1 Abstract

Nowadays, information and communication technologies (ICT) offer everyone new opportunities to provide care and assistance. Ambient Assisted-Living (AAL) is a paradigm where technology is used as a way to improve the independence and welfare of aged or disabled people at their own homes. Most paradigms develop AAL architectures, which follow techno-centric approaches. The architecture presented and implemented during this project considers such aspects related to the AAL business model and broader range of AAL services, from welfare to recreation and occupation in life. Our focus is the **instantiation** of AAL architecture on a Cloud Computing infrastructure.

2 Introduction

Our aim, during this project, is to develop an architecture for an Ambient assisted living (AAL) ecosystem. AAL is an area in which assistance services, supported by Information and Communcation Technology (ICT), are provided to elderly and disabled people, in order to improve their independence and wellbeing. . In an AAL system, a number of sensors are attached and installed in their homes, in order to monitor their wellness. At important events, associated to the users' conditions, alarms are sent to care centers, allowing prompt assistance. The aim of our work is to instantiate an AAL architecture, that is presented in the next sections, on a Cloud Computing Architecture.

3 State of the art

As our focus is on developing AAL architecture, we present some definitions on the concept of architecture in the next topics and also describe the Cloud Computing paradigm.

3.1 Architecture concept

According to (*Camarinha-Matos and Afsarmanesh 2008*), an architecture can be seen as an abstract representation of a system, describing it structure, components, interactions, functionality and restrictions. These aspects are represented in specific levels of details, according to the considered type of architecture, ranging from conceptual to logical and physical ones. We can also consider reference, implementation, and physical architectures.

A conceptual architecture is one that is specified at the most abstract level, following a descriptive style and not committed to any specific implementation approach.

A **Reference architecture** is a conceptual architecture that aims at structuring the design of architectures for a given domain by defining a unified terminology. It describes the functionality and roles of components, providing template components, giving example architectures and providing a development methodology. It corresponds to architecture as a style or method that it may represent a coherent set of design principles to be used in a specific area. The reference architecture is the basis for designing specific architectures for particular instances of systems in the class of systems covered by the reference architecture. In order for a conceptual architecture to become a reference architecture, it needs to gather a wide acceptance (as an authoritative guide) by the target community. In this sense, establishing a reference architecture is outside the scope of AAL4ALL, namely due to its national focus. Therefore, the goal is rather to establish a conceptual architecture. However it aims to represent a reference at national level.

Implementation architecture is a relatively well detailed specification of a (n intended) system that gives specific guidance on how to implement that system. The use of this term is typically restricted to the "technical sub-systems" (software or hardware) and not to general socio-technical systems, like an AAL ecosystem.

A **Physical architecture** is a particular view of implementation architecture, giving a description of the "physical" components of the system and their interconnections.

3.2 Cloud Computing

Cloud computing environment is a model that enables conveniently on demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model promotes availability and it is composed by five essential characteristics, three service models and four deployment models (Mell, Grance, 2011).

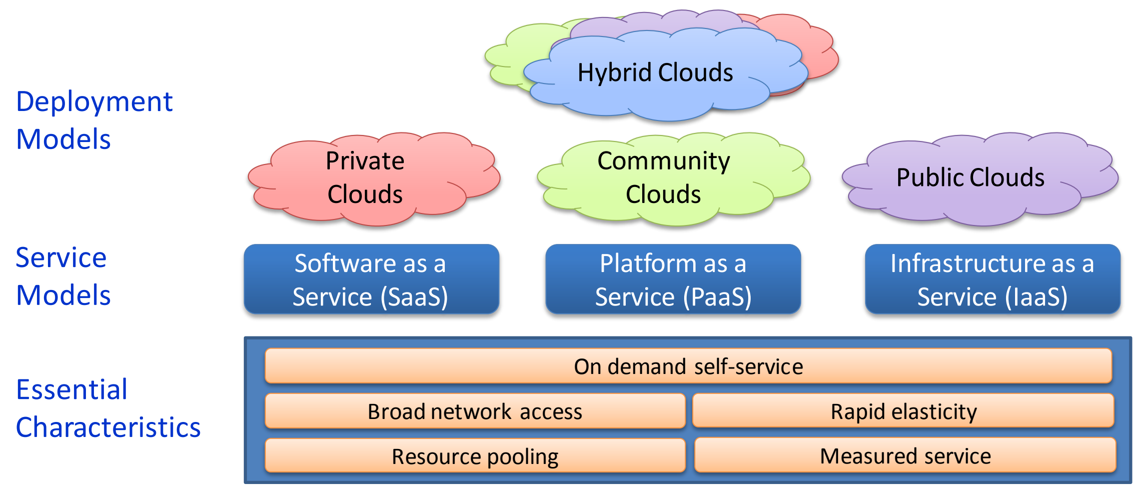
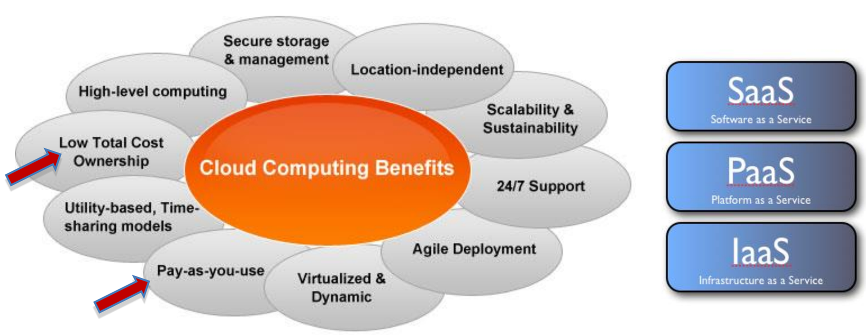


Fig. 1 Cloud Environment. Main typical features of Cloud Computing, from which faster development time and lower initial capital.



http://www.dotcominfoway.com/technology/cloud-computing

Fig. 2 – Computer Cloud Features

The next table exemplifies some of the announced benefits of Cloud and non-cloud approaches

EFFICIENCY	
Cloud Benefits	**Current Environment**
• Improved asset utilization (server utilization > 60-70%) • Aggregated demand and accelerated system consolidation (e.g., Federal Data Center Consolidation Initiative) • Improved productivity in application development, application management, network, and end-user	• Low asset utilization (server utilization < 30% typical) • Fragmented demand and duplicative systems • Difficult-to-manage systems
AGILITY	
Cloud Benefits	**Current Environment**
• Purchase "as-a-service" from trusted cloud providers • Near-instantaneous increases and reductions in capacity • More responsive to urgent agency needs	• Years required to build data centers for new services • Months required to increase capacity of existing services
INNOVATION	
Cloud Benefits	**Current Environment**
• Shift focus from asset ownership to service management • Tap into private sector innovation • Encourages entrepreneurial culture • Better linked to emerging technologies (e.g., devices)	• Burdened by asset management • De-coupled from private sector innovation engines • Risk-adverse culture

Table 1 Cloud Benefits (Source: (LIu et al., 2011))

4 Technical development

During this project we aim at instantiating an AAL architecture, described in (*Camarinha-Matos, Rosas etal., 2012*). The development starts by identifying the functional requirements of the AAL ecosystem architecture layer. As illustrated in the image below, the architecture is composed of several layers, being the last one the focus of our work:

- Support Infrastructure Layer
- Care and Assistance Services Layer
- AAL Ecosystem layer

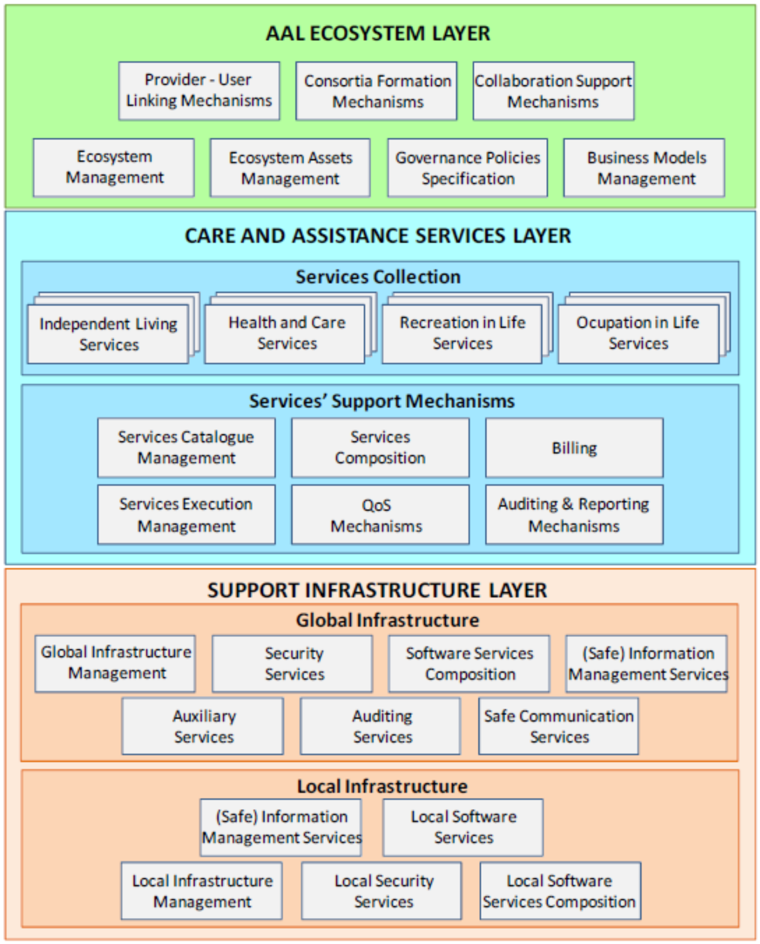


Fig. 3 AAL4ALL conceptual architecture

The Support Infrastructure layer plays the role of a facilitator (provides support) for the development and delivery of care and assistance services. Such infrastructure should provide, among other functionalities, channels and mechanisms for safe communications and information sharing and exchange among the members of a given AAL ecosystem. It has two sub-layers, the local infrastructure (Fig.4), corresponding to the support infrastructure located in a specific "location", e.g. users' home, care center, health care center, human-centered environment (intelligent cloth, mobile gadgets, etc.); and the global infrastructure supporting the network of "spaces" (or local environments) "inhabited" by the various stakeholders.

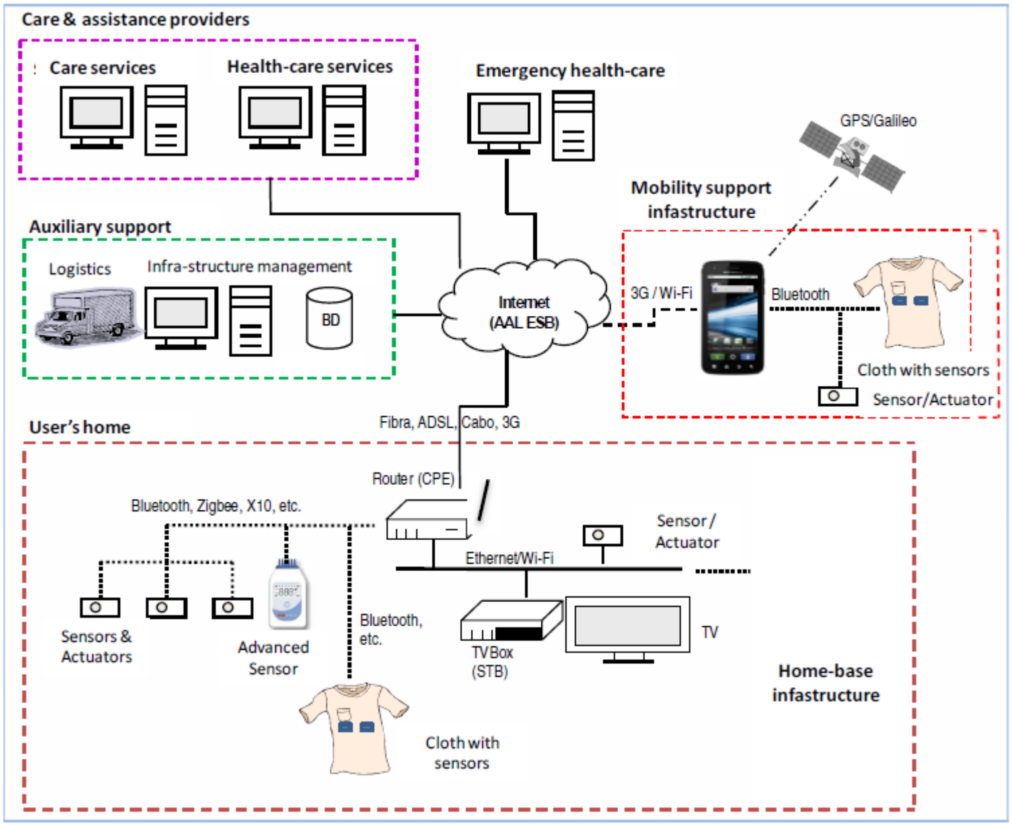


Fig. 4 Example of a local Infraestruture

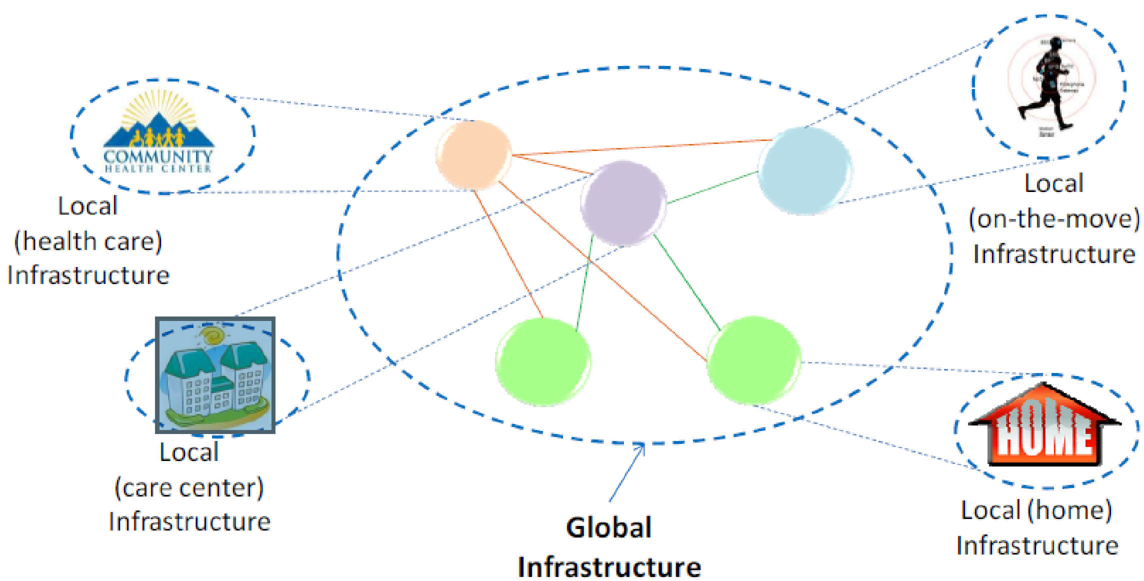


Fig. 5 - Representation of a global Infrastructure composed by several local infrastructures.

The intermediate layer - **Care and Assistance Services** - provides functionalities for managing and making available an open collection of services (care and assistance services). This layer of the architecture considers an open and scalable collection of services, allowing for easy plug ability of future developments. To facilitate the organization and management of the collection, services are divided into four groups according to the four life settings of Independent:

1. Living (IL)
2. Health and Care in Life (HL)
3. Occupation in Life (OL)
4. Recreation in Life (RL).

Lastly, the top layer of the architecture - **AAL Ecosystem** - provides organization, governance, and collaboration support for the AAL multi-stakeholders from a socio-technical perspective.

The technical development will be focused in the ecosystem layer, more specifically on the ecosystem management, assets management and consortia formation components of this architecture's layer. Some of the functionalities that we aim to develop are the assistance services management, service providers management and users management. We started developing basic use cases for these components, such as:

- Management of assistance services (insert, delete, update, consult, …)
- Management of service providers (insert, delete, update, consult, …)
- Management of users who need care (insert, delete, update, consult, …)
- Management of services subscription (by users who need assistance)
- Definition of tailored packages of assistance services (as small services list for attending specific users needs).

- Catalogue management of assistance services, according to a basic preset of classification, namely in terms of mentioned life-settings (IL, HL, OL, RL).
- Consortia formation of providers for delivering tailored packages of assistance services
- Services life-cycle management (e.g.: monthly billing, home interventions …)

Our development approach is based on the Cloud Computing paradigm, as illustrated in Fig.6 in order to benefit from the advantages mentioned in the previous section.

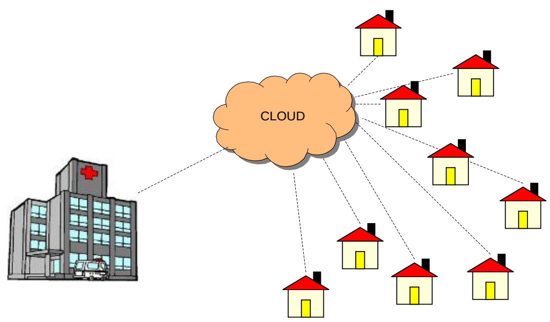


Fig. 6 Cloud Computing for supporting the AAL ecosystem

5 Work plan

Week 1

Specification of functional requirements of the ecosystem level for proposed architecture. This is done through the utilization of the ArchiMate specification language ((The Open, 2009)); design of the database model for supporting the ecosystem; design of adequate user interfaces.

Week 2

Implementation in a Cloud Computing platform, e.g. windows Azure of the ecosystem components. This comprises the implementation of the data model, the architecture components specified in the previous week, and adequate user interfaces.

Week 3

Continuation of work

Week 4

Execution of the developed ecosystem and public presentation.

6 Team profile

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Bibliography

Camarinha-Matos, L., J. o. Rosas, A. Oliveira and F. Ferrada (2012). "*A Collaborative Services Ecosystem for Ambient Assisted Living.*" Collaborative Networks in the Internet of Services: 117-127.

Camarinha-Matos, L. M. and H. Afsarmanesh (2008). "*On reference models for collaborative networked organizations.*" International Journal of Production Research **46**(9): 2453-2469.

Liu, F., Tong, J., Mao, J., Bohn, R., Messina, J., Badger, L., & Leaf, D. (2011). NIST Cloud Computing Reference Architecture. *NIST Special Publication*, *500*, 292.

Peter Mell, Timothy Grance (2011). *The NIST Definition of Cloud Computing*, Special Publication 800-145, http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf.

The Open, G. (2009). ArchiMate 1.0 Specification, Van Haren Publishing.