Cognitive architecture for the Future Internet Core Platform

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The presented architecture derives from the experience gained by the authors while working in 27 EU funded projects\(^1\).

The proposed architecture is shown in Figure 1: the Future Internet Core Platform (FI-CP) includes so-called *Semantic Virtualization Enablers* and a set of *Cognitive Enablers*. The Cognitive Enablers are the core of the FI-CP and include all the control and management functionalities. They interact with **Actors**, **Resources** and **Applications** through *Semantic Virtualization Enablers*.

**Actors** represent the entities whose requirement fulfillment is the goal of the FI-CP; for instance, **Actors** include users, developers, network providers, service providers, content providers, etc.

**Resources** represent the entities that can be exploited for fulfilling the Actors’ requirements; example of Resources include services, contents, terminals, devices, middleware functionalities, storage, computational, connectivity and networking capabilities, etc.

**Applications** are utilized by the Actors to fulfill their requirements and needs; the Core Platform allows the Applications to efficiently and flexibly exploit all the available Resources.

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1 Prof. Francesco Delli Priscoli has been the University of Rome “Sapienza” scientific responsible in 20 EU funded projects from FP4 to FP6, and is now the local scientific responsible for 7 FP7 projects: he coordinates a research group of 30 professors and researchers working on these projects, mainly in the field of ‘Pervasive and Trusted Network and Service Infrastructure’. For example, the research group in question participated to the following FP6 and FP7 projects: DAIDALOS I, DAIDALOS II, EuQoS, WEIRD, SATSIX, OMEGA, P2P-Next, MICIE, TASS, DLC+VIT4IP, BRAVEHEALTH, MONET and Artemis pSHIELD project.

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Actors, Resources and Applications interact with the Cognitive Enablers through **Semantic Virtualization Enablers**. They are in charge of virtualizing the heterogeneous Actors, Resources and Applications, describing them using dynamic, homogeneous, context-aware and semantic metadata aiming at preparing properly selected aggregated inputs for the Cognitive Enablers. Based on these metadata, the Cognitive Enablers elaborate proper decisions, which are handled by the Semantic Virtualization Enablers, in order to be applied and exposed to the Actors, the Resources and the Applications.

The **Cognitive Enablers** consist of a set of independent multi-layer, multi-network enablers which interoperate to provide specific Core Platform functionalities, on the basis of the aggregated metadata provided by the Semantic Virtualization Enablers. The control and management decisions taken by the Cognitive Enablers are put into operation by the Semantic Virtualization Enablers.

Note that, thanks to the aggregated semantic metadata provided by the Semantic Virtualization Enablers, all the control and management functionalities included in the Cognitive Enablers have a technology-neutral, multi-layer, multi-network vision of the surrounding Actors and Resources. So, the information enriched (fully cognitive) nature of the aggregated metadata which serve as Cognitive Enabler input, coupled with a proper design of Cognitive Enabler algorithms (e.g., multi-objective advanced control and optimization algorithms can be adopted), lead to cross-layer and cross-network optimization, as well as to the fulfillment of Actors' requirement through Applications.

It is worth noting that, thanks to its modular structure, the FI-CP can exploit one or more of the Cognitive Enablers in a dynamic fashion: depending on the specific scenario, the FI-CP can activate the needed Enablers in order to fulfill the Actors needs using the available Resources.

It should be clear that the proposed approach achieves **interoperability** among all the existing, available, heterogeneous Resources, Applications and Actors by means of the introduction of semantic virtualization. In addition, the **fully cognitive** nature of the proposed architecture allows to efficiently satisfy Actors' requirements. Furthermore, the proposed approach allows the **evolution** and the **adaptation** of the FI-CP to the changing needs of different usage scenarios: indeed, new Actors, Resources and Applications can be dynamically interfaced to the FI-CP and new or updated Cognitive Enablers can be dynamically added to the FI-CP, in a modular way, without affecting the continuity of operations.

In the context of the proposed approach, the University of Rome “Sapienza” can contribute with its expertise in the following aspects:

- **FI-CP architecture design**;
- **Cognitive Enablers design, simulation and implementation**:
  - **End-user access, adaptation and composition of resources** (experience acquired in FP6 DAIDALOS I, FP6 DAIDALOS II, FP7 P2P-Next, FP7 OMEGA projects),
  - **Service handling and SOA support** (experience acquired in FP6 DAIDALOS I, FP6 DAIDALOS II, FP7 MICIE, FP7 TASS, FP7 BRAVEHEALTH projects),
  - **Semantic support** (experience acquired in FP6 DAIDALOS I, FP6 DAIDALOS II, FP7 P2P-Next, FP7 MICIE projects),
  - **Identity, Privacy, Confidentiality** (experience acquired in FP7 TASS, FP7 MICIE, Artemis pSHIELD projects),
  - **Internet of Things** (experience acquired in FP7 MICIE, FP7 DLC+VIT4IP project),
  - **Connectivity** (experience acquired in FP6 DAIDALOS I, FP6 DAIDALOS II FP6 EuQoS, FP6 WEIRD, FP6 SATSIX FP7 OMEGA, FP7 MONET projects).