Cognitive Self-Organizing Networks: AI-driven Network Automation for 5G/6G

1. Problem Statement

With the transition from 5G to 6G, mobile networks are becoming more complex, with more connected devices, higher data usage, and narrower performance requirements. Traditional Self-Organizing Networks (SON) help automate network tasks, but they still rely on fixed rules and cannot fully adapt to changes in real time. Because of this, SON alone is not enough to manage the increasing demands of future networks.

To address this, researchers introduced Cognitive Self-Organizing Networks (C-SON). These networks use Artificial Intelligence (AI) and Machine Learning (ML) to make better decisions, learn from data, expect problems, and adjust network settings automatically. Previous studies have shown improvements in handover, load balancing, and network performance using C-SON. However, there are still challenges that limit its full adoption. Some solutions do not scale well for large networks, some AI-based functions work independently without coordination, and many systems are only tested in simulations rather than real deployments.

Even though real implementations like the Nokia and STC MantaRay C-SON solution have shown good results, they are still limited to a single operator and do not fully solve issues like interoperability, multi-vendor compatibility, and security. Therefore, there is a need for a practical, scalable, and secure C-SON framework that can work effectively in real 5G and 6G environments.

2. Research Objectives

Main Goal:
To develop and evaluate a accessible and AI-based Cognitive Self-Organizing Network (C-SON) framework for intelligent network automation in 5G and 6G environments.

Specific Objectives:

1. To identify the limitations of traditional SON and current C-SON solutions in scalability, coordination, and real-world deployment.
2. To design a scalable C-SON model that uses AI to support autonomous decision-making and coordination across network functions.
3. To simulate or test the proposed C-SON model in a 5G or 6G environment and measure its performance in areas such as handover, load balancing, latency, and throughput.
4. To compare the proposed model with traditional SON and existing AI-based solutions using measurable key performance indicators (KPIs).
5. To identify challenges like security issues, multi-operator deployment, and vendor compatibility, and suggest recommendations for future improvement.

3. References

1) Paper 1 – Moysen & Giupponi (2017): IEEE CSurT record via Semantic Scholar: https://www.semanticscholar.org/paper/From-4G-to-5G%3A-Self-organized-Network-Management-Moysen-Giupponi/bc874fbc690a73c24a523dbda0ec18a4646c0b8e
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3) Paper 3 – Banerjee et al. (2020): arXiv: https://arxiv.org/abs/2001.07031
4) Paper 4 – ACM Closed-loop Automation (2021): https://dl.acm.org/doi/10.1145/3472735.3474458
5) Paper 5 – Open RAN Survey (MDPI, 2024): https://www.mdpi.com/1424-8220/24/3/1038
6) Paper 6 – Nokia & stc (2024): https://www.nokia.com/newsroom/nokia-and-stc-group-optimize-network-with-ai-powered-mantaray-cognitive-son-solution-in-saudi-arabia/