Integrated Residential Gateway: Easy IA Management with P2P Community Using RFID

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Abstract − *Ubiquitous network connectivity and enhanced home-appliance technologies are leading to an evolution in advanced consumer electronics equipment, called the Residential Gateway (RG). This paper proposes an IPv6-enabled platform-independent Integrated Residential Gateway (IRG) skeleton that integrates a novel P2P solution based on IPv6 networks. For network equipment to exchange information and gain benefits, this approach combines the current RFID, RG IA management, native IPv6 DNS and the Blog Community.*[1]

Index Terms − **RFID, Residential Gateway, IA, IPv6**

I. INTRODUCTION

Ubiquitous network connectivity and enhanced home-appliance technologies are leading to advanced evolution in consumer electronics equipment, called the Residential Gateway (RG). In the near future, consumer electronics products at home are going to be fully intelligent and interactive with broadband access connection, wireless LAN connectivity, multi-media streaming, etc. To easily achieve wide intelligent appliance (IA) [1, 2] adoption reduce configuration efforts and time consumption in seeking support, this paper offers easy IA management interoperability methods among product suppliers (e.g., product manufacturers), product vendors (e.g., shopping-mall, wholesale market) and purchasers of home IA by accelerating the IA (or consumer electronics setup time).

To propose the above-mentioned concept, we implemented an IPv6-enabled platform-independent Integrated Residential Gateway (IRG) architecture, which combines the current trend of Radio Frequency Identification (RFID) [3, 4, 5, 6, 7], RG IA management, IPv6 DNS [8] and the Blog Community [9, 10]. The IPv6 [11, 12] end-to-end feature holds the potential architecture that closely correlates with peer-to-peer applications in order to archive a wide-reaching influence. After which, many new P2P [13] solutions based on IPv6 network might develop.

The RFID tag is planed to work together with product manufactures to establish standards for businesses that will enable them to link their entire supply-chain. The RFID chip is contained within a glass capsule that is slightly larger than a grain of rice. This capsule is injected into or glued onto products when they leave the plant. However, RFID tags do not have a power supply. An electrical current is induced by an antenna on the RFID reader and the incoming radio-frequency triggers enough power in the RFID tags to send a response.

This embedded system [14] supported by the IPv6 can work under the next-generation Internet environment and will be more effective because of its remote control capabilities which provide more functions than standard network controls. Through this embedded system, a residential gateway could easily deliver data to command, access and control information appliance products. A socket enables on-line function via the IPv6 form, called Socket6. If the embedded system is plugged into a wireless connection, the residential gateway would connect through the wireless network. The network could then be used to control the information appliance products and this frees up space restrictions.

A weblog P2P application contains periodic posts displayed in reverse chronology on a common web-page. Such a web site is typically accessible to any user on the Internet [15]. The blog system could allow users to publish content on their own web site without having to edit annoying HTML scripts. Each blog article has its own fixed globally accessible URL address, which allows an articulable citation. Blog users function as a community by posting comments and auto cross-referencing each other with the trackback feature. This enables automatic notification between websites of related content through RSS, an XML based web-content distribution, republication, and aggregation protocol.

The P2P community recognizes a supplier's server which replaces shared knowledge applications. With an auto-configured community, consumers can easily share and discuss their evaluations and experiences with purchasers without annoying searches (for web) and registration (for forum) processes. The blog represents the p2p community, running in a remote weblog system strutted in XML and a combination residential gateway, manageable news aggregator, displaying a digital diary or personal website for news publishing.

II. THE IPV6-ENABLED RESIDENTIAL GATEWAY ARCHITECTURE

The designed IRG is able to read information from the RFID tag, connect the supplier-side server to activate products, register a Home Network Domain Name [8], update the IA help manual and control module, and gain the required information for news aggregator and remote blog category trackbacks. As shown in Figure 1, the IRG is composed of

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four modules, the RFID module, the RG IA module, the IPv6 DNS module, and the Blog module, as presented in the following:

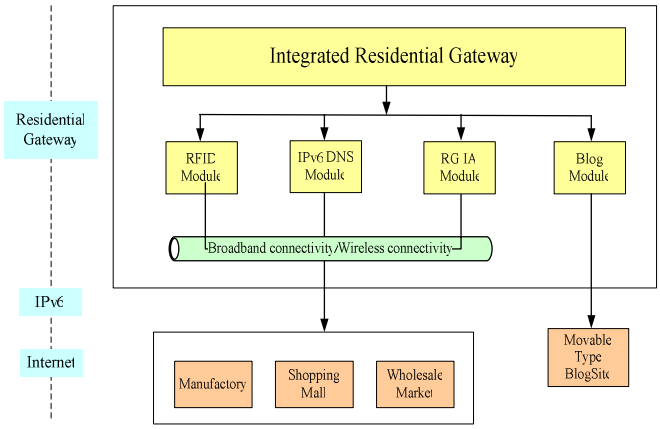

Fig. 1 The Integrated Residential Gateway Architecture

A. RFID Module

The RFID tag is attached to the consumer electronic product, expressing an active data structure including the product's identifier, which refers to its consumption services, including information on the consumer and shopping-mall. With the IRG, the identifier data is sent back to the factory to check whether the product is allowable or overdue. The product identifier can associate the inventory IT system in verifying the product's stock level. To recognize the IA product reliability, the RFID module can be supplied by the original product manufacturer with confirmation for downloading related services provided by manufacturer, such as user manuals, drivers, value-added content, periodic circulars or Web-based control operation interfaces, etc.

The RFID module is divided into two parts. The first is a tag card that stores data like bar codes or product identification. The second is a reader that induces the antenna to provide enough power for the tag, read data from the tag, and forward data to embedded systems for processing. Once the tag card is close to the reader, the reader can shoot electromagnetic wave energy to power the tag card. The card then identifies the data transmission, allows the reader confirm and further control actions using a lead-in electric wave. The data on the RFID determines what program is run.

B. RG IA Module

The RG IA module acts as an agent to support a wireless interface to control the IA bound in a controllable embedded system that can only be accessed through IRG. IRG can be used to download helpful manuals and web-based control panels from manufacturers, as well as control the IA equipment with the RG IA module.

The IA Module is needed for web-based control operations by the manufacturer for downloading, operating and controlling IS merchandise of IA that the consumer can buy through this interface. Different merchandise contains different characteristics and functions. Different IA merchandise therefore contains different web-based operation interface controls.. For example, air-conditioner and microwave ovens have different control interfaces.

C. IPv6 DNS Module

The IPv6 DNS system is designed for accessing decentralized resources, operating in an unpredictable IP address environment, and supporting IPv6 linked to IPv4 information. IRG nodes must operate the IPv6 DNS system and should be significant in terms of supplier-side servers. The IPv6 home network domain name auto-configuration also allows the IA to acquire its domain name automatically without manual configuration. Through an initial automatic message communication protocol, users can "plug and play" with IA devices via its unique ID.

D. The Blog Module

The Blog Module is a module that carries out the P2P operations. With this module, the consumer can establish IA merchandise clubs with the consumers of other products on the network. ALG (Application Level Gateways) helps the address in order make the residential gateway of the consumer, go to the RFID tag ID through the manufacturer's server address, and complete the conjunction for download.

When the RFID Tag ID can store more information, it can include the address of IPv6 of manufacturer's server. The ALG can go to the manufacturers server address. The Movable Type Blog site is an interface that uses a familiar gateway machine that provides interconnections.

III. Easy IA Management With the P2P Community

Let us assume that someone bought an IA product that is attached with an RFID tag from a specific supplier manufacturer. The supplier had all merchandise inside the RFID tag set up coded. The supplier also provides a server for users to register with and download the manual and web-based control interfaces for after product sales service. This server can provide periodic product information and a group list of products for the buyer. The workflow is shown in Figure 2.

The IA product is read from the RFID reader at the saleroom counter. The data (i.e. the identification of the product and the supplier's IP address) for the IA product will be sent to the supplier server for confirmation. If the supplier's server responds, this indicates that the merchandise is an original product. The saleroom then sends a confirmation message to the supplier. Once confirmed, the supplier will wait for the consumer to use the merchandise at home. The saleroom can spread the pen sale record into of the merchandise sale and restocks IT system, reporting to suppliers to indicate that that merchandise has been sold.

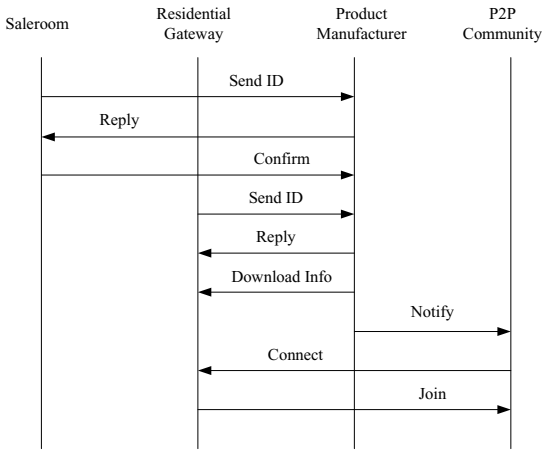

Fig. 2 The IA Management Workflow

The consumer then brings the IA product home. When the IA product passes through the RFID sensor the product information spreads to the residential gateway. The residential gateway then gets the product information and auto spreads to the supplier for registration and confirmation. The factory returns a message to the buyer and activates the merchandise. The supplier's server will provide and keep the information for the user manual of the IA product, the driver, the latest information of IA product, and web-based control interfaces for downloading to the residential gateway of the customer.

If the buyer notices any problems with the product, the buyer can contact the manufacturer immediately through the on-line system. The buyer can then obtain help to fix the problem. An example can be renewal of the latest program drive or software (such as cellular phones), etc. At the same time, the supplier can also periodically notify the buyer of latest dynamic state news, warranty term of the merchandise for the customer. To make use of the on-line real-time service system, the product can also have Q&A for its operation usage. The consumer can use the web to directly control the IA product.

The customer's residential gateway will join a PZP merchandize community. Customers can, at any time, browse through the community merchandise. The community uses the merchandize information to study or discuss the products, conditions, etc. together. With security in mind, we implemented an online registration procedure. After registering the new IA, the buyer can acquire command functions, online-help manuals and subscriptions to an officially supported blog community.

IV. IMPLEMENTATION

To achieve this objective, Figure 3 shows the basic IRG system. We chose the most popular web server combination, the LAMP (Linux, Apache, MySQL, PHP) as the based environment. The residential gateway comes to pass through the APACHE server and PHP module that supports the IPv6 network. To manage multiple IA in IRG, we designed a home network protocols to ensure smooth management for the customers. First, IRG can automatically acquire control functions from the manufacturer's server. If the server link is down, the IRG can observe IA signals and drain out the function strings, because the IRG is needed to recognize each kind of IA communication format from different manufacturers. Figure 4 illustrates the PHP program procedure [16]. All procedures are written in PHP script. When users brows the PHP web-page, the PHP script records information of the IA and connects to the embedded system for obtaining the device state string. The web server then generates a webpage-to-user browser.

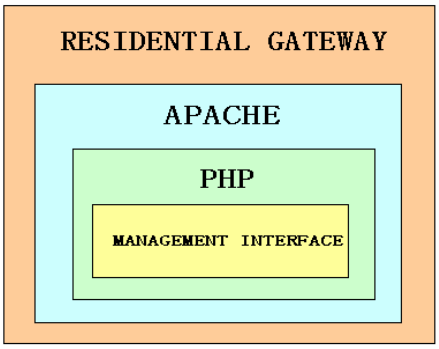

Fig. 3 Basic Residential Gateway Architecture

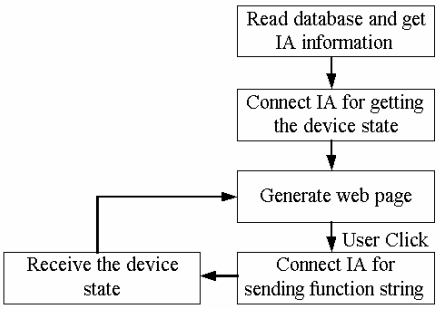

Fig. 4 Management Interface program Flow

As shown in Figure 5. the RFID reader scans the RFID tag to decode the tag's value, then sends it to its RS-232 interface. The linux-embeded system receives the ID value and transmits the data to the residential gateway using LAN. Figure 6 shows the RFID workflow between the tag and reader.

The Socket6 applies the program to a known communication to establish a link while designing the network program. Both ends must have a mutual transit order with the server. This communication, called socket, carries the order. Under the TCP/ IP, the Socket constitutes an IP and a port numbers (communication wharf serial number). A port number lets the IP host know which service is used. When a special subject team wants to develop a network-applied program, the socket that is done first decides the usage. In this instance, the network layer then use an IP, and the transmission layer uses UDP and TCPs.