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D5.4 Improved Integrated System and Test Sites Deployment

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Disclaimer:

No confidential material is included therein.

Deliverable Summary

This document reports on the improved integrated system at M30 and its deployment at fifteen test sites.

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1 Introduction

1.1 Scope of the document

The document describes the deployment of the improved version of the GiraffPlus system in the fifteen test sites, five per country (Sweden, Italy, and Spain). This document covers a brief description of the test sites, and the characteristics of the version of the GiraffPlus system installed at M30. The selection criteria considered, as in the first deployments comes from the results of task 6.2, while the deployment procedure and management was described in D5.3.

1.2 Deliverable structure

The document is structured in four parts:

Section 2 provides a brief description of the test sites deployed in this final stage of the project.

Section 3 and 4 present the improved version of the GiraffPlus system installed in the described testsites, detailing the main hardware and software components considered.

Finally, section 5 outlines the script of the video, which is part of this deliverable, demonstrating the usage of the system in a particular case.

1.3 Deviations with respect to the plan

This deliverable underwent a two weeks delay due to the difficulties and needed logistics for shooting the video in a real testsite.

2 Test sites description

In this section the new testsites deployed by M30 are described. The previous deployments carried out by M18 have been kept and maintained, although some of them has dropped out for different reasons, and then they have been substituted by others.

2.1 Test sites in Sweden

During this period four new test sites have been deployed in Sweden. Testsite number 1 chose to not participate in the project due to worsening of health problem. All test sites are situated in the city of Örebro. All participants have normal cognitive status (as tested with the Mini-mental state examination) and no one have depressive symptoms (as tested with the GDS-15). The test sites are described here:

Testsite 2 (SE2):

- Location: Örebro (Sweden)
- Primary user:
  - Man 82 years old.
  - Medical condition:
    - post stroke,
    - decreased balance and uses a rolling walker indoors and electric scooter outdoors.
- Secondary users:
  - gealth professionals (physical therapist and occupational therapist).
  - 3 sons who live in the same city,
  - grand children.
- Living conditions:
  - Living alone in an apartment (moved in may this year). 2 room apartment.

Testsite 3 (SE3):

- Location: Örebro (Sweden)
- Primary user:
  - Woman 80 years old.
  - Medical condition:
    - post stroke, decreased balance and uses a rolling walker outdoors.
- Secondary users:
    - health professionals (physical therapist and occupational therapist),
    - 2 daughters, and
    - 1 grand son living in Örebro
- Living conditions:
  - Lives alone in an apartment, 3 rooms.

Testsite 4 (SE4)

- Location: Örebro (Sweden)
- Primary user:
  - Man 78 years old
  - Medical condition:
    - post stroke,
    - chronic obstructive lung disease,
    - heart infarction.
    - decreased balance and uses a rolling walker outdoors. Has fallen several times.
  - Secondary users:
    - health professionals (physical therapist and occupational therapist),
    - wife (they live separately) living in Örebro
- Living conditions:
  - Lives alone in an apartment, 2 rooms.

Test site 5 (SE 5)

- Location: Örebro (Sweden)
- Primary user:
  - Woman 73 years old
  - Medical condition:
    - post stroke,
    - diabetes,
    - decreased balance and uses a rolling walker outdoors.
  - Secondary users:
    - nurse at the primary health care centre,
    - 1 daughter living in Örebro.
- Living conditions:
  - Lives alone in an apartment, 2 rooms

Test site 6 (SE 6)

- Location: Örebro (Sweden)
- Primary user:
  - Woman 75 years old
  - Medical condition:
    - some decreased vision
  - Secondary users:
    - health professionals (physical therapist and occupational therapist),
    - 1 son living abroad,
    - 1 son living in a city nearby, and
    - 1 brother living in a city about 200 km away.
- Living conditions:
  - Lives alone in an apartment, 2 rooms.

2.2 Test sites in Italy

In this period, three new test sites have been deployed in Italy. Additionally one of the previously installed test sites is still running. All Italian test sites are in Rome.
Overall four active tests sites are currently running while one of the first two installed (IT2) dropped out last April. In this case, the PU actually preferred a personal relation with her caregivers and friends who live closely, so she found the use of the technology not needed. Currently, an additional effort is being carried out to select another candidate.
Below we report the description of all recruited test sites. The recruitment has been done according to the selection criteria agreed by the medical part of the consortium, excluding psychiatric disease and cognitive impairment.

Test site IT1

- Location: Roma Testaccio
- Primary user:
    - Women (94 years old). Widow. Living alone
    - Medical history:
        - high blood pressure
        - mobility problems
        - emphysema
        - walking problems (help with tutor) - She never goes out of the house because too hard to use the stairs and to walk in the street. Twice a week she receives helps from an organization connected to the municipality for shopping and house keeping tasks. Her caregivers are the nephews and her daughter.
- Secondary users:
    - medical doctor
    - psychologist
- Living conditions:
    - apartment: 1 bedroom, a living room, a bathroom, a kitchen.

Test site IT2 (Dropped out)

- Location: Roma San Giovanni
- Primary user:
    - Women (93 years old). Widow. Living alone
    - Medical history:
        - low blood pressure
        - arthrosis
        - problems with physical limitations
- Secondary users (She has 4 children. The real caregivers are one son and one daughter):
    - medical doctor
    - psychologist
    - 2 children
- Living conditions:
    - apartment: bedroom, a living room, a dining room, a bathroom, a kitchen.

Test site IT3

- Location: Roma Portuense
- Primary user:
  - Women (80 years old). Widow. Living alone
  - Medical history:
    - ictus episode,
    - renal insufficiency,
    - neuropathy,
    - mobility problems with serious physical limitations
- Secondary users (She has 1 children. The real caregiver):
  - psychologist
  - medical doctor
  - her son
  - **1 additional medical doctor** (family practitioner) has been recently contacted to be involved in the study
- Living conditions:
  - 2 bedrooms, a living room, a bathroom, a kitchen, a guest room.

Test site IT4

- Location: Roma Porta di Roma
- Primary user:
  - Women (72 years old). Divorced. Living alone
  - Medical history:
    - previous ischemic heart disease
    - angina pectoris
    - high blood pressure
- Secondary users (She has 2 children (one adopted):
  - medical doctor
  - psychologist
  - son
  - operators of a remote assistance organization
  - **1 additional medical doctor** (member of the remote assistance organization) has showed his availability to be involved in the study
- Living conditions:
  - apartment: bedroom, a living room with a kitchen corner, a bathroom.

Test site IT5

- Location: Roma Monteverde
- Primary user:
  - Women (80 years old). Widow. Living alone
  - Medical history:
    - high blood pressure

- Secondary users (She has 2 children (male and female):
    - medical doctor
    - psychologist
    - son
    - **1 additional medical doctor** has showed his availability to be involved in the study
- Living conditions:
    - apartment : 1bedroom, 2 living room, a bathroom, a kitchen.

2.3 Test sites in Spain

In this period, four new testsites have been deployed in Spain, since the primary user of one of the testsites described in D5.3 (Spanish testsite 1) finally could not participate in the project due to a worsening in his medical problems. Next we report the description of the total testsites (5) already deployed and running in Spain:

Test site 1 (the previous Test site 2 in D5.3; its description is included here for the convenience of the reader).

- Location: Estepona (Malaga)
- Primary user:
    - A man (82 years old).
    - Medical history:
        - high blood pressure
        - high Cholesterol
        - type 2 Diabetes Mellitus
        - stomach and prostate problems, on medical treatment.
- Secondary users:
    - medical doctor
    - practice nurses
    - community nurse
    - 2 children and one granddaughter, living in the same town
    - 1 sister, living 600 Km away
    - 1 granddaughter living 100 km away
- Living conditions:
    - 2 bedroom apartment with a bathroom, a kitchen and a living room.

Test site 2

- Location: Torrequebrada, Benalmádena (Malaga)
- Primary user:
    - A man (76 years old).
    - Medical history:
        - angina
        - diverticulitis

- Secondary users:
    - medical doctor
    - 1 daughter living abroad
    - 2 friends that live nearby

- Living conditions:
    - 2 bedroom house with 2 bathrooms, a kitchen and a living room.

Test site 3

- Location: Arroyo de la Miel, Benalmádena (Malaga)
- Primary user:
    - A woman (85 years old).
    - Medical history:
        - fluctuating blood pressure
        - mobility problems (one hip removed as a child, now the other one is giving her problems)
        - stent implanted
- Secondary users:
    - medical doctor
    - 1 friend living nearby
    - community nurse
    - 1 niece living in UK
- Living conditions:
    - 2 bedroom house with a bathroom, a kitchen and a living room.

Test site 4

- Location: Málaga.
- Primary user:
    - A man (79 years old).
    - Medical history:
        - high blood pressure
        - high Cholesterol
        - type 2 Diabetes Mellitus
        - stent implanted
- Secondary users:
    - medical doctor
    - 1 friend living abroad
    - 1 son living in the same town
- Living conditions:
    - 1 bedroom apartment with bathroom, a kitchen and a living room.

Test site 5

- Location: Málaga
- Primary user:
    - A woman (82 years old).
    - Medical history:
        - fluctuating blood pressure
        - peacemaker
        - osteoporosis
        - arthrosis
        - sleeping problems
        - psoriasis
        - an ictus several months ago, in treatment with Adiro
- Secondary users:
    - medical doctor
    - 1 daughter living in other town 100 km away but working nearby
    - 1 son and several grandchildren living in other towns
    - 1 grandson living abroad
- Living conditions:
    - 2 bedroom flat with 2 bathrooms, a kitchen, a big dining room and a living room.

3 Hardware components

The hardware components were already described in D5.3. Only devices that has been improved in this period are commented below, namely the android-based sensors, and the Giraff robot.

3.1 Android-based sensors

The android-based sensor platform has been successfully integrated into the GiraffPlus platform. As a result MDHPulseOximeter and MDHFallDetector were added to the system (via Engineering GUI) as complementary sensors. Subsequently, a number of real-life tests were initiated to perform continuous monitoring of physiological parameters and assess both entities in terms of user acceptance, data collection and communication reliability.

Additionally, alarm notification functionality based on Pushover application has been tested into the monitoring process. With latest improvement complementary sensors are able to communicate with caregivers directly in case fall alarm has been triggered.

3.2 Giraff robot

In this period the Giraff robot has been largely enhanced according to the user requirements. The new version of the Giraff robot (v.4.0), includes new features which are related with night vision and height adjustment. A new high resolution camera is used with 720p resolution. The new camera also gives the ability to drive in dark rooms and allows to zoom. Status indicators like on/off status, charging status and battery status are used. Moreover, a feature that allows the Giraff robot to charge when it's off has been implemented.

The new software version (v2.4) for both Giraff and Pilot developed and released during this period includes new features for the 4.0 version Giraffs which are related with the night vision and height adjustment. The feature of sending an alert when a Giraff is not charging has been developed.

4 Software components

The software components deployed in each test site are installed in the home server computer, the secondary user computer, and on the Giraff robot. The different software components of the GiraffPlus system have been largely enhanced by M30. The modifications and improvements are described below.

4.1 DVPIS

In the period covered by this report the development of the DVPIS tool went through a significant set of improvements. This is from the double effect of the requirement gathered in real use on test sites and for the parallel development of new features. In particular, we have intensively tested the functionalities of the DVPIS@Office as described in D6.2 and designed a brand new version called 2.0 that is described in detail in D4.2. Additionally a version of the @Home that allows delivery of additional information to the Primary User has been released for general use through an application that runs on the Giraff robot and its technical description is also given in D4.2.

4.1.1 @Office

It is worth reminding that the 1.0 version of the DVPIS@Office has been in intensive use since early November 2013 and, with continuous refinement, has achieved a stable behavior in version 1.4.3 in early February 2014. In the meantime, we have started a redesign of the tool to better fit the needs of the real users. The DVPIS@Office 2.0 has been released to the consortium end of June 2014 in a version that now contains all the scheduled changes and that is described in D4.2.
The @Office 2.0 has the following new features:

- The new Home that integrates a Summary view of the status in all the connected GiraffPlus houses with the aim of giving a synthetic information to carers with multiple assisted people;
- The subdivision of information of a single house in three panes:
    - Real Time
    - Long Term
    - People.

The Real Time panel contains a completely new visualization based on a map of the apartment that allows for a more immediate appreciation of what is going on through the representation of simple icons for the sensors and using colors to signal activation.
The Long Term panel contains a re-organization of information already present in @Office 1.0 but more rationally subdivided into timeline views for raw environmental sensors, activities, and physiological readings plus a panel for the reports.
The People panel creates the possibility to contact the human ecology around a given home. It supports two functionalities for:

- the interaction point-to-point of the @Office Secondary User with Primary User through the DVPIS (this functionality is directly connected with the @Home tool).

- the social networking among the Secondary Users. This is an initial release of a service similar to a social chat that we plan to further refine by the end of the project.

In general the people panel allows an easier implementation of the reminding service already present in 1.0 that is now rationally connected to this new functionality.

4.1.2 @Home

In this period we also developed a more robust version of the DVPIS@Home, that runs on the telepresence robot and contributes an additional information channel between outside the home to inside and vice versa. The Beta version of the DVPIS@Home has three main functionalities:

- *Avatar* that preserves the "telepresence" service that the Giraff robot provides;
- *Messages* that is an environment where primary users can to receive messages from secondary users or reminders and suggestions;
- *Personal Data*, this panel allows to show personal data to the primary user (e.g., physiological measures.

The tool endows the system with a shared space between the primary user and the secondary users. This is done thanks to the connection of a panel in the People service of @Office 2.0 with the Messages part of @Home current release.

4.2 Remote Access

To enable remote access to computers at test sites, XLAB provided access to their remote support software ISL AlwaysOn, which was installed at all test sites. During this period, ISL AlwaysOn has enabled GiraffPlus engineers to access GiraffPlus test sites from anywhere allowing them to remotely install and update new versions of software and, if necessary, to fix any outstanding issues. Remote access has turned into an essential tool to conveniently configure and manage the deployed testsites in this period.

4.3 Middleware

The final version of the middleware has installed in all test sites and it is used as communication layer in all the DVPIS instances used in the evaluation. The delivered version has been improved and now presents more functions in order to increase both the robustness and the flexibility. The most important features added are:

- Enriched interfaces for both the desktop and mobile versions allowing queries to obtain the current location and the relative configuration of the installed sensors.
- A heartbeat mechanism by which all the instances of the middleware periodically sends a presence signal composed of several information about the running state (timestamp, uptime, component versions, etc.). These messages allow a real-time status check of the all locations and devices in which the GiraffPlus software is deployed, thus easing the maintenance and monitoring activities.
- A failover procedure, requiring a local mongo DB installed, that allows to temporary save the generated messages to the local database in case of long term connection outage. Later on, when the connection is recovered the messages are automatically sent to the remote server without the user application intervention;

- A dynamic reconfiguration is possible by programmatically passing a new set of properties to the middleware avoiding the need to restart the related bundle. The middleware takes care of reconfiguring the underlying communication connector module as well.

Moreover, a continuous maintenance activity has been carried out and few bugs were fixed on both the desktop and mobile middleware versions increasing the stability of the system.
The mobile version of the GiraffPlus middleware has been published on the Google Play Store allowing to automatically updating the software when new application packages are released.

A detailed description of the presented work can be found in section 3 of D2.3.

4.4 Data storage

The GiraffPlus Long Term Storage system has seen a lot of changes in the past year. Changes were made at all levels of the storage system – from the data schema to the actual cloud infrastructure used to store data and server information to other components in the system.

4.4.1 Data schema for configuration entities

In the past year a decision was reached to store middleware configurations for each home in the GiraffPlus LTS system. Since the system already contained configurations entities needed by the DVPIS, these entities were extended to accommodate needs of middleware configurations.
Configuration entities in the GiraffPlus database now describe the exact setup of each home included in the project. Configuration entities describe everything needed to properly set up individual middleware instances in each of the homes and devices connected to each home (e.g. android tablets) avoiding the need for hardcoded configurations based on files and enabling easy configuration of individual homes via the GiraffPlus EngineerUI (see Deliverable D4.2).
Also in the first prototype a data schema was used in which all configuration entities (home, sensor, giraffe, context recognition, etc.) were stored independently, which made it very hard to ensure proper consistency. In the second year we created a new schema in which the home configuration entity includes all entities relevant to that home, except user, sensor type and room configuration entities, which are still stored independently (e.g. one caregiver may be responsible for multiple homes – therefore the home configuration entity contains only reference to users – primary, secondary and engineers). This data schema makes consistency checking much easier and enables middleware instances to fetch all relevant entities in a single call to the GiraffPlus LTS system.
In addition we decided upon a unified format of messages sensors send to the MQTT bus. Each sensor is now required to send a JSON message in the following format:

```
{
      sensor_id: <unique id of the sensor>,
      timestamp: <time of the measurement creation>,
      values: <JSON object containing exact values of measurements
}
```

This enables unified parsing of message and ensures that each message contains the necessary information enabling the GiraffPlus LTS system to store the message for efficient retrieval at a later date.
Although all these changes required a major rewrite of the entire GiraffPlus LTS system and connected components, we now have a more efficient and inherently consistent system.

4.4.2 GiraffPlus LTS Web Service

To reflect changes in the data schema for configuration entities the GiraffPlus LTS Web Service was completely rewritten.
In addition to the changed data schema, we decided to move from the password-based authentication to PKI-based authentication, a change which required creation of a new GiraffPlus Certificate Agency web service. This web service is used to automatically generate certificates (public-private key pairs) for users of the GiraffPlus system and various GiraffPlus software components. Generated keys are in turn used to authenticate various users and software components and to secure communication between GiraffPlus software components. In this way each user is responsible for safekeeping of his key pair and authentication and authorization can be done in an efficient and reliable manner.

4.4.3 GiraffPlus Cloud Infrastructure

In addition to changes in software components, we have also migrated the GiraffPlus cloud infrastructure from bare-metal servers to an OpenStack-based cloud infrastructure at XLAB.
This change will enable us to easily and efficiently scale out our infrastructure as needed with the increasing number of test sites included in the project. In addition, the variety of virtualization possibilities in OpenStack allows us to be very flexible in terms of needs of different cloud-based components – from fully virtualized solutions, which are good enough for low-load web service, to bare-metal solutions suitable for HPC-like real-time requirements introduced by e.g. contex recognition.

4.5 Motion Control

The algorithms for semi-autonomous navigation has been enhanced with a new control mode, called *collaborative control*. By using this feature, the secondary user can directly drive the robot while her commands are continuously monitored by the system. In case any command given by the driver might cause a collision, the semi-autonomous module overdrive it, moving the robot to a free-obstacles area. This new control mode has been integrated into the Pilot software by means of a plugin. More details are described in D2.3.

During this period the semi-autonomous navigation module has been deployed in some selected test sites for which geometrical and topological maps have been created. In the next months, the new features implemented will be tested.

4.6 Context Recognition and Configuration Planning

The context recognition has been updated in both architecturally and functionally during this last year. The architecture changes now consider the inference and the preprocessing modules as one integrated software component. These changes were performed together in an integrated effort during the coding camp in Örebro. Another architecture change relates to how the context recognition interacts with the database.

The functional changes to the context recognition algorithm are several in M30. These changes have been motivated by the need to improve data processing, capture richer events that may occur in the home and also provide the possibility to trigger alarms. These changes include the possibility to allow for preprocessing of negated events. For example, it is now possible when querying the low level data to encapsulate terms such as “not in kitchen”. Another change allows for the possibility to adjust how much discontinuity (or gaps) there may be in sensor readings before an inference is triggered. Also the language used for expressing rules has been enriched in order to allow for multiple sensor data information to be considered in a rule. This has been done by changing the rule based language from only 1:1 mappings between variables and sensor readings to a 1:many mapping. For example, If motion was detected in the TVroom in the recent past, but still not detected elsewhere in the home, we maintain that the person is still in the TVRoom. The effect is that multiple sensors are now used to trigger variables. Lastly, an important consideration in the context recognition was the possibility to alarm. This is done by adding the alarm checker which polls a rule regularly to see if that rule can be fired and if so, an alarm is sent.

Regarding the configuration planner, the integration with the context recognition has been completed. Using XML has the interface point between the two, the configuration planner takes activities not just as observable state variables as input.

4.7 Intellicare Android Application

The Android Application OneCare GiraffPlus Edition was updated and is being installed using google play services. The defects found with normal usage were corrected and the new functionalities provided by the middleware were explored so that the application is easier to install and configure. The current location functionality provided by the Middleware allowed the implementation of a set of automated tasks which are responsible for this improvement. Another key improvement in the application is the heartbeat and error reporting functionalities which allowed the identification and resolution of most of the defects found.

5 Video Storyboard

Following the GiraffPlus DOW, milestone 3 includes a video demonstration of the improved integrated system. This section details the storyboard and the main components involved in the video.

The chosen scenario is a real testsite, the Spanish testsite 1, located in Estepona, Málaga. This testsite was deployed by M18 and includes the standard configuration of sensors and devices described in D5.3. The improved version of the GiraffPlus system installed by M30 entails the aforementioned features, i.e., enhanced visualization and personalization services, enabling the notification of warnings to secondary users, improvements in the context recognition module, and in the motion control of the robot, etc.

The video is divided in two parts:

1) Description of the current prototype of the GiraffPlus system and its deployment in Europe.
2) Utilization of the system in a real situation.

Next the latter part is described in detail.

5.1 Improved version of GiraffPlus in action

Adolfo had a bad night, some problems with his stomach made him sleep bad. In the morning he is thirsty but not willing to eat so he only drinks water. Then, he sit down on his chair and watches TV, read the newspaper, and even falls to sleep (see fig. 1). Time passes but he does not cook: he is not going to have lunch today.

The situation is detected by the GiraffPlus sytem warning Ana, his daughter: Adolfo has not have lunch today. This warning is received in the smartphone of Ana who was chatting with some work mates (see fig 2.). She goes to her office and connect to the DVPIS to check the situation.

Figure 1. Adolfo had a bad night, with some stomachache and he spends all the morning in the livingroom. The lunch time passes but he is not willing to eat.

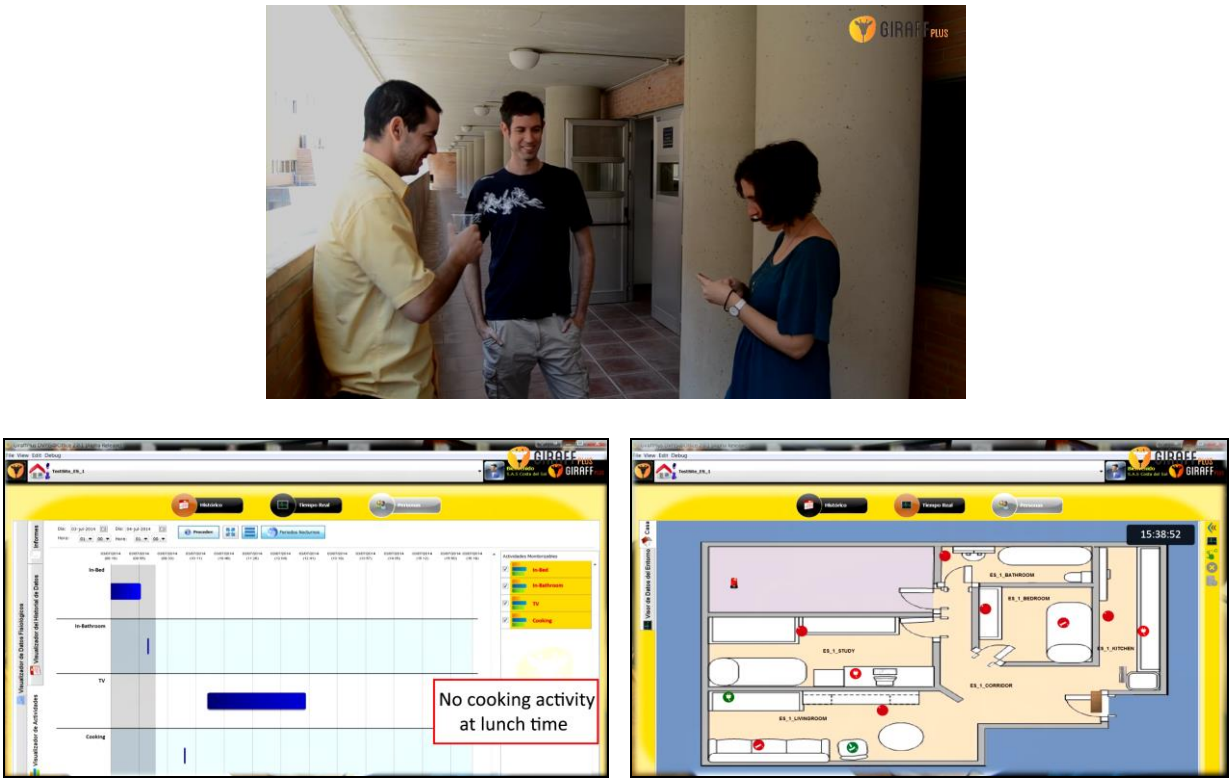

Figure 2. Ana receives a message about the current situation of Adolfo. She connects to DVPIS and check the last activities of Adolfo and the real-time environmental data.

Ana decides to communicate to Adolfo through the Giraff robot and makes a call. Ana drives the robot using the collaborative mode. She is angering to arrive to the livingroom where Adolfo is, without paying too much attention to the obstacles. When she arrives, she chats with Adolfo to figure out what is happening.

Figure 3.- Ana drives the robot in collaborative mode and arrive to the livingroom

Ana realizes that Adolfo is not feeling well and decides to personally visit him in the afternoon with some food (see fig. 4).

Figure 4.- Ana goes to the Adolfo's apartment bringing some food and spending all the afternoon with him

From this story, it is worthy to mention that the system early detects a problem which could worsen, warning a relative who react and act accordingly to the particularities of the primary user. Also, this situation reveals that the personal contact is not lost, achieving a tradeoff between the independence of the primary user and his health care from secondary users.