ARCHITECTURE OF HOME NETWORK AND RESIDENTIAL GATEWAY FOR IOT

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ABSTRACT
with development of IOT (Internet of Things), a new architecture of home network is required. In the architecture, semantic description of services and devices is introduced. And hardware architecture of residential gateway is for the home network architecture based on the multi-core processor. At last software architecture of residential gateway is put forward.

KEY WORDS
Home Network; Internet of Things (IOT); Residential Gateway(RG); Multi-core Processor

1 INTRODUCTION

In recent years, with development of computer technology, network communication technology, sensor technology, and increase of intelligent home devices, it is possible for them to network and work together, to build a smarter home network and provide more convenient services, such as Entertainment services, communication services, Automated Services, Security Services and Care Services[1].

For telecommunications technology, home network standards, ITU-T, ETSI and CCSA (China Communications Standards Association), are to study how to introduce NGN(Next Generation Network) services to the home, as a part of NGN. ITU-T Study Group has several studies in the direction of home network standards. NGN @ Home in ETSI has established a special work group, currently developing series of standards related to home network. In addition, CCSA's home network standard project completed two standards of home network, such as the general technical requirements for telecommunications network equipment and home network, technical requirements for home gateway.[2]

For home network devices interoperability, researches, such as DLNA(Digital Living Network Alliance), IGRS, ITopHome, UOPF (Ubiquitous Open Platform Forum) , are as the representative. They ensure compatibility and interoperability between electronic devices of home network, such as entertainment devices, household appliances and information equipment.[2]

For network transmission, researches, mainly inluding HomePlug(home Powerline Alliance), HomePNA (Home Phoneline Networking Alliance), Wi-Fi, Bluetooth (bluetooth), IEEE 139, HomeRF, Zigbee (IEEE 802.15.4), MoCA (Multimedia over Coax Alliance) and other IEEE standards, are to examine how the home network devices communication between the internal and external network.[2]

For home automation, researches are mainly for solving automatic control problem between varieties of home lighting, security, electrical appliances. Echonet Association aims to develop through the power line communication technology and wireless communications equipment to connect to a variety of standard household appliances. CEBus develops a network communication standard, which describes communication and control methods between home electronic products.[2]

For middlewares in home network, their functionalities are to shield heterogeneity between hardware, operating system and communication technology, to enable a variety of home network devices to discovery and interoperate. Related organizations are UPnP, OSGi (Open Service Gateway Alliance), HAVi, Jini, LnCP. [2]

But the devices in home network follow different standards and have different performance and functionality, which builds a heterogeneous network. Previously, the home network interconnection is mainly based on interoperability of the home network protocols. In the context of IOT, these ideas have been unsuitable for the construction of home network architecture. Semantic methods are introduced for heterogeneity in home network. [3]

For the home networks of IOT, home network must be available, secure, manageable and accountable. To achieve these objectives, a residential gateway (RG) is presented based on multi-core network processor in the paper. Section II describes application model and architecture of home network. Section III describes hardware architecture of RG. And section IV describes software architecture of RG.

2 APPLICATION MODEL AND ARCHITECTURE

In fig.1, home network application needs three links, such as SPL (Services Providing Link), SDL (Services Delivering Link) and SRL (Services Rendering Link), in order to carry out various service operations in home network.

In SPL, home networking applications are classified into five categories, Entertainment Service, Communication Service, Automation Service, Security Service and Care service. They use the their own system to provide services.

In SDL, Telecommunication Networks, TV networks and Internet would be service delivering network. Home network Applications is not only typical applications of IOT, but also typical applications of tri-networks integration.

In SRL, there are RG(Residential Gateway), STB (Set-top box), TV, phones, sensors and automation equipment. These devices are classified to different subsystems, such as Entertainment Subsystems, Communication Subsystems, Automated Subsystems, Security Subsystems, Care Subsystems of Home Network, according to the requirement of services. Each of subsystems is assumed in rendering different services.

Home network architecture for IOT is shown in fig.2. It includes five layers, such as DEIL(Device Entity Implementation Layer), DSDL(Device Semantic Description Layer), DCML(Device Cooperation Mapping Layer), SSPL (Service Semantic Parsing Layer) and SRAL (Service Rendering Agent Layer).

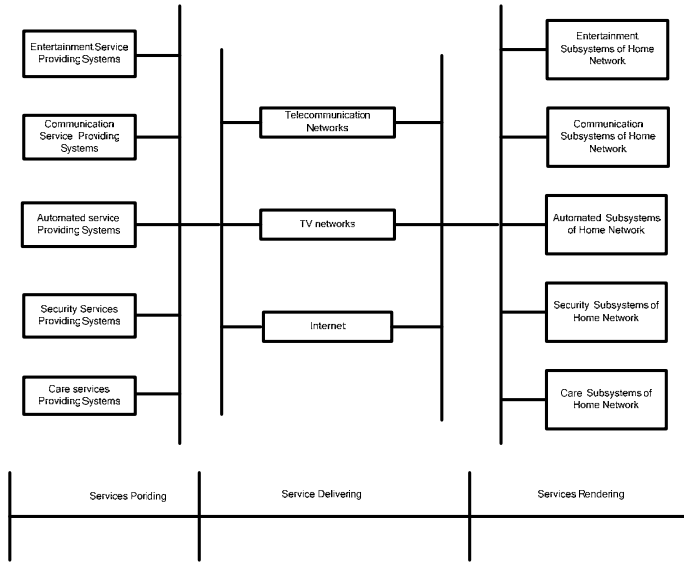

Fig 1. Home Network Application Scenario

DEIL include common intelligent device in home network, such as RG, STB, TV, phones, sensors and automation equipment. They can use interfaces to exchange information and instructions with external devices, which is their common feature.

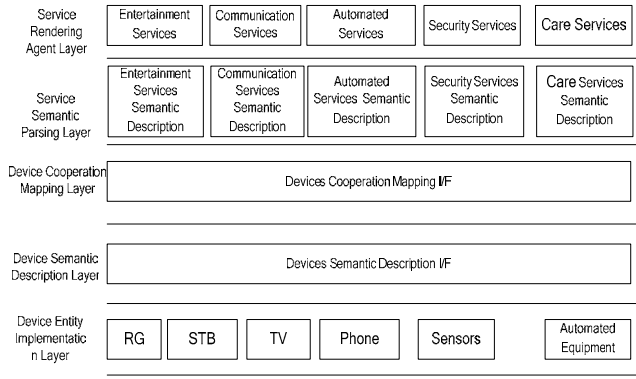

Fig 2. Home Network Architecture for IOT

DSDL achieves the semantics abstract of the device capabilities, to support devices semantics description interfaces, which shields the differences of device protocols.

SRAL achieves specific service with service agent, which includes specific service logic. Each class of services has the same architecture of agent. With SSPL, service semantics descriptions are achieved.

DCML implements map between SSPL and DSDL. According to requirements of services, DCML organizes more devices to work together, which support more complex applications.

3 HARDWARE ARCHITECTURE OF RG

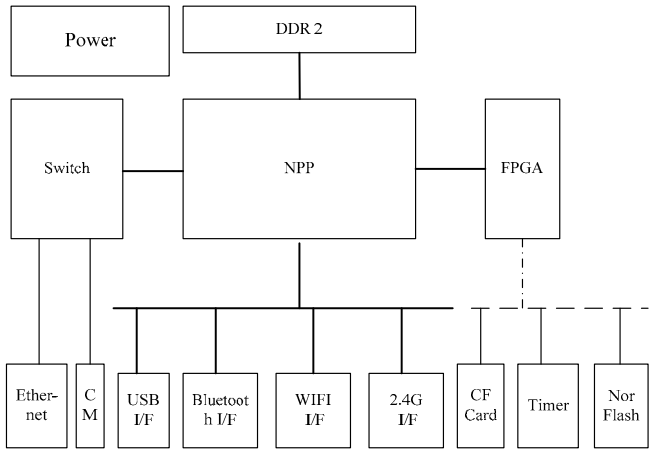

Fig 3. Hardware Architecture of RG

RG mainly consists of five modules or parts, which are NPP (Network Processing Part), DDR2 memory, network switch module, extended interfaces and extended module, as shown in fig 2.

NPP is mainly based on multi-core processor Main chip of NPP is CN3860 coming from Cavium corporation[3]. CN3860 is Multi-core MIPS64 processors, which targets intelligent, multi-gigabit networking, control plane, storage, and wireless applications in next-generation equipment. The family includes fifteen software-compatible processors, with four to sixteen cnMIPS64 cores on a single chip that integrate next-generation networking I/Os along with the most advanced security and application hardware acceleration[4].

With network switch module, RG supports Ethernet and CM(Cable Moderm). Extended interfaces mainly include USB I/F, Bluetooth I/F, WIFI I/F(802.11a/b/g), 2.4G I/F, which can support more kinds of devices. With FPGA logic, extended module supports CF card, Timer and NOR FLASH.

4 SOFTWARE ARCHITECTURE OF RG

As shown in fig 4, Software Architecture of RG includes seven parts, OS, DEIL module, DSDL module, SRAL module, DCML module, SSPL module and Knowledge DB(Database).

For OS, CN3860 support SE (Simple Executive) and Linux OS. Some real-time applications or software modules can be developed on SE OS.

DEIL module mainly includes device drivers and protocols, in order to implement device inter-network. Real-time features must be confirmed, so some software must be implemented on SE OS.

DSDL module achieves the semantics abstract of the device capabilities, which shields the differences of device protocols. And same kind of devices should have the same software architecture.

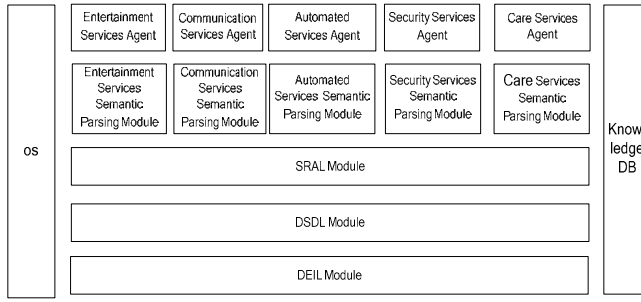

Fig 4. Software Architecture of RG

SRAL module achieves specific service with service agent, which includes specific service logic. In the architecture, Entertainment Services Agent, Communication Services Agent, Automated Services Agent, Security Services Agent and Care Services Agent are implemented to support common service.

Each kind of service agents has one kind of Service Semantic Parsing Modules. So there are five kind of Service Semantic Parsing Modules: Entertainment Services Semantic Parsing Module, Communication Services Semantic Parsing Module, Automated Services Semantic Parsing Module, Security Services Semantic Parsing Module, Care Services Semantic Parsing Module.

5 CONCLUSION

The paper presents the architecture design of Home Network for IOT. It gives hardware and software architecture of Residential Gateway. It supplies a total solution to the digital home network.

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