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Application-level Swarm-based Orchestration Across the Cloud-to-Edge Continuum



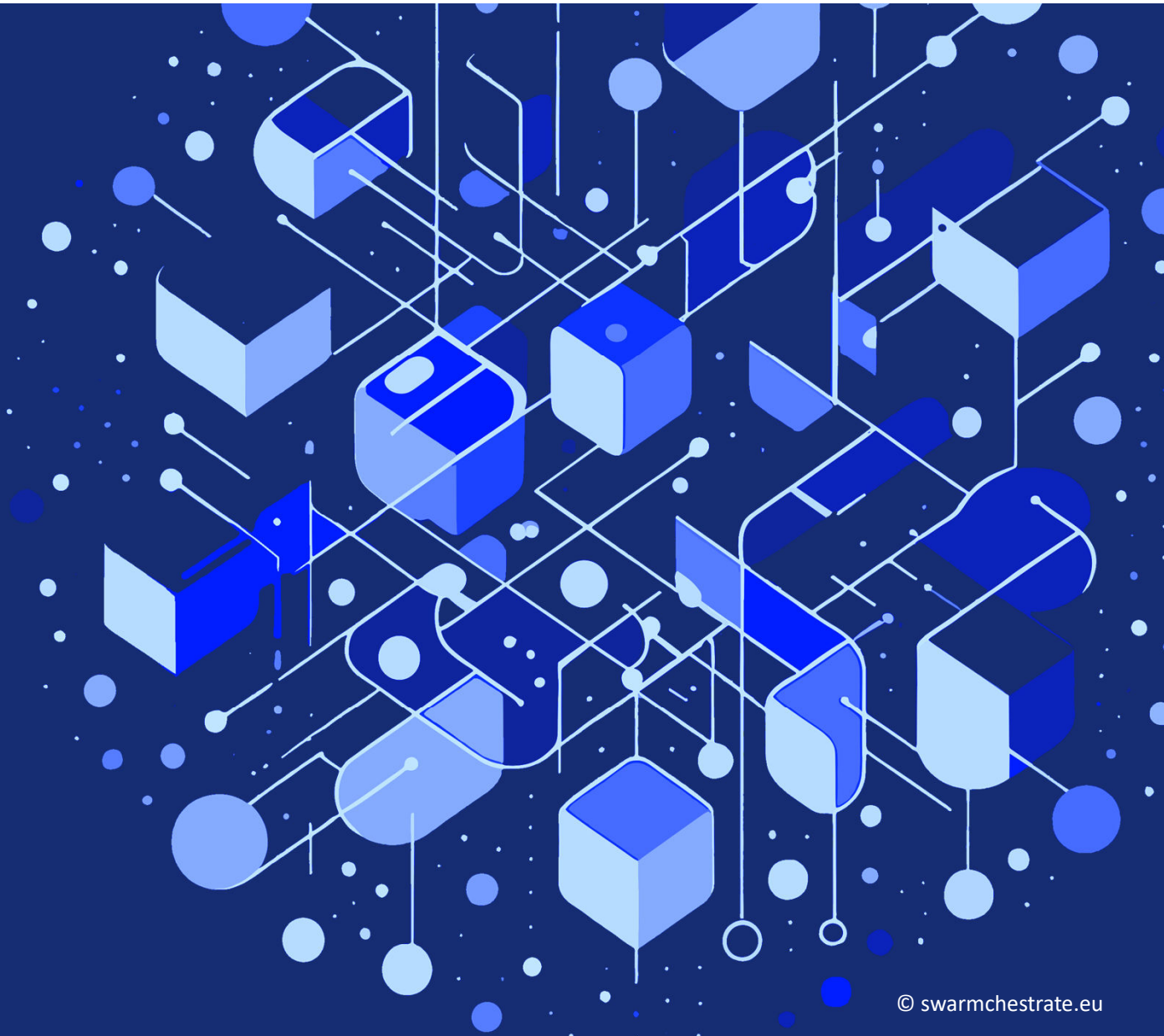
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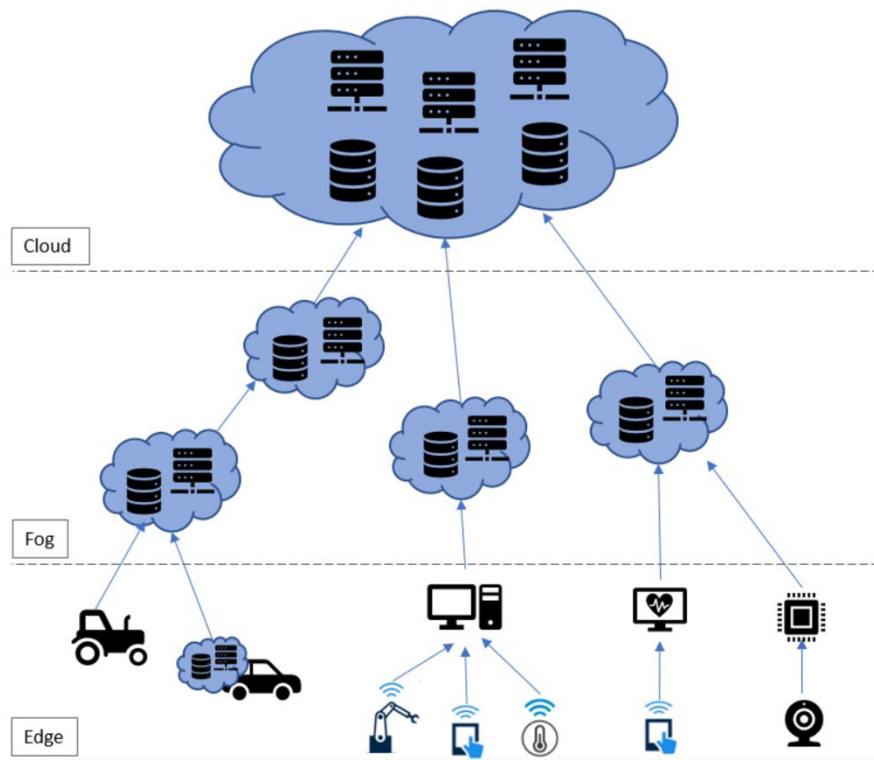
Introduction



Cloud-to-Edge Continuum



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Application areas

- Smart manufacturing/Industry 4.0
- Smart cities
- Precision agriculture
- Self-driving cars
- Augmented reality
- Etc.

Orchestration



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- **Orchestration** is the automated configuration, management and coordination of computer systems, applications and services (by RedHat)
- **Cloud Orchestration** can be used to provide or deploy servers, assign storage capacity, create virtual machines, manage networking, deploy complex microservice architectures, auto-scale applications at run-time, etc.
- **Cloud-to-Edge Orchestration** extends this concept beyond the cloud layer; e.g., offload tasks from fog/edge servers to the cloud

Centralised vs. Decentralised Orchestration



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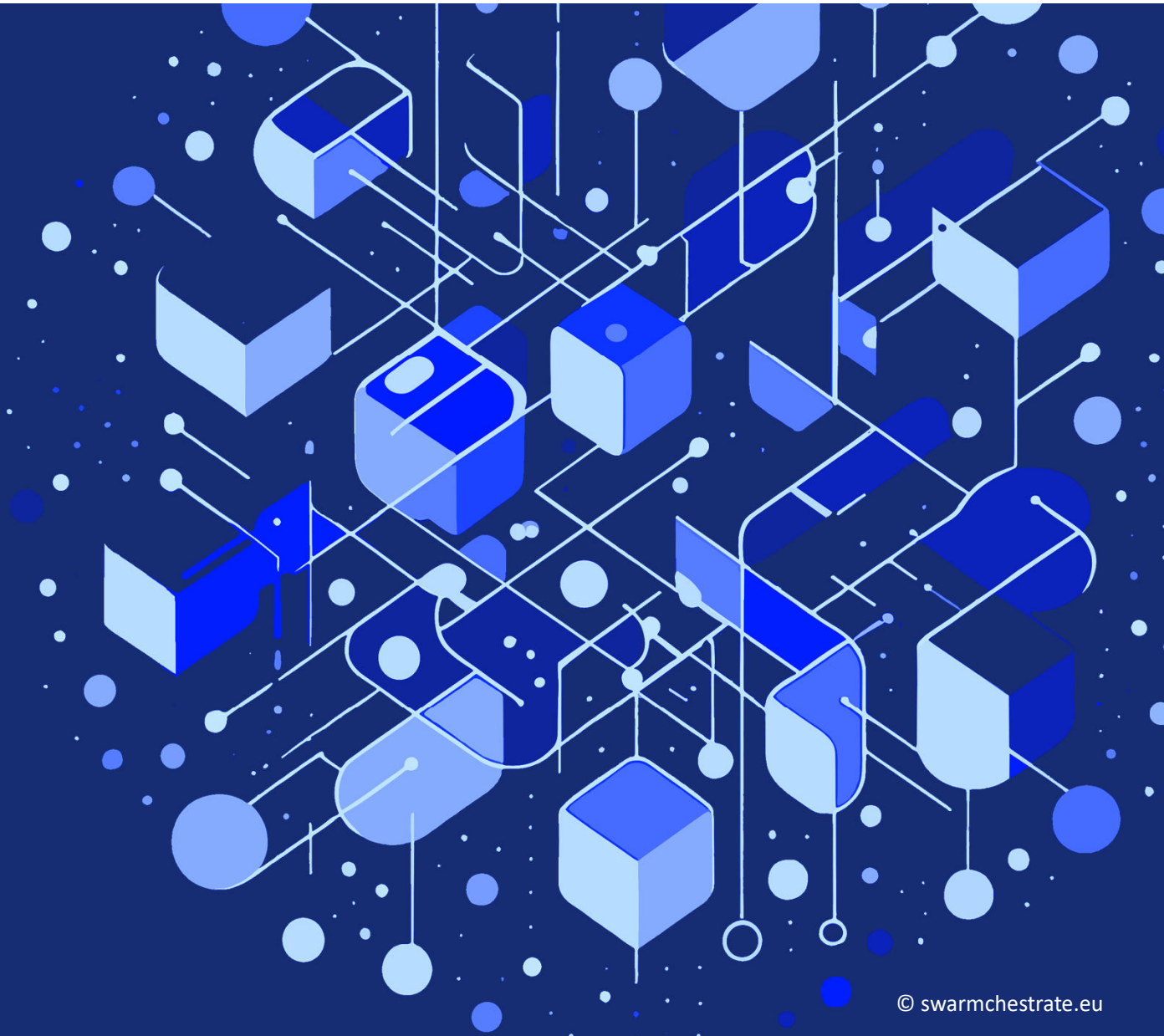
Centralised

- All current orchestrators have a central component
- Single point of failure
- Performance bottleneck
- Central point for an attack
- Does not fit the decentralised Cloud-to-Edge continuum

Decentralised

- Self-organisation without central component
- Fast reaction and fast adaptation to changes in local environment
- Fits well to the decentralised nature of the Cloud-to-Edge continuum
- Main technical principles: swarm computing, distributed AI, blockchain, decentralised identity management

Swarmchestrator Objectives & Concept



Swarmchestrator Project Objectives



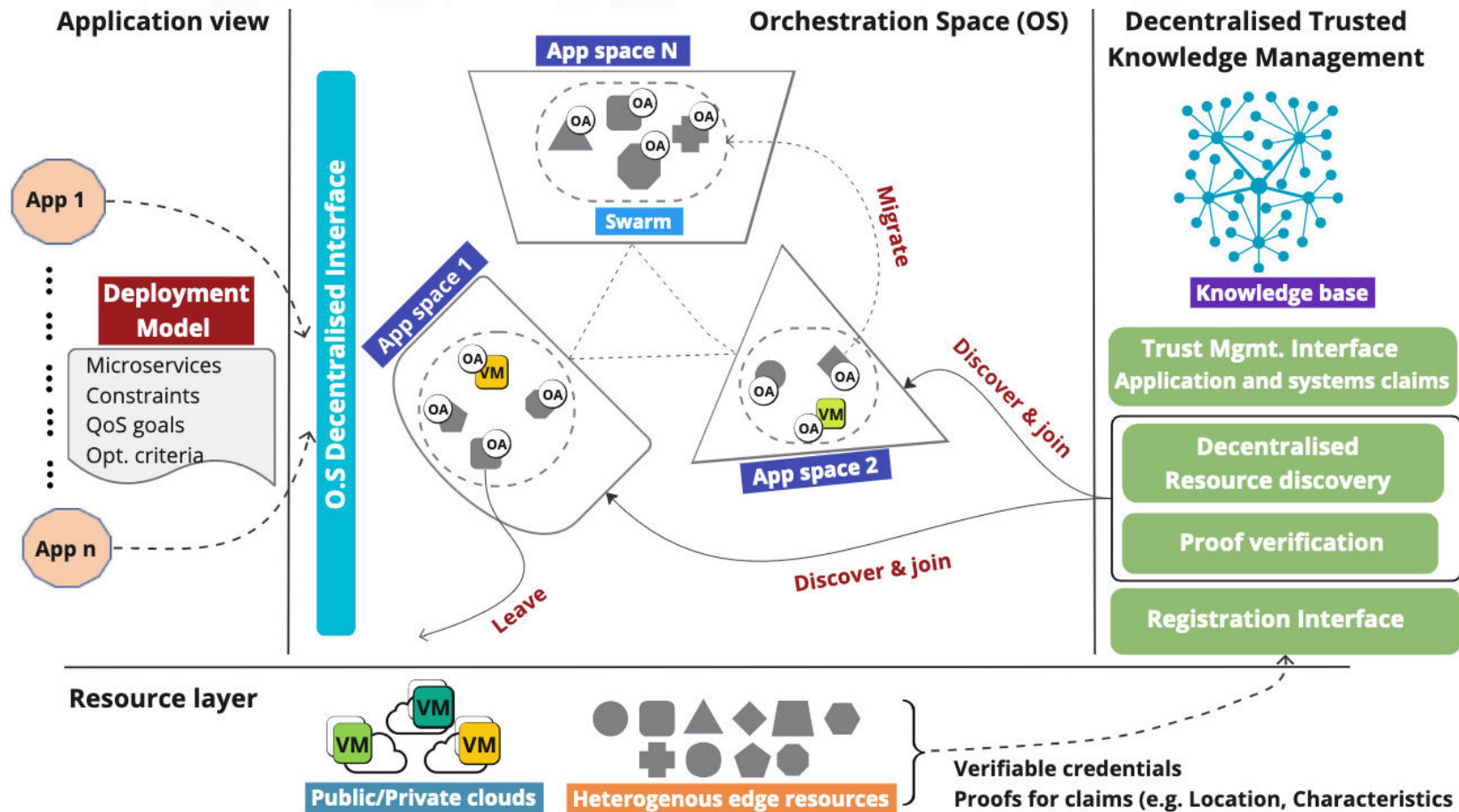
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- Develop an **application-level decentralised orchestration framework**, utilising Swarm-based distributed intelligence
- Dynamically create and manage a set of **interconnected Swarms** across the distributed Cloud-to-Edge infrastructure
- Develop **matchmaking algorithms** using **decentralised AI** methods to optimise energy efficiency and effectiveness
- Develop trusted, reliable, secure and transparent **knowledge management**
- Develop a **simulation environment** based on the novel decentralised orchestration concept of the project
- Implement **real-life application demonstrators** utilising Swarmchestrator services in realistic scenarios

Swarmchestrator Concept



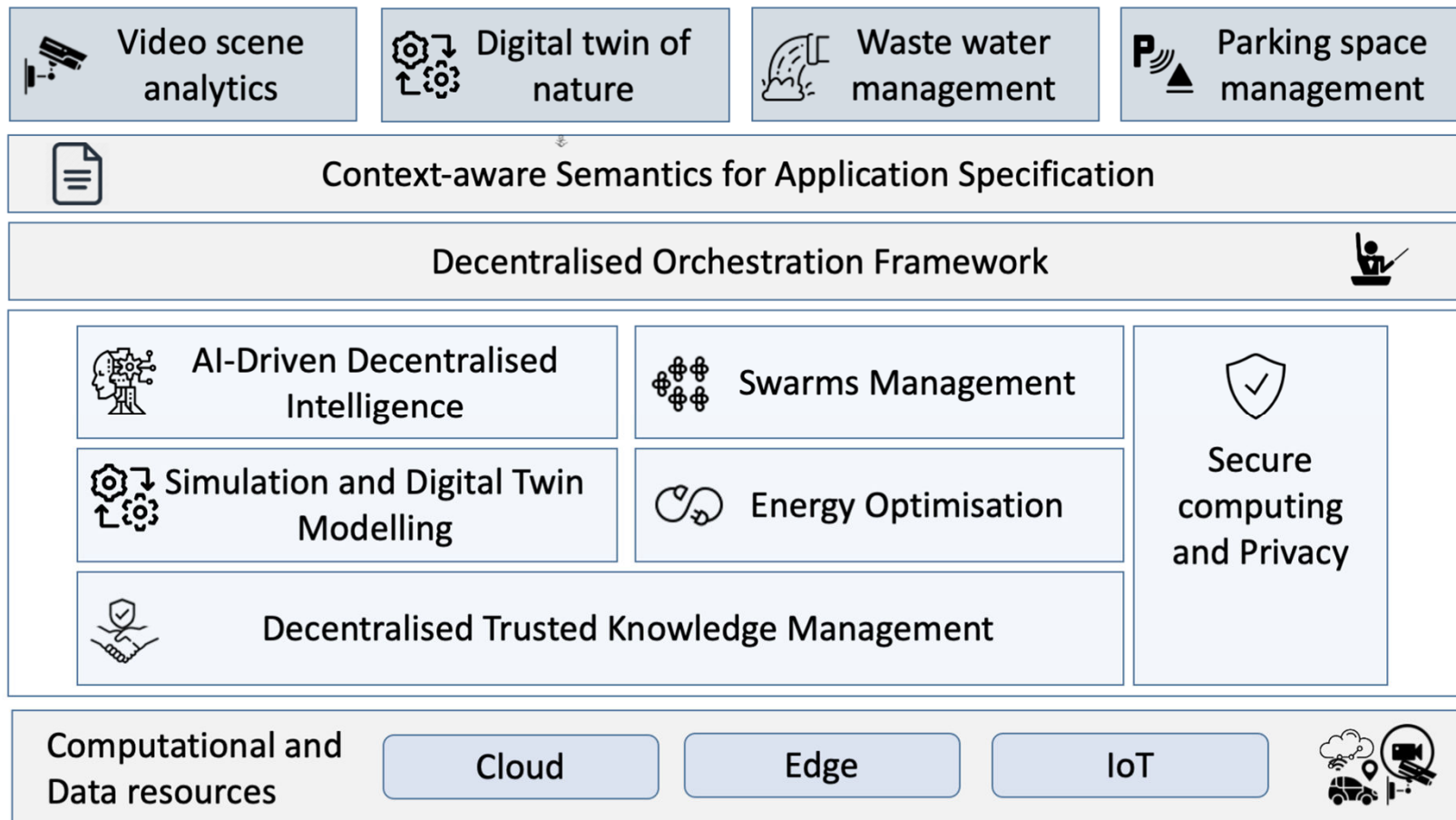
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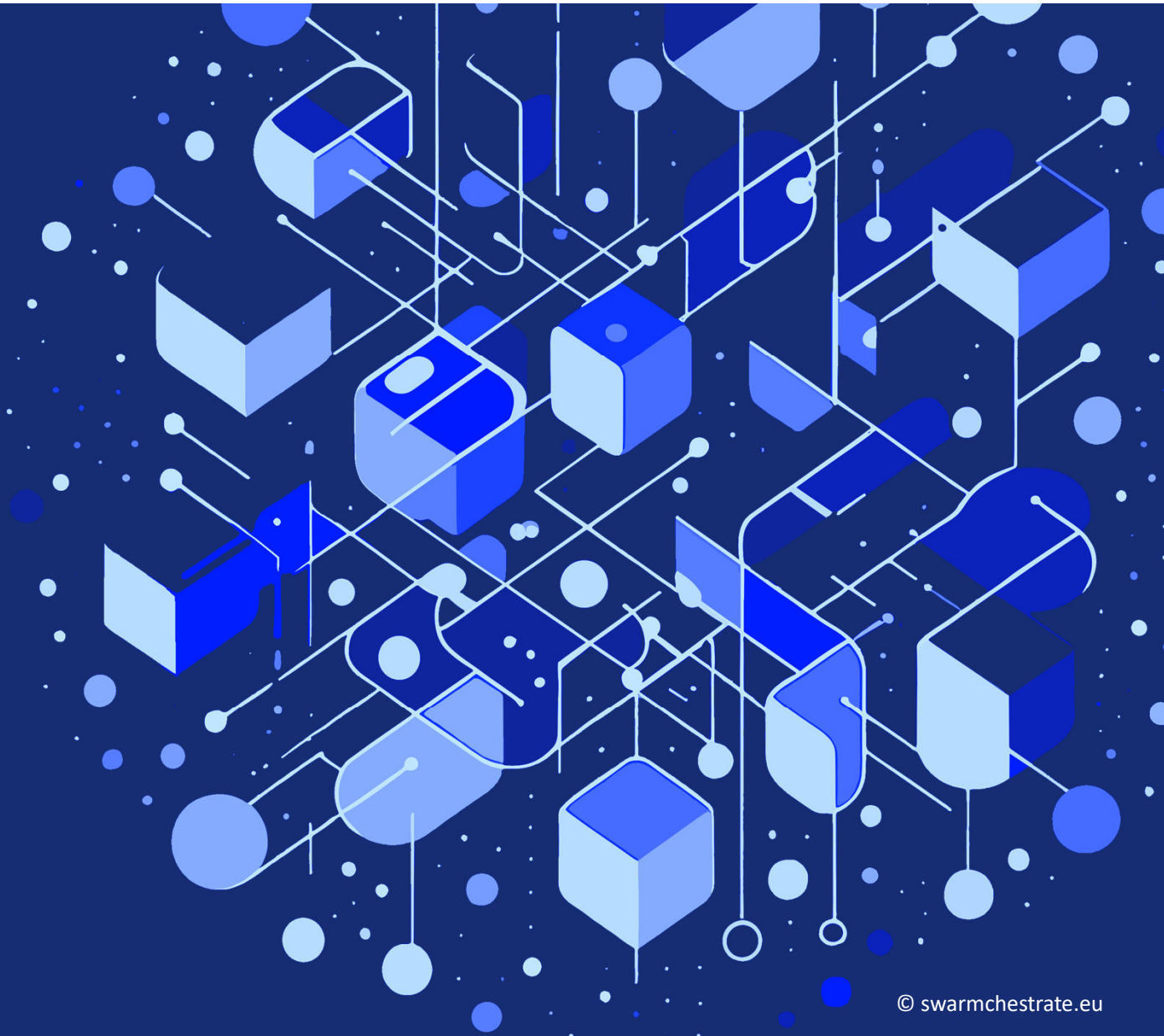
Main Swarmchestrade Components



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Swarmchestrator Demonstrators



Flood Prevention



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- This demonstrator will focus on a network of ultrasound water-level measurement sensors used for the early flood warning in the Athens metropolitan area
- Use Swarmchestrator to dynamically reconfigure a large network of sensors (~100), using data from external sources like weather forecast and weather databases, to optimise the measurement and connection interval of each sensor, extending battery life
- Additionally, make use of external data to dynamically create Swarms of application components in the Cloud-to-Edge Continuum that will combine the measurements and use the upstream data to forecast a possible flood event before it actually occurs and gets detected by the physical sensors



Read more: swarmchestrator.eu/flood-prevention/

Parking Space Management



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- This demonstrator will be based on the FUELICS parking occupancy, battery-operated sensor that offers parking and anti-parking roadside services
- Use Swarmchestrator to combine the magnetic flux data of multiple sensors, and in the case of abnormal behavior, to will trigger the auto-calibration and reconfiguration of the sensors in an automated way
- Additionally, create a network of sensors that spawn globally across countries in very different longitudes/latitudes and attempt to depict changes of the earth's magnetic field over time at planetary scale, as well as, using smaller localised sensor networks to study possible effects of local phenomena (e.g., an earthquake) at a particular location



Read more: swarmchestrator.eu/parking-space-management/

Urban Noise Classification



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- This demonstrator will be based on InnoRenew's sound pressure sensors already installed at the Municipality of Koper. These sensors track noise levels in the surrounding environment continuously, in an effort to identify and reduce noise pollution. The sensors record short audio clips when noise levels surpass a certain level, which are then used to identify the source of the excessive noise
- Use Swarmchestrator to significantly enhance the existing noise monitoring infrastructure by leveraging the computation power of the deployed sensors. By processing the audio signals on the edge sensors and transmitting only the precomputed data to the cloud, the system will mitigate privacy concerns, reduce data transmission requirements, and utilise the untapped computational resources of the edge devices.



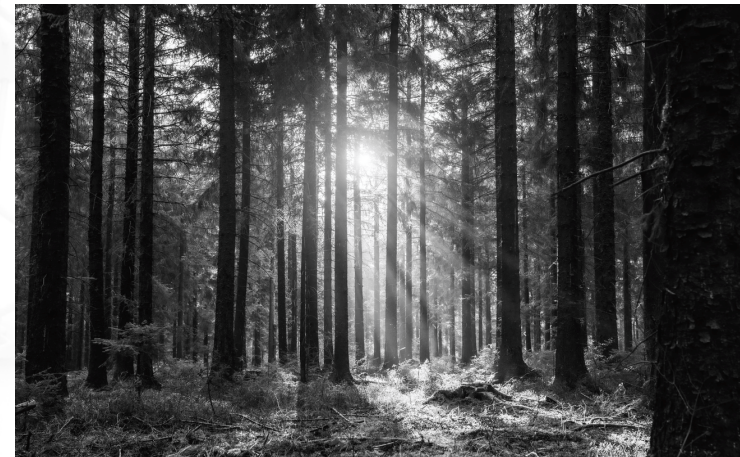
Read more: <https://www.swarmchestrator.eu/urban-noise-classification/>

Digital Twin of Natural Habitat



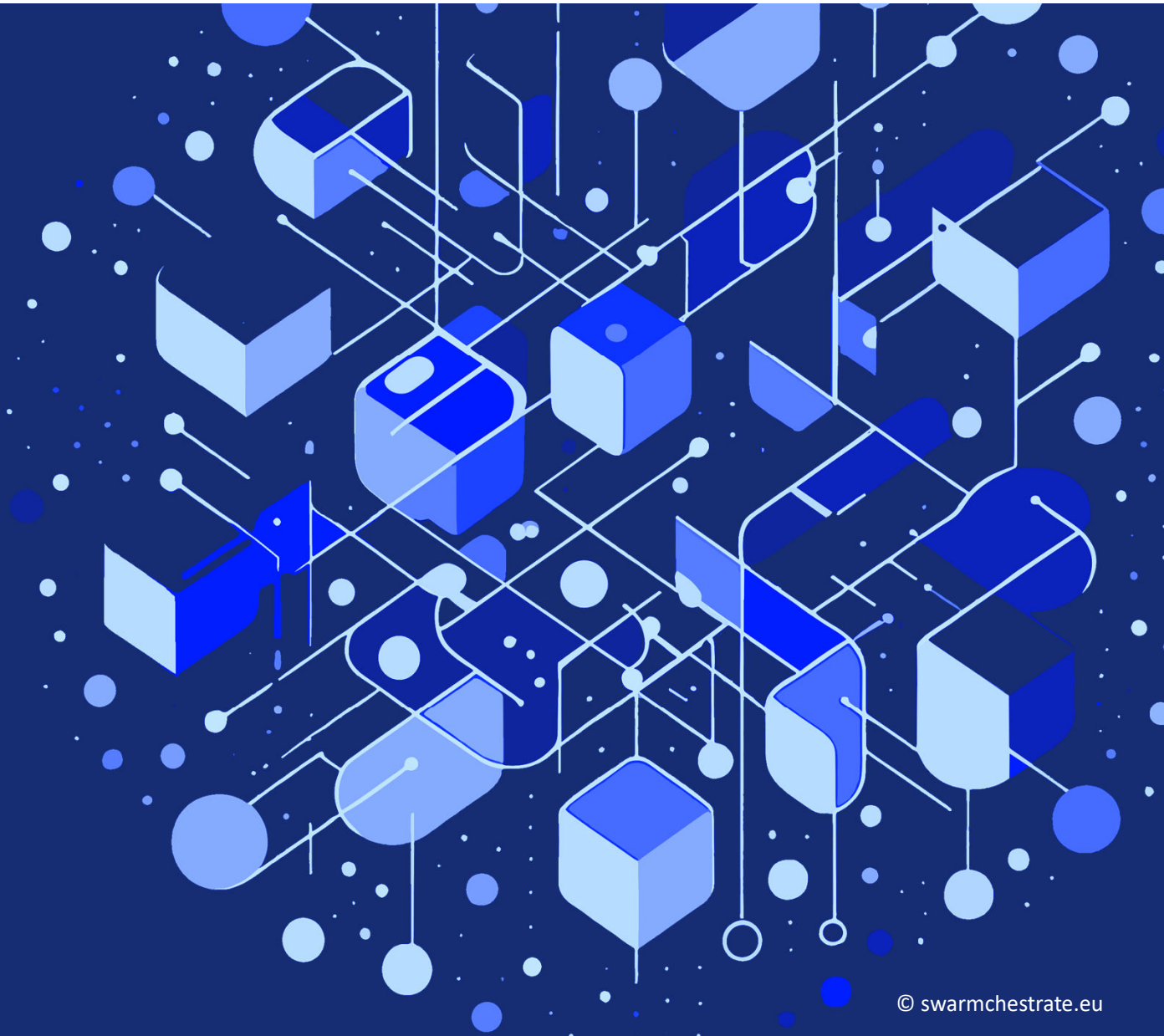
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- Getting and processing data collected from the physical environment cost-effectively is a fundamental issue for Cloud-to-Edge systems
- Use Swarmchestrator for edge processing and swarming between on-location devices which can preprocess data and reduce overall storage, transmission and processing costs
- Additionally, prepare the ground for full scale digital twins that harness the localised digital resources to inform of real time changes to be made to virtual environments enjoyed by many remote users



Read more: swarmchestrator.eu/digital-twin-of-natural-habitat/

Project Details



Project Details



- Budget: ~ EUR 5.5 Million
- Co-funded by EU Horizon Europe, UKRI and South Korea
- Duration: 3 years (1 January 2024 – 31 December 2026)
- 15 project partners from 10 countries across Europe and South Korea
- Combination of academic and industry partners
- Project coordinator: [Dr Robert Lovas](#) (HUN-REN SZTAKI / Institute for Computer Science and Control, Hungary)
- Project Scientific Coordinator: [Prof. Tamas Kiss](#) (University of Westminster, UK)

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This work was co-funded by UK Research and Innovation (UKRI) under the UK government's Horizon Europe funding guarantee (grant numbers 10101169 and 10102651).

PARTNERS



This work was supported by Seoul National University (Institute of Engineering Research) and through grant NRF-RS-2023-00302083 by the National Research Foundation of Korea (NRF), which is funded by the Korea government, Ministry of Science and ICT (MSIT).