Native AI 6G architectures: Research Challenges and SDO Opportunities

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Why AI in Telecommunications

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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

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