

# Global Collaborative Research on 6GARROW: 6G AI-Native Integrated RAN-Core Networks

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**Abstract**—To fully realize the potential of AI in 6G networks, it is essential to move beyond fragmented deployments across the User Equipment (UE), Radio Access Network (RAN), and Core Network (CN). Accordingly, an end-to-end integrated approach is needed to deliver substantial gains in service quality, energy efficiency, and network sustainability. In response to this need, a new collaborative research and development project titled 6GARROW has been launched by leading companies, research institutes, and universities from Korea and Europe. This collaboration aims to develop and validate AI-native 6G network architectures, enabling seamless intelligence across all domains of the network.

**Index Terms**—AI-native networks, 6G architecture, Semantic communications, Cross-domain AI networks

## I. INTRODUCTION

Modern wireless networks are gradually incorporating Artificial Intelligence (AI) and Machine Learning (ML), particularly in 5G, where AI is being applied to limited use cases such as network optimization and anomaly detection [1]. Additionally, current deployments treat AI as an add-on rather than as an integral part of the network infrastructure [2]. AI functionalities are mostly isolated, reactive, and lack real-time decision-making capabilities [3].

To address these challenges, the 6GARROW project [4] has been launched, introducing a paradigm shift from AI-assisted systems to truly AI-native 6G networks. The vision is to embed AI into every layer and function of the communication stack, including Radio Access Network (RAN), Core Network (CN), and User Equipment (UE) [5]. This integration enables dynamic adaptation, automated decision-making, and intelligent collaboration between the network and devices. The resulting system improves flexibility, performance, scalability, and supports new classes of AI-driven services.

## II. THE INTEGRATED APPROACH: A HOLISTIC 6G VISION

The 6GARROW system architecture integrates AI/ML functionality throughout the UE-RAN-CN domains. As shown in Figure 1, the architecture supports:

- Distributed AI agents at the UE, RAN, and CN levels.
- Standardized interfaces that ensure seamless interconnection between components.
- Intelligent data and model sharing across network layers.

A major architectural advancement is the system's data-centric design. Each component, including mobile devices,

base stations, and core functions, features built-in data collection and analytics capabilities. These are connected to advanced modules such as:

- Network Data Analytics Function (NWDAF)
- Management Data Analytics Function (MDAF)
- RAN Intelligent Controller (RIC)

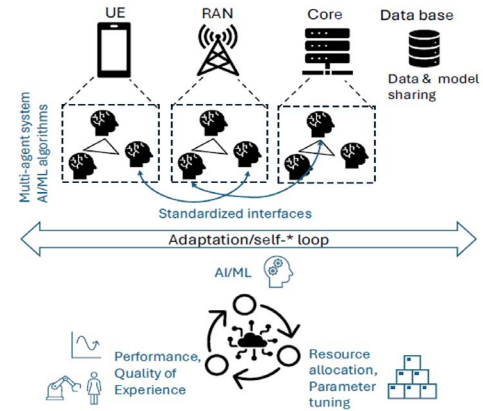


Fig. 1. 6GARROW AI-native system with integrated approach

## III. TECHNICAL INNOVATIONS AND RESEARCH THEMES

The 6GARROW project investigates multiple technical enablers, grouped into three domains as follows.

### A. Interfaces and Signaling

This research investigates the behavior of federated learning in wireless environments, with a particular focus on overcoming challenges such as signal distortion and data heterogeneity that arise in real-world deployments. In addition, it explores the design and implementation of a semantic communication plane [6], including the definition of novel semantic interfaces that bridge the application layer and the lower layers of the protocol stack. These interfaces are intended to facilitate more efficient and goal-oriented data transmission. Furthermore, the project develops advanced compression algorithms for Channel State Information (CSI) and Channel Quality Indicators (CQI), aiming to reduce the overhead of feedback transmission without compromising accuracy. Finally, it designs signaling

frameworks that support the exposure and access of AI-as-a-Service (AIaaS) APIs, enabling both internal and external entities to interact seamlessly with AI functionalities embedded in the network.

### B. Device-Level AI Enhancements

At the device level, the project introduces semantic-aware data processing techniques to reduce communication overhead while simultaneously enriching the quality and relevance of transmitted data. It also proposes a context-sensitive compression framework, which adapts encoding strategies based on latent space representations to ensure efficient use of bandwidth and computation. To further enhance energy efficiency, especially in mobile and edge devices, the research explores generative AI models that intelligently balance the trade-off between computation and communication. These models allow minimal information to be transmitted while maintaining task performance through local inference at the receiver side. Additionally, the project investigates hardware impairment mitigation by employing AI-driven Digital Pre-Distortion (DPD) methods. These techniques aim to reduce hardware complexity and improve energy efficiency while addressing challenges such as power amplifier non-linearity and environmental variations.

### C. RAN and CN Intelligence

The project leverages AI-powered orchestration mechanisms to optimize resource usage and improve energy efficiency across both RAN and CN domains. Through intelligent and adaptive control, the system can dynamically allocate and scale resources based on real-time network conditions. Moreover, the research explores real-time beamforming optimization and the simulation of massive MIMO channels using AI models, enabling more responsive and efficient physical-layer performance. To improve system resilience, the project implements cross-domain inference coordination mechanisms that support robust fault detection and AI-based recovery techniques. Lastly, by integrating transfer learning and reinforcement learning, the system can continuously adapt to evolving user demands, traffic patterns, and environmental conditions, ensuring sustained performance and adaptability in the forthcoming 6G networks.

## IV. DEMONSTRATIONS AND PROOF OF CONCEPT (POC)

To substantiate the theoretical frameworks and architectural advancements proposed in the 6GARROW project, a series of four functional demonstrations will be conducted, along with a comprehensive Proof of Concept (PoC) showcasing system-level integration. The first demonstration focuses on semantic-aware device-edge co-inference, where semantic encoding techniques are utilized in a gesture recognition application. This setup exemplifies real-time edge intelligence and highlights the potential of collaborative inference between devices and the edge infrastructure.

The second demonstration presents an end-to-end cross-domain AI coordination framework designed to support dynamic network slicing. As illustrated in Figure 2, this framework enables AI-driven decision-making across both RAN and CN domains, ensuring that slice requirements are continuously validated and optimized in real time.

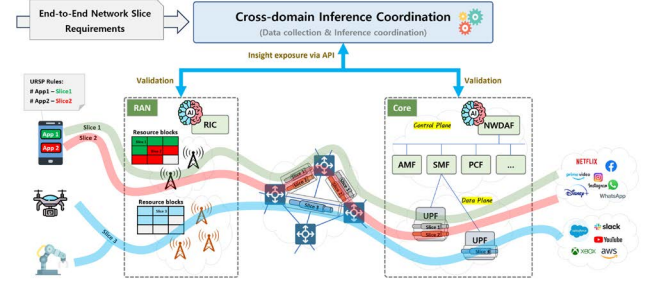


Fig. 2. 6GARROW cross-domain network intelligence framework

In the third demonstration, the project explores AI/ML-based physical layer optimization within an Open RAN environment. Utilizing Open-RU and Open-DU platforms, this testbed validates the performance and adaptability of AI-enabled techniques such as channel estimation, beam management, and CSI feedback under realistic operating conditions.

The fourth demonstration addresses AI-based compression of CSI and CQI feedback, leveraging field channel data and edge intelligence platforms. This scenario highlights the effectiveness of machine learning algorithms in reducing signaling overhead while maintaining transmission quality.

Beyond these component-level validations, 6GARROW will implement a fully integrated PoC, leveraging a cross-continental testbed connecting European and Korean infrastructures. It demonstrates the full deployment of AI-native functionalities across all domains, including device, RAN, and CN, within a unified testbed. The PoC includes real-time orchestration of network functions, such as fronthaul and backhaul management, authentication services, and user management. Furthermore, it facilitates the exposure of open APIs that allow third-party developers and applications to interact with the network's AI-driven capabilities. This validation confirms the practicality, interoperability, and openness of the integrated intelligence framework envisioned by the 6GARROW initiative.

## V. CONCLUSION

6GARROW is more than a technical research effort; it is a comprehensive initiative to redefine wireless communication for the AI era. By embedding intelligence across all network domains and devices, the project introduces a new model of adaptive, semantic, and goal-oriented communication. With its strong emphasis on demonstrable architecture, regulatory foresight, and interdisciplinary innovation, 6GARROW is positioned as a key enabler of the global 6G vision. It offers a scalable, sustainable, and market-aligned framework for building the intelligent infrastructure of the future.

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