

MultiX: Advancing 6G-RAN Through Multi-Technology, Multi-Sensor Fusion, Multi-Band and Multi-Static Perception

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Abstract

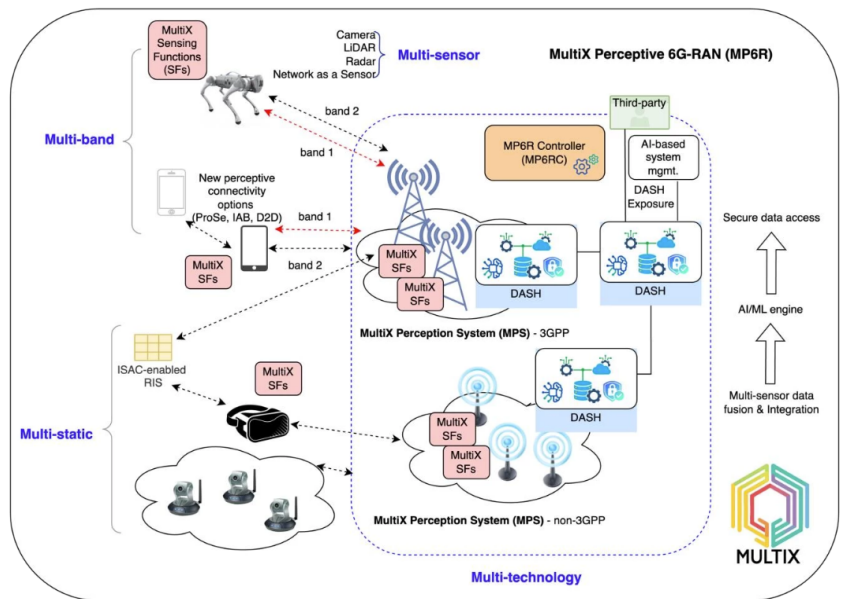
MultiX enables integrated sensing and communication in 6G through the **MP6R** framework, combining **multi-band**, **multi-static**, and **multi-sensor** capabilities for greater awareness and adaptability. Its distributed architecture includes the sensing-focused **MPS**, the orchestration unit **MP6RC**, and the secure data hub **DASH**. A **Multi-Layer Digital Twin** demonstrates its real-time optimization for applications like autonomous systems and smart manufacturing.

Challenges on Sensing

Most **ISAC** research focuses on a **single wireless technology**—either **3GPP** (e.g., 5G/6G) or **non-3GPP** (e.g., Wi-Fi)—limiting performance in heterogeneous environments. Traditional sensing with separate sensors like **LiDAR** or **radar** leads to redundant hardware and spectrum use. A major challenge is integrating diverse sensing sources across the **RAN**, from infrastructure to **UEs**, while managing differences in **frequency bands**, **waveforms**, and **hardware**. An effective **ISAC framework** must support **spectrum sharing**, **real-time processing**, and **cross-layer data fusion**. **AI**, **edge computing**, and **dynamic resource allocation** for perception-aware systems.

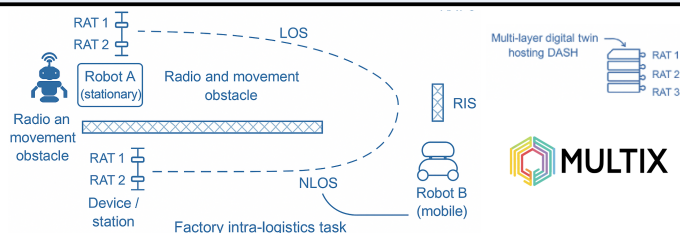
MultiX vision: Main building blocks

- **MultiX Perception System (MPS)**: Embeds sensing functions across RAN layers (RU, DU, CU, UE), enabling joint signal processing for passive radar-like perception, localization, and environmental awareness. Its distributed design supports flexible, optimized deployment.
- **MP6R Controller (MP6RC)**: Acts as the intelligence hub, coordinating sensing and communication across multiple technologies (5G, 6G, Wi-Fi...) and managing object mobility. It also oversees distributed data aggregation and processing through **DASH** for scalability and responsiveness.
- **Data Access and Security Hub (DASH)**: Aggregates, processes, and securely exposes multi-sensor data. Key functions include access control, heterogeneous data fusion, and dynamic exposure to authorized network functions, applications, and external services.



PoC: Multi layer DT for industrial Manufacturing

To validate **MultiX**, a **Multi-Layer Digital Twin for Industrial Manufacturing** is presented, integrating sensing, communication, and decision-making. It optimizes operations using **real-time data**, **adapts networks to changing conditions**, and **supports human-machine collaboration**. **AI-driven DASH** processes **multi-sensor data**, enabling **efficient**, **reliable**, and **autonomous** industrial applications.



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