PREDICT-6G

(PRogrammable AI-Enabled DeterminIstiC neTworking for 6G)

6G is envisioned to accelerate the path started in 5G for catering to the needs of a wide variety of vertical use cases, both current and emerging. This will require major enhancements of the current 5G capabilities especially in terms of bandwidth, latency, reliability, security, and energy. **PREDICT-6G's mission** is therefore set towards the development of an end-to-end 6G (E2E) solution including architecture and protocols that can guarantee seamless provisioning of services for vertical use cases requiring extremely tight timing and reliability constraints. To succeed, the solution will target determinism network infrastructures at large, including wired and wireless segments and their interconnections. PREDICT-6G will develop a novel **Multi-technology Multi-domain Data-Plane (MDP)** overhauling the **reliability and time sensitiveness** design features existing in current wired and wireless standards.

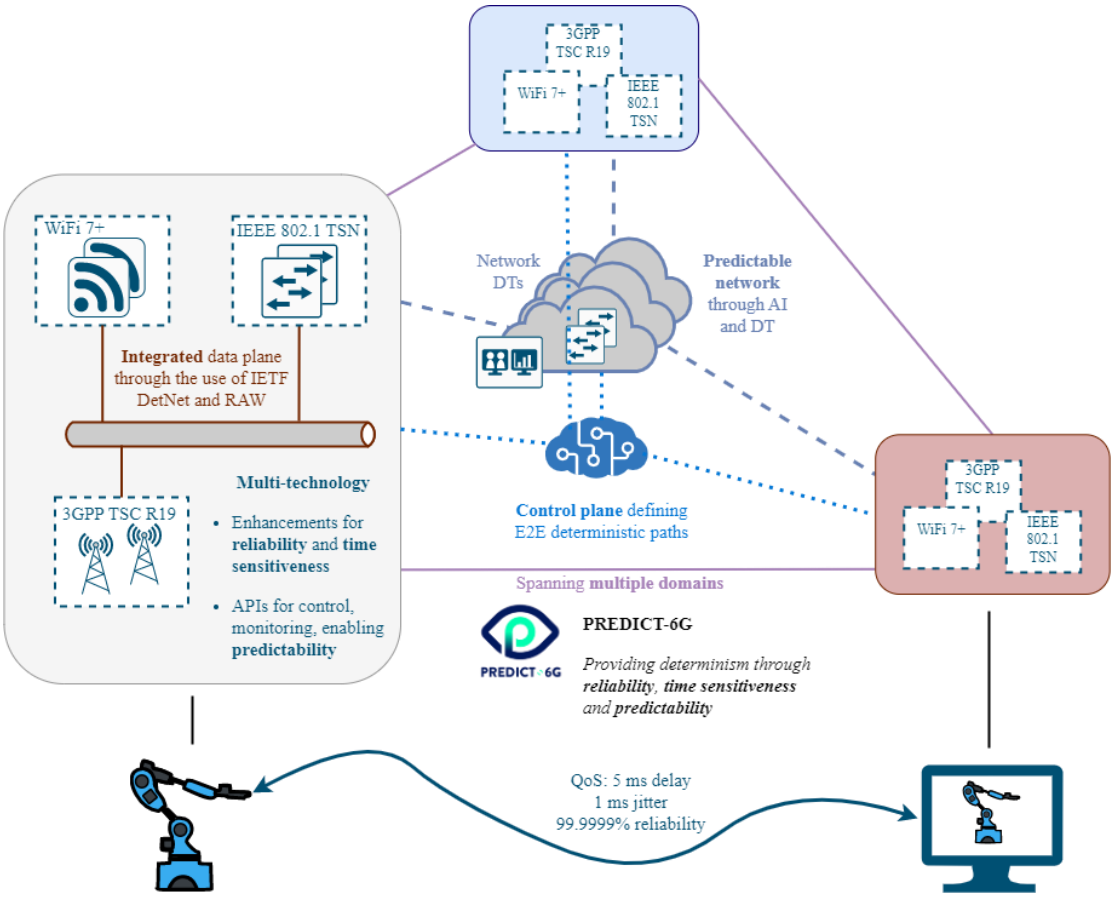

Figure 1. PREDICT-6G vision

PREDICT-6G aims to create a secure, modular, interoperable, and extensible deterministic network and management framework that automates the definition, provisioning, monitoring, fulfilment, and life-cycle management of end-to-end (E2E) deterministic services over multiple network domains, hiding the complexity of

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continuously balancing and re-configuring the constituent domain specific enablers to maintain a consistent E2E determinism. As shown in Figure 1, **PREDICT-6G builds on top of three pillars**:

- To extend the **reliability and time sensitiveness** features of IEEE 802.11 (targeting WiFi7/8) and 3GPP (targeting contributions to R19/20) networks, including APIs for the monitoring and control of such capabilities, enabling predictability. This pillar also considers the provision of a certain level of determinism (for specific applications) involving links or networks without native support (at layer-2) of deterministic features or not capable of guaranteeing a certain level of time sensitiveness, reliability, or predictability.
- To develop a **multi-technology multi-domain Data-Plane (MDP)** jointly with an **AI-driven multi-stakeholder inter-domain Control-Plane (AICP)**. This will enable the creation of E2E deterministic paths, by leveraging on IETF Deterministic Networking (DetNet) and Reliable and Available Wireless (RAW) mechanisms.
- To enhance the **predictability** of the network through intelligence, enabling the forecasting of the occupancy of network resources and the effect of accepting a new flow into the network. This feature will be enabled through **AI and network digital twining** approaches.

There are several ***significant technical challenges*** that must be overcome to achieve a seamless end-to-end deterministic service. These include inconsistencies in the definition and explanation of determinism across different domains, as well as the lack of standardized APIs to attain determinism on the data plane. In addition, the various link layer technologies result in different inherent network capabilities, and there are incompatible control- and management-plane interfaces that hinder the provision of determinism.

To address these technical challenges and trial and deploy Proof-of-Concepts (PoCs**),** **PREDICT-6G** intends to leverage and expand the capabilities of two Open-Labs: the ***5TONIC Innovation Lab in Madrid and the Nokia Open Lab in Budapest (5G Innovation Network).*** Both labs offer pre-commercial hardware and the participation of various industries in various scenarios (such as Vehicle-to-Everything (V2X) and smart manufacturing) to enable innovation in the control- and data-plane in realistic network environments. The data, control and management plane components developed in **PREDICT-6G** will be proven through working prototypes implementing the services, functionalities and workflows specified in the system architecture. The system integration will be performed in iterative cycles, taking as input the HW and SW modules continuously delivered from data plane mechanism as well as control/management-plane and providing back the required feedbacks in terms of bug fixing, missing features or potential improvements. The testing environment will progressively move from the initial labs where the single modules have been developed to the target open labs in Madrid and Budapest.

In summary, **PREDICT-6G offers several benefits** by providing a system architecture that spans data, control, and management frameworks for deterministic networks. These benefits include improving the reliability and time sensitivity of wireless network domains, extending the concept of determinism to non-deterministic network infrastructures, and providing a control and management framework that automates and autonomously operates the network infrastructure while simplifying

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provisioning, control, and monitoring workflows. Additionally, PREDICT-6G incorporates an **AI-powered network Digital twin (DT)** infrastructure that enables the implementation of advanced provisioning, diagnosis, and prognosis algorithms for the fulfillment of deterministic network services. The overall goal is to achieve a frictionless data path with a deterministic behavior at the data-plane level and to automate the full life cycle of service provisioning over multiple administrative/technological network domains, while ensuring interoperability and extensibility.

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