INCODE - PROGRAMMING PLATFORM FOR INTELLIGENT COLLABORATIVE DEPLOYMENTS OVER HETEROGENEOUS EDGE-IOT ENVIRONMENTS

John Avramidis (UNIS)
Concertation and Consultation on Computing Continuum: From Cloud to Edge to IoT, 10.5.2023, Brussels
The entire continuum starting from IoT devices and going all the way to core cloud systems is not here yet!

How can we…

exploit IoT processing capabilities?

enable intelligent collaborative deployments?

**Under the hood… The INCODE solution**

1. **Infrastructure management layer (IML)** -&gt; performs resource allocation/release & process scheduling across the entire IoT-to-edge-to-cloud continuum including microservices like:
   - Infrastructure manager controllers (Cloud, network, mobile, o-RAN, IoT)
   - Infrastructure drivers (Cloud, networks, mobile, o-RAN, IoT)
   - Core components (resource manager, scheduler, file system)
   - Security & Trust (auth. through BC, attestation, data & app provenance through BC)

2. **Applications and Business Programmability stratum (ABPS)** -&gt; allow apps to run on the underlying HW in a HW-agnostic way including microservices like:
   - UI portal
   - RBAC
   - Runtime Orchestration
   - Telemetry
   - Software Lifecycle
IMPACT & TEAM WORKING

Scientific & Technology:
• Easy interconnection of multiple IoT platforms
• Creation of a common development framework for IoT drivers & controllers
• Enhanced trust & security
• New & custom applications for smart IoT-edge cross-industrial environments

Business & Social:
• New business opportunities for infrastructure providers & systems integrators
• Verticals benefited from new types of applications
• Safety in working environment
• Work quality & satisfaction increase
• Goods quality through traceability
• Advance community crisis management services

Working with other projects and CSAs
• Avoid working in silos
• Establish relationships with stakeholders who can be benefited from INCODE
• Organization of joint events
• Participation in CSA workshops
• Share material & lesson learnt

The team
THANK YOU FOR YOUR ATTENTION

incode-project.eu
Objectives

Obj 1
• Design a decentralized, agile and secure architecture for collaborative smart nodes at the edge backed by the Decentralized Autonomous Organization (DAO) paradigm integration.

Obj 2
• Native device support by integrating Self Sovereign Identity (SSI) for a portable digital identity. OASEES Decentralized device identity will be a new class of identifier that fulfils all four requirements: persistence, global resolvability, cryptographic verifiability, and decentralization.

Obj 3
• Build rapid development kits (RDKs) for an open programmable framework across different smart edge nodes, while incorporating efficient cloud-to-edge continuum intelligence across heterogeneous target environments.

Obj 4
• Demonstrate the framework and programmability toolkit in a set of different vertical use cases and evaluate the benefits across different sectors.

Obj 5
• Maximize the impact of the OASEES results. Foster the creation of an open-source community around the OASEES solution, engaging a diverse set of stakeholders
OASEES Swarm Use cases

01 **E-Health:** Smart Nodes for Analysis of Voice, Articulation and Fluency disorders in Parkinson Disease

02 **Mobility:** EVs fleet coordinated recharging to support optimal operation of electricity grid

03 **Security:** Drone Swarm over 5G for High Mast Inspection

04 **Buildings:** Swarm powered intelligent Structural safety assessment for Buildings

05 **Industrial:** Robotic Swarm powered Smart Factory for I4.0

06 **Renewable Energy:** Smart Swarm Energy harvesting and Predictive Maintenance

Wind turbines
Ambition

Trigger the next revolution in truly **collaborative smart nodes**: devices augmented with **embedded intelligence** to interpret and understand the data they are generating, **communicate efficiently** even when moving around.

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<thead>
<tr>
<th>Pillar 1</th>
<th>Pillar 2</th>
<th>Pillar 3</th>
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<tbody>
<tr>
<td><strong>Orchestration of Collaborative Smart Nodes</strong></td>
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<tr>
<td>• Communication: augment industrial IoT technology, add mobility, cool new “Zero-Wire” communication paradigm</td>
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<td>• Security: standardize a true zero-touch solution</td>
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<td>• Decentralized coordination: true peer-to-peer Coaty</td>
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<td><strong>Collaborative Energy-Aware AI</strong></td>
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<td>• Cool new AI-capable low-power micro-controllers (e.g. MAX78000 includes a CNN!)</td>
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<td>• Nodes themselves process the data</td>
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<td>• Duality between central node for training and distributed nodes for executing model</td>
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<td><strong>Energy-Aware Swarm Programming</strong></td>
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<td>• Control the emergent behavior of the swarm rather than individual devices!</td>
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<tr>
<td>• how can we enable the operator to express this behavior?</td>
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<td>• Towards a swarm compiler!</td>
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**testbeds**

On a 1,000 “DotBot” testbed...

... and a 1,000 “kilobot” testbed.

**real-world use cases**

**PoC1. Cities & Community**: Renewable Energy

**PoC2. Environmental**: Supporting Human Workers in Harvesting Wild Food

**PoC3. Environmental**: Ocean Noise Pollution Monitoring

**PoC4. Industrial/Health**: EHS in industrial production sites

**PoC5. Mobility**: Moving Network in Trains
**Continuous Semantic Integration**

A. Standardized Semantic Interfaces
B. DataOps tool for semantic management of things and embedded AI apps
C. Creation and Orchestration of Swarm Intelligence Apps

**Dynamic Swarm Networking**

A. Automatic Discovery and Dynamic Network Swarm formation in near realtime
B. Embedded network security
C. Hardware-accelerated in-network operations for context-aware networking
D. Dynamic Swarm Networking
SmartEdge Use Cases

Smart Factory with Low-Code Edge Intelligence

Smart Factories with Intelligent Mobile Robots

Edge/Swarm Intelligence in Health

Active automotive option-zone Management

Cooperative Perception for Driving Assist
TaRDIS

Trustworthy and Resilient Decentralised Intelligence for Edge Systems

Coordinator: Carla Ferreira (NOVA University Lisbon)
TaRDIS toolbox

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