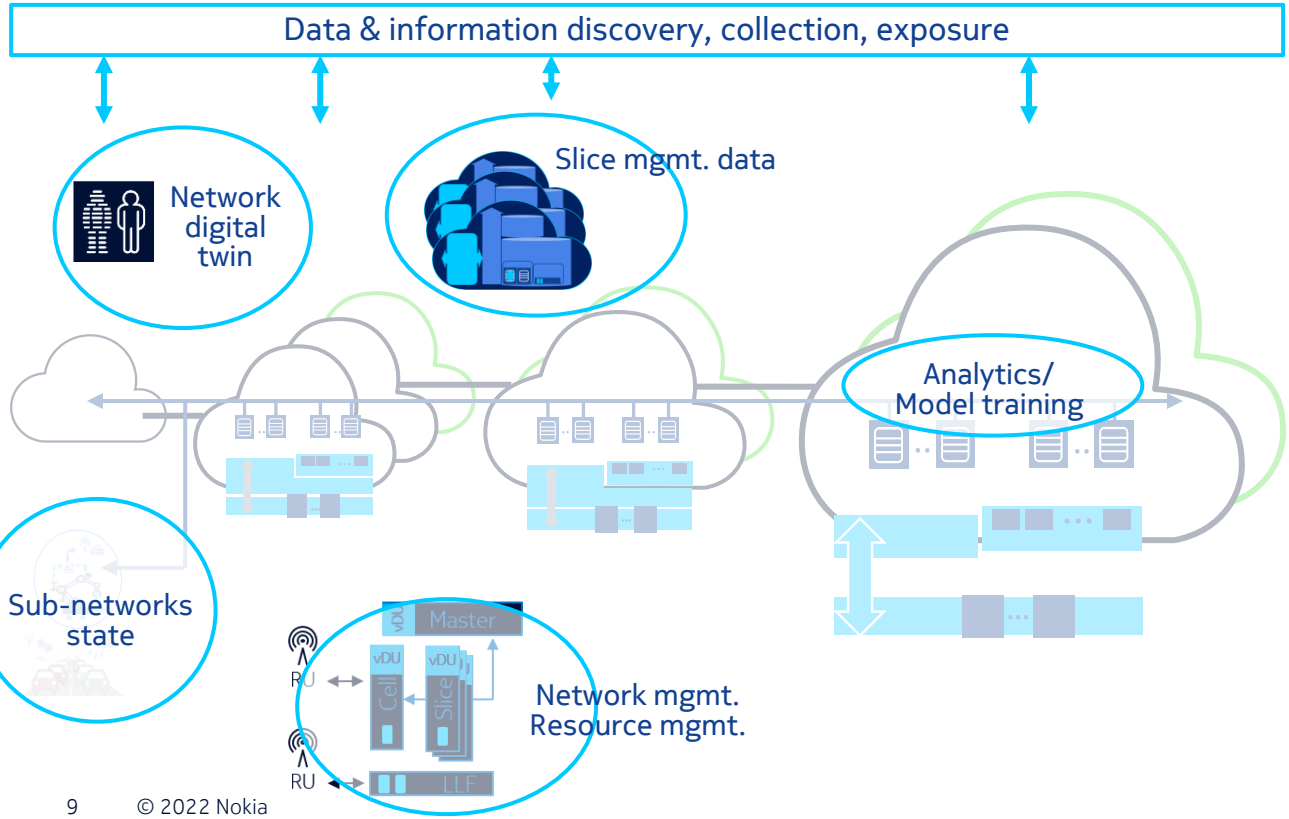
Cloud transformation towards 6G is heterogeneous, multiple stakeholders run applications at different sites.

Functionalities needed are capability discovery, cloud agnostic NFs, service bus integration for inter cloud scenarios, service monitoring, cross domain service discovery.

Benefits

- Easily & efficiently create, place, scale, and move services between clouds.
- Brings flexibility and simplicity.
- Allows highest level of trustworthiness by trusted execution environment (TEE).

Data and Information framework



Ever more data is collected in multiple parts of the network and consumer devices by, e.g., ML agents and network analytics.

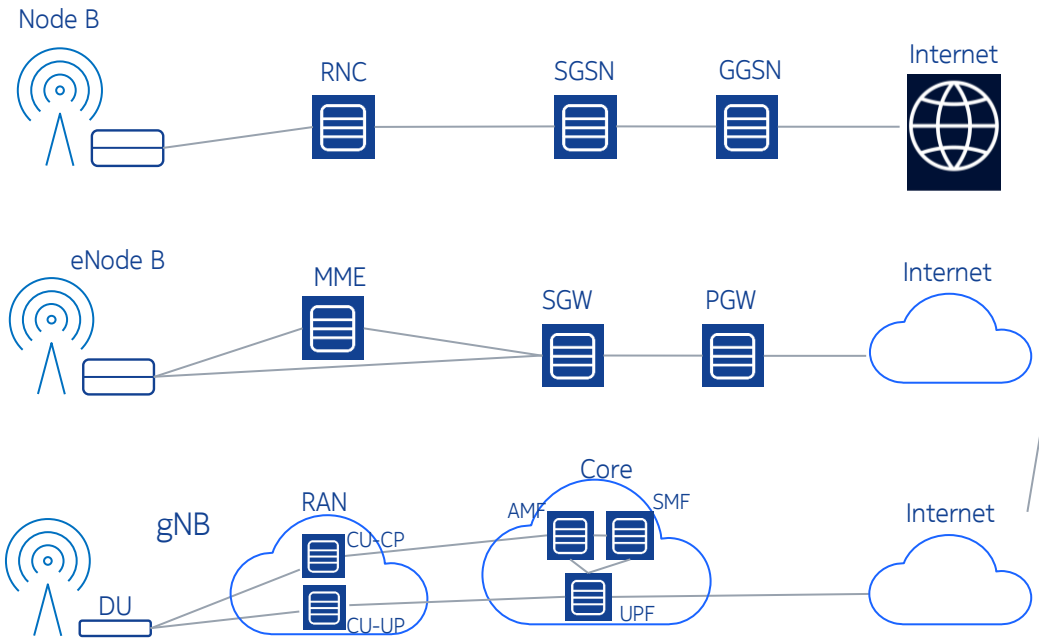
Data can be:

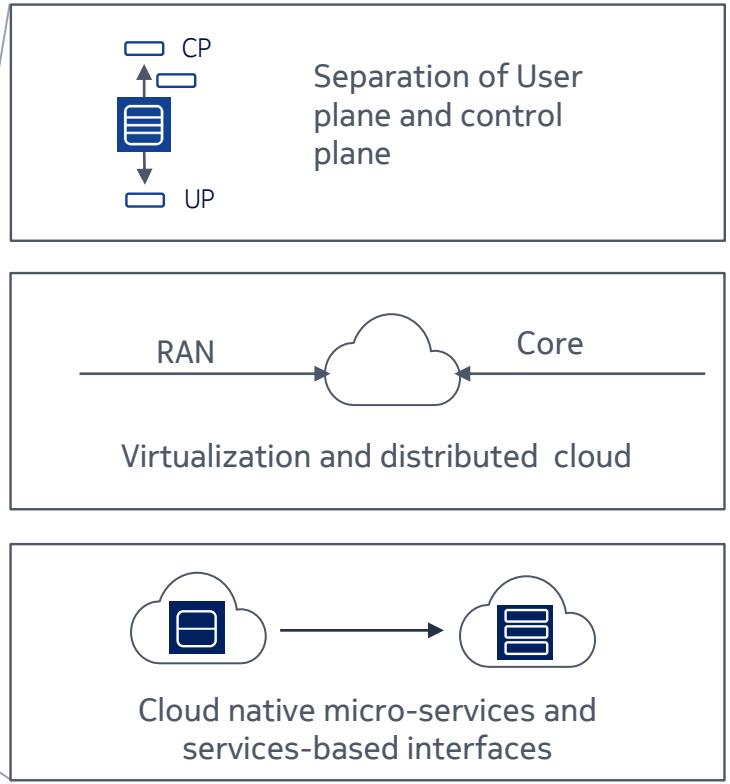
- Near real time streamed data
- Accumulated time series for training the network models
- Registration data kept in various registrars

Target for common exposure, discovery and delivery framework(s).

Study introduction of pub-sub in addition to subscribe/notify.

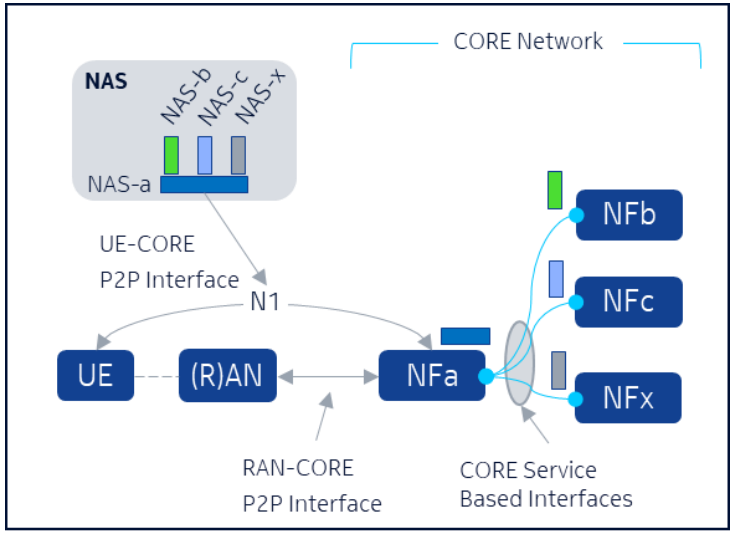
RAN-Core evolution
Historical Trends





5G System Architecture

Current N1 & N2 Interfaces & Architecture



1. N1 interfaces carries Non-Access Stratum (NAS) signaling transparently via (R)AN between UE & NFa.
2. NAS protocol consists of NAS-MM messages for RM/CM, Security, etc., but also provides transport service for other payloads, e.g., SM, SM, UE Policy, SoR, etc.
3. AMF terminates NAS-MM messages and relays payloads transparently via service-based interfaces towards relevant NFs, e.g., SM to NFx, UE Policy to PCF etc.
4. NFa also terminates the N2 interface from (R)AN which transports the NAS messages among other functions.
5. NFs which terminate NAS-MM payloads (e.g., NFc, NFb…) communicate indirectly with UE via AMF.

ALL inter-(R)AN & 5GC Signaling anchored at NFa -- due to NAS termination at NFa

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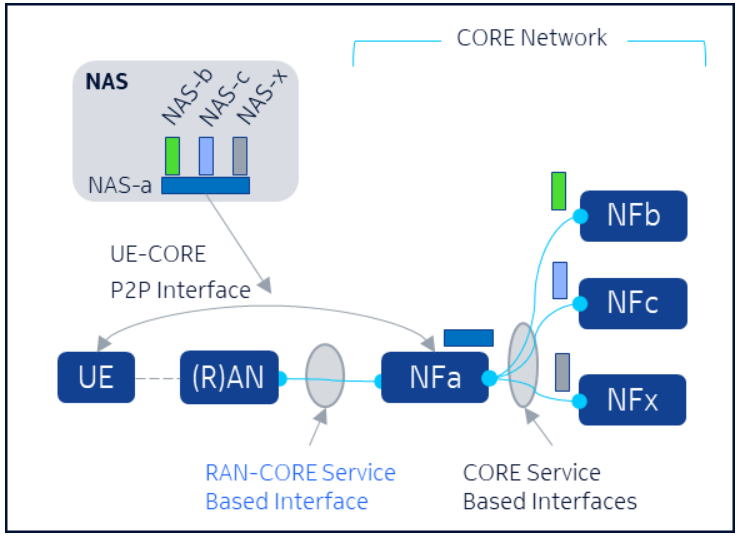
Evolution of RAN – Core interface

RAN - Core interface evolved to Service-Based Interface



1. Adoption of a Service Based Interface for N2 would remove need for SCTP protocol and align with 5G Core Service Based Interfaces.

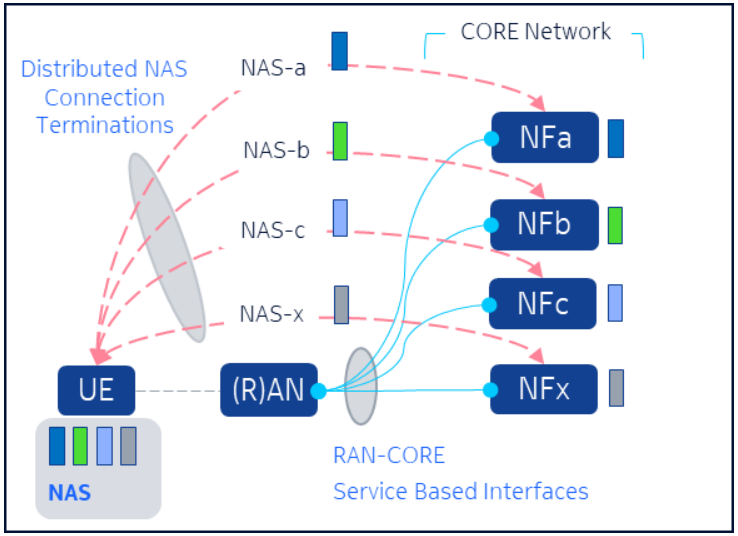
   However, (R)AN nodes would still only communicate with NFa since NAS-MM is terminated at NFa, i.e. (R)AN only has NFa Identifiers and no other NF info.

2. NFs such as NFx, NFc, etc. continue to communicate indirectly with UE via NFa.

   For example, it is NOT possible for (R)AN to communicate directly with NFx since (R)AN receives no NFx Identifiers plus the NAS-SM payload is not visible to (R)AN.

Limited benefits realized with N2 SBA – restrictions due to single NAS termination

Proposal for 6G Architecture
Distributed NAS termination & N2 service-based interface



A **Distributed NAS Architecture along with N2 SBI** would enable:

- UE-any NF direct communication without AMF
- Direct (R)AN-NF communication with service-based interfaces

Potential benefits include:

- Leverages the full benefit of Service Based Architecture between (R)AN & Core, e.g., direct (R)AN-NF SBI's
- Signaling Load distribution across multiple NFs with reduced signaling load, e.g., no SM signaling via NFs handling MM
- Reduced signaling hops (latency improvements)
- Strengthened security, e.g., UE-NF Encryption/Integrity

Areas for further study:

- Distributed NAS Design
- Security Architecture, e.g., Temporary Identifiers, Keys & Hierarchy
- (R)AN-Core NF Service Based Messages/Procedures

Fully benefit from SBA realized with distributed termination of NAS in **ALL** NFs

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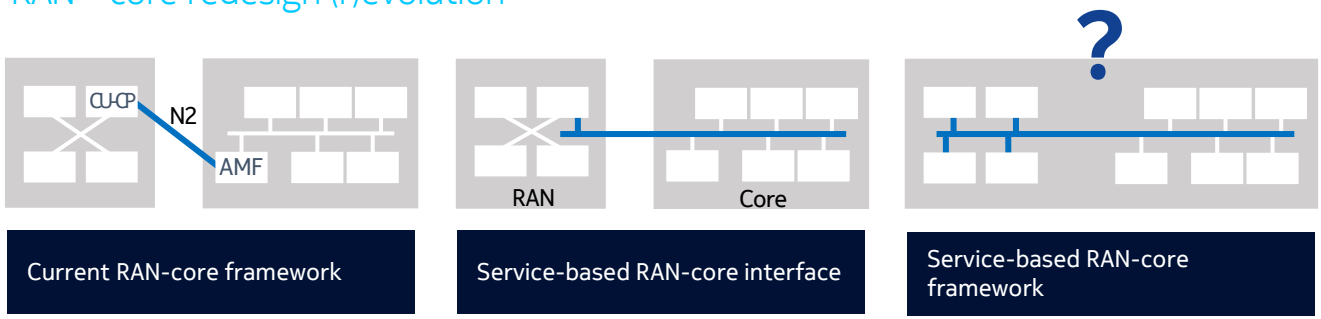
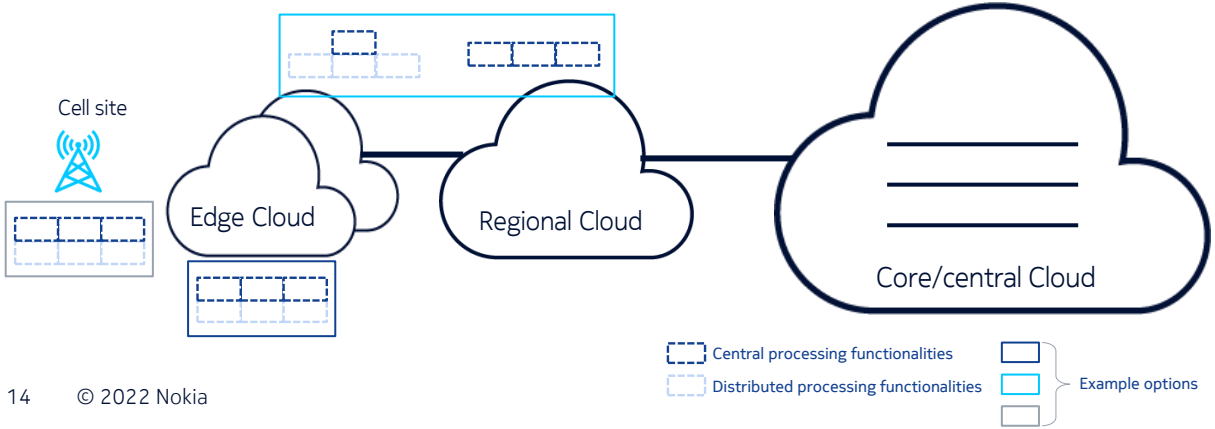
RAN architecture

RAN – core redesign (r)evolution



RAN deployment and split options



RAN Architecture

- SBA within RAN
- Deployment and split options
- Cloud-native technology employ

Benefits

- Specialized deployments per requirement
- Common transport and security
- Direct communication at a service level
- Easy, efficient, and flexible feature development and deployment

Research Areas

- CU/DU (non)split and deployment options
- Standardization vs. proprietary impacts
- Analysis of RAN functions for SBA adoptability

6G activities
Worldwide

North America

NEXT G ALLIANCE

Europe

EU — Hexa-X; SMART NETWORKS & SERVICES

FI — 6Genesis

DE
Other countries

6G Hubs and other national initiatives

Asia

CN — MIIT; 中华人民共和国科学技术部; 未来移动通信论坛 FUTURE MOBILE COMMUNICATION FORUM

KR — Ministry of Science and ICT; 5G Forum

JP — MIC Ministry of Internal Affairs and Communications; IOWN GLOBAL FORUM

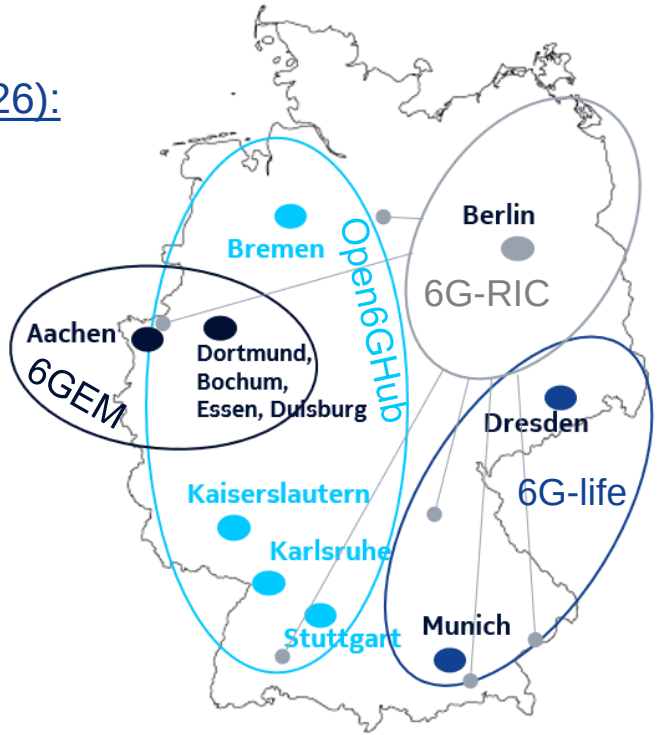
IN — tsdsi

6G activities
German Digitalization Initiative

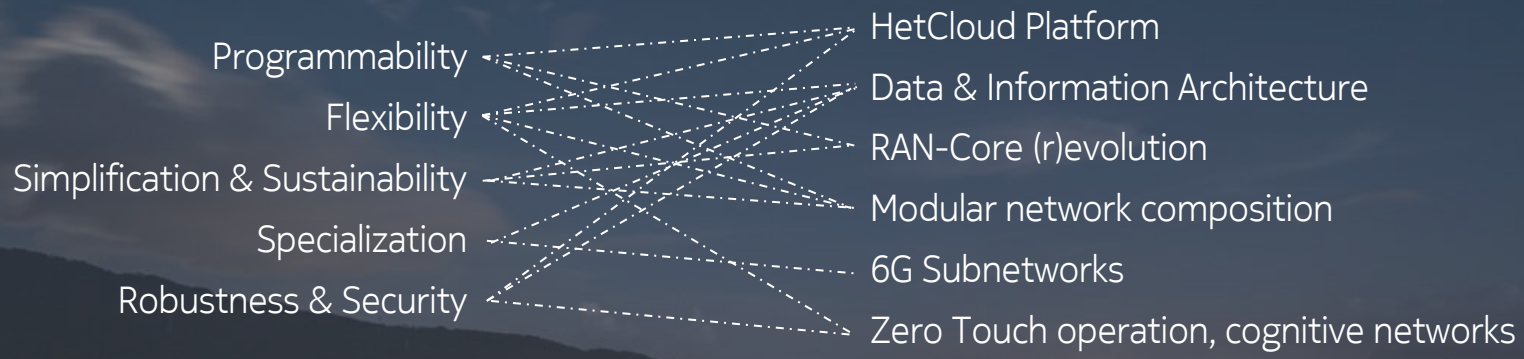
Communication Systems Program (BMBF, 2021 - 2026):
AI-NET (lighthouse project), 6G calls
Volume: 600 – 700 m€

Phase 1 (universities, research institutes)
Volume:	190 m€ (250 m€)
6G Hubs:	6G-life, 6G-RIC, Open6GHub, 6GEM, + 6G platform

Phase 2 (industry)
Submission deadline:	06.12.2021
Funding decision:	~~End of February 2022~~ May 2022
Project start:	Q3 2022
Volume:	> 100 m€
Funding:	Industry 50%
Projects:	Small dedicated industry projects, lighthouse project: 6G-ANNA (proposed)



https://www.6g-life.de/
https://6g-ric.de/
https://www.open6ghub.de/
https://www.6gem.de/



6G to unify the experience across the physical, digital, and biological worlds

What is 6G? - Nokia Bell Labs (bell-labs.com)
Whitepaper "Technology Innovations for the 6G system" (April 2022)
Blog "The metaverse will never move beyond our living rooms without a powerful network"