



CoGNETs

Continuums of Game Nets

Continuums Of Game NETs: Swarm intelligence as information processing

www.cognets.eu

Cognitive Computing Continuum (CCC) - ENACT Joint Webinar

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Date: 24/03/2026



**Funded by
the European Union**



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

Federal Department of Economic Affairs,
Education and Research EAER
**State Secretariat for Education,
Research and Innovation SERI**

**Grant Agreement
no 101135930**



CoGNETs - Enabling Decentralized AI Coordination

CoGNETs is a Horizon Europe project developing a decentralized middleware framework for autonomous coordination of AI services across the IoT-Edge-Cloud continuum.

Motivation: As AI-driven services expand across IoT, Edge and Cloud environments:

- AI workloads become highly distributed and dynamic
- Centralized orchestration limits scalability and resilience
- Energy efficiency and security become critical constraints

CoGNETs Vision: Enable decentralized, secure and energy-aware coordination of AI services across distributed infrastructures.



Key Exploitable Result: Open Distributed Middleware Framework

CoGNETs delivers an **open distributed middleware framework** for autonomous orchestration across the IoT-Edge-Cloud continuum.

It integrates three core innovation pillars:

- Decentralized game-theoretic intelligence for swarm and node coordination (decision layer)
- Federated multi-context broker for distributed orchestration (execution layer)
- End-to-end identity, access control and AI protection mechanisms embedded across the continuum (security layer)

Designed for scalable, adaptive and secure AI infrastructures.



Core Innovation 1 - Game Intelligent Agent System

A distributed game-theoretic decision system enabling autonomous self-organization of IoT-Edge-Cloud nodes within the CoGNETs middleware.

Functionalities

- Implements decentralized pricing, bidding and auctioning mechanisms
- Enables self-organization at node and swarm level
- Supports dynamic swarm formation and task allocation
- Enables joint optimization of computing performance, energy consumption and security risk

Impact: Enables autonomous decision-making and adaptive self-organization across nodes and swarms



Core Innovation 2 - Decentralized Multi-Context Broker

A decentralized broker coordinating swarm-level and node-level execution contexts across the IoT-Edge-Cloud continuum.

Functionalities

- Coordinates distributed service lifecycle across swarm environments
- Optimizes workload placement across nodes
- Synchronizes data and execution states across contexts
- Manages distributed resources in dynamic swarm topologies

Impact: Provides the operational backbone of the middleware.

The screenshot displays the CoGNETS Game Monitor interface. At the top, it says "Game results are posted to DDM Broker by SGA". Below this, there's a "DDAG" section showing a "Game Result" for "urn:ngsi-l3:gameResult:game1771607001363" with a percentage of 50.0%. A "DeviceKPI monitor" section shows three devices (urn:ngsi-l3:DeviceKPI:cognets-node03, urn:ngsi-l3:DeviceKPI:cognets-node01, urn:ngsi-l3:DeviceKPI:cognets-node02) with their respective CPU, Memory, and Disk usage. The bottom section is titled "Decision Centre" and shows five decision-making units (DMUs) with their status (e.g., ONLINE, OFFLINE) and a "DAO Vote Audit Log" table below them.

Operator	Decision	Vote	Timestamp
You	FedSeath-CNN v1.3	Decline	13/02/2026, 10:57:10
You	MedMapping-DNN v2.1	Approve	13/02/2026, 10:57:10
Dr. Müller	V2XSecurity-ML v1.0	Decline	13/02/2026, 10:47:08
K. Schmidt	V2XSecurity-ML v1.0	Decline	13/02/2026, 10:45:08
M. Kowalski	V2XSecurity-ML v1.0	Abstain	13/02/2026, 10:43:06

Decision Centre Utilising the DAO Protocol



Core Innovation 3 - End-to-End Security, Identity & Resilience Mechanisms

An embedded end-to-end security layer protecting the CoGNETs middleware across hardware, system, application and AI levels.

Functionalities

- Implements decentralized identity and authentication (SSI/DID)
- Secures hardware roots of trust (PUF-based attestation)
- Integrates AI-level adversarial protection
- Supports privacy, data sovereignty and resilience

Impact: Establishes trust and integrity as foundational properties of the middleware.



Competitive Advantages

- Federated and decentralized coordination without single points of failure
- Joint optimization of computing performance, energy efficiency and security risk
- Native support for dynamic IoT-Edge-Cloud swarm formation
- Security and identity mechanisms embedded by design
- Vendor-neutral and modular architecture enabling interoperability



Pilot Demonstrations

Manufacturing - Adaptive AI Execution in Robotic Production Lines

- AI-based packing/unpacking & visual inspection
- **Challenge:** Distributed/split execution of vision models under limited resources
- Middleware dynamically offloads heavy AI tasks to high-capacity edge/cloud nodes

Mobility - Adaptive Powertrain Optimization in Electric Vehicles

- Distributed AI for vehicle powertrain decisions
- **Challenge:** Fluctuating connectivity & energy constraints
- Middleware coordinates workload placement across vehicle-edge-cloud

Healthcare - Secure Processing of Sensitive Medical Data

- AI-driven analysis across hospital edge and cloud
- **Challenge:** Confidentiality & multi-site coordination
- Middleware enables controlled task distribution with secure identity-based access



Market Relevance & Adoption Pathways

Immediate Deployment Contexts (Post-Project)

- Industrial automation providers needing distributed AI orchestration
- Edge-cloud platform operators managing dynamic AI workloads
- SMEs and startups developing distributed, privacy-preserving AI services
- Federated AI ecosystems and data space initiatives

Expansion Markets

- Smart city digital infrastructures
- Distributed energy management & smart grid systems
- Critical infrastructure monitoring & resilience



IPR Status & Open-Source Exploitation Strategy

IPR Status

- Foreground and background ownership clearly defined within the consortium
- Exploitable assets structured at middleware, intelligence and security levels

Open-Source Exploitation Strategy

- Core middleware components released under permissive licenses (e.g., Apache 2.0)
- Alignment with European open ecosystems (FIWARE, ETSI NGSI-LD)
- Modular architecture enabling third-party extensions and SME participation

Strategic Impact for Europe

- Contributes to Europe's digital sovereignty through open and interoperable technologies
- Strengthens European leadership in distributed AI and Cloud-Edge-IoT systems
- Enables an open innovation ecosystem around cognitive computing continuum for SMEs, researchers and technology providers



Thank you!

We welcome collaboration with industry, SMEs and ecosystem stakeholders across the Cognitive Computing Continuum.

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The CoGNETs project received funding from the European Union's Horizon Europe Research and Innovation Programme under Grant Agreement No 101135930. This work has received funding from the Swiss State Secretariat for Education, Research and Innovation (SERI).



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Project funded by



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