



6G SNS

Short-range in-X subnetworks for extreme communications

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with contribution of 6G-SHINE project partners

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6G-SHINE overview



- The **6G SH**ort range extreme communication **IN** Entities (**6G-SHINE**) project is entirely focused on in-X subnetworks, with the goal of pioneering new technology components for short-range communication with extreme performance requirements

- 12 partners, 9 countries
- Smart Networks and Services Joint Undertaking (SNS JU) project – Stream B-01-03 (Communication infrastructure and devices)
- 5.5M EUR total budget
- 30 months (March 2023- August 2025)

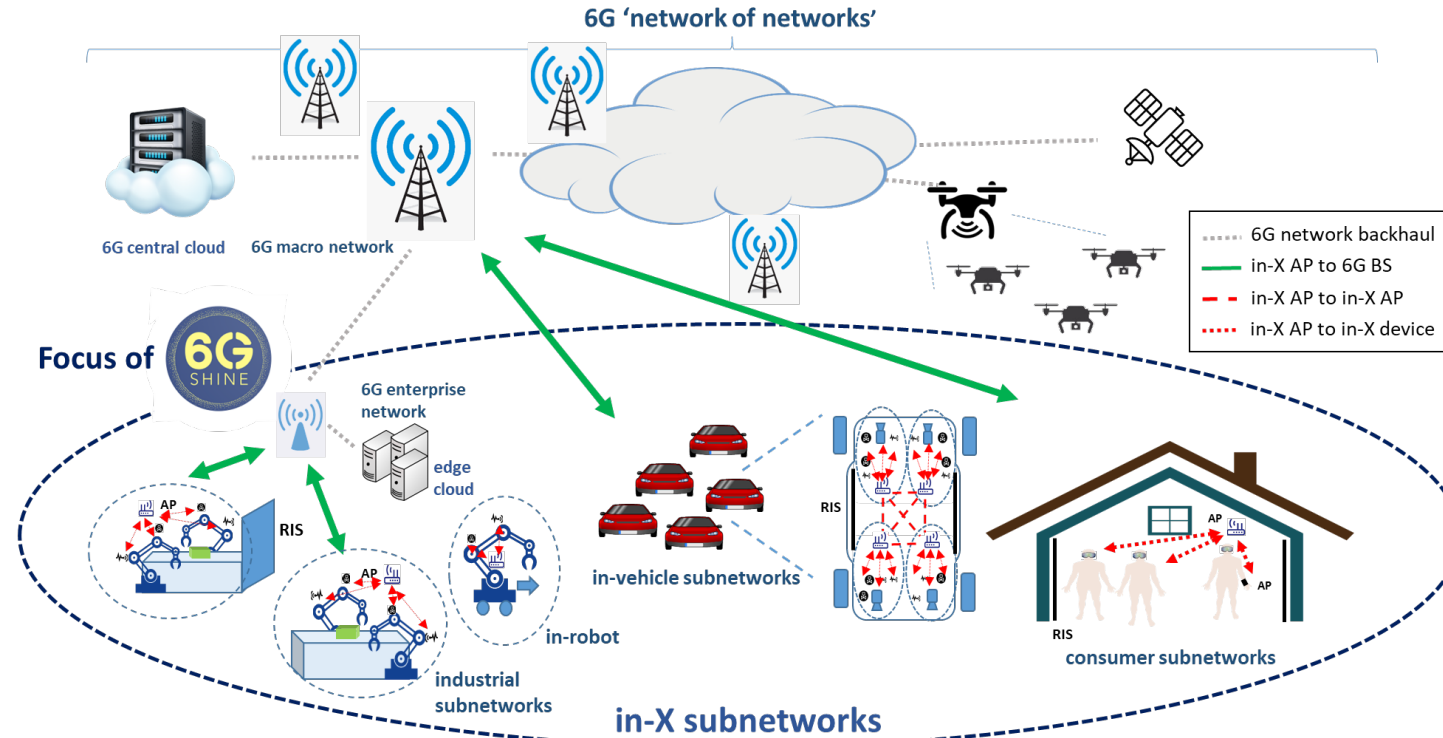
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In-X subnetworks: the "very edge" subnetworks



In-X subnetworks are highly specialized short range low power cells to be installed in entities like robots, vehicles, production modules, classrooms, etc.

Demanding performance requirements in terms of latency, reliability, or data rates

Potential high density subnetwork crowds (e.g., vehicles in a congested road)

Possible in-X scenarios/use cases

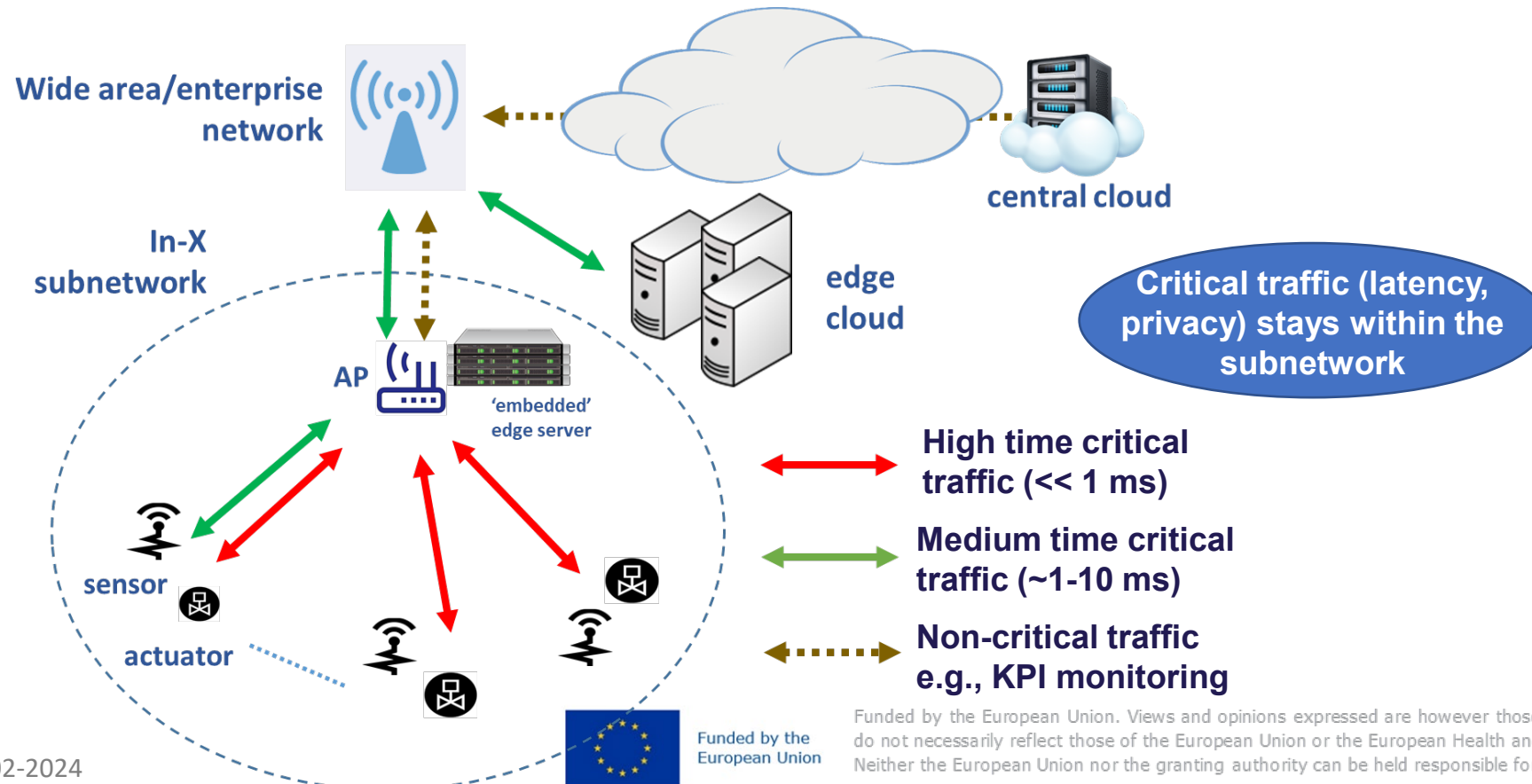
- Industrial: Fast closed loop control (e.g, force control) in robots and production modules
- In-vehicle: motor control, breaking, advanced driver assistance systems (ADAS) sensors
- Consumer: XR applications for education; gaming; entertainment



Why in-X "sub-networks"?



- In-X subnetworks can operate standalone, but are also part of a larger 6G ecosystem, benefiting from connection to a wide area/enterprise parent network
 - Aiding radio resource management, traffic steering, service discovery and subscription, authentication / authorization, policy enforcement for traffic to/from devices in the subnetwork
 - Subnetworks can be task-specific, spatially confined, and time-bounded





Main objectives of



- Define relevant application scenarios, use cases and architectures for in-X subnetworks, and analyze related performance requirements.
- Design novel radio enablers for 'extreme' communication in in-X subnetworks, and their smooth integration into the larger 6G 'network of networks'

→ leveraging specific characteristic of in-X deployments for an energy efficient and low-cost design

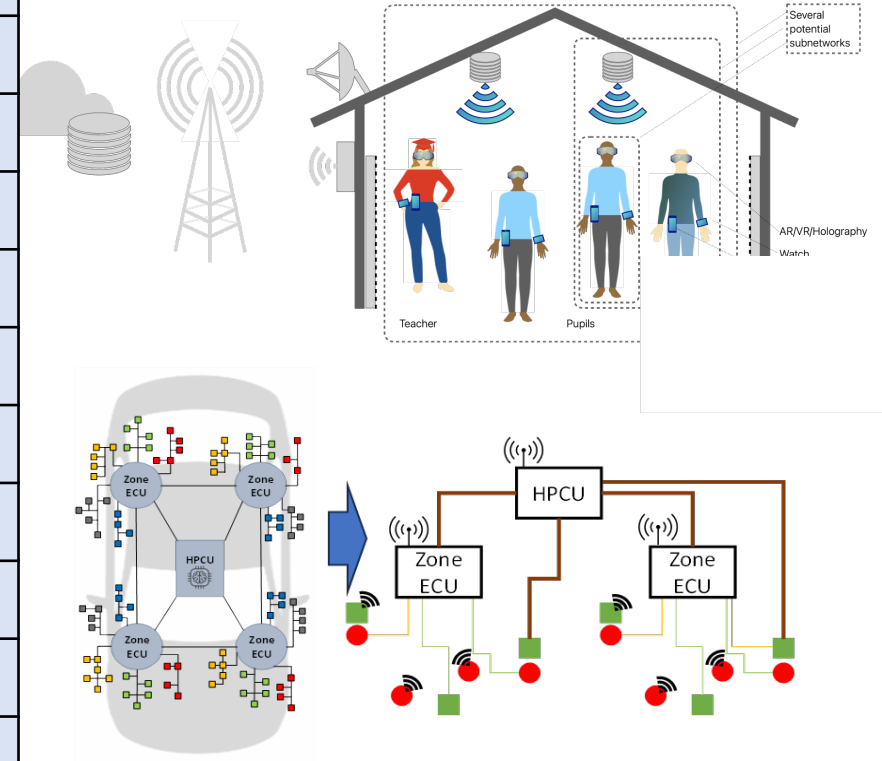
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Relevant in-X subnetworks use cases



Consumer	Immersive education
	Indoor interactive games
	Virtual live production
	AR navigation
Industrial	Robot control
	Unit test cell
	Visual inspection cell
	Subnetwork coexistence in the factory floor
	Subnetwork segmentation and management
In-vehicle	Wireless zone Electronic Control Unit (ECU)
	Collaborative wireless zone ECU
	Inter-subnetwork coordination
	Virtual ECU



Use cases and related requirements are described in our coming 6G-SHINE deliverable D2.2, to be submitted at the end of February 2024.

Main PHY/MAC innovations for in-X subnetworks



3GPP Rel.19

Existing HW/SW technologies

2024

towards 2030

novel HW/SW technologies

beyond 3GPP Rel.20

Short term impact

...towards long term impact

PHY

Antenna arrays/panels for in-X subnetworks

Sub-THz transceiver architecture and throughput/energy consumption tradeoff analysis

Jamming-robust PHY design

- Native robust design
- Detection and mitigation

Metasurfaces for short range joint beamforming and communication

MAC

Predictive scheduling based on

- Context information
- Knowledge of underline application and service

Multiplexing services with different requirements:

- Flexible/full duplexing schedulers

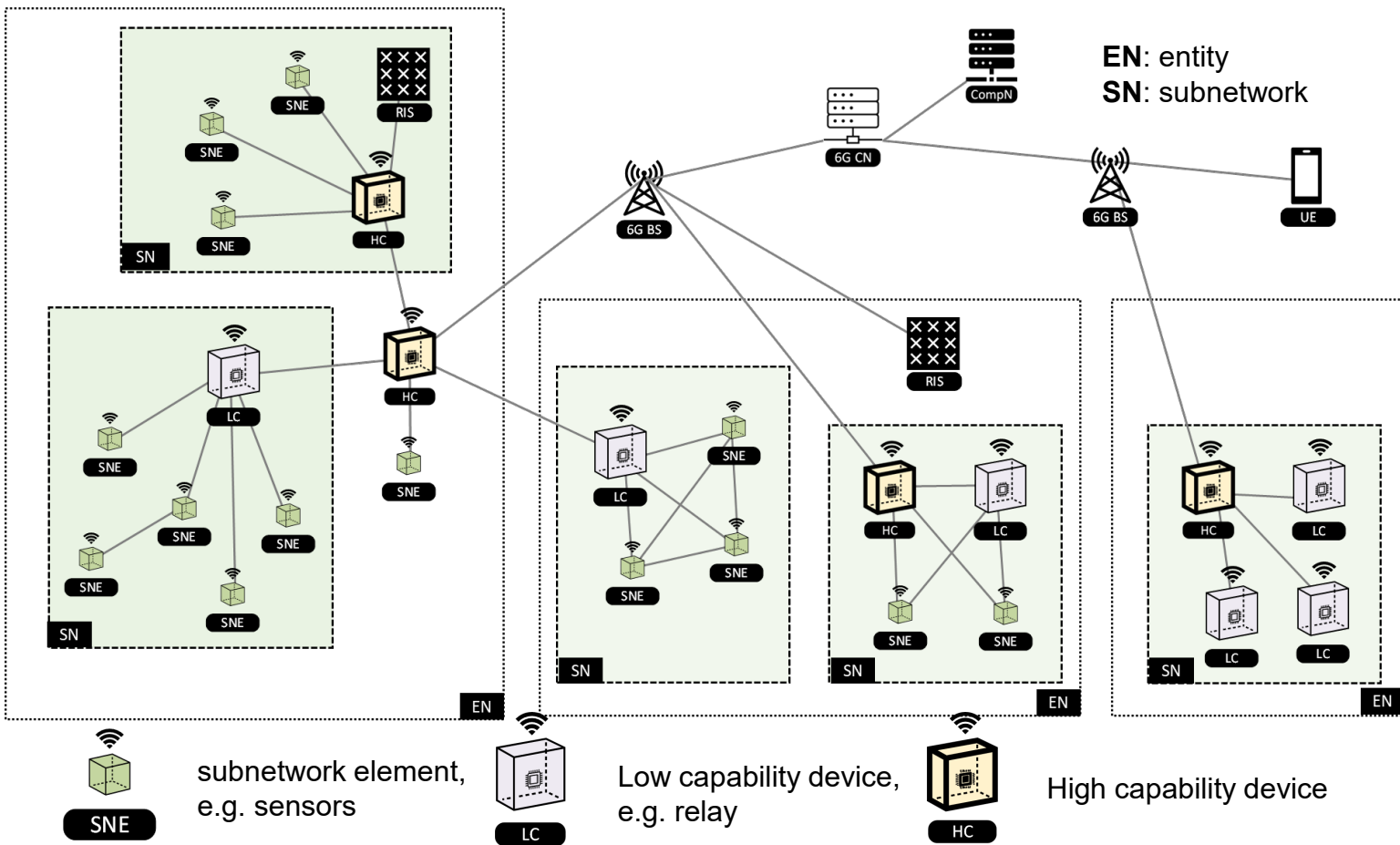
Low latency enhancements

- Proximity grouping & pre-emptive retransmissions
- Configured grant enhancements

Multi-link solutions for improved reliability

- Cooperative in-X communications
- Network coded operations

RRM and operation management



EN: entity
SN: subnetwork

- Subnetworks can spontaneously become very dense
 - Possibly cumbersome and time-varying interference levels

Centralized RRM

- best ideal performance
- poor scalability
- limited by backhaul quality

Distributed RRM

- fully scalable
- limited environment visibility at each subnetwork

Hybrid solutions

Dynamic spectrum sharing between 6G network and in-X subnetworks

Dynamic and elastic computational offloading from subnetworks to 6G edge-cloud

- Nodes in the subnetwork can have different and flexible roles in coordinating and combining the communication links
 - novel distribution of control and data plane functionalities





- Support of extreme communication requirements → go local → go in-X → subnetworks!
- In-X subnetworks are short range, highly-specialized low power cells, with demanding communication requirements, e.g. multi-Gbps rates, support of sub-ms communication cycles with a wired-like reliability.
 - Architectural innovation: standalone operation (at least for critical services) while benefitting from connection to a 6G parent network
- Relevant use case categories: industrial, in-vehicle, consumer (e.g., XR education or gaming)
- Significant innovation needed in PHY, MAC, radio resource management and network architectures, for achieving demanding performance requirements at a low cost





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