Home Gateway Enabling Evolution of Network Services

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Broadband access services have spread rapidly and are now widely diffused. Also, new network services offered via broadband access are attracting public attention. We are now conducting R&D on a home gateway that connects various devices and appliances in the home to the network and provides new network services through them. This paper introduces our newly developed "Multigateway," which is a multifunction home gateway with an integrated broadband router and service adaptors. It then describes the concept of a platform for providing services for the next-generation network and the architecture of a home gateway called Service Gateway that realizes this concept. Finally, this paper describes a home appliance remote control service as an example of new services provided on the platform and describes our newly developed technologies that enable the realization of these services, including a prototype system.

1. Introduction

Recently, broadband access services have attracted worldwide attention. In particular, in Japan the number of broadband access lines has increased dramatically over the past several years. As of December 2005, there are 22 million lines,[1)] making Japan the world leader in penetration of broadband access. Also, there is a growing interest in providing new network services over these broadband lines. The network services attracting the most attention are high-speed Internet access, Internet Protocol telephony (IP telephony), and IP-TV, which collectively are called Triple Play. A large number of service providers have started providing Triple Play as their key network services over broadband access lines.

Among the key elements enabling Triple Play are broadband access devices, including Asymmetric Digital Subscriber Line (ADSL) and Fiber To The Home (FTTH) access devices. Fujitsu Access of the Fujitsu Group provides a full line-up of these devices.

Also, the Voice over Internet Protocol (VoIP) adaptor needed for IP telephony service is increasing in importance. We assume this adaptor box placed in the users' homes will evolve into a critical device that provides various new network services to users. We call this device a "home gateway." Although the term "home gateway" is often used, there is no standard definition yet. We have defined a home gateway as not only a device that provides Triple Play but also a device that enables new network services to be realized by connecting home appliances to a network. We are currently developing home-gateway technologies and products.

This paper introduces a home gateway that provides IP telephony over broadband access and Wireless Local Area Network (WLAN) within the home. It then proposes the concept of the service delivery platform and describes the architecture of the home gateway, which plays the most

important role in the platform. Lastly, this paper describes home appliance remote control as an example of the new services provided on the service delivery platform and technology we have developed that makes the service secure.

2. Multifunction home gateway

These days, broadband access services usually bundle optional services such as IP telephony and WLAN. Conventionally, to use these optional services, users had to install IP telephone adaptors and WLAN adaptors in their homes. However, installing multiple adaptors in a living space can become problematic from the viewpoints of installation space and economical efficiency. Moreover, it can be very difficult for general users to connect and set up these devices, and the resulting large number of calls to support centers has become a serious problem for service providers.

To solve these issues, in September 2005, Fujitsu Access released a multifunction home gateway called the Multigateway. As shown in **Figure 1**, the Multigateway is a box that integrates a VoIP adaptor, WLAN adaptor, and broadband home router. The Multigateway requires less space and is less expensive than the conventional solution. It also automatically sets itself up to reduce the users' workload.

The Multigateway has VoIP functions to provide IP telephony service. They include a Quality of Service (QoS) function, which forwards VoIP packets with high priority and provides a high-quality telephony service.

The Multigateway also provides WLAN within the home using a Personal Computer Card

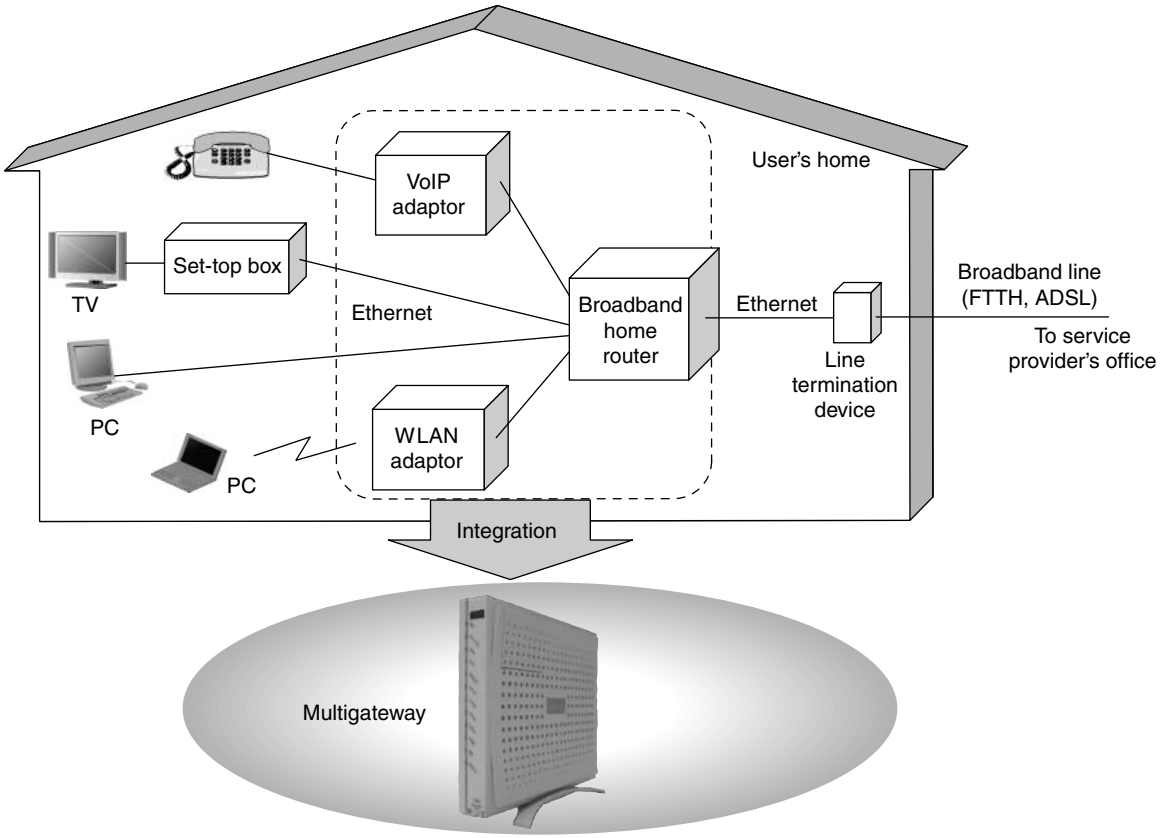

Figure 1
Multifunction home gateway: Multigateway.

International Association (PCMCIA) based access-point card that is installed in the Multigateway if needed. Because of this add-on feature, the service provider can easily add a WLAN service, even after initial setup. The Multigateway has a four-port wired Ethernet interface on the LAN side to connect multiple devices within the home. The Multigateway can assign bandwidth and QoS to each port individually. Therefore, it can provide advanced QoS-enabled services by cooperating with the QoS features of service providers' networks.

To prevent problems during setup, the Multigateway automatically sets up the parameters for IP telephony, WLAN, and Internet access. It automatically downloads parameters from the service provider's server and then sets itself up. This feature prevents incorrect setups and also enables management of setup parameters by service providers. In addition, the Multigateway periodically accesses the service provider's server to look for updates of its software and automatically downloads the updates when they are found. The Multigateway also supports IPv4/IPv6 dual-mode routing, so it will be ready for the upcoming IPv6 networking.

With its integrated VoIP adaptor, WLAN adaptor and broadband router functions, and the automatic setup function, the Multigateway reduces the installation and operation costs so that an economical broadband access service can be realized.

3. Service delivery platform

The previous section described how the Multigateway contributes to smooth and economical provisioning of services over broadband access. This section describes our proposed concept of a service delivery platform and the technologies we developed for the platform. It also describes the Service Gateway (SGW), which is the key component of the platform.

3.1 System architecture and features

As shown in **Figure 2**, the service delivery platform consists of an SGW, SGW management server, and service portal. The SGW is positioned at the boundary between the home network owned by the user and the network provided by the access service provider. The SGW management

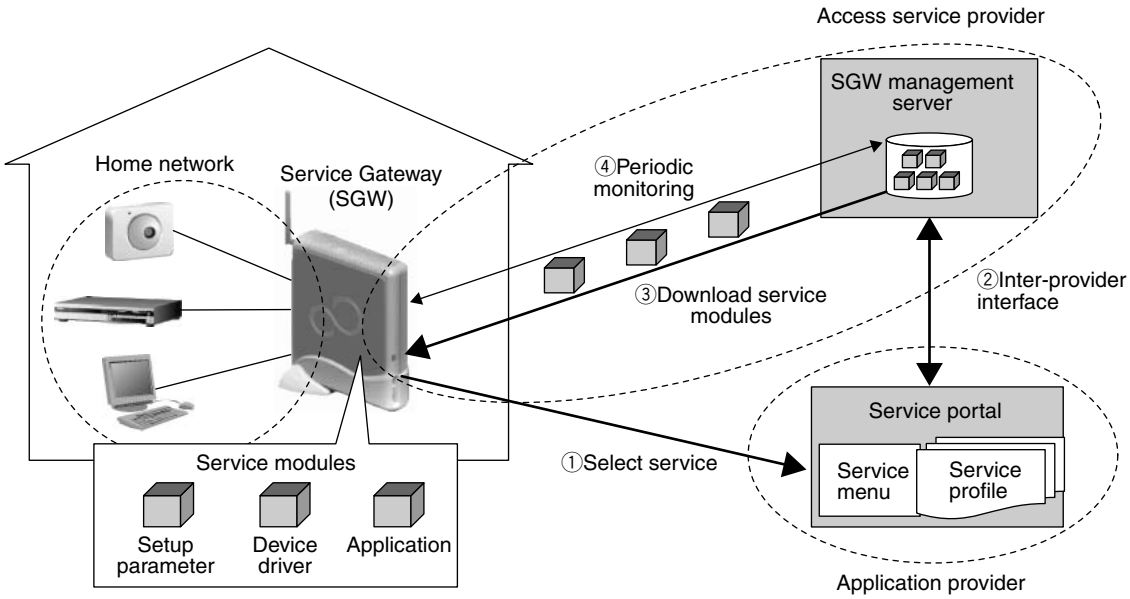

Figure 2
Service delivery platform.

server is placed in the operation center of the access service provider and managed by the provider. We separated the service portal from the SGW management server so third-party application providers can offer services to users over access services providers' networks. We assume that the Web-service-based server interface (② in Figure 2) is an inter-provider interface.

The key feature of this platform is that when additional SGW software modules are needed to provide a new service, they are automatically downloaded from the SGW management server to the SGW without any manual operation. The software modules, which we call service modules, are the setup parameters, device drivers, and application software. The procedure for automatic download is as follows:

1) The user accesses the service portal through the Web browser of a home appliance or PC and selects the desired service (① in Figure 2).
2) The service portal references the profile of the requested service and tells the SGW management server the names of the service modules needed for the service (② in Figure 2).
3) The SGW management server checks the service modules installed in the target SGW against the database in the server. If the SGW management server detects that the required service module has not been installed, the server sends the module to the SGW and installs it (③ in Figure 2).
4) The SGW management server periodically monitors the SGW, upgrades service modules, and installs additional service modules when the user connects a new device to the SGW (④ in Figure 2).

3.2 Prototype system

We developed a prototype system to confirm the feasibility of the proposed service delivery platform. The software architecture of the prototype SGW enables various types of service modules (setup parameter, native code, Java code, and OSGi bundle[2]) to be added or removed (**Figure 3**). Compared to the OSGi framework, which targets only Java-based OSGi bundles, this software architecture enables a much wider usage. The service-module management block communicates with the SGW management serv-

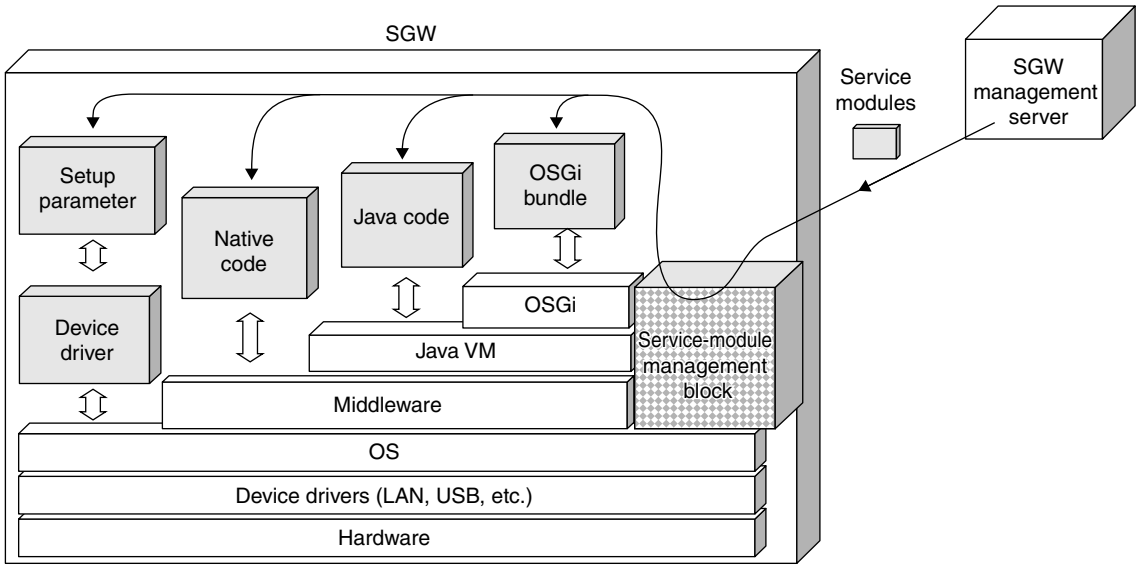

Figure 3
Software architecture of SGW.

er and forwards the service modules to the appropriate layer in the SGW. Communication between the SGW and SGW management server is performed with eXtensible Markup Language (XML) coded data (e.g., setup parameters and status data), which is transferred using HyperText Transfer Protocol (HTTP). We chose this architecture because it is universal and extensible.

We also developed SGW manager software to be installed on the SGW management server. **Figure 4** shows a screen shot of the SGW manager used to perform the following administrative operations:

- View the firmware version and setup parameters of the SGW.
- Add, update, or remove device drivers.
- Add, update, or remove service modules.

Using this prototype system, we confirmed the feasibility of the service delivery platform.

4. Home appliance remote control technology

One of the attractive applications that can be implemented on the service delivery platform will be home appliance remote control using a mobile phone. This service will enable users to program a video recorder's timer, view the inside of their homes via network cameras, and lock/unlock doors.

Since this type of network service allows access from the Internet into the home, prevention of illegal access from the Internet is very important. However, because access control functions of conventional broadband home routers are generally based on IP address filtering, they cannot distinguish authorized accesses from unauthorized ones due to the following reasons:

1) PCs take dynamically assigned IP address when they are used in WLAN hot spots.

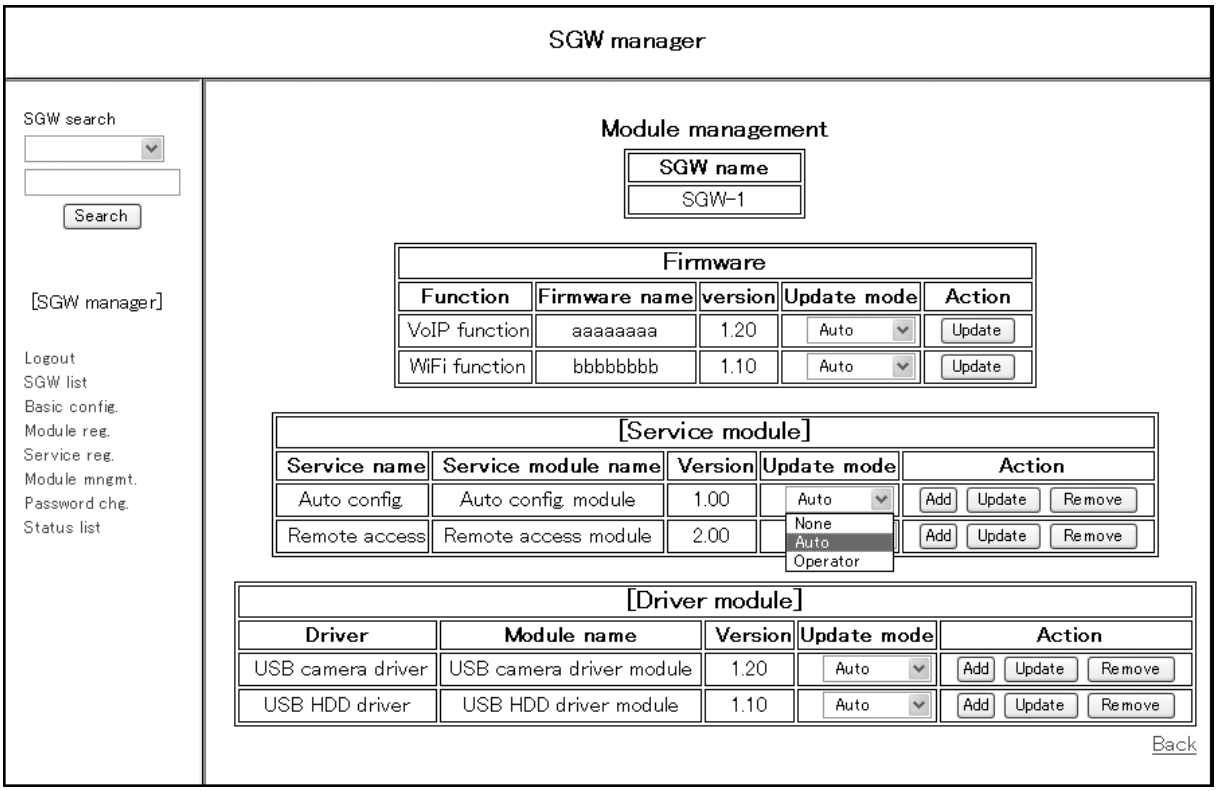

Figure 4
Screen shot of SGW manager.

Therefore, IP addresses cannot be known in advance.

2) Mobile phones do not have their own IP addresses. They use the IP addresses of the gateway devices owned by the mobile communications provider, and many mobile phones use the same IP address.

To solve these problems, we have developed a remote access system that can identify unauthorized accesses and realize stronger security (**Figure 5**). We achieved these features by tightly coupling the operations of the home gateway and the center server, which performs authentication.[3),4)] In this system, the user first logs in to the center server with an ID and password through the Web browser of the remote terminal (mobile phone, PC, or PDA) (① in Figure 5). When the authentication process is completed, the center server sends an access permission code to the remote terminal and home gateway (② and ③). The access permission code is a random number generated by the center server for each access, and it is used like a one-time password in this system. Next, the remote terminal accesses the home gateway with the code (④). Lastly, the home gateway compares the codes received from the center server and the remote terminal, and permits the access only if the codes match (⑤). This authentication procedure therefore can reject unauthorized accesses from terminals that do not have the correct access permission code.

We developed a prototype home gateway to test our proposed architecture. **Figure 6** shows the software architecture of the prototype's remote access function. Web-server functions are implemented on the home gateway to generate Web-based operation menus that are sent to the remote terminal. In this system, the users can utilize the standard Web browsers that are installed in mobile terminals (mobile phone, PCs, and PDAs), and they do not need to install dedicated software on their terminals to use the service. In addition, the system provides easy operation through the unified Web-menu generated by the home gateway, even if each home appliance has a dedicated control interface. The system also supports Universal Plug and Play (UPnP) based automatic appliance discovery and

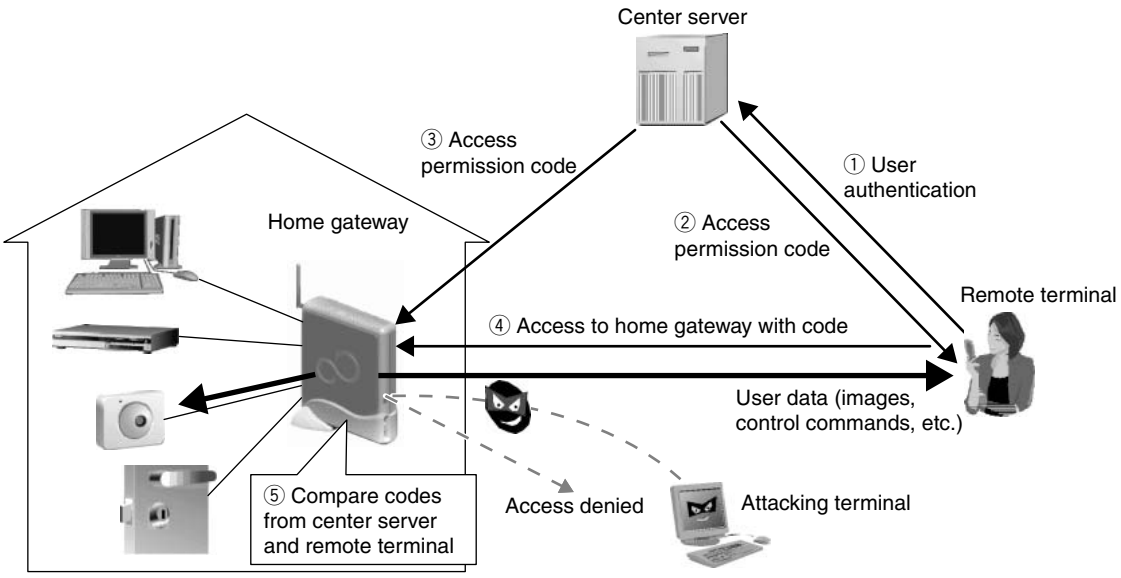

Figure 5
Architecture for home appliance remote control.

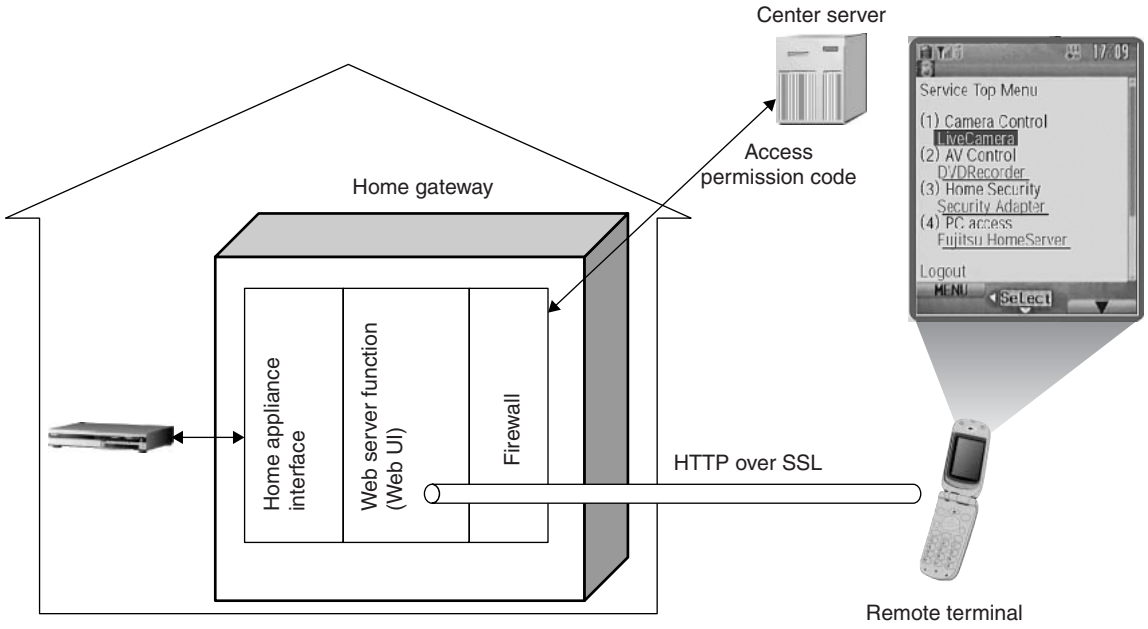

Figure 6
Software architecture of remote access function of home gateway.

HTTP-based appliance control.

Using this prototype, we have demonstrated the following service examples through mobile terminals:

1) Monitoring a room via a network camera
2) Programming a DVD recorder's timer
3) Checking, opening, and closing an electronic door lock.
4) Turning a light on and off
5) Browsing data stored in a home server

These functions are bundled as a remote access module, which is automatically downloaded to the home gateways of subscribers to the remote access service.

Using the prototype, we confirmed that our proposed architecture can deny unauthorized access and that various mobile terminals can be used without installing dedicated software.

5. Conclusion

This paper introduced our R&D activities for achieving smooth and economically effective deployment of new network services over broadband access. Our activities are currently focusing on the home gateway because we believe it will be a very key device to providing future network services. We also believe our technologies and products are contributing to the evolution of network services.

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