
# Evolving 5G: ANIARA, an edge-cloud perspective

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Ian Marsh
ian.marsh@ri.se
RISE AB
Stockholm, Sweden

Nicolae Paladi
nicolae.paladi@ri.se
RISE AB
Stockholm, Sweden

Henrik Abrahamsson
henrik.abrahmssonon@ri.se
RISE AB
Stockholm, Sweden

Jonas Gustafsson
jonas.gustafsson@ri.se
RISE AB
Luleå, Sweden

Johan Sjöberg
johan.sjoberg@ericsson.com
Ericsson AB
Stockholm, Sweden

Andreas Johnsson
andreas.a.johnsson@ericsson.com
Ericsson AB
Stockholm, Sweden

Pontus Sköldström
pontus.sköldström@ericsson.com
Ericsson AB
Stockholm, Sweden

Jim Dowling
jim.dowling@logicalclocks.com
Logical Clocks AB
Stockholm, Sweden

Paolo Monti
mpaolo@chalmers.se
Chalmers University of Technology
Gothenburg, Sweden

Dominik Flick
dominik.flick@opel-vauxhall.comm
Opel Automobile GmbH
Germany

Mohsen Amiribesheli
mohsen.amiribesheli@konicaminolta.co.uk
Konica Minolta Global R&D
London, United Kingdom



## ABSTRACT

ANIARA[1] enhances edge architectures for smart manufacturing and cities. AI automation, orchestrated lightweight containers, and efficient power usage are key components of this three-year project. Edge infrastructure, virtualization, and containerization in future telecom systems enable new and more demanding use cases for telecom operators and industrial verticals. Increased service flexibility adds complexity that must be addressed with novel management and orchestration systems. To address this, ANIARA will provide enablers and solutions for services in the domains of smart cities and manufacturing deployed and operated at the network edge(s).



## CCS CONCEPTS

• **Hardware** → **Energy metering**; • **Computing methodologies** → **Multi-agent systems**; **Self-organization**.

## KEYWORDS

Edge comp., AI, container tech., orchestration, energy metering

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[1]https://www.celticnext.eeu/project-ai-net



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## 1 INTRODUCTION

Figure 1 shows the functional technologies for evolving 5G systems we are developing in ANIARA. Namely, automated application deployment and management across distributed edge sites; generic edge services to simplify application and service development; an AI & data framework to accelerate development, deployment and management of algorithms; and optimized power distribution working in synergy with network management. The project is based on three use cases addressing public safety, industry, and smart cities.

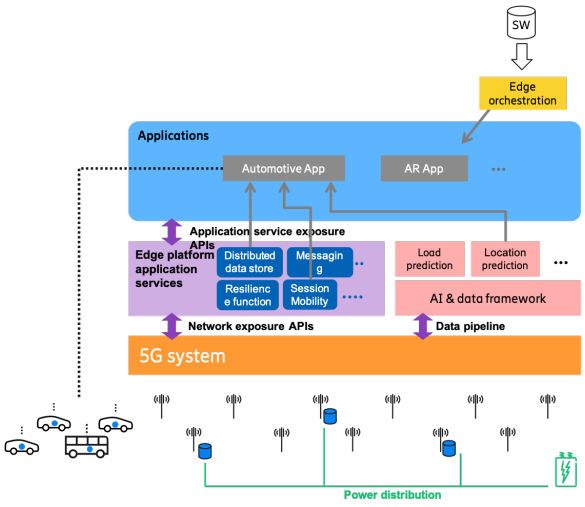


**Figure 1: Functional structure of the ANIARA project**

## 2 ANIARA'S USE CASES

5G networks enable new cases for telecom operators and industrial verticals. One work package explores digital technologies by implementing 5G networks and edge computing in individual use cases. From these use cases, the technical requirements as well as the values will be derived and used as the base for further research described in the following paragraphs. The use cases in ANIARA will be in smart manufacturing and smart cities. This work package will include the elaboration of detailed use case descriptions for verticals using 5G and the edge cloud. The definition of edge cloud scenarios and architecture requirements will formulate use cases as well as develop software and demonstrators of the key concepts.

## 3 AI FOR EDGE-CLOUD COMPUTING

One effort is to develop AI technologies for predictive and proactive automation of edge infrastructures, as illustrated in Figure 1. Today's AI algorithms are not tailored for the edge infrastructure. We will develop algorithms compatible with the, sometimes resource constrained, infrastructure for increased efficiency, reliability, & scalability. Edge automated AI will consider predictive and proactive infrastructure and service operations, including fault management, performance optimization exemplified with load prediction in the figure, resource optimization, and energy efficiency. We explore i) methods and concepts for resource-constrained AI for the edge nodes using federated learning. ii) and exploring robust and reliable automation technologies to reduce the management complexity. During the first six months we developed ML model adaptation using transfer learning [1], and online feature selection [4]. The objective is to lower the overhead in the ML training process and transfer of data through the edge infrastructure.

## 4 EDGE-CLOUD DISTRIBUTED PLATFORMS

Contains three thrusts: first, evaluation of available open, lightweight containerization solutions. We converged on evaluating seven existing technologies concerning needs, use cases and industry requirements. The second is i) how LogicalClocks's feature store performs within in-situ testbeds, particularly with respect to latency ii) WebAssembly - an open programmable compiler technology - producing lightweight secure virtual machines. We will evaluate WASM for the Edge, specifically access to networking services and security. iii) Longer term topics within distributed data and synchronization, how to share, migrate shared data across the Edge-cloud borders. In other words *how AI models follow users*. A technical report on containers using open source will soon be available through the ANIARA website [2]. Articles and white papers on Logicalclocks' FeatureStore are available through their site.

## 5 EDGE-CLOUD ORCHESTRATION

Slice-as-a-Service, Function-as-a-Service, and microservices are key concepts in cloud services [3]. Low latency and energy requirements ask for the design of automated and proactive orchestration solutions tailored for edge-cloud platforms. We will develop the orchestrations functionalities highlighted in Figure 1 following three distinct, yet complementary, directions. i) Management of the distributed edge cloud infrastructure: the objective is to investigate closed loop-approaches for automated and proactive resource scaling and workload assignment. ii) Service management: the focus is on developing techniques to optimize the placement of large-scale edge cloud applications, compute, and network resources over a distributed edge cloud. iii) Multi-tenancy and service isolation: the objective is to investigate solutions for resource slicing spanning across access, aggregated, and on-premise private/public cloud infrastructures while ensuring, with the help of secure containers and confidential computing, that the edge-cloud can be used for heterogeneous workloads without compromising on security.

## 6 EDGE-CLOUD POWER CONSIDERATIONS

To obtain full power from the 5G-infrastructure, service latency must be kept low, meaning compute resources need to be located close to 5G-access points. Installing thousands of EDGE data centers will also require significant power, however power grids in many cities are utilized close to 100%. To maintain high availability and power, the EDGE-datacenters traditional power supplies have to be used with alternative power sources and pro-active power usage. This requires tailored hardware solutions integrated with local power sources, and actively support load balance control. We are working on the design and implementation of a series of micro-EDGE-data center demonstrators that are prepared for deployment in indoor and outdoor locations. The first generator demonstrator will be shown Aug. 2021, and consists of a full rack, cooling, UPS-system including batteries, multiple power sources and IT-hardware. It will be prepared to withstand challenging industrial environments with heat recovery later. We are evaluating how deployment of EDGE-datacenters affects the power grid and where future EDGE-DCs should be placed to avoid overloading of sections in the grid.

## 7 A THREE YEAR OUTLOOK

ANIARA further develops existing working solutions and conducts research in distributed systems and AI for the Edge-Cloud infrastructure. The adoption of these technologies leads to 5G enhancements and 6G concepts through the project coordinator, Ericsson. The other partners include Opel Automobile GmBH, a number of SMEs, two research institutes and four universities.

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