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A Novel Smart Home Application Using an Internet of
Things Middleware

Agenda

1. Abstract
2. Introduction
3. Smart Home Implementation
4. Conclusions and Future Works



1. Abstract

- The aim of this paper is to describe the development of a novel smart home application based on an architecture and middleware of the Internet of Things.
- It integrates temperature and light sensors and the residence interacts directly with them by means of the middleware, controls the brightness of the lights, turns on and off the air and entertainment systems of house.
- The proposed architecture provides an intuitive user interface, security, environment self-adaptation and user context awareness.

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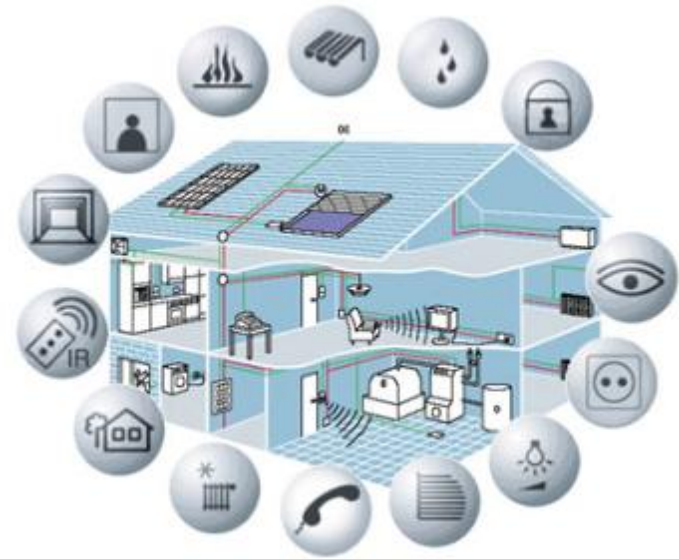
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2. Introduction

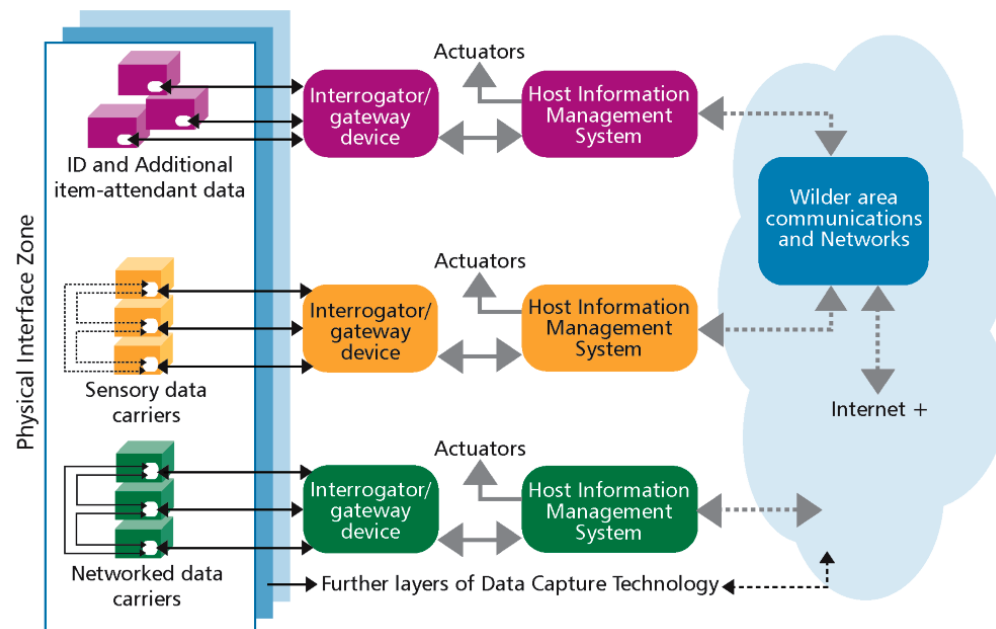
Pervasive Computing

- Pervasive (or ubiquitous) computing is a model where the users naturally interact with their environment. In such a model, environment objects are used to interact with computer systems;
- Preliminary studies have shown that hundreds of devices per person per environment shall be connected to wireless networks making computing omnipresent. Additionally, the interfaces with the human being shall be simpler and more transparent ;



Internet of Things

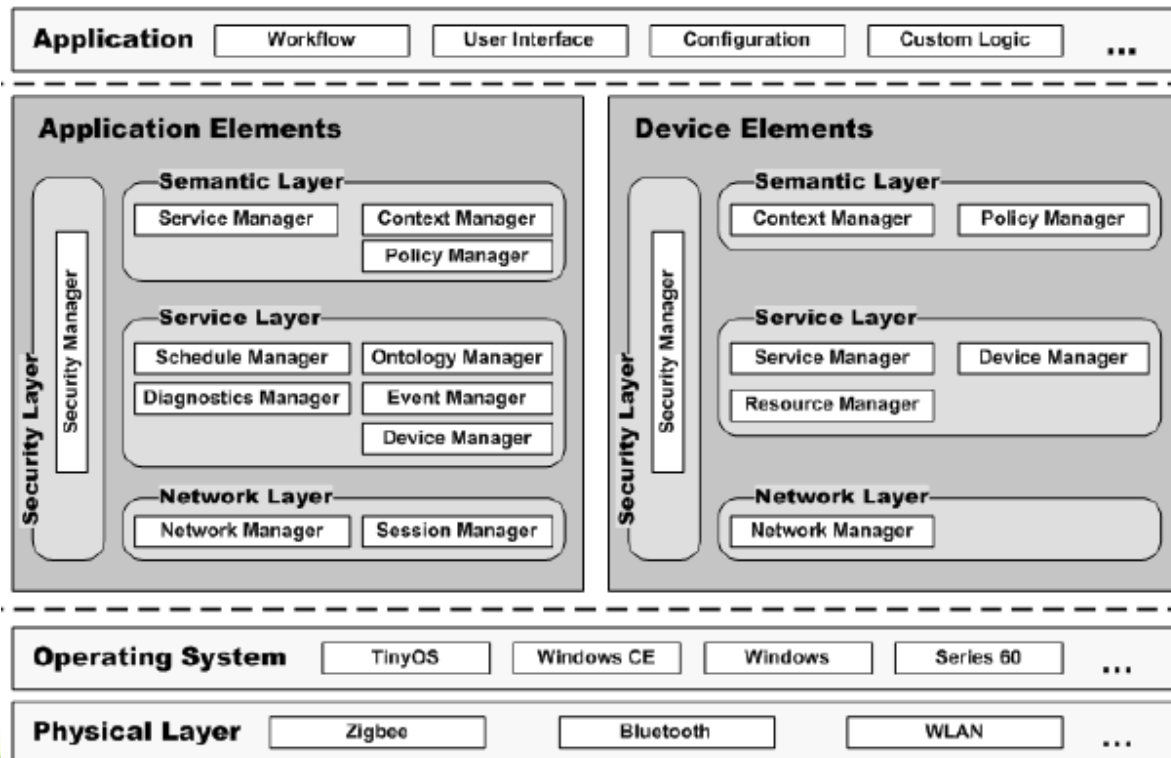
- As stated in [4], the Internet of Things is defined as global network infrastructure that interconnects objects physically and virtually, in order to exploit the captured data and their communication skills.
- It is characterized by a high degree of autonomous data capture, event transfer, network connectivity and interoperability.



IoT LinkSmart Middleware

- The objective of the Hydra Project was the development of a software middleware based on the Service-Oriented Architecture (SOA) [4];
- The communication occurs transparently between the lower layers.

- Composed by:
- Application Elements running on performance-wise hardware;
- Device Elements running on small device;



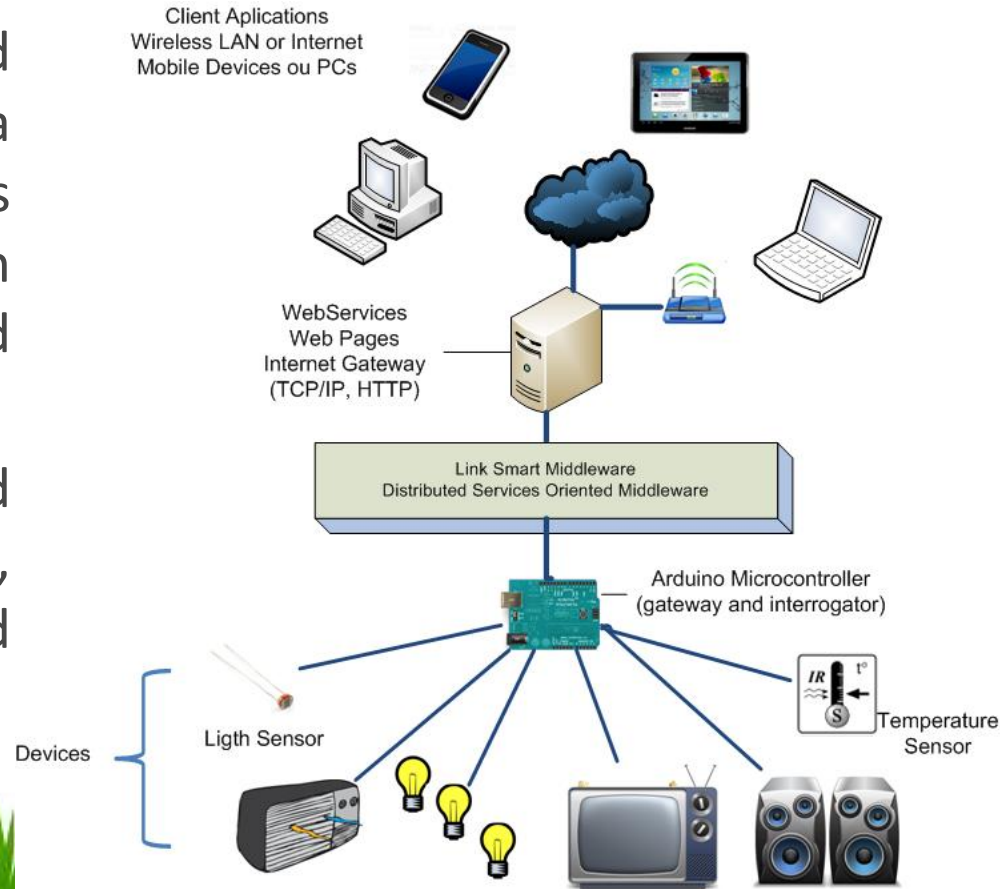
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3. Smart Home Implementation

- The architecture comprises a layer of devices equipped with sensors and actuators which are interconnected via the Arduino microcontroller;
- It implements the IoT gateway function;
- The microcontroller embedded application implements a protocol that interprets and acts upon the environment in response to messages received via its network interface.
- The upper layers are represented by the LinkSmart Middleware, applications for processing and the user interface.



3. Smart Home Implementation (2)

- 1) Physical devices: this layer monitors environmental variables and acts upon the environment;
- 2) Gateway device: this layer is represented by the Arduino microcontroller;
- 3) LinkSmart middleware: these components register and publish events generated by the physical devices and establish the communication with different applications enabling the data to be consumed by the top layer;
- 4) WebServices: this layer acts a proxy for other applications;
- 5) Client Application: logic of the service and user interface are implemented.

Mobile Client for Smart Home Application

Web Pages for Smart Home Application

WebServices (actuation and get informations)

LinkSmart Middleware (OSGi Components)

Gateway Device (Arduino Microcontroller)

Devices (sensors and actuators)

3. Smart Home Implementation (3)

- » The figure shows a mobile application developed using J2ME technology;
- » The mobile application accesses the web services interface implemented at the LinkSmart Middleware;
- » The application's interface provides the temperature, the ambient light intensity and the states of the rooms;
- » The user can also turn on or off the devices;



3. Smart Home Implementation (4)

- » The application receives the information of the user presence in each room;
- » This information is used to control the lamps in each room, i.e., the application turns on or turns off lamps, using the user presence information and threshold value;
- » **On the web page, the user can visualize the temperature, ambient light intensity values and states of the house's devices**

localipv6:8080/ControlHouseIoT/index_1.

Hello Alberto.

Data and Hour: 23/01/2013 22:28:35

Ligth: 384

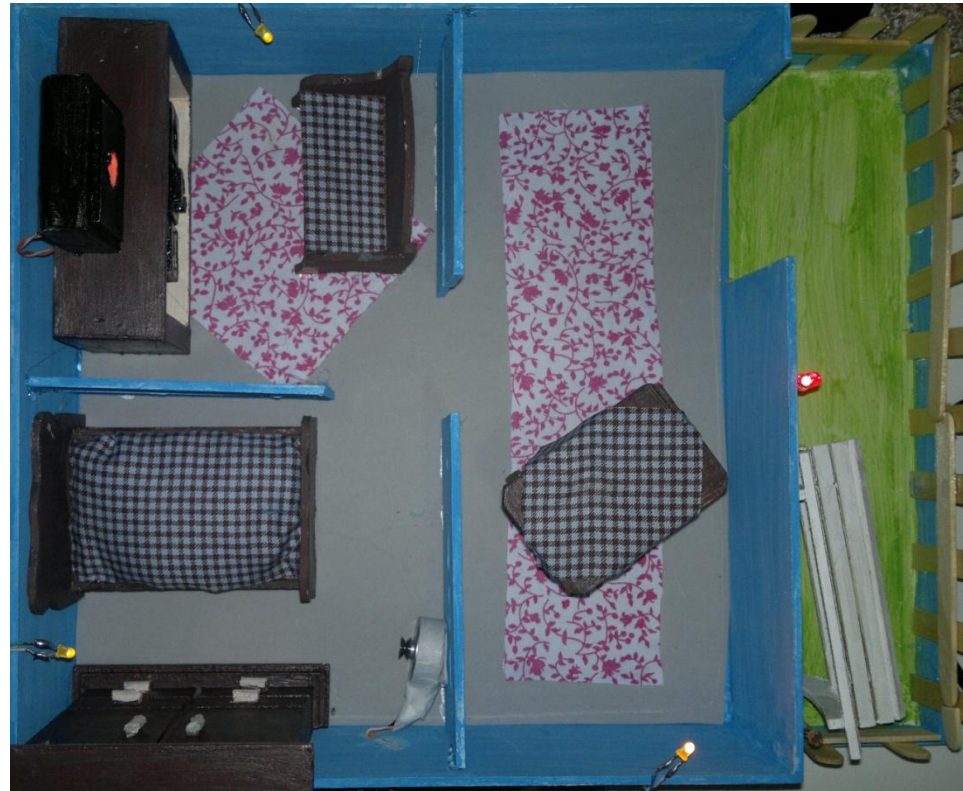
Temperature: 27.8

Room/System	State	Enable	Disable
TV	Enabled.	Enable	Disable
Sound System	Disabled.	Enable	Disable
Air System	Enabled.	Enable	Disable
Backyard	Enabled.	Enable	Disable
Bedroom	Disabled.	Enable	Disable
Kitchen	Disabled.	Enable	Disable
Room	Enabled.	Enable	Disable
Enable All		Disable All	

Parameter	Value	Submit
Temperature	<input type="text"/>	<input type="button" value="Submit Temperature"/>
Light	<input type="text"/>	<input type="button" value="Submit Ligth"/>

3. Smart Home Implementation (5)

- » The figure shows the developed model of the smart home;
- » The figure shows the rooms with LED lamps simulating the lighting system, television and sound system miniatures that simulate the home entertainment system, and a small motor that simulates the air conditioning system placed in the bedroom of the house;
- » The light intensity and temperature sensors are located outside the house, in the backyard, the temperature sensor under the bench and the light sensor on the bottom left corner of the house.



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6. Conclusions

- The user interfaces are simple and intuitive, they provide recognition of user context, implement data security and integrity, and make the applications to become invisible;
- The application uses the IPv6 protocol for communication;
- The architecture and implementation demonstrate the use of the IoT LinkSmart middleware;
- This framework provides scalability, and flexibility by enabling different kinds of devices and is aware of the environment context.
- The information from a single light sensor, for example, can be read by various applications without impacts on others.
- All sensors and devices present in a same environment may be configured as belonging to the same context or not, which is an important capability for IoT and pervasive services.

6. Future Works

- We intend to implement SSL encryption in the browser interface and web services access;
- We intend to use the security mechanisms already present in the LinkSmart middleware.
- We plan to implement algorithms for pattern recognition to understand users' behaviors, estimate missing parameters and detect outliers or erroneous values of the environment variables or context of the application;
- These algorithms implementations aim to optimize the network's traffic, by not sending raw data, but only IoT application relevant processed information.
- It is important to integrate these algorithms in the IoT middleware making them part of the IoT infrastructure and providing services for the top layers;



Thank you for attention.

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