Ambient Assisted Living in Smart City
Proof of concept implementation

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Outline

- Intelligent Knowledge as a Service (iKaaS) platform
- Assisted Living in Smart
  - Overview
  - Storyline hints
  - Operation scenarios
  - Implementation details
  - Evaluation
- Contact details
- Combination of innovative technological areas:
  - Cloud technologies
  - Internet of Things
  - Big Data & Machine Learning
- Development of a new multi-cloud platform for generation of knowledge that will be provided to users and empower a variety of value-added smart city applications
- Cloud-IoT platforms federation
  - **Global Cloud**: centralized IaaS that includes mechanisms for the efficient distributed service management
  - **Local Clouds**: distributed small scale deployments of Cloud-IoT iKaaS mechanisms for services provisioning and management
- Cloud-IoT Applications based on end-user requirements
Assisted Living in Smart City - Overview

- Combination of Smart Home and Smart City cloud-based IoT services
- Automated home environment adaptation
  - Learning user patterns to forecast user desires with respect to home and appliances configuration and proactively take actions/offer recommendations
- Remote Health Monitoring
  - Learning patterns in user physical status and behaviours to identify pattern irregularities (any abnormality in usual patterns)
- Smart mobility
  - Provision of navigation instructions, helping with the use of public transportation, information on potential dangerous locations in the proximity of the individual taking into account user preferences and health/well-being status
Mr T. uses an Ambient Assisted Living (AAL) application in order to monitor his health status, as well as to monitor and/or control/adjust the conditions of the surrounding environment, whereas at the same time can be informed, through the application, about the suitability of the conditions in accordance with his health status.

When at home,
- the application is supported by the Smart Home local cloud.

When outdoors,
- The global cloud is notified by the change on context (user location) and the service is “reconfigured” dynamically, so that the service is -seamlessly to the user- migrated to another local cloud;
- The application is now served by the Smart City local cloud.

Service reconfiguration includes
- Managing sensors/actuators in order to obtain the optimal environmental conditions in home (or in city where relevant) - this is directly related to the change of cloud.

Service reconfiguration also implies an adaptation on the service context itself
- Environmental conditions @Home: Temperature, Humidity, Luminosity.
- Environmental conditions @Smart City: Temperature, Humidity, Luminosity, Pollen, Pollution.
**Scenario#1**: Simple Service Registration per Local Cloud

**Scenario#2**: Dynamic Complex Service Creation, Learning of user preferences wrt home temperature and home environment adaptation, Forecasting of potential blood pressure issues and issuing of notifications

**Scenario#3**: Dynamic Complex Service Reconfiguration
Scenario #1 – Components Instantiation
[Simple Services Registration]

1. Insertion of Simple Services RDF descriptions

2. Storage of RDF descriptions in the Local Service Catalogues

3. Stored data as RDF triples

Simple Service Registration UI

Local Service Catalogue (RDF Store)

RDF triples

Intelligent Knowledge-as-a-Service
Scenario #2 – Components Instantiation  
[Dynamic Deployment of Complex Service in “Smart Home” local cloud]

1. **Service Creation Request**  
   - Assisted Living Application: Service Request

2. **Derivation of available simple services**
   - Global Service Manager

3. **Decision on optimal complex service composition**
   - Global Service Catalogue (RDF Store)

4. **Complex Service registration in Global Service Catalogue**

5a. **Activation of Services and corresponding Local Service Manager(s)**

Intelligent Knowledge-as-a-Service
Scenario #2 – Components Instantiation

[Dynamic Deployment of Complex Service in “Smart Home” local cloud]

Service Activation

5a

Local Service Manager – Smart City

Service Activation

5a

Local Service Manager – Smart City

Local Data Processing
Bayesian Statistics

Home Automation - Machine Learning

<table>
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<th>Temperature Probability</th>
<th>Time-Slot</th>
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<td>0.1033</td>
<td>10:00 - 14:59</td>
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</tr>
</tbody>
</table>

Learning of user preferences for home automation based on Bayesian statistics

6

Notifications/Alarms

Assisted Living Application: Smart Home

8b

Assisted Living Application: Smart Home

8a

Home environment monitoring and adaptation

9

Local Cloud DB (JSON DB)

Retrieval of data from Local Cloud DB

Local Cloud DB

Smart Home devices

7

Monitoring of actuators status & sensors values

8a

Home environment monitoring and adaptation

9

Intelligent Knowledge-as-a-Service
Scenario #3 – Components Instantiation

Dynamic Reconfiguration of Complex Service in “Smart City” local cloud

1. Service Activation
   - Change of location from Smart Home to Smart City

2. Deactivation of Smart Home Local Cloud
   - Smart Home cloud idle

3. Activation of Smart City Local Cloud
   - Smart City cloud active

4. Blood pressure forecasting using Timeseries
   - Retrieval of data from Local Cloud DB
   - Local Data Processing for Remote Health Monitoring based on Timeseries Forecasting

5. Notifications/Alarms
   - Intelligent Knowledge as a Service

6a. City environment monitoring
   - Assisted Living Application: Graphs for monitoring of Sensor values

6b. Assisted Living Application: Smart City

Local Service Manager – Smart Home

Local Service Manager – Smart City

Local Cloud DB

Assisted Living Application: Smart City

Assisted Living Application: Graphs for monitoring of Sensor values
Implementation details (1/2)

- GUI for service request
- Measured data visualization
- Presentation of alarms/notifications
- RDF data storage and query/update SPARQL endpoint
- Data federation of the distributed LSC
- Store RDF data of the Complex Service Model instances
- Decision making, optimal composition of complex service
- Complex service registration
- Local Cloud activation
- Supports service migration (activation/deactivation of local cloud)
- Initial processing of data/information for the decision making towards alerts generation
- Data retrieval from all available VEs, Data visualization & alerts/notifications creation
- RDF data storage and query/update SPARQL endpoint
- Store RDF data of the Simple Service Model instances
- Initial processing of data/information for the decision making towards alerts generation
- Data retrieval from Local cloud available VEs, Data visualization & alerts/notifications creation
- Local cloud entities interconnection with global cloud entities such as the VEs data measurements
- Supports the cloud switch / service migration
- Support the federation process of the LSC data to the GSC
- Arduino Sensors & Actuators VEs that correspond to Smart Home and Smart City Local Clouds
- JSON DB that stores sensor measurements
- Bayesian / Timeseries Algorithms
- Creation of alarms/notifications
**Ambient Assisted Living (AAL) Knowledge**

- Application of Bayesian Statistics in the context of 'home automation' for estimating the probability of the level of user settings for the available devices, that are deployed in the Smart Home local cloud, given a certain location and time.

- Application of Time series forecasting for the acquisition of knowledge in the context of the 'remote health monitoring' by aiming to the prediction of vital signs measurements by deployed devices in the Wearable local cloud.

- Further methods and types of knowledge will be included to support additional aspects, such as the prediction of the best navigation route into a smart city based on traffic, pollution levels, user health status, etc.
**Evaluation**

1. **Federated Query time (ms)**
   - Time needed to perform a federated query over the federated semantic storage systems that keep data of the distributed Cloud-IoT infrastructures.

2. **Service Creation time (sec)**
   - Time required for the completion of the decision making process for the complex service creation, depending on the number of simple services.

3. **Service Reconfiguration time (sec)**
   - Time required for the completion of the application reconfiguration to support the service migration across different edge Cloud-IoT deployments, depending on the number of simple services.
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