Newsletter #4 March 2025

nephele

Part of EUCloudEdgeIoT.eu

A lightweight software stack and synergetic metaorchestration framework for the next generation compute continuum

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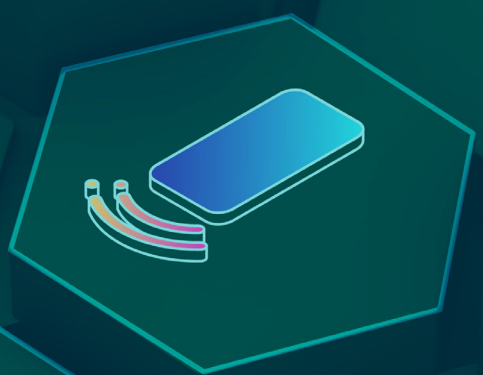
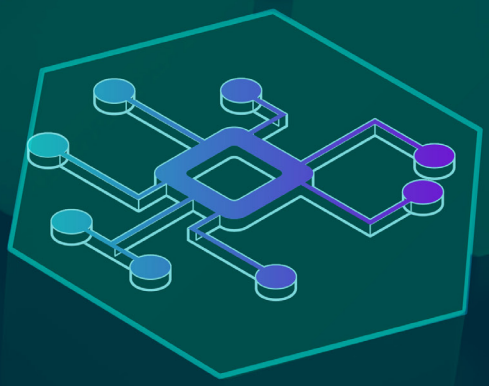




This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101070487.

NEPHELE ECOSYSTEM AND OPEN CALLS

Edge computing is transforming the Internet of Things (IoT) landscape. It is not just a trend; it is essential for realizing the full potential of IoT, enabling faster processing, reduced latency, and enhanced data security. The NEPHELE project, funded by the European Union's Horizon 2020 research and innovation programme, is leading this transformation by cultivating a dynamic ecosystem for edge computing innovation, mainly through its two open calls.

OUR OPEN CALLS: A CATALYST FOR EDGE COMPUTER INNOVATION

The objective of NEPHELE Open Calls is to extend the application domain of its four use cases.

Our First Open Call distributed €608 000 to eight SMEs or Mid-caps and has been focused on the extension of NEPHELE Virtual Object Stack (VOStack) and development of Virtual Objects (VOs), composite Virtual Objects (cVOs) and Digital Twins (DTs) -and generic IoT enablers in accordance with the provided software stack. Newsletter#3 provides further information about the winners of this call.

On the other hand, NEPHELE Second Open Call is distributing up to €880,000 among eight SMEs or Mid-caps to validate NEPHELE's proposed architectural approach and synergetic meta-orchestration framework implementation, based on the development of intelligent orchestration mechanisms and a set of use cases provided by partners outside of the NEPHELE Consortium in relation to various vertical industries.

A HIGHLIGHT OF THIS PERIOD: NEPHELE SECOND OPEN CALL BENEFICIARIES ANNOUNCEMENT

On February 2025 we announced the beneficiaries of this open call. This has been one of the most important project highlights on this period. NEPHELE second open call has selected a diverse and promising group of beneficiaries, each contributing unique expertise and innovative solutions.

These beneficiaries represent the future of edge computing, and their contributions are vital to NEPHELE's vision:

- **METACUS AI** (Meta-Orchestrated European Sensor Grid) by NovelSense UG haftungsbeschränkt, a core partner of DEUS joint venture - Europe's largest climate and environmental measurement grid, using modular sensors to measure traffic, CO2, PM2.5, PM10, VOC, weather, and more. As a DEUS partner, NovelSense develops ABAKUS. AI, a real-time edge AI traffic monitoring and control solution; the dashboard for data ingestion, visualization, AI-based prediction; and the DEUS stationary sensor architecture.

The diverse compute types (cloud, VPS, edge, IoT) and workloads make DEUS version rollouts, ops, and installs prohibitively complex. This project upgrades the current stationary architecture to NEPHELE's Meta-Orchestration framework, improving scalability, flexibility, and standardization across the compute continuum. DEUS contributes new VOStack objects and a European environmental sensor network, validating NEPHELE's framework and advancing Europe's autonomy in data processing for hyper-distributed applications and environmental monitoring.

- **SWARMEON (Distributed Control for Collaborative Autonomous Mobile Robots Swarms)** by Mantelbi: Autonomous Mobile Robots (AMRs) offers a fast and cost-effective solution for logistics in manufacturing environments. However, the need to increase their flexibility in handling heterogeneous loads has led to approaches where swarms of AMRs are coordinated when necessary to jointly move heavy loads that would otherwise require large mobile platforms. The ability of the swarm to operate with precision is dependent on the controllability of each of its agents for the compensation of the whole against individual or global disturbances.

Thus, the development of a distributed edge control application that improves the efficiency of logistic processes by enhancing the cooperative capabilities of the swarm is proposed. Based on the VOStack software approach, SWARMEON will develop a new VO as a virtual counterpart of each of the AMRs, as well as a cVO capable of combining the joint information of the AMR swarm. It is also

proposed to integrate the existing 'Camera VO' for integration of edge cameras.

- **SWIM (Smart Water Interoperability and Management)** by SWHARD s.r.l. will develop a distributed infrastructure for water plant monitoring, maintenance and leaks detection by using IoT sensors, edge devices and analytics AI-based algorithms. and to deploy it into NEPHELE.

Europe's water networks face significant challenges, with inefficiencies contributing to up to 30% water loss during distribution. Modern techniques involve IoT sensors (accelerometer, temperature, GNSS, audio) to monitor relevant plant's sections, edge devices for data collection and filter, and a cloud infrastructure for data analysis.

This scenario offers an optimal test case for NEPHELE architectural approach, improving automation and decentralized intelligence, and removing interoperability issues among CEI components. During its project lifetime, SWIM plans to deploy a testbed water plant management infrastructure into the NEPHELE framework, including a distributed application to continuously monitor the infrastructure.

- **VOGrid Real (Time Grid Monitoring & Analytics)** by Linc Systems ApS will digitalise transformers using Linc's scalable IoT hardware and real-time analytics to provide predictive maintenance and enhanced grid management. The system will track electrical, thermal and vibrational data using NEPHELE's Virtual Object (VO) and Composite Virtual Object (cVO) framework to create digital twins of transformers, optimising performance & preventing failures.

By leveraging NEPHELE's architecture, VOGrid will integrate data seamlessly and process it at the edge with low latency, ensuring scalability across diverse grids. The solution is expected to reduce transformer downtime by up to 30%, extend asset lifespan by 20%, and cut operational costs by 25%. Two major DSOs in Denmark will pilot the project to validate it in real-world conditions. Cost-benefit models project a 3-month payback and a 9x ROI, making VOGrid an attractive investment. It is also aligned with EU goals by reducing grid maintenance costs and improving resilience of critical infrastructure.

- **H3NI (Real-Time Grid Monitoring & Analytics)** by Abilian: H3NI (Hop3/NEPHELE Integration) is an open-source project designed to enhance the orchestration of hyper-distributed applications across IoT, edge, and cloud infrastructures. By integrating the flexible Hop3 orchestration platform with NEPHELE's Synergetic Meta-Orchestrator, H3NI enables dynamic scaling, compute offloading, live migration, and AI/ML workflow management. The project addresses the growing need for efficient, secure, and scalable orchestration in industries such as healthcare, smart cities, logistics, and energy.

H3NI reduces operational complexity while promoting digital sovereignty by offering a cloud-agnostic, open-source solution. H3NI will be a catalyst for community-driven innovation, ensuring that all developed software is available as open-source, encouraging collaboration and minimizing vendor lock-in. This integration supports key European initiatives, such as the Green Deal, by optimizing energy consumption and fostering sustainable digital infrastructures.

- **Headlight (Intelligent orchestrator for the NEPHELE ecosystem)** by SUNESIS (Kumuluz): Headlight is an AI-enabled and context-aware orchestration mechanism to support the NEPHELE Synergetic Meta-Orchestrator in scaling, offloading and live migration. The mechanism is based on graph-based composite architecture, i.e., a heterogenous graph (system-of-systems) combining the software (microservices, serverless functions, APIs) and infrastructure (nodes (cloud, fog, edge), network, storage, IoT devices, databases, event streaming) to obtain a holistic view of the system. The graph is equipped with run-time data for each workload, including metrics, logs, traces from Open Telemetry, NEPHELE components, and the K8s mechanisms (Prometheus) with Graph Neural Networks, the optimization actions for scaling, offloading and live migration, and optimal deployment to the Multi Cluster Resource Manager.

The mechanism is inherently dynamic, with the system image being dynamically captured followed by optimization actions and orchestration for the NEPHELE components.

- **DROP (Distributed Resource Offloading for IoT comPuting)** by Nubificus Ltd will develop a distributed resource offloading mechanism leveraging the vAccel framework for ESP32-based IoT devices. DROP will enable NEPHELE to support seamless computation offloading to neighboring edge nodes, thus, optimizing resource utilization and enhancing application performance. It will include a lightweight transport layer for efficient communication between IoT devices and edge nodes, ensuring interoperability across the IoT-Edge-Cloud continuum. Additionally, the framework

will feature a secure, cloud-native OTA firmware management system for vAccel-enabled IoT devices.

By integrating these components to the NEPHELE Synergetic Meta-Orchestrator, DROP seeks to enable real-time processing capabilities for resource-constrained devices while reducing latency and improving overall system efficiency. DROP will significantly contribute to the advancement of edge computing in IoT applications, fostering innovation in logistics, smart home and industrial automation.

- **AIoTGuard (AIoT app for accident prevention in logistic plant)** by Secmotic is an innovative solution to enhance safety logistics environments by preventing accidents between pedestrians and forklifts. The system integrates AI-powered computer vision models at the edge to detect pedestrians in real-time and trigger dynamic alerts by projecting warning signs on the ground. By leveraging NEPHELE's IoT-Edge-Cloud continuum, AIoTGuard ensures low-latency video analytics and centralized event management.

AIoTGuard approach goes beyond the state of the art by reusing NEPHELE's VOs and developing new ones. These components are orchestrated using NEPHELE's meta-operating system, optimizing resource utilization across the continuum. The scalability of the system will allow you, in the future, to detect additional risks in the workplace.

AIoTGuard is designed for flexibility, ensuring adaptation to different environments and operational needs, providing a solution that improves both safety and operational efficiency in the logistic industry.

THE IMPORTANCE OF COLLABORATION: NEPHELE SUPPORTIVE PARTNER PROGRAMME

Beyond these beneficiaries, NEPHELE recognizes the importance of collaboration and community, which is why the project offers a supportive partners programme. This is an opportunity for organizations and individuals passionate about edge computing to get involved.

The NEPHELE Supportive Partner Programme provides access to valuable resources, networking opportunities, and the chance to contribute to the growth of the edge computing ecosystem. Partners become part of a dynamic community driving innovation and shaping the future of IoT.

Interested parties are encouraged to join this collaborative programme. Together, a thriving edge computing ecosystem can be built, empowering businesses, improving lives, and unlocking the full potential of the Internet of Things. For more information, visit the application site and become a NEPHELE Supportive Partner!

OTHER HIGHLIGHTS OF THE PERIOD

NEPHELE DEMO BY INRIA RECEIVES THE BEST CIoT Demo Award

The demo paper "Virtualized Wireless Sensor Networks for Distributed Applications over the Cloud Continuum" by Adriana Arteaga, Alexandre Veremme, Carol Habib and Nathalie Mitton from Inria with acknowledgement to NEPHELE received the Best Demo Award of the 7th Conference on Cloud and Internet of Things (CIoT24) that was celebrated on 29-31 October 2024 in Montreal, Canada. The demo paper was included in the conference proceedings and submitted to the IEEE Xplore Digital library.

This 3-day event showcased the latest advancements in intelligent systems, cloud computing, and the Internet of Things (IoT). The conference acted as an international platform for academic and industrial exchanges, addressing the challenges of cloud and IoT systems—from sensors and machines to end users and applications connected to the Cloud.

Read the paper in open access.

A member of NEPHELE in the INSTAR European Task Force on IoT/ Edge/ Cloud/ Internet

David Raggett from W3C - and a member of NEPHELE team – is from now one of the proud members of the INSTAR Standards European Task Force (ETF) on IoT/ Edge/ Cloud/ Internet. This ETF is currently involving leading European stakeholders in building an IoT/ Edge/ Cloud/ Internet standardisation roadmap with the participation of selected international partners.

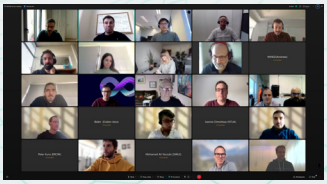
NEPHELE IN ECLIPSE MONTHLY NEWSLETTER

September 2024

Our Technical Coordinator Anastasios Zafeiropoulos from NTUA published an article about our project in the Eclipse monthly Newsletter. This publication provided excellent visibility to the NEPHELE project in the open source community.

The article was entitled "NEPHELE Adopts a SoS Approach to Deliver an OSS Stack for IoT Virtualisation and a Meta-Orchestration Framework" and explained what is our project about, as week as our approach. It enclosed a brief introduction to Virtual Objects and provided links to our use cases, our open calls and NEPHELE GitLab repository.

Read the article.



NEPHELE 6th Consortium Meeting

On 28th and 29th November 2024

The NEPHELE team held a productive online meeting focusing on the updates on our four use cases, plus progress and challenges faced across other key work packages.

The meeting started with a presentation of the current project status overview presentation by our technical coordinator. The rest of the first day was devoted to WP6 (use cases) and WP7 (Open Calls). Each one of the four cases presented its overview, implementation status and planning (development status, VOs/cVOs development, application graph development, integration with the SMO, plans for trials and evaluation results).

The main part of the second day addressed WP8 progress. An exploitation workshop took place with four parallel sessions - one per use case/vertical industry - that

discussed stakeholders, exploitable assets, business model canvas and SWOT analysis for each use case.

The latest updates from WP3 (VOStack features), WP4 (SMO features) and WP5 were also presented. The meeting was concluded with a wrap-up session, an open discussion, new planning and concluding remarks.

NEWS & EVENTS

PAST EVENTS

88th Thessaloniki International Fair

7-15 September 2024, Thessaloniki (Greece)

This year's edition focused on Greece's modern challenges and critical sectors of economy, emphasizing new technological tools, innovation and sustainable development. Georgios Papathanail (UoM) showcased on behalf of NEPHELE its Virtual Object Stack and Meta-Orchestration Platform in two sessions.

Webinar: "Semiconductors in the World of Cloud, Edge, and IoT"

10 September 2024, online event

This event - organised by EUCloudEdgeIoT and ALLPROS.eu - highlighted emerging trends, challenges and opportunities in the fields of cloud, edge computing, IoT and semiconductors technology, NEPHELE technical coordinator, Anastasios Zafeiropoulos, presented cloud-edge-IoT use cases.

Towards deployment of Cloud-Edge-IoT solutions across the computing continuum: from market pathways to large scale pilots (UNLOCK-CEI final event)

23 September 2024, Brussels (Belgium)

This event highlighted industrial success stories originated from the Meta-OS projects supported under the Horizon Europe Work Programme 2024. The event was an ancillary initiative to the AIOTI days on 24th and 25th September 2024. Our technical coordinator Anastasios Zafeiropoulos participated in Session 2 - Supply-demand dialogue.

"Innovating in the continuum: orchestration, network, trust and sovereignty" workshop at AIOTI Days 2024

24-25 September 2024, Brussels (Belgium)

NEPHELE and aerOS projects co-organised this event. The agenda featured discussions on innovative solutions addressing topics such as meta-orchestration frameworks, real-time control, and trust management in smart grids. Speakers included Dr. George Agapiou (WINGS ICT Solutions), and Dr. David Raggett (W3C).

Jornada de Presentación de convocatorias Cascade Funding (in Spanish)

25 September 2024, online event.

This online info session - in Spanish - explained what is Cascade Funding, the European Commission mechanism to distribute public funds to support SMEs and midcaps but also start-ups. Antonio Salvador from FBA presented NEPHELE 2nd Open Call here.

NEPHELE 2nd Open Call info day

30 September 2024, online event

On this session, our technical coordinator Anastasios Zafeiropoulos (NTUA) and our Open Call Manager Diana Järve (FBA) provided information about NEPHELE 2nd Open call.

14th edition of Sploro Cascade Funding Info Days

14 October 2024, online event

NEPHELE was invited to explain its 2nd Open Call at this event. Other invited EU funded projects were dAIEDGE, StandICT.eu and Resilmesh.

eSAAM 2024 on Data Spaces

22 October 2024, Mainz (Germany)

Our technical coordinator Anastasios Zafeiropoulos (NTUA) and Marco Jahn (ECL) represented NEPHELE on this event that was co-located with Open Code Experience 2024 (OCX 2024, formerly EclipseCon).

4th Conference on Cloud and Internet of Things (CIoT24)

29-31 October 2024, Montreal, (Canada).

On this event, the demo paper "Virtualized Wireless Sensor Networks for Distributed Applications over the Cloud Continuum" by Adriana Arteaga, Alexandre Veremme, Carol Habib and Nathalie Mitton (Inria) with acknowledgement to NEPHELE received the Best CIoT24 Demo Award.

Open Source Monitoring Conference

19-21 November 2024, Nuremberg (Germany)

On this conference, our colleague Jonathan Rivalan (Alter Way - SMILE) presented "Palindrome.js: 3D Monitoring for Distributed Systems".

INSTAR - CEI-Sphere Workshop on Cross-Domain Standardisation and Architecture for Edge Computing

26-27 November 2024, Brussels, Belgium

Our colleague Dave Raggett (W3C) was invited by Rolf Riemenschneider (DG Connect, EC) to speak about NEPHELE and cross-sector standardization. Dave also took part on a panel about scaling up standards from pilots to international actions. Also on this event, our technical coordinator Anastasios Zafeiropoulos (NTUA) represented NEPHELE in a panel about standardisation strategies from the EU CEI.

WoT Conference 2024

27 November 2024, Munich, Germany

This conference was a part of the WoT Week 2024 organised by Siemens and Microsoft. Haoyu Ren (Siemens) introduced here a demo on NEPHELE energy use case (UC3).

AIOTI Workshop on Semantic Interoperability and Digital Twins

5-6 February 2024, Sophia Antipolis, France

With support from NEPHELE, W3C/ERCIM hosted the AIOTI Workshop on Semantic Interoperability for Digital Twins at the Inria campus. This workshop was focused on finding practical solutions for real-world industrial challenges. Discussions involved a mix of invited talks, breakout sessions, and community-submitted presentations

ETSI NFV#49

11 March 2025, Sophia Antipolis, France.

Panagiotis Papadimitriou from University of Macedonia was invited to present NEPHELE at this event. This meeting series joins together relevant people from the NFV community. The work done in NEPHELE regarding virtual objects is very relevant to this community.

UPCOMING EVENTS

2nd Workshop on MetaOS for the Cloud-Edge-IoT Continuum (MECC 2025)

31 March 2025, Rotterdam, The Netherlands

This workshop co-organised by the MetaOS cluster - FLUIDOS, NEPHELE, aerOS, NebulOuS, NEMO and ICOS EU funded projects - will be co-hosted at the ACM EuroSys 2025.

IEEE ICC 2025 (Next-Generation Networking & Internet Symposium)

8-12 June 2025, Montreal (Canada)

This event will focus on “Communications Technologies 4Good”, and will include 13 symposia and a variety of tutorials and workshops. The paper “Joint Placement and Scheduling for Time-Sensitive Applications in Edge Computing” with acknowledgement to NEPHELE has been accepted here.

MEET OUR PARTNERS

THIS SECTION WILL BE PRESENTING THE PARTNERS OF THE CONSORTIUM, THEIR PROFILE, MAIN EXPERTISE AND CONTRIBUTION TO THE PROJECT.

ECLIPSE

The Eclipse Foundation is Europe's largest open source organisation. It is an international not-for-profit association supported by over 300 member organizations who value the Foundation's unique working group governance model, open innovation processes and community-building events.

The Eclipse Foundation started first as the Eclipse Project, originally created by IBM in November 2001 and supported by a consortium of software vendors. The Foundation was created in January 2004 as an independent not-for-profit, vendor-neutral, open and transparent corporation to act as the steward of the Eclipse community. Part of the Eclipse Foundation members are now industry leaders who have embraced open source as a key enabler for business strategy.

The Eclipse Foundation provides a mature, scalable and business-friendly environment for open source software collaboration and innovation. The Foundation is home to the Eclipse IDE, Jakarta EE, and over 400 open source projects, including runtimes, tools and frameworks for a wide range of technology domains such as the Internet of Things, automotive, geospatial, systems engineering, and many others.

The Eclipse Foundation core activity in research projects is focused in open source guidance & leadership, guidance creating open source software, open source ecosystem development and open collaboration infrastructures.

In NEPHELE, Eclipse is leading the task related to Open Source Ecosystem, Community Building and Sustainability. Eclipse also participates in use cases and architecture specification; compute resource, network management and synergetic orchestration; and dissemination and communications activities


Marco Jahn


Philippe Krief


Rosaria Rossini

WINGS

WINGS ICT Solutions is a company that provides innovative and complete integrated, end-to-end intelligent digital (software, hardware) solutions and transformation for vertical business sectors like environment (air quality, natural disasters), utilities and infrastructures (energy/water/gas, transportation, construction), production and manufacturing (food, factories/logistics), service sectors (health, education/culture, government, security/defense), as well as smart cities. Based on its extensive expertise and in order to achieve these results, WINGS exploits advanced technologies, such as artificial intelligence, big data, cloud technologies, telecommunication networks - 4G, 5G, WiFi, Lora, etc. -, advanced visualization techniques - augmented / virtual / extended reality (AR / VR / XR), mobile applications, etc. - aiming to provide extremely reliable solutions that help businesses improve their decision-making processes, expand their knowledge through detailed forecasting and predictive analytics, increase their efficiency and in the end, focusing on customer satisfaction. WINGSPARK++ is the wings product for the management of transportation infrastructures like parking, management of transport infrastructures and mobility services.

In NEPHELE, WINGS is providing the platform for AI-assisted logistics operations in the port use case. WINGS optimises port logistics and container


Andreas Georgakopoulos


Panagiotis Demestichas

operations and elaborates on the concept of virtual objects (VOs) for creating services with higher interoperability. WINGS platform - based in AI algorithms - deals with real-time allocation of resources and containers routing. This includes allocation of automated guides vehicles (AGVs) and forklifts to move containers. The objective is routing optimisation of containers inside port area to get reduced routing times, lower CO2 emissions and higher truck/forklift utilisation. WINGS platform facilitates container localization and route status aspects, trucks and forklifts availability and location information, monitoring and alerts of devices while considering policies and targeted KPIs.

IBM

IBM Ireland is one of Ireland's leading providers of advanced information technology, products, services and business consulting expertise.

The goal of the OpenXChange Unit in IBM Ireland is to accelerate the growth and scale of solutions using IBMs hybrid cloud and AI technologies. They develop and execute strategies to identify optimum market and technology fits on a per client basis and manage their relationships through discovery, collaboration, and co-creation phases. These partnerships are sourced from domestic markets, European frameworks, pre-existing and new client relationships.

IBM Ireland Innovation Exchange team specialises in the development of proof of concepts, novel technologies and transitioning them into go to market offerings for IBM.

In NEPHELE, IBM Ireland is leader of Edge and Cloud Computing Synergetic Meta-Orchestration, and contributes to Synergetic Orchestration Requirements, Autonomic Functionalities and Ad-hoc Clouds Management, Orchestration Management Interfaces, Compute Continuum Network Management, AI-assisted Synergetic Orchestration, NEPHELE Platform Integration, Testing and Refinement, DevOps Environment, Continuous Integration and Quality Assurance, Use Cases Framework (Definition, Planning, Monitoring and Coordination), Design, Implementation and Evaluation of the use cases in the domain of natural and human disaster/emergency management and remote health care services. IBEM also participates in the support programme of the NEPHELE open call and takes part in communication and exploitation activities.


John Farren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