Native AI 6G architectures: Research Challenges and SDO Opportunities

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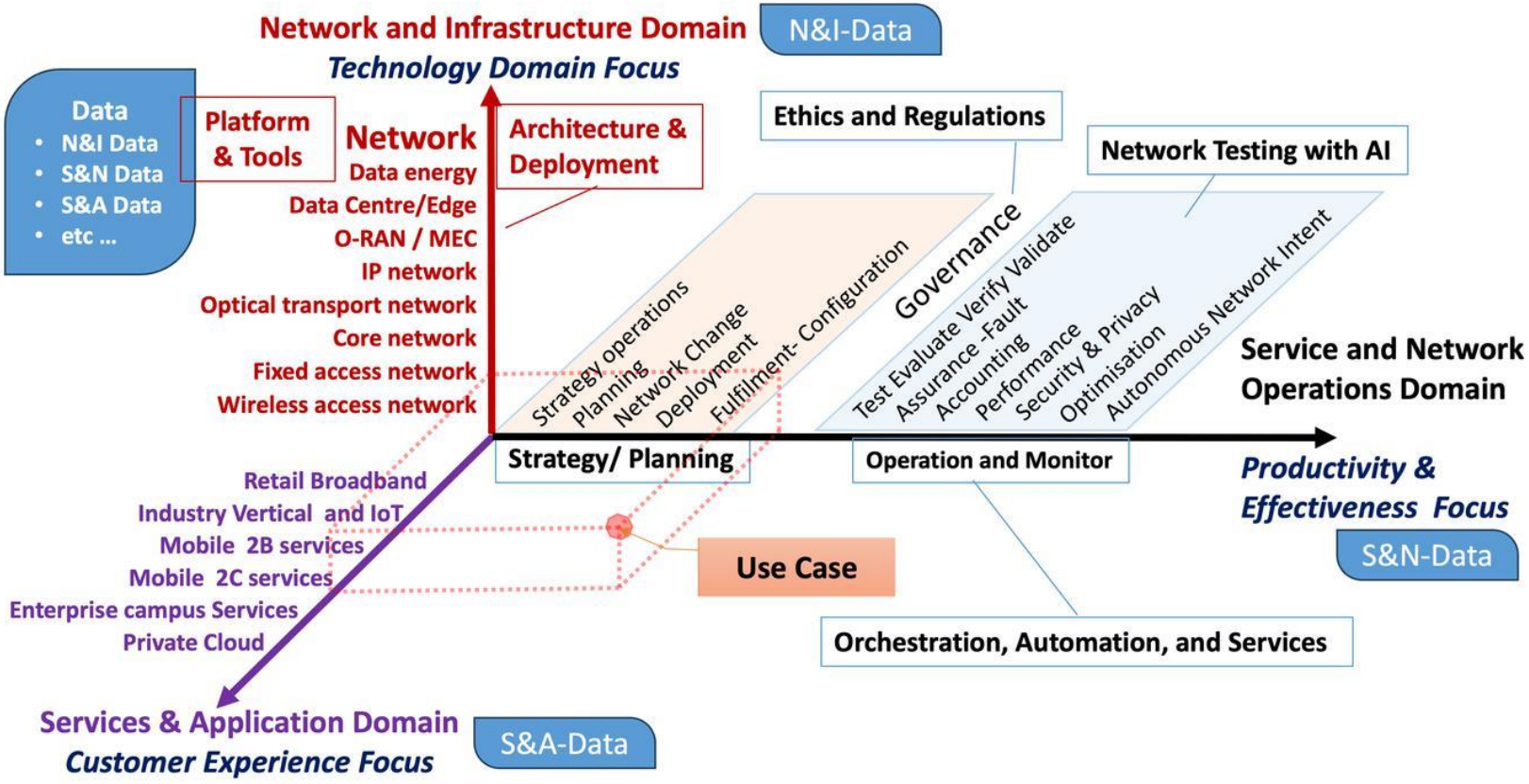
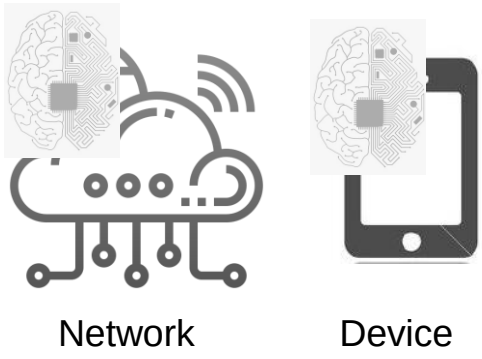
Why AI in Telecommunications



Source: UKTIN, 2024

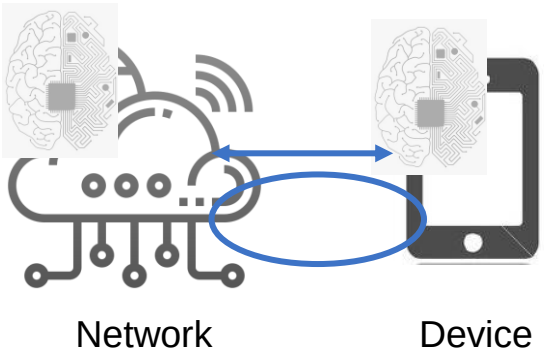
AI/ML Deployment in Networking

Independent AI/ML



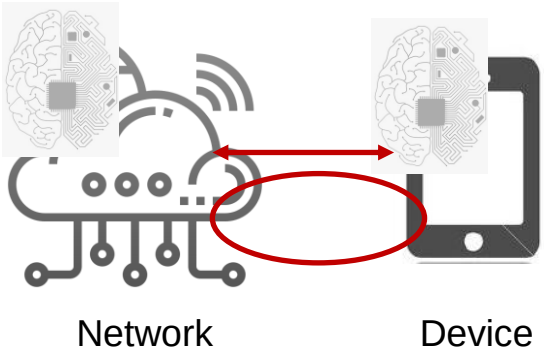
- ML can be deployed independently either at the network or at the device
- Proprietary ML deployment
- Proprietary data collection

Co-ordinated AI/ML



- Co-ordination between network & device
- Proprietary & standardized ML procedures
- Data collection for both training and monitoring

Native AI/ML



- Autonomous ML deployment between network and devices across all layers
- ML procedures to train performance and adapt to different environments
- From DevOps to MLOps

Use of ML in 5G networks

- RAN Functionalities (Energy Efficiency, Interference)
- Predict Failures and Outages
- Automated Network Functions (routing, policy)

SON vs IBN

	Self-Organised Networks (SON)	Intent-Based Networking (IBN)
Objective	• Automate learning, configuration, optimization, healing.	• Align network configurations and operations with business intentions.
Automation	• Network tasks	• Autonomous network operations based on high-level business intents and policies
Technologies	• Machine Learning • Data Analytics • Network Intelligence	• Intent translation • Machine learning • Closed- loop operation
Benefits	• Improved QoE • Network Efficiency • Reduced OPEX	• Autonomous zero touch network management • Agility • operational efficiency

AI in 5G and Beyond

- Radio Network

- Management and Core

AI in 5G and Beyond

- Radio Network

- Management and Data Core Level

RAN

- AI Optimisation
  - CSI feedback enhancements
  - Beam management
  - Positioning accuracy
- Native AI Design
  - Physical layer
    - transmitter, channel and the receiver
  - MAC Layer
    - Random Access, Spectrum Sharing

AI in 5G and Beyond

- Radio Network

- Management and Core

Management and Data Core

- MDAF (Management Data Analytics Function): It is a service-based management architecture
  - Deployment analytics services for automated network management and orchestration
  - Data-driven decisions drive the logic of the NSMF (Network Slice) and NSSMF (Network Slice Subnets) Management Functions
- NWDAF (network data analytics function):
  - Analytics logical function (AnLF) and model training logical function (MTLF)
  - A 5G network can feature several NWDAF instances, each associated with a different service area

Next Steps and Roadmap

- Expose monitoring and status information about resource utilization to authorized third parties
- Inform AI/ML operation about predictions of changes in network conditions
- IBN facilitating NS requirements
- Multi-domain end-to-end network slicing

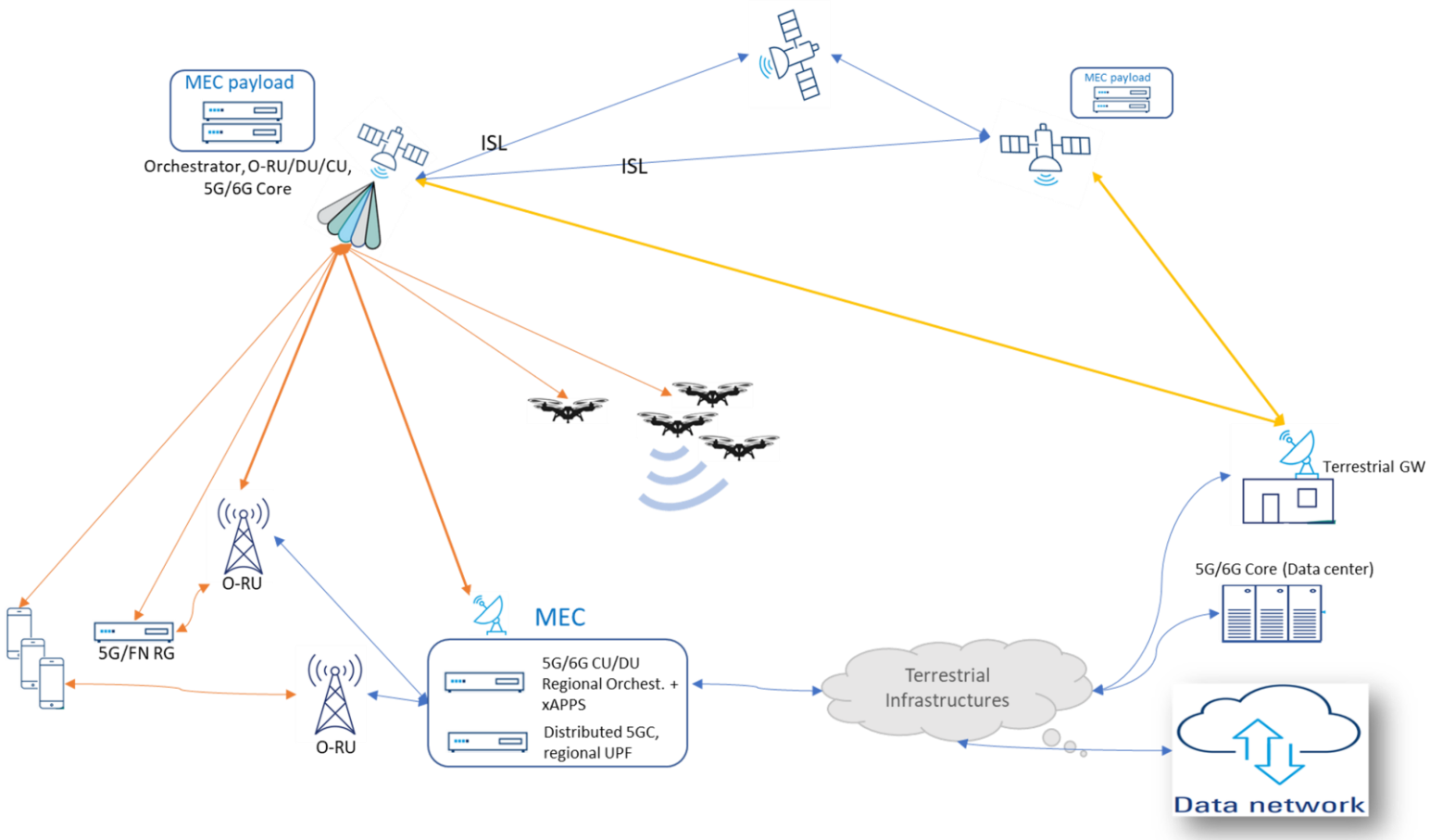
Transition to Distributed Intelligence-(1)

- Parallel Training
  - partition the data and feed the different portions to a set of distributed nodes, deploying the same model.
- Model Splitting
  - Different portions of a complex ML model are executed sequentially in different processing nodes
  - Decision on data handling vs ML Deployment
- Federated Learning
  - the model is locally trained on their own data by distributed devices
- Explainable AI
  - XAI has been designed to explain decisions made by AI

Transition to Distributed Intelligence-(2)

- Transfer Learning
  - partition the data and feed the different portions to a set of distributed nodes, deploying the same model.
- Distributed Reinforcement Learning
  - Different portions of a complex ML model are executed sequentially in different processing nodes
  - A learner takes actions in a stochastic environment over a sequence of time steps, to maximize the long-term cumulative rewards received from the interacting environment according to a given policy

TN/NTN Integration



Challenges

- Multi-domain orchestrator
- Edge Cloud Multi-tenant utilization and AI Workload management
- Network slicing in hybrid TN/NTN
- NetApps provisioning
- Resilience

Questions

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