



ARCADIA

Newsletter # 5 — jUNE 2017

***A Novel Reconfigurable By Design Highly Distributed
Applications Development Paradigm Over
Programmable Infrastructure***

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Dear Readers,

Welcome to our fifth issue of **ARCADIA** Newsletter that we would like to present to you! Here you can find updated information on the progress of our project and read news related to **ARCADIA**, which we hope will be of interest to you.

In this issue, we have prepared the following selection of articles in order to provide a deeper look into the work being done in the context of the EU-funded project **ARCADIA**:

- How the ARCADIA framework could support the design, implementation and evaluation of edge computing principles
- Report on the 2nd review meeting in Brussels
- Dissemination activities in the first semester of 2017
- Plenary meeting in Ljubljana and preparation of next events

We will regularly keep you updated with the most recent news about the status of the project, the consortium dissemination activities and a recommendation of conferences that might be of interest to you.

Moreover, we kindly invite you to also regularly consult our website:

<http://www.arcadia-framework.eu>

We are happy to invite you to follow our activities with this newsletter and we are looking forward to your feedback.

Yours sincerely,

The **ARCADIA** consortium



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A MIDDLEWARE FOR MOBILE EDGE COMPUTING

Telecom operators have recently started to deploy massive computing and storage resources at the very edge of their access networks, hence evolving their infrastructures into large, distributed, and capillary computing environments, capable of placing applications very close to users and terminals and well-suited to effectively fulfill the challenging requirements for delay-sensitive applications. Edge computing is the emerging paradigm that pervasively brings computing in the environment, by shifting processing from data centers to the network edge, allowing a large class of applications in growing fields, like Big Data and the Internet of Things, to be deployed in a very effective way. In the following it is briefly presented how the ARCADIA framework can be used for running applications over heterogeneous environments, made of telecom networks and legacy data centers and more specifically how it can be exploited for developing and deploying modular applications in an automatic way.

The growing “cloudification” wave and the need to support low-latency applications in a more effective way have motivated the interest in new cloud paradigms, which envision deployment of applications and services at the network edge. Telco infrastructures are typically organized in access, metro, and core segments. Access segments (often referred to as “last-mile”) connect customer devices (modems, computers, phones) with the most peripheral network equipment (Broadband Remote Access Servers and similar devices), located in so-called “Points of Presence” (PoPs). Metro networks are used to interconnect several PoPs in densely populated areas (i.e., large cities), while the core network provides wide area connectivity over the entire country served by the operator.

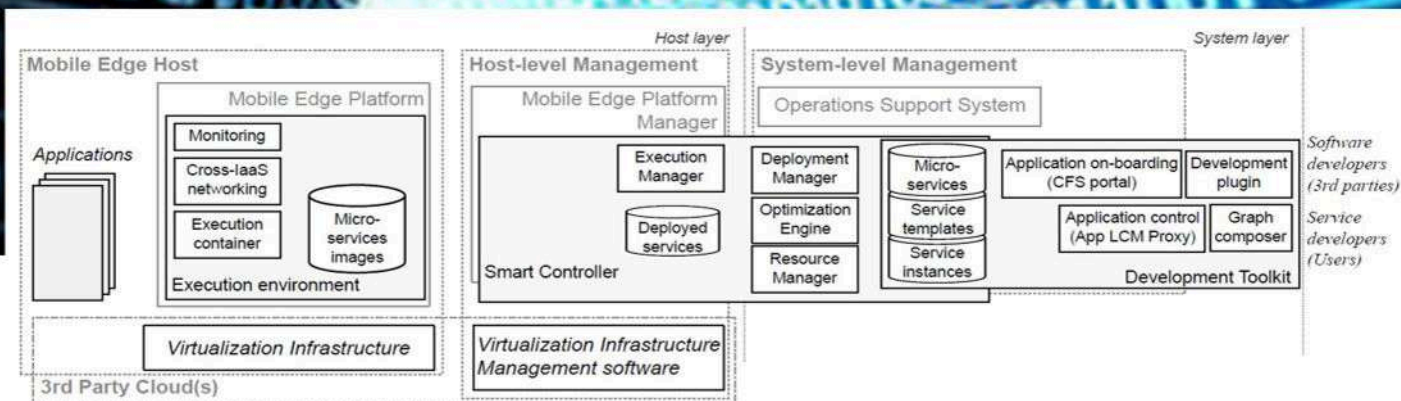
Today, telco networks are rapidly evolving from mere communication infrastructures to rich fabrics of information and communication technologies,

with computing and storage resources located close to the border (namely, in PoPs), in addition to traditional installations in central offices. The original purpose was to replace specialized network appliances with software running on plain COTS hardware; however, virtualization technologies also enable to use this peripheral and capillary infrastructure to provide localized cloud services, hence leading to the concept of “edge” computing (recently also indicated as “mist” computing).

The amount of resources in such installations will be limited due to space, power, and cost constraints; in this respect, edge computing is seen more as an extension rather than full cloud replacement. Typical deployments will consist of distributed applications running core processing-intensive tasks in the cloud and lightweight tasks at the edge; the latter will provide functions with strict constraints on latency, bandwidth, quality of service.

The European Telecommunications Standards Institute (ETSI) has already published an architecture for Mobile Edge Computing (MEC), which specifically targets cellular networks. It is a reference architecture that defines the main architectural elements and their functionality; the objective is an overarching framework for distributed computing offloading of applications from mobile devices, and onboarding from third parties.

The ARCADIA architecture can actually be mapped to the ETSI MEC framework as it is depicted in the figure above. ARCADIA basically consists of three main components: the interactive Development Toolkit, an intelligent orchestrator called Smart Controller, and the Execution environment.



A. Development Toolkit

The ARCADIA Development Toolkit enables development of micro-services and service graphs through an intuitive and immediate Web User Interface (Web UI), which also includes plugins for Integrated Development Environments (e.g., Eclipse Che). Developers implement software as ARCADIA micro-services, including metadata for their correct instantiation and execution, and upload them into the microservices repository; telco operators as well are expected to provide network-related micro-services, for example functions related to network status, mobility and QoS management. Hence, the Development Toolkit represents a superset of the functionality of the MEC CFS portal. Note that the micro-services repository at this layer is mainly conceived to store their description (i.e., metadata), which is necessary to create service graphs; software images are stored in each execution environment by the Smart Controller. Applications are created through the Graph Composer, by dragging available micro-services and dropping/chaining them; they are automatically saved as service templates. Applications may be developed by the same users (as foreseen in MEC) or by third party developers. When a user wants to activate an application, he picks the service graph from a list and annotates deployment policies and constraints (locality and mobility, QoS, security and privacy levels, response latency, redundancy and resilience level, lifecycle management, etc.), hence creating a service instance. The Web UI permits full control on the application lifecycle (start, stop, re-start), therefore playing the same role of the App LCM Proxy in the MEC architecture.

B. Smart Controller

The Smart Controller splits orchestration into different functional modules. A Deployment Manager takes the application model instance and translates it into an optimal deployment plan, by solving a placement problem that takes into consideration available infrastructures (Mobile Edge Hosts, external clouds), their current load and performance, deployment policies and constraints. The plan includes: i) the placement of each micro-service to a specific installation, ii) additional micro-services and functions to be deployed (for instance, to create virtual networking across different cloud providers), iii) the mapping of each micro-service to its execution environment (VM or software container), and iv) the list of deployment actions for each micro-service and the entire graph (Operating System, libraries, configurations, network topologies, etc.). The Deployment Manager also keeps an updated view of the whole system, based on deployed Mobile Edge Hosts, available resources, running applications and micro-services, and topologies. An Optimization Engine continuously processes monitoring information from hostlevel components about microservices and service graphs, and triggers re-configurations as needed (re-placement, vertical/ horizontal scaling, and any other lifecycle management action set by accompanying policies), pursuing close-to-zero service disruption. The Resource Manager keeps an inventory of all available infrastructures: Mobile Edge Hosts, internal and external clouds. It maintains identity information and authentication secrets and translates internal high-level calls into platform-specific APIs to the Virtualization Infrastructure Management Software for provisioning resources, configuring the execution environment, starting and stopping applications. The combination of these components implements all the orchestration functions envisaged by the ETSI framework.

The Execution Manager carries out deployment actions, including provisioning and configuration of the execution environment, retrieval of missing software images, microservices configuration, execution of lifecycle hooks; it also collects monitoring measurements from both the infrastructure management software and specific probes available in each micro-service. The Execution Manager is also responsible for setting up virtual networking, configuring access policies and packet filtering. Run-time information is kept about active instances, their configuration, their status, and any other relevant information for lifecycle management; it can be used by the orchestrator to dynamically connect services, whenever the same micro-service (like databases) could be shared among different applications. Run-time information plays a similar role of the "Service registry" in the MEC framework. All together, the Execution Manager and the run-time repository implement the Mobile Edge Platform Manager in the MEC architecture. The specific software used to manage the virtualized infrastructure is not relevant for ARCADIA, since the framework is conceived to support cross-IaaS domains. The design of the Resource Manager allows to simply add drivers for different management APIs: OpenStack, Amazon Web Services (AWS), Open Cloud Computing Interface (OCCI), etc.

C. Execution environment

The Execution environment is deployed by the Smart Controller when the infrastructure is registered in the Resource Manager. Its main purpose is to provide common functions to all software deployed in the IaaS. For instance, it sets up virtual secure networking among all managed infrastructures. The execution environment also collects monitoring information and delivers it to the Smart Controller. This barely corresponds to the functions of the Mobile Edge Platform for MEC.

The ARCADIA framework can enhance the current architecture for mobile edge computing, by providing a flexible and integrated way of developing and deploying distributed applications. Nevertheless, further enhancements are still required especially at the infrastructure level in order to better cope with the peculiarity of mobile environments, including better mobility support and tighter control of the network.

2ND ARCADIA REVIEW MEETING

The second review meeting of ARCADIA was held in Brussels on 31st March 2017 at the EU premises at Beaulieu. A demonstration of the ARCADIA software platform was done at the beginning of the meeting, so as to provide a concrete basis for discussions and allow a deeper understanding of the subsequent presentations on each work package. This approach also enabled more constructive remarks and guidelines about the progress and the next steps of the project. The reviewers acknowledged the good work that has been done and they proposed to the consortium to carry out a more intense communication of the benefits that can derive from the adoption of the ARCADIA platform by potential client companies. A direct marketing channel could be the best option to follow in this case and this is a plan that is being organized and will soon start to be implemented.

Consortium members have presented ARCADIA concepts in the following events:

- 5th International Conference on Model-driven Engineering and Software Development (MODELWARDS 2017), 19 – 21 February 2017, Porto, Portugal
- Second IFIP/IEEE International Workshop on Management of 5G Networks (5GMan 2017), 12th May 2017, Lisbon, Portugal
- 33rd workshop on Telecommunications VITEL 2017, 22th May 2017, Slovenia
- 16th International IFIP TC6 Networking Conference, 12 – 15 June 2017, Stockholm, Sweden

DISSEMINATION
ACTIVITIES



6TH PLENARY MEETING IN LJUBLJANA

The 6th plenary meeting of the **ARCADIA** project took place in Ljubljana, Slovenia, (13 - 14 March) hosted by the University of Ljubljana. The final steps for the upcoming 2nd review meeting in Brussels were planned and the last updates on the revised documents and the software modules development were discussed. The progress of the implementation of the three ARCADIA use cases was also discussed during this meeting.



Project Coordinator



NUI Galway
OÉ Gaillimh

Insight Centre for Data Analytics
National University of Ireland
Galway

Project Manager: Dr. Adegboyega Ojo

Tel: +353 91 495336

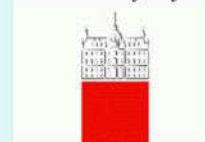
Email:

adegboyega.ojor@insight-centre.org

Consortium



Univerza v Ljubljani



A novel reconfigurable by design highly distributed applications development paradigm over programmable infrastructure

DO YOU WANT TO KNOW MORE ABOUT ARCADIA PROJECT?

Contact Us



<http://www.arcadia-framework.eu>



adegboyega.ojor@insight-centre.org



<https://www.linkedin.com/groups/6949809>



https://twitter.com/eu_arcadia

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