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Using Service Oriented Architecture in Multimedia Control Systems Smart Home

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Abstract: In smart home domains, grids and service oriented architectures are considered to improve application design, integration and execution. In the audiovisual industry, applications are very data-intensive, time-constrained and computationally demanding and design of a service oriented architecture in this domain is no straight forward task. Efficient resource allocation is paramount to meet user's requirements in terms of deadlines and responsiveness and offer high scalability at the same time, a system which is based on service oriented architecture, function is wrapped as a set of compatible services which can be used in multiple systems of different domains. Systems and heterogeneous computer programs might belong to independent organizations and thus the service oriented architecture enables organizations to use services of other organizations easily by defining contracts based on these standards. Actually service oriented architecture is a proper solution for combining services for reaching the acquired service in a way that each of its components could act as a loose connection. Home network is an essential facility in a modern house; multimedia services are one of the important issues in designing smart homes. By using multimedia system inSmart Home management system, by using the latest technologies and regarding to service oriented architecture an ideal situation will emerge in buildings.

Key words: Smart home, multimedia systems, system control, service oriented, architecture

INTRODUCTION

Human from the inception had the dream of a safe and secure place and for reaching this dream never stopped effort and research. Now in the third millennium and computer and communication era only smart homes can fulfill this require. Thus efforts for controlling buildings have begun and continue. Now a days facilities and conveniences considered in a building have vital role in the success of the organization user which causes increase of efficiency and optimizing performance of that organization. Low budget, progressive increase of energy cost, utilizing and maintenance, personnel problems and issues, protection and controlling commute of the personnel and visitors, reducing the damage caused by fire or human negligence and creating proper environmental conditions force owners and building managers to compete in implementing new methods in order to reduce costs, fuel operation and power improvement. Moreover to provide the context for more safety and welfare and also increase the supervision and organizational management by using computer and telecommunication facilities. Building's intelligent management system is the provisioner of all necessary facilities and conveniences for eliminating problems and above-mentioned issues which provides the user the possibility of controlling the environment, optimizing energy consumption, labor welfare, safety and continues and non-continues supervision from each place (Blumendorf, 2013).

An smart home should have a system of neurons which includes sensors and embedded stimulators which self-controls information in a right time correctly. However the building can act static or dynamic so change or no change in internal or external structure of the building is samples of capabilities of an smart home (Hoeke *et al*., 2014). Neural system of the building has the responsibility of integrating all systems so that smart home has a flexible shape to have a proper action in facing changes in the environment it is placed in. These systems beside controlling different parts of the building and creating proper environmental conditions by providing simultaneous services, cause energy consumption optimization, level of performance and efficiency of the

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systems and existent facilities in the building. Control and access to the system by using related softwares is possible from anywhere inside the building or outside it through internet. We have recently seen a remarkable advance in smart home technology. It is moving rapidly from programmable thermostats to an era where all of a home's systems are integrated into a centralized control unit, accessible from multiple entry points such as touch pads, computer screens and other wireless mobile devices (e.g., smart phones and tablets). The result is a highly personalized environment, a home that reacts to individual needs and demands and even anticipates actions and events (Riha, 2014; Viani *et al*., 2013).

Building intelligent management is a new technology in Iran which is in progress and the general goal of this system is reduce in costs of building industry and optimized use of technology and using information technology and computer which in total will contain lots of benefits.

In close future pervasive computing and information technology will enter in people's daily lives and gradually will change the method of information contrast, human contrast with each other and with their around world. Emerge of intelligent tools, mobile devices, PDAs and sensors, provided required facilities for creating pervasive computing environments which as a result normal physical places are turned to intelligent places (Anbarasi and Ishwarya, 2013). In such places a structure of accessing anywhere and anyplace engenders. One challenge of such environments is security management and access control. First thing that comes into mind for access control is using a list of access control which in that list of valid users for accessing a specific object is mentioned; but in pervasive computing systems user access authorities doesn't only depend on user's identity. But user's status and system's status at the moment and its access history can have effect on use's authorities. On the other hand access histories alone have high importance (Ferraiolo *et al*., 2001). Also access control system includes multiple parts which are person identification, competence authentication and granting access license to him which this process is a complete subject and for brief permissions can contain passwords, tokens or physical permissions, biometric indices such as fingerprints and we identify a smart home management model for the proposed framework and the main tasks that should be performed at each level. additionally discuss practical design challenges with emphasis on data processing as well as smart home communication protocols and their interoperability (Stojkoska and Trivodaliev, 2017). During many past decades one important research aspects in smart home area for creating a strong and reliable system is that user's demands be done with providing higher convenience and reduce of building's performance in its best way. Actually service oriented architecture is a method for creating distributed systems which addressed presenting software capabilities as a service for ending applications or for creating other services and adopting an approach for codification and formulating the problem of energy management in building (Chehri and Mouftah, 2013). These services moreover than creating and controlling branches are divided to measuring, analysis, reporting, classification, supervision and user interface configuration. Service coordination and flexible combination should be supported; that is why it is done by Service Oriented Architecture (SOA). One other important aspects of device cooperation capability is how devices of different companies establish connection by using multimedia systems in order to acquire required result and related task (Teich *et al*., 2014). As it was mentioned this research is about developing infrastructure for sharing building's control services by using a multimedia system control platform by using service oriented architecture. Actually a service oriented approach is provided for controlling and how to manage building facilities through an intelligent controller. This platform is open source which allows different people use it easily for company and help.

MATERIALS AND METHODS

Building stable smart homes: For making a building smart first of all the control logic of the building should be recognized, this logic is based on subsystems which are integrated and in communication with each other so for more familiarity with control logic some explanations around the most important subsystems of an smart home is provided.

Emergence of smart homes: Among all effects of information technology on construction field, the necessity of existence of a proper environment for information technology labor force activity and deploying related facilities will have the result of moving toward creating smart homes. On the other words, smart homes are one of the main aspects of using information technology in the field of building (Ding *et al*., 2011). smart homes have been engendered more than about 100 years and its beginning was with emerge of electricity and change in homes infrastructures and then impressive changes surrounded us more than many decades such as automatic inside communications, entertainment, internet, video, weather control and security systems.

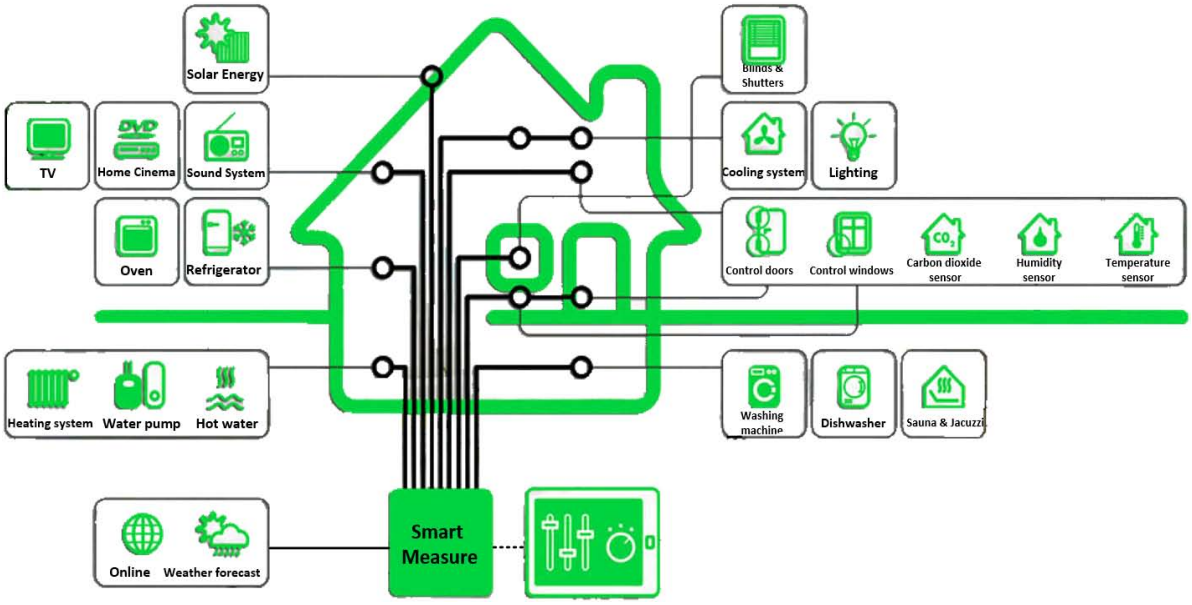

Fig. 1: General view of an intelligent house and some of its under covered capabilities

Intelligent and integrated building management system is called to a set of softwares and hardwares which are installed for monitoring and an integrated control of important and vital parts in buildings. The task of this set is continuous monitoring of different components of the building and applying commands in such a way that the performance of different components of the building be in balanced interaction with each other be in an optimized situation, unwanted consumption get reduced and safe and pleasant environment be created. In this method public lightening electrical panels, generator diesels, alarm and fire extinguisher systems, protection systems, elevators, commute control system and also components of the central powerhouse including chillers, boilers, circulation pumps, cooler towers, air conditioners and exhaust fans are controlled and coordinated in an integrated and coherent way by one or more computers. Controlling and accessing the intelligent management systems is possible by using related softwares inside the building and even outside it (through internet). Intelligent control systems have high flexibility which can be adopted different requirements as it is shown in Fig. 1, a general view of smart home capabilities are shown generally. Intelligent based buildings and different features are considered.

Important aspects of the performance of smart home include comfort of people, organizational flexibility, technologic adaptation and environmental performance (Yang and Peng, 2001). Main components of smart home contain: security, safety, comfort, energy management, accessibility, communication systems and integrity.

Smart home contains ten main issues: health principles in the building; proper benefit of space and flexibility; cost effectiveness; human comfort in building; efficiency in doing tasks; security and safety in building; culture; an image of progressive technology; creating process and structure; lovely environment, energy saving and environmental health (Preface, 2004).

Capabilities of an smart home: Smart home based on the definition of "Smart Home institution" is a building which by optimized use of some basic elements: structures, system, service and management and their internal relation creates a proper and cost effective environment (Kroner, 1997; Derek and Clements, 1997). Intelligent control systems will have high flexibility which can be adopted with different requirements easily. Also while utilization, change operation and optimization for better leadership and decreasing energy costs and decreasing costs of repairs. By using variety of sensors inside and outside the building and by using a network and a unit system we can have permanent and real-time information of "temperature, pressure, humidity, weather flow rate, amount of oxygen and carbon dioxide" and use them for reaching to an ideal situation. In smart home by using created software facilities different diagrams based on time can be available and they can be used for improving the quality of living conditions and maximum use of natural weather for residents. There has been a lot of work focussing on activity recognition in smart homes with the aim of the home being to monitor the activities of the

inhabitant and identify deviations from the norm. For a smart home to support its inhabitants, the recognition system needs to accurately learn from the observations acquired through sensors which are installed in the home (Chua and Foo, 2015). While using the intelligent system residents are not allowed to open the window because of energy consumption savings and in administrative buildings before the work hour finishes this system automatically and continuously starts to turn off air conditioning systems. Now a days, modern system's building management are written based on web which its biggest advantage is using privileges of worldwide internet and remotely control of the common communication systems in the world so that by running the considered building's site and by inserting username and password the building can be dominated from any place. User Location Discovery (ULD) is a key issue in smart home ecosystems as it plays a critical role in many applications. If a smart home management system cannot detect the actual location of the users, the desired applications may not be able to work successfully (Ahvar *et al*., 2016).

For fulfillment of smart home different components are involved in researches, execution and exploiting the building which this subject highlights its role and position in urban management. Selecting the ground, geographical environment, choosing building materials, structural design, interior architecture andfinally predicting automation capabilities and controlling the components involved in buildings safety and also controlling the access and recognizing different people affect the principles and frameworks of civil and urban development activities. So considering intelligent design principles as mandatory civil engineering standards in future is not so far. Service oriented technology by sharing processes in worldwide web has many applications in commercial and industrial problems. In subjects such as crisis management and energy management two topics of information updating and processing have significant importance which service oriented technology could provide ease in these two. Regarding to that in smart homes and the way of controlling the system because of rapid changes and wide domain of smart home's facilities, existent of sensors and various motivators including control of environment, energy consumption optimization, labor force welfare, safety and continues and non-continues supervision from any place in different periods of time and integrated for doing normal functions from change, regulation, report, measuring, counting an also containing necessary infrastructure for controlling mechanical and electrical installations, air conditioning, fire alarm and extinction, security and surveillance, control of elevators and other components of the building, requires management and correct performance recognition of each one of the

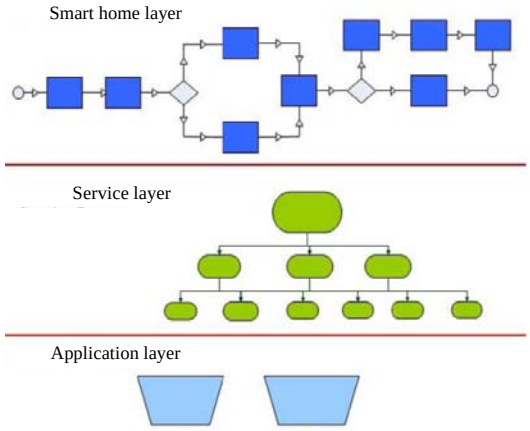

Fig. 2: SOA layers in smart home

facilities in proper time based on data obtained from building facilities; service oriented architecture because of having access to various database and service in range of internet is a proper solution for accessing updated data and processing it for decision making and planning goals, also use of multimedia systems in this topic will cause ease and better performance for the user. Smart grid is a concept that integrates Information and Communication Technologies (ICT) with grid power systems in order to achieve efficient and intelligent energy generation and consumption (Iyer and Agrawal, 2010).

Service-oriented architecture in smart home: The increase in building automation has several reasons. In addition to energy savings, the user also expects higher comforts, safety aspects and flexibility in the housing sector. For the implementation of the advanced requirements in building automation smart metering systems are required which additionally feature a digital meter, internal memory and a data interface (Schrader and Tschulik, 2009). The smart building is an extension of the smart meter approach. Different home areas (air, heating, water etc.) are equipped with modern technology. Sensors and actuators are integrated into these areas to perform typical functions such as switching, setting, reporting, measuring and counting. By taking a service-oriented approach, particular sections are linked, reused and defined in a better way. In computer science, a SOA is required for the implementation of service-orientation. SOA is an IT concept that supports the execution of business processes by using comprehensive services (Teich *et al*., 2014). Figure 2 shows structure of SOA layers in smart home

When using a service-oriented architecture an efficient Service-Oriented Platform (SOP) which ensures

a simple handling of the services must be implemented. In this context, the java-based service platform OSGi (Open Services Gateway initiative) is used which provides an open architecture for the development, deployment and management of services. Modularization is the basic concept of OSGi which aims to break down complex software into individual parts that are easier to handle. The OSGi module is a set of Java classes and resources that are packed in a Java archive. In OSGi terminology an OSGi module is called a bundle. This modularization is comparable with classic application extensions which can be linked dynamically at runtime (Teich *et al*., 2014). From the perspective of software development, a Service Oriented Architecture (SOA) can be installed by the use of OSGi. Like services in a SOA, single software components can be implemented, updated and exchanged without problems in OSGi. Software is divided into several manageable modules and smart home processes into reusable services. For stable performance, a bundle corresponds to one or more services of the smart home layer (Weber *et al*., 2010).

Service oriented capabilities and multimedia systems alongside smart home: In building automation field, lots of intelligent components and existent devices are under cover of similar applications. This variety shows a major challenge for developing flexible software for controlling systems. By using service oriented architecture, traditional state of using the integrated devices and components within the residential complex could be shared with each one of the systems and communicate by protocol. Amazing programming efforts for executing same functions or similar ones in different places of each device has been increased. Moreover, solution provided by a specific producer is usually limited and only some options are provided for optimizing supervision on complex processes (Teich *et al*., 2014). In addition to service, supervision and control algorithms will be executed. Smart home systems comes towards SOA where devices become services though abstraction which wraps device functionality into machine-understandable format. A typical SOA for intelligent SH (Smart Home) system is shown in Fig. 3 which shows how middleware technology interoperates with various services from heterogeneous connected devices (Hui *et al*., 2016). Middleware is usually deployed as a Mulit-Agent System (MAS) with each software agent performing unique interoperation between services autonomously inside intelligent system platforms (Liang *et al*., 2008; Pahl *et al*., 2009).

Detection of human activities is a set of techniques that can be used in wide range of applications including

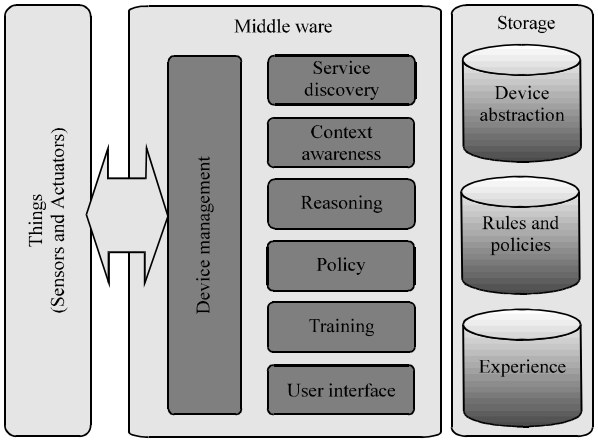

Fig. 3: Typical SOA for intelligent SH (Smart Home) system (Hui *et al*., 2016)

smart homes and healthcare. This information can be used in applications that control HVAC (Heating, Ventilation and Air Conditioning) and lighting systems or in Ambient Assisted Living (AAL) applications which monitor the people's wellbeing (Skocir *et al*., 2016). Processing received signal from different sensors shows some attributes about objects and/or events happened around them. However, sensors usually don't apply any effects on each other which in practice is an optimized state. Each sensor processes information without considering feedback account from neighbor sensors and forcing lots of limitations in smart homes. Moreover, compressed researches in past few years have lead to optimization of reliability of information from sensors, however has reached to constraints in that (Hu *et al*., 2004). Users have access to multiple sources of digital content, including user-generated content and commercially distributed content. At home, users want the option to find relevant content sourced from any location (internal or external) and render the content on any target device connected to the home network. So for more improvement of people's support from controlling systems in daily lives gathering and cooperating and processing of sensor data is necessary. Thus existent information and of all sensors and intelligence could be added to each one of them for performance optimization. For example, when a visitor has to be recognized or an insane patient should be investigated, smart home platforms could convert to infrared video sensors in bad light condition dynamically or by using other image processing algorithms in response to change in movement, temperature or light be done (Hoecke *et al*., 2014). Combination of sensor information in a smart homes platform is a promising approach toward improving recognition and interpreting

advanced events and is also the subject of this study. By combing sensor data, amount of available information is increasing rapidly which unfortunately face that with numbers of problems (Molla and Ahamed, 2006). So, below challenges should be addressed in order to confront with these amounts of data: Presenting sensor information, finding data of the related sensor, issues related to performance (Hoecke *et al*., 2014). The core components behind these multimedia technologies are human-centered multimedia services which combine many Welds of information technology including computing, telecommunication, databases, mobile devices, sensors and virtual/augmented reality systems. Human-centered multimedia services are built upon three key research pillars that includes. These are: Human Computer Interaction (HCI); multimedia delivery and multimedia data management. HCI (e.g., via. the use of keyboard/mouse input devices) is the initial component of the multimedia information Xow with the responsibility of generating outputs by interpreting inputs from the users. Multimedia delivery systems (e.g., the Internet) are responsible for transparent information delivery (e.g., streaming video) from sources to destinations. Finally, the multimedia data management components facilitate information access (e.g., browsing, retrieval and indexing) (Jinman *et al*., 2008).

Although, smart homes are composed of heterogeneous networks and device's capacities. Devices differ in terms of both communication technologies and capabilities (software and hardware). Indeed, these devices often use different communication technologies where the interoperability cannot be ensure. Moreover, these devices range from high-end PC devices to low-end battery-less devices. The heterogeneity of networks and device's capacities increase the complexity to exchange information between them (Pardo *et al*., 2016). Current solutions for smart homes are presented by using different technologies which are dedicated or non-compatible with each other which are obstacle for mass development in market. For overcoming this subject, service oriented architecture is presented for supervising multiple sensors in smart homes (Hoecke *et al*., 2014). Moreover, reasoning strategies and advanced interpret could be added to sensor data combination which allows information to combine and investigate between video sensors (camera) and other non video sensors (such as temperature, voice and heart beat). This will enable advanced capabilities of sensors for recognizing complex events which are not discovered yet. As a result, supervision and providing care services in a platform of smart home could be improved significantly. For increasing energy efficiency in smart home first of all you need to control building services and devices regarding to current situation and their framework (Marian *et al*., 2013). Smart home control is a customer based intelligent control which is defined by using system's configuration for a specific place by a specific user. When control software is available, control of the device will be done from server. Thus powerful traditional mechanism can yet be also used for device calculations but they download the code and run it in the controller as a result control devices can remain simple, small and low cost and can be settled in an extensive scale (Marian *et al*., 2013).

Moreover, the general performance is simple and also by utilizing adoptive behavior benefits provided by service oriented architecture. Each service brings one unique capability for creating an all-task and adoptive system. So, design is simple while it allows dynamic behavior and continues validation. Control is small, simple and portable but allows control services to be downloaded from server and by different control services, it will have different behavior. In this method, the control of adoptive behavior provided by service oriented architecture as control service and new policies could be created or in future without control change support is created. A motivation for a control is small and portable that could be expended to many buildings in the world from financial point of view and yet working with variety of devices, operating systems and control policies so it is not necessary for existent devices or infrastructure devices and living environment such as hosting to be ready for change. As it is depicted in Fig. 4 some smart home applications before and after using service oriented architecture are compared with each other.

RESULTS AND DISCUSSION

Evaluation: Regarding to some investigations and also in the study of "Ubiquitous Multimedia Information Delivering Service for Smart Home" which was done by Hsu *et al*. (2007) researchers investigate and provide non-stop multimedia services (for example sharing voice and image, playing simultaneously from multiple points of the home and) in smart homes which based on the subject of this thesis the goal of doing this research is investigating and expressing the positive effect of service oriented architecture alongside multimedia systems and also controlling the system by using multimedia services in smart homes. Also in the article "SAMUS: Service Oriented Architecture for Multisensor Surveillance in Smart Homes" which was done by Hoecke *et al*. (2014) also the emphasis of researchers is on investigating multiple sensors and applying service oriented architecture on sensors. Also in study

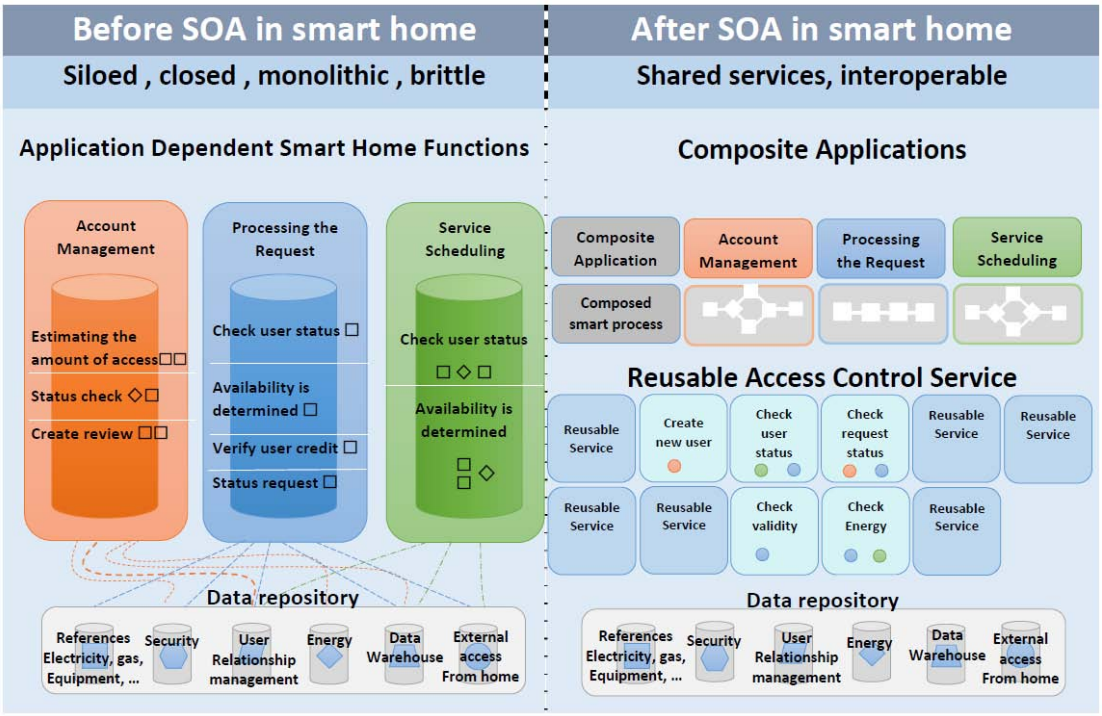

Fig. 4: Comparing some intelligent house applications before and after using service oriented architecture

"Context-aware multimedia streaming service for smart home" which was done by Lai and Huang (2008) has spoken about services such as sharing information, entertainment and relationship of the family members in a smart home. Also in these two past samples the aspect of using multimedia system has not been mentioned. In the study of "Multimedia for future health-smart medical home" which was done by Kim *et al.* (2008) has spoken about presents the latest research and development in multimedia technologies and the transition of these technologies into health care products for the smart medical home. Due to specific applications for smart homes such as healthcare, the potential failures of the system have to be taken into consideration. Hence, anomaly management systems become an indispensable part of the overall architecture (Pardo *et al.*, 2016). Also in article "Design of a service oriented architecture for efficient resource allocation inmedia environments" which was done by Desmet *et al.* (2012) has spoken about the convergence of grids and service oriented architectures offers both performance and flexibility, making it an attractive combination for any business domain. Due to the particularities of a media environment however and especially at the network level, design and implementation of an efficient Service Oriented Architecture is no trivial task. In subjects such as crisis management and energy management, two topics of information updating and processing has lots of importance which service oriented technology can provide ease in these two; unfortunately, that will be faced with lots of problems so below challenges should be issued in order to confront with this amount of data: presenting sensor information, finding data related to sensors; issues related to performance for overcoming this subject service oriented architecture was presented for supervision and correct, on-time and easy decision making in smart home.

CONCLUSION

This study addresses the vision that the residential buildings would shift themselves toward modern households that would be an evolution of the passive household. In most study the aspects of patients, elderly and children caring is considered and also in dedicated topics energy management topics are covered and regarding to opportunities which are created from the combination of sensor information in a smart home platform and multisensory supervision in smart homes which was the subject of many researches and regarding to the novelty of the subject in using multimedia systems and service oriented architecture in intelligent systems and its application in wide range of smart homes, this

subject will be converted to a functional plan; performance and presentation of better and on-time service in smart homes for ease of better use of the user. In this study, ubiquitous multimedia services were proposed for presenting information in smart homes. Smart home can feel situation changes automatically and response to reactions dynamically and help easier life of residents; and also is as a comprehensive solution which in automatic using, dynamic selecting and sensor combination is presented. A combination of sensor information in a smart home platform is a hopeful approach toward improving recognition and developed event interpretation and is also the subject of this research.

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