The Internet TCP/IP Protocol, Scalar Intelligent System Support for Buildings

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***Abstract* — Once the home automation systems based on automata cases have been analyzed, it is proposed a new generation of Scalar Intelligent Systems specifically focused on collective residential buildings and Internet of Things, based on the controlled management by computers and TCP/IP protocol based networks, in order to provide home users the greater adaptability.**

***Index Terms* — TCP/IP, intelligence, management, scalability.**

I. Introduction

In the field of artificial intelligence installed in residential buildings, the Intelligent Systems implementation has met several difficulties, and one of the traditional problems is the general lack of market research designed to know the needs home users really perceive, because the company policy has consisted of adapting the industrial applications and skipping the necessary steps to understand the field in which it was expected to operate and listen to its users. This is a fact that we have been checking in other articles and conferences.

The convergence of Telecommunications, Computing and Entertainment at home thanks to broadband networks is a strong worldwide tendency. The future 'Digital Home' [1] is the materialization of this idea of Entertainment, Telecommunications, dwelling intelligent management services convergence, as well as its infrastructures and equipments.

Therefore it could be considered if it is possible to implement the Intelligent System using a technology that enables to meet the previously explained requirements corresponding to users, applied I.C.T. Industry and the correct building implantation, without altering the quality of the architectural space.

The main problem derived from several networks integration need is the coexistence of different communication protocols used by each team and its control from a unique and accessible interface. Using a solution based on computers, I.C.T. infrastructure and TCP/IP protocol instead of 'programmable automata' seems an obvious solution for an apartment building.

If the implementation of the Intelligent System in a building goes parallel to I.C.T. networks or it is directly part of them, all the regulatory and technical aspects do exist and are known. It is thus achieved an easy organization of the Intelligent System layout in an apartment building, with access to any area of it.

Keeping the I.C.T. networks diagram specified by the current Spanish regulations [2], we can place the control and processing element (equipped with the necessary capacity) at the head of networks, sharing the route up to the U.A.P. (user access point) and from it, setting up a gateway (home gateway) that allows us to connect the necessary sensors or actuators according to the desired services, solution to be used in both common and private building area [3].

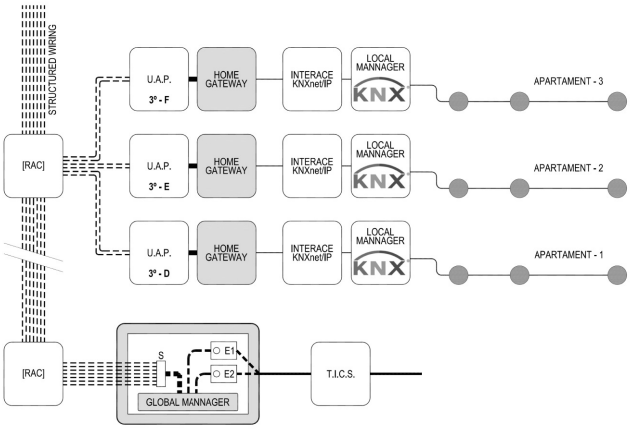

Fig. 1. KNX [4] Intelligent System & ICT networks in a apartment building.

II. Scalability, Transparency and Usability

A. Scalability

The main characteristic of an Intelligent System in this kind of buildings must be the scalability and its platform character for services and applications.

Considering this and putting the Intelligent System in the incipient Information Society, added to software and hardware successive reduction in the price, enables to predict a large increase of the demand of new services at homes, if they are offered in an appropriate and flexible way. Buildings with

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Telecommunications Common Infrastructure made according to the current Spanish regulations since 2003, have the necessary potential for the implementation of this kind of future services.

The most important concept of scalability is its ability to share information and coordinate actions in different plants or properties

B. Transparency

The evolution towards the technological convergence in which every home element collaborates and forms an only system, is devised long time ago. This situation is even more evident when the target is the integration of several dwellings in one system, since heterogeneous purposes, services and aims will be superimposed inside and outside the houses.

In order for the Intelligent System integration to be complete, the target is going from the layout level to the functional level, and this can only be achieved if the appropriate cooperation exists between its elements, with a correct configuration and applying the suitable protocols. The covered field is complex, since it includes the functional integration of several dwellings in a neighborhood, each one with specific services equipped with a changeable working autonomy.

It is very important to take into account that most of the protocols that exist were created for specific purposes, so they have a specialized character. Thus, whereas some of them make not possible the high-speed data transfer, others are not efficient for management.

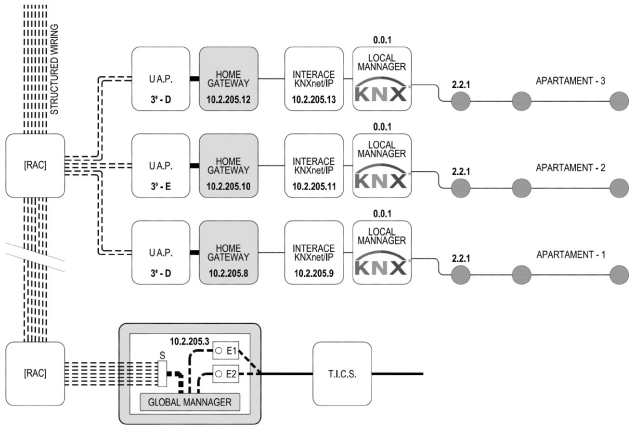

Fig. 2. KNX directions and TCP/IP directions in a apartment building.

For example, a KNX system defines a logical address to its elements (sensors and actuators), which are not specific to each home. The telecommunication network based on TCP / IP protocol [5], is able to distinguish each separate housing. The TCP / IP executes a difference between subnet addresses and host addresses, which can be used to group homes for orientations and heights (very useful when programming actions).

As can be seen in the figure 2, KNX addresses are conditioned to the TCP/IP addresses that are senior in the intelligent system in a natural and transparent way.

C. Usability

The network protocols great achievement is that they diffuse the difference between data processing and data communication. There are not either basic differences between the data, voice or the multimedia service transfer. And at the same time, the frontiers between local area networks (LANs) and wide area networks (WANs), or even metropolitan area networks (MAN) are more and more tenuous. This network regulated by protocols is the one that allows the information exchange between different systems and provides with applications distributed to users.

That is to say, from the functionalities contributed by different applications that coexist in a particular System, the user must will be provided with a higher value functionality or service. So some device will have to combine all those subsystems in order to perceive them outward (if necessary) as an only entity: the residential gateway.

Open Service Gateway Initiative (O.S.G.I.) [6] defines its own configuration, it was designed for its compatibility with Jini or UPnP (Universal Plug and Play), and it has two fundamental elements from which the Service Platform is located in the local network and connected to the services supplier through a gateway in the operator network. This element will be responsible for allowing the interaction between devices or devices networks that will be able to use different technologies and communicate (for example, KNX and Zigbee management networks).

We could define the usability concept [7] as the simplicity with which people can use a tool made by humans in order to achieve a specific aim. When we put into practice this concept to a system, we get an empirical and relative usability measurement at the same time: empirical because it is based on usability tests made in laboratory or by field work; relative because the result depends on the comparison with other similar systems.

The Intelligent System installation at home must get the highest usability levels, in order for user to be able to interact easily with it; and the most important, to be able through the years to update and model the System according to its needs and desires in a simple way, as much for equipments to be installed in building as for the more and more numerous devices that we take with us.

The HCI (Human-Computer Interaction) researches carried out in the last years have led to cognitive theories, design methods and software tools designed to build useful and easy systems. Most of the advances achieved in this field are related to the maturing of Web programming techniques, responsible for the evolution web pages have suffered from

initials, with static content, to current pages with which it is able to interact in a dynamic way.

When we arrive at this point, we may ask how the devices and applications that manage them are going to exchange information between subsystems networks, System networks, BAN networks, etc., in an efficient way (figure 3).

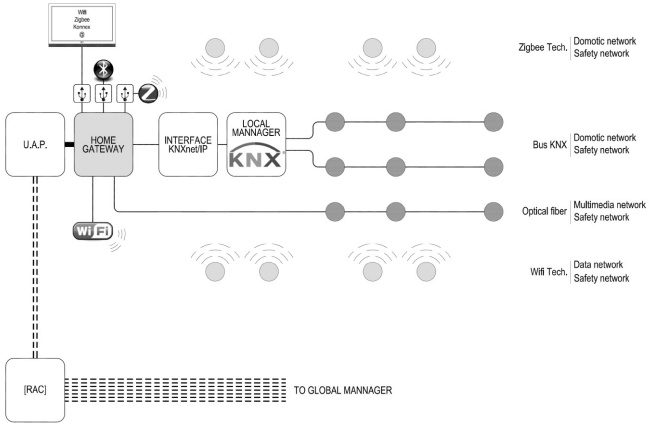

Fig. 3. Different technologies networks connected to the home gateway.

The interaction with nearby networks (BAN and PAN) are the aim of wireless technologies and perceptual interfaces, which are those that include interaction techniques with the computer similar to those used in the interaction between people, and thanks to the miniaturization we will end 'wearing' them as a garment more. The interaction with higher level networks is aimed to the exchange of large information volumes which need higher bandwidth and commutation speed: basically wired networks and classical physical interfaces.

The home gateway is the component that handles the communications between different networks with different technologies or protocols are transparent in the private sphere of the home, is what is called "digital home integrator".

And the name is very appropriate since this element from communication between different systems from different apartments can be done through a universal protocol: the Internet Protocol, using the binary system of ones and zeros transmitted by ICT networks.

III. The Internet Protocol TCP/IP Applied & Others

Although presented as a single protocol, it is actually two but working together and coordinated. And as different protocols have different and specific functions.

The most widely used protocol in the network communication layer is the IP protocol, because it is used for both private networks and local networks and the Internet, and for various services of voice, data and multimedia. An IP address is a numerical label that identifies, in a logical and hierarchical, an interface of a device within a network using the IP protocol. This number must not be confused with the MAC address is a fixed hexadecimal number is assigned to the network card or device by the manufacturer, while the IP address can change. This address can be changed two or three times a day, and this form of IP address assignment is called an "IP address dynamically" (usually abbreviated as dynamic IP). Internet sites which by their nature need to be permanently connected, generally have a fixed IP address (commonly, fixed IP or Static IP), ie not change over time.

Mail servers, DNS, public FTP and Web servers must necessarily have a fixed or static IP address, as in this way allows their location in the network. There is a protocol for assigning dynamic IP addresses called DHCP (Dynamic Host Configuration Protocol) [8] especially useful for users who connect and disconnect. The elements of an intelligent system must have fixed IP addresses to be in permanent operational state.

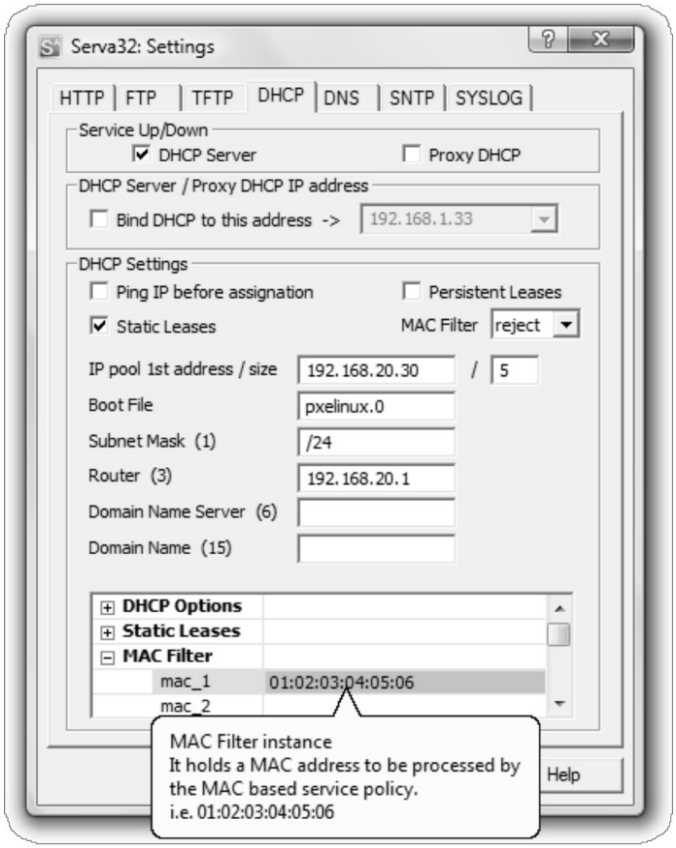

Fig. 4. IP address and Subnet Mask they identify each home gateway.

Transmission Control Protocol (TCP), is one of fundamental Internet protocols. It was created between 1973 and 1974 by Vint Cerf and Robert Kahn. TCP supports many of the Internet's most popular applications, including HTTP, SMTP, SSH and FTP. Is a protocol of layer 4 according to the OSI model, the top layer which supports the IP protocol. Many programs within a data network consisting of computers, TCP can be used to create connections between them through which it can send a data stream. The protocol guarantees that the data will be delivered to its destination

without errors and in the same order they were transmitted. It also provides a mechanism for distinguishing different applications within the same machine, through the concept of port.

Besides above these two protocols is located middleware that provides intelligent systems a great improvement in integration and scalability of different technologies, concealing any complications from the lower levels to the application layer (which acts artificial intelligence).

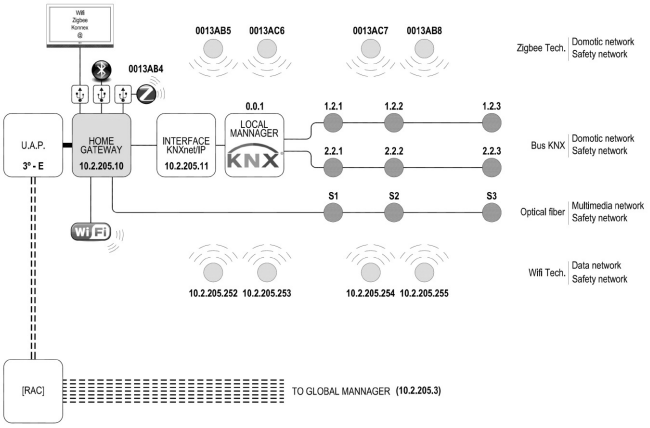

Fig. 5. Different system directions integrated by means home gateway.

To make attractive and useful Intelligent System in view of the user, the system itself must be able to recognize new equipment added, or that another has been disconnected or no longer serve. And, very importantly, you must recognize that element type is and be able to automatically configure. This functionality is already present in the computer networks, able to recognize the object and associate the necessary driver and update via the Internet, all without user action.

This technology became known as Plug & Play (plug and play) as it comes from the field of gaming. Today is one of the protocols of general purpose middleware most widespread: the UPnP (Universal Plug and Play) that fits the needs of the collective residential environment. Supports the work of a network without configuring and automatically detects any device that can be incorporated into this, it get its IP address (logical name) informing others of their functions and processing power, and informs, in turn, of the features and capabilities of others.

It has clear advantages that make it very suitable for the residential environment:

- Media and device independence: They can operate over any medium including telephone lines, power cables, Ethernet, RF, wireless, and 1394 [9]. This makes them suitable in Intelligent Systems.

- Platform Independence: No matter the programming language or operating system for the development of products using this technology.

- Internet-based technologies: They are built on IP, TCP, UDP, HTTP and XML among others.

As final data highlight that UPnP is able to work simultaneously with other network technologies and existing management in the residential as EIB, KNX, X10, LonWorks and other specialized use in residential environment existing middleware. These protocols can participate in a network based on UPnP technology by a bridge called Proxy-UPnP.

IV. Internet of Things and Buildings

The idea is very simple but its application is difficult. If all boxes, books, shoes or parts of a vehicle to be equipped with minuscule identifying devices, daily life on our planet would undergo a transformation. Things no longer exist out of stock or lost products, because we would know exactly what is consumed on the other side of the planet. The theft would be a thing of the past, we would know where the product at all times. The same applies to the lost packets. If all objects of daily life, from yogurt to an airplane, were equipped with radio tags could be identified and managed by computers in the same way as if they were for humans. Every human being is surrounded by 1000-5000 objects, and the Internet of Things should encode 50 to 100,000 billion objects and track movement of these.

The system will likely be an example of "event driven architecture" built from the bottom up (based on the context of processes and operations in real time) and take into account any additional level. Therefore, the event-driven model and functional approach coexist with new models capable of handling exceptions and unusual process evolution.

Internet of Things will probably be "non-deterministic" and open network (cyberspace), in which self-organized intelligent entities (Web services) or virtual objects (avatars) will be interoperable and able to act independently (each pursuing their own or shared), depending on the context, circumstances or environment. This produces an Ambient Intelligence (built in Ubiquitous Computing) in public spaces and buildings, which make them more secure and efficient.

The model to use in the information exchange between the Intelligent System applications and Internet of Things is ‘the subscription to JScript events’ (RegRemoteEvSusc [10]) one, by which any subsystem control application will broadcast events to the net and will subscribe to the ones published on the net which are necessary to be able to act correctly with updated information. This enables to each subsystem to have the necessary autonomy and the exchanged information volume to be precise, and if necessary, a subsystem to be able to receive the necessary information from other subsystem sensors that apparently wouldn’t have an obvious relation.

V. Conclusions

The planning, installation and operation of the Intelligent System on an experimental housing [11] has allowed us to validate two very important elements: the local manager and the global manager.

The local manager is located in each house and brings together the technologies and networks needed to meet the needs and desires of the users. A conclusion or suggest applications and extensions. The global manager has the ability to settle freely and to act depends only connection to a data network. In a block of flats, logically, should be located on the campus of telecommunications as it guarantees permanent connection to the energy and telecommunications networks.

These elements (local and global manager) are basic and show that it is possible to monitor different variables or different sensors in homes equipped with KNX Intelligent Systems and interface KNXnet / IP over a telecommunications network. Each home must have a static IP address and known for the global manager. The sensors it is to receive information both locally and manager global addresses must have KNX, Zigbee, etc.., Identified by the global manager.

For example, we identified the third floor housing and side E (its residential gateway has the IP address: 10.2.205.10), which in the Zigbee network 0013AB5 device is a rain sensor located on the north side. In case of activation of the sensor, the manager instructs the actuator 2.2.1 KNX proceed with the collection of the sheets of this housing.

The activation of this sensor is also transmitted to the global manager. In this situation collected by the rain sensor housing located at the 3rd-E and other (must be scheduled a minimum), the global manager issues the order to collect residential awnings rest facing north or to all homes (some not even hit by rain). This order is transmitted to different static IP addresses KNXnet interface / IP of each house are also identified in 2.2.1 to address KNX actuator awnings (figure 5).

This also shows that it is possible to consider managers at higher levels than a single building using the scalar model, and apply it to neighborhoods or districts.

References

[1] The 'Digital Home' term turned up in Spain recently, coined by Telefónica, in its Digital Home White Book and Telecommunications Infrastructures. 2003.

[2] Regulations that rules Telecommunications Common Infrastructures. 2011.

[3] I. Mendizabal, R. Hernández. "*The ICT Networks support for a scalar intelligent system in collective residential buildings*". Oral presentation. I Annual International Conference on Architecture and Civil ngineering. Singapore, mars 2013. Editor: Global Science & Technology Forum (GSTF). ISSN: 2301-394X, E-Periodical ISSN: 2301-3958.

[4] KNX is a standardized (EN 50090, ISO/IEC 14543), OSI-based network communications protocol for intelligent buildings. KNX is the successor to, and convergence of, three previous standards: the European Home Systems Protocol (EHS), BâtiBUS, and the European Installation Bus (EIB or Instabus). The KNX standard is administered by the KNX Association.

[5] The Internet protocol suite is the networking model and a set of communications protocols used for the Internet and similar networks. It is commonly known as TCP/IP, because its most important protocols, the Transmission Control Protocol(TCP) and the Internet Protocol (IP) were the first networking protocols defined in this standard. It is occasionally known as the DoD model due to the foundational influence of the ARPANET in the 1970s (operated by DARPA, an agency of the United States Department of Defense).

[6] O.S.G.I. is the abbreviation of Open Services Gateway Initiative, more precisely the O.S.G.I.14. 1999.

[7] Usability: Definition and Fundamentals – What, Why, How (Jakob Nielsen's Alertbox). 2003.

[8] The Dynamic Host Configuration Protocol (DHCP) is a network protocol used to configure devices that are connected to a network (known as hosts) so they can communicate on that network using the Internet Protocol (IP). It involves clients and a server operating in a client-server model.

[9] IEEE 1394 is a standard platform for input / output serial data at high speed developed by Apple Inc.

[10] In 1997, authors proposed the JavaScript in order to be adopted as standard for European Computer Manufacturers Association (ECMA). It was adopted as an ECMA standard under the name of ECMAScript. Then it also became an ISO standard.

[11] UPV/EHU's Ekihouse experimental home. Solar Decathlon Europe 2009 – 2012. Madrid.

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