

COMPUTER AND CONTROL ENGINEERING

TIM - Multi-Provider Cloud-Edge Continuum

Funded By	TIM - TELECOM ITALIA MOBILE S.P.A. [P.iva/CF:06947890015]
Supervisor	RISSO FULVIO GIOVANNI OTTAVIO - fulvio.risso@polito.it
Contact	
Context of the research activity	Future cloud computing systems will be complemented with additional resources operating at the edge, either on the telco side or on the customer's premises. This research activity tackles the above problems: (1) scalable, infrastructure-wide and multi-provider orchestration; (2) enhanced resiliency and capability of the software infrastructure to survive and evolve also in case of network outages or planned disconnections; (3) network optimizations in case of infrastructure involving $N > 2$ federated clusters.
	Cloud-native technologies are increasingly deployed at the edge of the network, usually through tiny datacenters made by a few servers that maintain the main characteristics (powerful CPUs, high-speed network) of the well-known cloud datacenters. This project proposes to aggregate the above available hardware into a gigantic, distributed datacenter, potentially controlled by multiple administrative entities. This would originate a set of highly dynamic, yet still secure and robust, "virtual" clusters spanning across multiple physical infrastructures. The key objectives of the present research are the following: 1) Architectural Paradigms and Resource Management: Develop new paradigms, algorithms, and protocols for advertising, negotiating, and acquiring resources across different administrative domains. 2) Orchestration and Lifecycle Management: Create scalable algorithms and protocols for orchestrating the computing continuum, optimizing the placement of software services, and managing the lifecycle of virtual clusters. 3) Resilience and Evolution: Ensure the software infrastructure and virtual clusters can survive and evolve during network outages or planned disconnections. 4) Data Exchange Optimization: Optimize data exchange between virtual services when clusters span multiple sites. The research activity will be based on outputs of the IPCEI-CIS Project initiative (https://www.bmwk.de/Redaktion/EN/Artikel/Industry/ipcei-cis.html), in particular in collaboration with TIM S.p.A. . The research activity will be organized in the following phases. Year 1: Foundation and Initial Development

Objectives

- Q1-Q2: Literature Review and Requirement Analysis
 - o Conduct a comprehensive literature review on cloud-native technologies, edge computing, and distributed datacenters.
 - o Identify key challenges and gaps in current technologies.
 - o Define detailed requirements for the project.
- Q3-Q4: Architectural Design and Initial Prototyping
 - o Develop novel architectural paradigms for resource management across multiple administrative domains.
 - o Design initial scalable algorithms and protocols for resource advertisement, negotiation, and acquisition.
 - o Create a prototype for testing basic functionalities.

Year 2: Development and Testing

- Q1-Q2: Advanced Algorithm Development
 - o Develop scalable algorithms and protocols for orchestrating the computing continuum.
 - o Focus on optimized placement for software services and applications.
 - o Implement lifecycle management for virtual clusters.
- Q3-Q4: Resilience and Data Exchange Optimization
 - o Design and implement algorithms for infrastructure resilience during network outages or planned disconnections.
 - o Develop scalable algorithms for optimizing data exchange between virtual services across multiple sites.
 - o Conduct extensive testing and validation of the developed algorithms and protocols.

Year 3: Integration and Evaluation

- Q1-Q2: Integration and System Testing
 - o Integrate all developed components into a cohesive system.
 - o Perform comprehensive system testing to ensure functionality and performance.
 - o Optimize the system based on testing results.
- Q3-Q4: Evaluation and Dissemination
 - o Evaluate the system in real-world scenarios to assess its effectiveness and robustness.
 - o Document findings and prepare research papers for publication.
 - o Present results at conferences and workshops.
 - o Plan for potential exploitation or further research extensions.

Expected target venues for publication are the following:

Top conferences:

- USENIX Symposium on Operating Systems Design and Implementation (OSDI)
- USENIX Symposium on Networked Systems Design and Implementation (NSDI)
- International Conference on Computer Communications (INFOCOM)
- ACM European Conference on Computer Systems (EuroSys)
- ACM Symposium on Principles of Distributed Computing (PODC)
- ACM Symposium on Operating Systems Principles (SOSP)

Journals:

- IEEE/ACM Transactions on Networking
- IEEE Transactions on Computers
- ACM Transactions on Computer Systems (TOCS)
- IEEE Transactions on Cloud Computing

	Magazines: - IEEE Computer - IEEE Network
--	--

Skills and competencies for the development of the activity	The ideal candidate has good knowledge and experience in computing architectures, cloud computing and networking.
---	--