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FIT4WORK

SELF-MANAGEMENT OF PHYSICAL AND MENTAL FITNESS OF OLDER WORKERS

CO-FUNDED BY

PARTNERS

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AAL middleware specification

Ambient Assisted Living Joint Programme project no. AAL-2013-6-060

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1. Introduction

1.1. Fit4Work

The Fit4Work project aims at delivering an innovative system capable of detecting, monitoring and countering physical and psychological stress related to professional occupation of older adults. To this end the project will build on top of a combination of state-of-the-art ICT, including such advanced technologies as 3D motion sensing, wearable wellness sensors, ambient sensors, mobile devices, AAL middleware and cloud services. These off-the-shelf technologies will be extended with specialized components able to collect, store and analyze physical and mental fitness related information in order to provide personalized recommendations and exercises through intuitive user applications. From the point of view of end users, the resulting product is a light-weight coupling of non-distracting devices with a smartphone equipped with a 3D motion sensor and a watch-like wellness sensor forming the core of the personal wellness network.

The service provided this way makes it possible to continuously monitor oneself at work and manage one's own fitness thanks to highly motivating training participation scheme. As a result, Fit4Work supports increase in quality of life for end users and their health-related fitness, thus making them more eager to actively participate in their work. High quality of the proposed service model is ensured through collective expertise of the project consortium and through the fact that Fit4Work developments are driven by end user participation at all stages of project implementation. In Fit4Work end users define initial requirements, continuously support technological teams with their expert knowledge on ICT usability for older adults, validate the system prototypes in two pilot trials and provide input for the market analysis leading to elaboration of a detailed business model. These users act as representatives of the target group of Fit4Work solution users, which includes most persons aged 55 and more, actively occupied in paid and voluntary settings.

1.2. AAL middleware

Ambient Assisted Living is a concept where the environment aids people in their everyday lives, and is related to the following goals (AAL Programme) :

- extending the time people can live in their preferred environment by increasing their autonomy, self-confidence and mobility;
- supporting the preservation of health and functional capabilities of the elderly,
- promoting a better and healthier lifestyle for individuals at risk;
- enhancing security, preventing social isolation and supporting the preservation of the multifunctional network around the individual;
- supporting careers, families and care organizations;
- increasing the efficiency and productivity of used resources in the ageing societies.

In the context of ICT solutions, those goals can be reached through a set of services working in cooperation within the immediate surroundings of where people live, work and otherwise spend their time. Fit4Work and other AAL services create smart spaces allowing their inhabitants to, in a very broad sense, function more independently.

The wide scope of aforementioned goals results in a very large number of possible ICT solutions, created by multiple vendors. In order to increase the value and functionality provided by smart AAL spaces hosting those solutions, the need for a communication framework between separate services arises. Such an AAL middleware framework allows various independent services to seamlessly exchange information about the environment, in order to provide a more intelligent space, by giving them a platform on which to build their integration.

The current report discusses the role of AAL middleware in the context of the Fit4Work system development and deployment in Section 2. Section 3 presents the general assumptions concerning integration of the Fit4Work system within AAL environments. Finally, Section 4 describes the possibilities of integrating Fit4Work within AAL environments working under control of the leading AAL middleware framework – UniversAAL.

2. AAL middleware framework in Fit4Work

2.1. Basic definition and role

As previously defined, AAL middleware constitutes an integration framework between Fit4Work and other potential AAL services present in the user space, binding them into one smart environment working towards aiding the user (see Figure 2.1). Such integration framework would allow Fit4Work to share its contextual information - for example, user mental or physical stress levels - with other external services that can incorporate this knowledge into their workflows and change their behavior to minimize further user stress. Conversely, Fit4Work can also use additional information obtained from other services in its operation.

This kind of integration should also be very flexible and, because of a potentially large number of user space AAL services, should not relay on static APIs defined by those services.

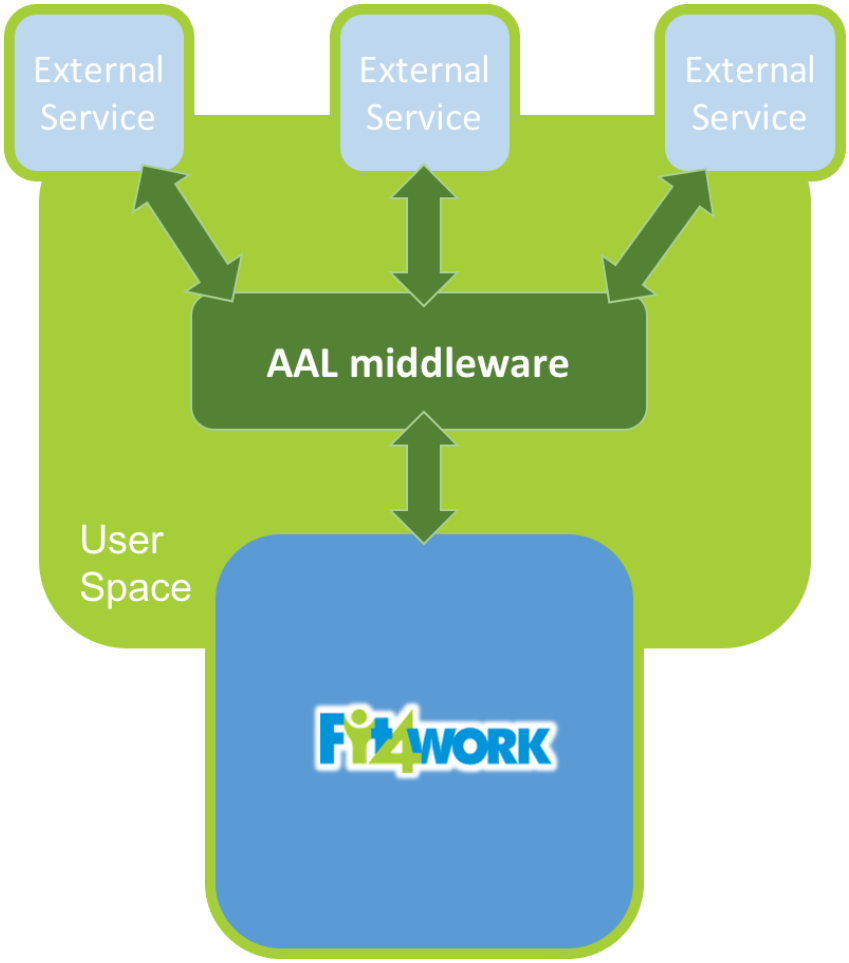

Figure 2.1 AAL middleware role in Fit4Work

What is important to note in this respect, the AAL middleware can be employed as a software framework allowing a loosely coupled integration between Fit4Work and other user space services, and specifically does not have to be used for implementing internal integration of various Fit4Work components.

2.2. universAAL

The universAAL framework (universAAL Project, 2013; universAAL Project, 2016) has been chosen as the recommended AAL middleware framework satisfying above mentioned goals and requirements (Figure 2.2).

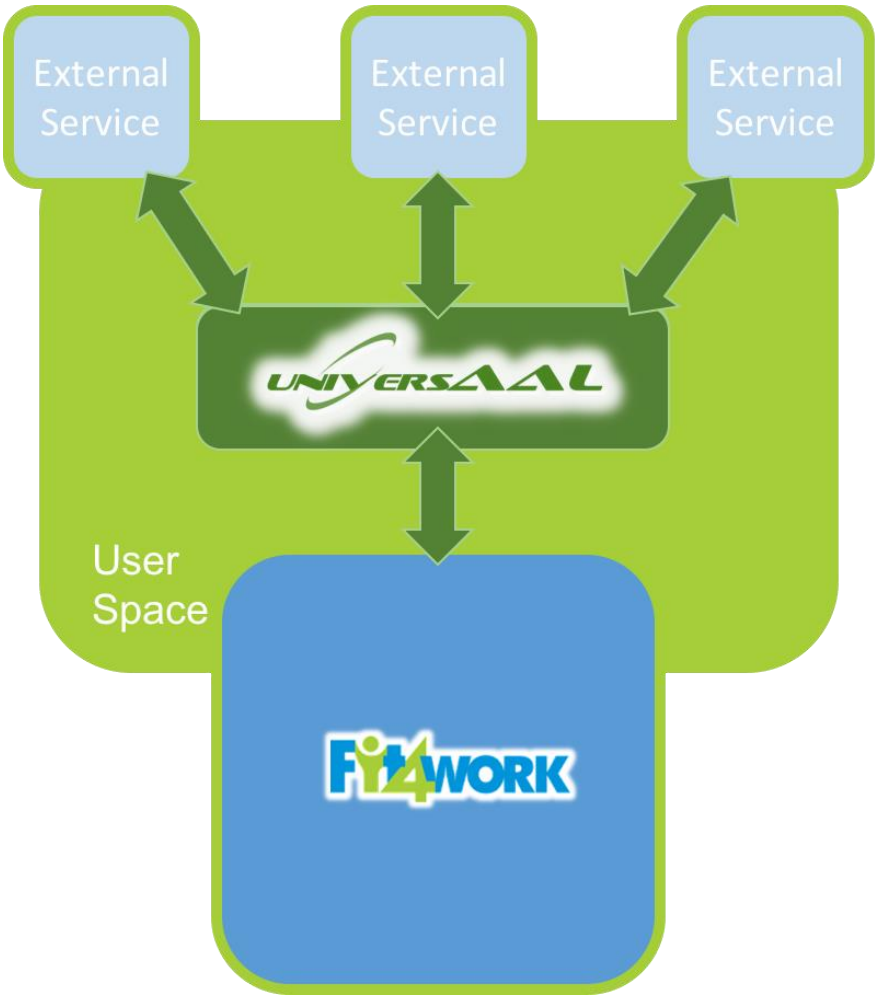

Figure 2.2 universAAL as the AAL middleware in Fit4Work

2.2.1. Introduction

UniversAAL middleware is an open source software framework, part of an AAL platform resulting from an FP7 EU project with the same name. It is based on previously conducted work, extending earlier FP6 and FP7 projects such as Persona, Oasis, M.Power, Genesys and others.

The middleware defines the notion of an AAL Space (i.e. user space), a virtual space within which AAL applications are running:

"AAL Space is a smart environment centered on its human users in which a set of embedded networked artefacts, both hardware and software, collectively realize the paradigm of Ambient Intelligence, mainly by providing for context-awareness and personalization, reactivity, and pro-activity" (Gil, 2015) .

The main role of universAAL middleware is to establish seamless peer-to-peer communication between physical devices (called nodes) running universAAL enabled applications in an AAL Space (see Figure 2.3.). It's composed of the following basic building blocks:

- A container running on each of the nodes (e.g. PCs, embedded systems or mobile devices)
- Communication channels - application level purpose-specific communication buses (Context, Service and User Interaction) using ontologies as the means of describing shared information
- Peering mechanism - providing physical connection and low level communication between nodes

UniversAAL has been chosen as the AAL middleware solution in Fit4Work mainly for the following reasons:

- It offers rich functionality - e.g. encapsulation of low level communication over different networking protocols, set of low level support applications called Managers, such as Context History Entrepot providing history of events within the current space, or Situation Reasoner allowing composition of high level events based on a set of rules and conditions
- It is fully open sourced
- It is heavily supported by the EC and moving towards becoming a standard for AAL solutions developed in EU projects (European Comission, 2015a; European Comission, 2015b)

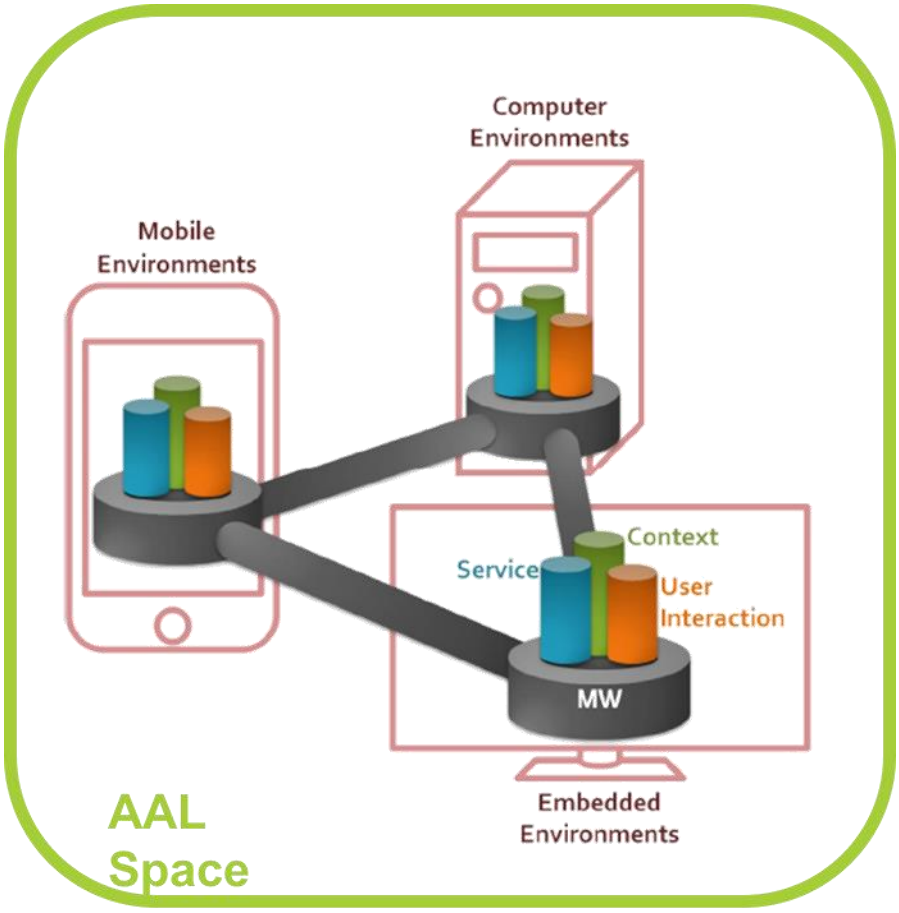

Figure 2.3 UniversAAL middleware architecture

2.2.2. Communication buses

Communication buses constitute the backbone of the universAAL middleware. From the point of view of universAAL enabled applications all communication between them is facilitated by three communication buses as presented in Figure 2.4:

- The Context Bus
- The Service Bus
- The User Interaction Bus (UI Bus)

Context Bus

The Context Bus is used for sharing state - i.e. sharing knowledge about the AAL Space environment. Communication over this bus is event based, with Context Events sent by Context Publishers and consumed by Context Subscribers.

Service Bus

The Service Bus is responsible for sharing access to services - i.e. sharing functionality within the AAL Space. The communication over this bus is request/response based, with Service Callees (service providers) and Servicer Callers (service clients).

User Interaction Bus

The User Interaction Bus is responsible for sharing information related to active user interaction (for example when the user is required to directly enter some information about them). This interaction is also request/response based with UI Callers requesting specific information and UI Handlers being able to obtain this information from the user.

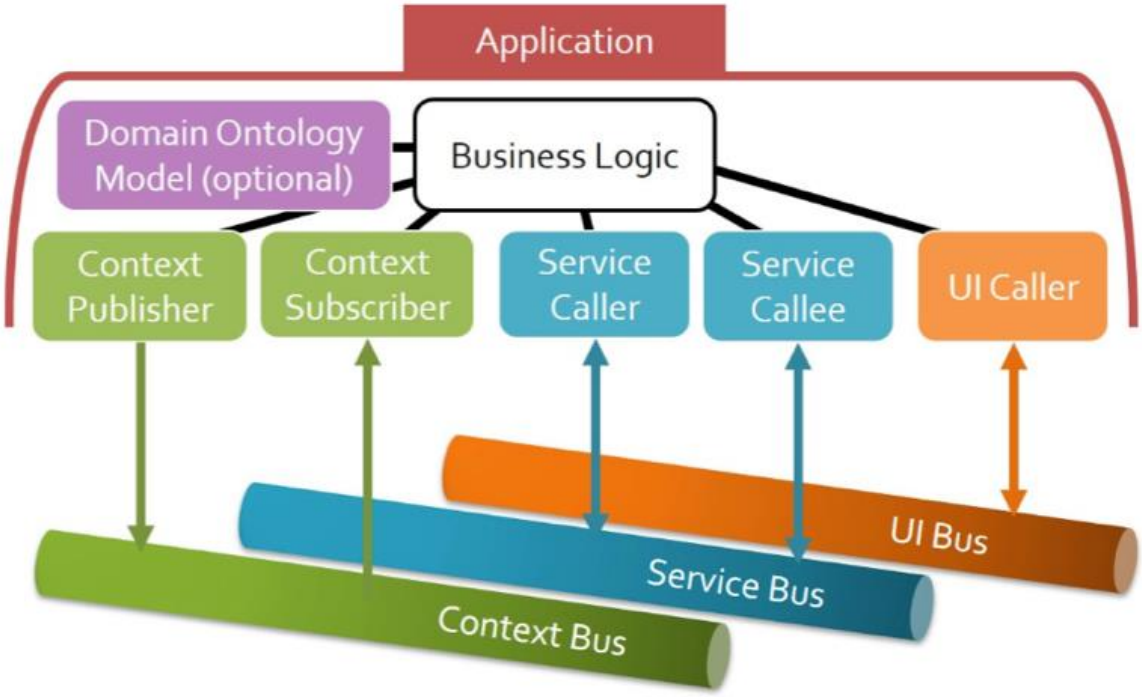

Figure 2.4 universAAL communication buses

2.2.3. Ontologies

All aspects of knowledge sharing within universAAL use ontologies (Figure 2.5). Ontologies are a way of representing information about the physical world, so that it can be understood by computers. They, essentially, take the form of a network of concepts linked by properties.

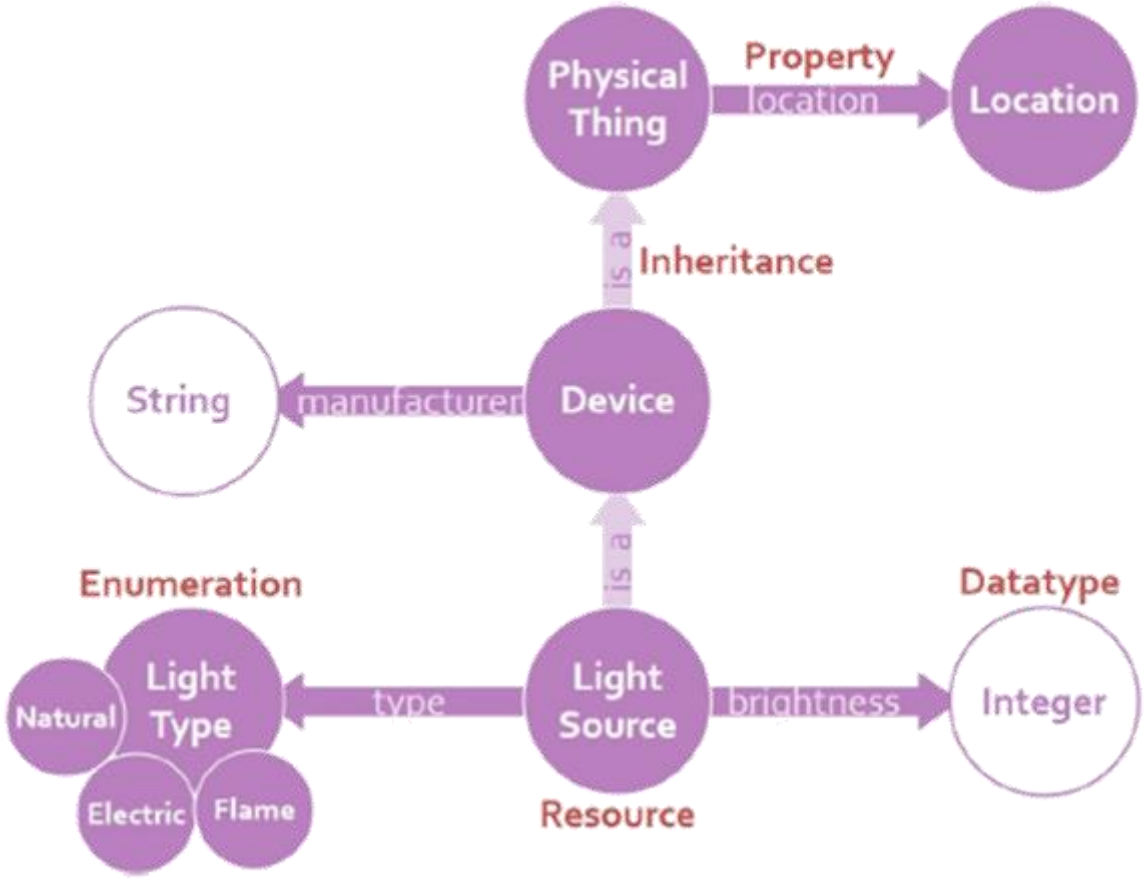

Figure 2.5 Ontologies are the information model in universAAL

The main advantage of using ontologies is that they allow a very high degree of flexibility of interaction in a very dynamic environment of universAAL applications. Once all applications running within the AAL Space agree on the same definition of certain ontologies, service requests that quite literally say “turn the light on in the kitchen” (instead of “turn on the light with specific ID”) become possible, without the need for the service requester to know what application implements the light controls in the kitchen, or how it’s being done.

The universAAL platform comes with a set of predefined ontologies (universAAL Project, 2015a), but it also allows creating and using custom ontologies and provides tools (universAAL Project, 2015b) for building them.

3. Fit4Work system in context of AAL Space

Fit4Work can be viewed as one of many applications running within an AAL Space. It is continuously monitoring the user in order to provide them with timely recommendations relating to their physical and mental health. These recommendations are based on complex analysis performed within Fit4Work, the results of which can be shared with other AAL applications. Some of the information needed to perform the analysis can also be contributed from those external AAL applications.

3.1. Fit4Work as consumer and provider

The following is a general list of information consumed by Fit4Work in order to provide its services:

- user heart rate
- user energy expenditure
- user galvanic skin response
- ambient noise level
- ambient illumination level
- ambient air temperature
- ambient humidity
- ambient air quality

The above will be provided by various sensors deployed as part of the Fit4Work system, therefore it can not only be directly consumed by Fit4Work services, but also provided as contextual knowledge within an AAL Space.

The information gathered about the user is analyzed by Fit4Work and turned into actionable recommendations, conclusions or other information potentially sharable with AAL applications. The following are examples of those:

- user daily activity goal has been reached
- user physical stress has been detected
- user physical stress has been relieved
- user is performing a physical exercise
- user activity type is walking/running/sitting etc.
- user mental stress has been detected
- user mental stress has been relieved
- user is performing a mental stress relief exercise
- user is performing a physical exercise

4. UniversAAL within Fit4Work

4.1. Events and services

UniversAAL can be used to share contextual knowledge with other AAL applications in form of Context Events corresponding to events triggered within Fit4Work. In this sense, Fit4Work can function as a provider of context to other external AAL applications, or conversely, as a consumer of context provided by those applications.

Fit4Work as a provider

Below is a list of proposed events sharable within an AAL Space with other potential AAL applications:

- User inactivity has been detected
- User is active
- User daily physical activity goal has been reached
- User mental stress has been detected
- User mental stress has been relieved
- User is performing a physical exercise
- User is performing a mental stress relief exercise
- Ambient noise level is high
- Ambient noise level is back to low
- Ambient temperature is high
- Ambient temperature is back to normal
- Ambient air quality is low
- Ambient air quality is back to normal
- Ambient light level is low
- Ambient light level is back to normal

Fit4Work could also provide services allowing external AAL applications to request certain information, such as:

- User information service providing:
  - Stress level
  - Current activity type

- User environment service providing:
  - Environment comfort score

This is a preliminary list of events and services which could be narrowed down or otherwise modified during the course of further development and implementation of the Fit4Work system depending on which of those events are deemed most useful in combination with scenarios providing greatest value to the user.

Fit4Work as a consumer

Fit4Work can also subscribe to all of the above contextual events. Specifically, any additional information useful in determining user physical and mental comfort could be useful to Fit4Work - for example, additional ambient environment status coming from sensors not provided by Fit4Work.

The specifics of this type of integration will also be developed at a later stage of the project, based on external services available for integration.

4.2. Ontologies

UniversAAL comes with a set of ontologies (universAAL Project, 2015a) that can be useful from the point of view of Fit4Work. Those ontologies, however, are not fully sufficient and will have to be extended to include entities defined and used by the Fit4Work system.

Below is a list of ontologies available in universAAL that will potentially be used by Fit4Work.

Health related ontologies:

- ont.health.measurement: Health-specific measurements,
  - blood pressure
  - person weight
  - blood oxygen saturation
  - heart rate
- ont.measurement: Measurement concepts
  - measurement
  - signal
  - measurement error
- ont.personalhealthdevices: Health-related sensors for personal use.
  - blood oxygen saturation sensor
  - blood pressure sensor
  - heart rate sensor
- ont.profile.health: User's Health subprofile, and concepts like illness
  - treatment
  - treatment planning
  - measurement requirements
  - privacy
- ont.health.disease: Diseases and illnesses
- ont.medication: Medication
  - drug package
  - pill dispenser

General ontologies:

- ont.languages: Languages (based on ISO 639 codes, contains representation for 182 languages.
- ont.phWorld: Basic concepts of the physical world

    - location
    - place
    - way (path)
    - building level
    - corridor
    - home
    - room
- ont.profile: All Profiles: Users, AAL Services, AAL Spaces...
    - user
    - caregiver
    - *and others*
- ont.security: Authentication and authorization login security
- ont.multimedia: Multimedia appliances
    - stereoset
    - TV

4.3. General architecture

4.3.1. Assumptions and approach.

In terms of Fit4Work architecture, it is planned to implement the AAL Space integration with other universAAL enabled services through a component called AAL Connector. The role of the AAL Connector is to translate and relay messages between the Fit4Work system and the AAL environment. On the one hand, it will receive messages from within the Fit4Work system, in a protocol and format defined in the course of developing Fit4Work, and on the other hand it will convert those messages into a format specified by the universAAL framework, using appropriate universAAL APIs. This translation process can work in both directions.

The basic architectural assumptions for the use of AAL Connector within Fit4Work are:

- AAL Connector is not a critical communication component within FIt4Work - i.e. if it fails, the Fit4Work system will still work from the point of view of its user
- UniversAAL framework is used for integration with other, external AAL services within the AAL Space, and specifically not for integration between internal Fit4Work components
- AAL Connector forwards selected events associated with the user or their environment, through the universAAL's Context Bus, and possibly provides services through the Service Bus
- Currently, there are no plans to use the universAAL UI Bus

This approach has the following benefits:

- It makes it possible to work independently on integration between internal Fit4Work components and on integration between Fit4Work and other AAL Space services
- It provides a single point of integration between the AAL Space and Fit4Work
- It makes it possible to gradually introduce a deeper integration with the AAL Space while universAAL and Fit4Work as solutions mature and the development team's knowledge and experience with using universAAL grow
- It is compliant with the AAL Space model
- It significantly lowers the complexity, risks and implementation cost involved with internal Fit4Work communication (when compared to the case of using universAAL for all Fit4Work internal communication)

4.3.2. Logical architecture.

In this section, we present the logical Fit4Work architecture from the point of view of integrating it with other AAL services working within an AAL Space. Figure 6. shows a diagram of this integration and reference the Fit4Work architecture defined in *D5.1 System Architecture Definition* (Carjan et al, 2016) .

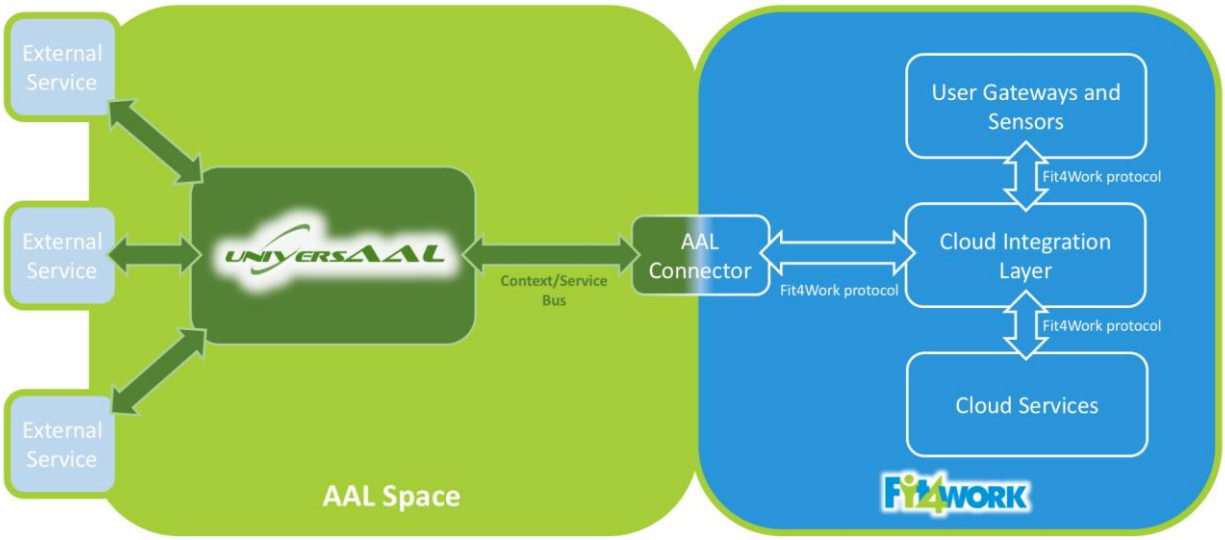

Figure 4.1 Fit4Work and AAL Space integration architecture

The following sections describe components shown in Figure 4.1:

AAL Space

Virtual space within which a series of intelligent AAL applications or services are present and work towards aiding the user. Those services can communicate with each other using an AAL middleware, in this case the universAAL framework.

External Service

AAL service or application present in the AAL Space with which Fit4Work could potentially integrate through the universAAL framework using universAAL middleware communication buses (Context, Service and UI Bus).

AAL Connector

Fit4Work service functioning as a connection point or integration layer between Fit4Work services and other AAL services. The AAL Connector exposes selected Fit4Work information or functionality to the AAL Space containing multiple AAL services and applications.

User Gateways and Sensors

User gateways are devices running Fit4Work applications (e.g. a mobile phone or desktop computer). They provide the user with means of interacting with the Fit4Work system (including receiving personalized recommendations from the system) and relay information from the sensors present in the user environment to the Fit4Work system.

The sensors include a user activity sensor (measuring user's physical and mental activity) and environment sensors (measuring such parameters as temperature, air quality, noise, humidity etc.). The sensors provide contextual information and raw data about the user to the Fit4Work system. This information is then analyzed by the applications running on user gateways and also sent for further processing and storage purposes to Fit4Work Cloud Services.

Cloud Services

Backend Fit4Work services performing analysis of data coming from user gateways and sensors and providing recommendations based on this analysis. Those services also include long term data storage and synchronization between user's mobile and desktop applications, as well as other auxiliary services.

Cloud Integration Layer

This is the primary integration layer between different Fit4Work components, described in detail in *D5.3 Cloud Services Specification*. This layer functions as a central integration hub for the Fit4Work system, allowing easy communication between Fit4Work user gateways and their applications and various Fit4Work Cloud Services.

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5. Summary

Fit4Work is a system which combines monitoring of user's physical and mental activities, as well as monitoring of their work environment parameters into one intelligent solution providing the user with personalized recommendations based on this collected information. The goal of those recommendations is to maintain or improve overall health and fitness of the user. In the process of providing its features, the Fit4Work system can share its findings with other, third party AAL solutions to further increase positive impact on the user's well-being.

In order to facilitate this kind information sharing, an AAL middleware solution has been adopted and based on the universAAL framework. The universAAL framework provides a highly flexible and advanced middleware allowing loosely coupled integration of multiple AAL applications into one smart user environment through the use of ontologies.

General strategy and scenarios for integrating Fit4Work with other AAL services using the universAAL middleware have been described in sections 3 and 4 of this document. Specifics of those scenarios are planned to be devised and verified based on tests of the Fit4Work solution with end users. Detailed technical aspects of the integration are also planned to be developed at a later stage once specific interfaces between Fit4Work system components and technologies for those interfaces have been established.

6. References

AAL Programme. (n.d.). *Objectives.* Retrieved 2016, from AAL Programme, Active And Assisted Living: http://www.aal-europe.eu/about/objectives/

Carjan, C., Mitrea, A., Neagu, C., Lustrek, M., Cvetkovic, B., Franco, O., . . . Kosiedowski, M. (2016). *System Architecture Definition.* Fit4Work project report.

European Comission. (2015a, October 14). *TOPIC : EU-Japan cooperation on Novel ICT Robotics based solutions for active and healthy ageing at home or in care facilities*. Retrieved from European Comission, Research & Innovation: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2433-sc1-pm-14-2016.html

European Comission. (2015b, October 14). *TOPIC : Large Scale Pilots*. Retrieved from European Comission, Research & Innovation: http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2223-iot-01-2016.html

Gil, A. M. (2015, May 25). *universAAL UI Wiki.* Retrieved from universAAL Github: https://github.com/universAAL/ui/wiki

universAAL Project. (2013). *The universAAL Primer, Advanced*. Retrieved from universAAL Developer Depot: http://depot.universaal.org/Documents/The%20universAAL%20Primer%20-%20Advanced.pdf

universAAL Project. (2015a, July 1). *universAAL Ontology Wiki*. Retrieved from universAAL Github: https://github.com/universAAL/ontology/wiki

universAAL Project. (2015b, September 21). *universAAL Tools Wiki*. Retrieved from universAAL Github: https://github.com/universAAL/tools/wiki

universAAL Project. (2016). *universAAL.* Retrieved from universAAL Project: http://www.sintef.no/universaal