Project Information

RAI-6Green

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Partners:

AITIA International Inc., Hungary

Akkodis, France

Celfinet, Portugal

CentraleSupélec, France

CityPassenger SA, France

Effnet, Sweden

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Gandi, France

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Project Website

www.celticnext.eu/project-rai-6green

https://tools.celfinet.com/

Robust and AI Native 6G for Green Networks

RAI-6Green tackles Europe's need for robust, energy-lean wireless networks. Disasters and conflicts expose reliability gaps. 5G is more energy-efficient, yet overall, it consumes more energy than predecessors. AI-native radio network management orchestrates coverage, capacity, and power states for resilience and savings. Elastic designs replace rigid architectures, improving resiliency while cutting energy consumption.

Main focus

Recent advancements in virtualisation, softwarisation, and cloudification of network resources enable us to design cloud-based cell-less networks in which processing and network resources can be dynamically reconfigured in response to changing traffic conditions. Both resilient and energy-efficient networks by design are then possible if advanced network technologies at the physical layer can be adaptively controlled by a fully elastic, cloud- and AI-native network architecture. These technologies also enable the deployment of small data centres at the network edge for storing and processing local data, and the orchestration of processing, storage, and networking resources along the continuum between radio access and the central cloud.

Approach

RAI-6GREEN will deliver robust, green 6G networks through an elastic, cloud-native, AI-driven architecture that adapts resources across time, space, and layers. Step 1 defines new KPIs that quantify robustness and sustainability of connectivity services, establishing measurable targets. Step 2 integrates sensing-as-a-service into the communications stack to build environmental awareness, improving channel prediction, localisation, and resource assignment. Step 3 advances cell-free massive MIMO with joint/CoMP transmission and elastic, cell-less self-backhauling to raise spectral efficiency and resilience, while jointly optimising topologies with cloud and edge resources in Open RAN. Step 4 deploys Reconfigurable Intelligent Surfaces and energy-harvesting to extend coverage at minimal cost and power, enabling self-sustainable sites. Step 5 introduces risk-aware machine learning: intent-driven policies balance reliability and energy, enabling parameter-free control and instant elasticity of coverage and capacity. Step 6 replaces costly drive tests with multi-modal fault, failure, and anomaly detection using network telemetry and federated analytics. Step 7 explores energy and connectivity marketplaces that share or lease infrastructure and power, delivering service without systematic new deployments. Step 8 develops techno-economic strategies for green edge computing, aligning placement, acceleration, and orchestration with carbon-aware objectives. Step 9 prototypes federated data centres powered by renewables for offloading ML-intensive tasks, minimising embodied and operational energy. Novel aspects include: unified sensing-communication co-design as a service; elasticity from cell-free, RIS-assisted, self-backhauling networks; intent-driven, risk-aware AI for closed-loop O-RAN control; and market-based mechanisms linking energy and connectivity. Together, these steps realise measurable resilience gains while reducing end-to-end energy consumption. Methods will be validated on realistic pilots.

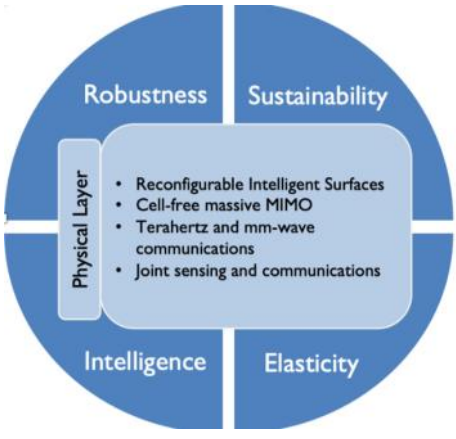

Figure 1: RAI-6Green Objectives

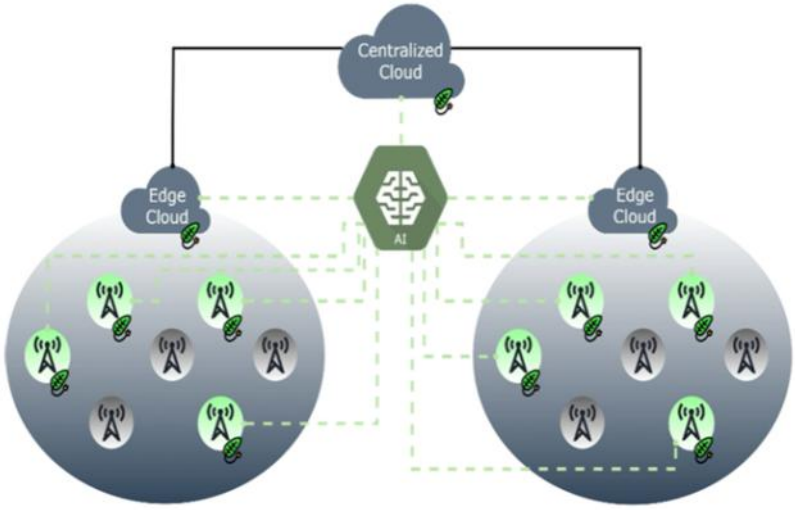

Figure 2: AI-assisted network reconfiguration in virtualised cloud RAN

Main results

The project delivers a comprehensive set of results to improve energy efficiency and resiliency across telecom networks. An AI-assisted end-to-end efficiency toolkit will measure and optimize energy and spectral efficiency across RAN, points-of-presence, and core networks. Data-driven multi-objective optimization will combine traffic prediction, resource pre-allocation, and self-healing to jointly tune performance, energy, and robustness. A risk-sensitive policy engine will manage delay, reliability, and energy risk along the end-to-end path, producing service-level policies per slice. Autonomous base-station agents will learn from context and automatically activate the right energy-saving features and RF/compute states. Site power orchestration will minimize consumption with dynamic radio scheduling and power-usage optimization, including local solar and storage integration. Green AI-compute blueprints will guide placement, scheduling, and acceleration at edge and central locations to support low-carbon automation. Grid-interactive operations will link 6G networks, edge data centers, and the smart grid to exploit surplus renewables and enable carbon-aware AI-as-a-Service offloading. A techno-economic toolkit and co-investment models will provide business cases for green edge deployments. Standards-ready KPIs and reporting methods will target robustness and energy efficiency of slices. Industrial-grade datasets, simulators, and reference implementations will be validated in realistic pilots.

Expected value includes approximately 30–40% end-to-end energy -efficiency improvement versus today's networks, stronger resilience to failures and disasters, and lower OPEX/CAPEX through elastic capacity and smarter site power management. Operators gain faster time-to-market, reduced vendor lock-in via open interfaces, and credible inputs to ETSI and 3GPP.

Benefits extend beyond mobile operators to cloud, AI/ML, sensing, and integrator partners via interoperable interfaces, speeding innovation, creating new service models, and fostering worldwide adoption

Impact

RAI-6Green will translate research into operational gains across telecom ecosystems. By reducing network energy consumption and deployment costs, it delivers environmental and economic value simultaneously. An Open RAN–based elastic architecture lets capacity scale without CAPEX growing linearly with performance. Increased resilience and reliability unlock safety-critical and time-sensitive services—remote driving, telesurgery, and secure remote access to medical, governmental, and business resources. Uplifted reliability in rural and urban areas promotes equitable access to digital services. The architecture and resource-allocation model broaden the value chain: AI/ML operations, edge and cloud computing, sensing-as-a-service, and fronthaul/backhaul connectivity can be provided by specialised players or system integrators in partnership with major vendors and mobile operators. This modularity accelerates innovation, lowers vendor lock-in, and enables new business models such as energy and connectivity marketplaces. Consortium partners active in ETSI/EE and 3GPP will channel results into standards for network efficiency, resilience, and power systems, amplifying industrial adoption globally.

About CELTIC-NEXT

CELTIC-NEXT is the EUREKA Cluster for next-generation communications enabling the digital society. CELTIC-NEXT stimulates and orchestrates international collaborative projects in the Information and Communications Technology (ICT) domain.

The CELTIC-NEXT programme includes a wide scope of ICT topics based on new high-performance communications networks supporting data-rich applications and advanced services, both in the ICT sector and across all vertical sectors.

CELTIC-NEXT is an industry-driven initiative, involving all the major ICT industry players as well as many SMEs, service providers, and research institutions. The CELTIC-NEXT activities are open to all organisations that share the CELTIC-NEXT vision of an inclusive digital society and are willing to collaborate to their own benefit, aligned with their national priorities, to advance the development and uptake of advanced ICT solutions.

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