Home Network Service Management Technologies

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Abstract

The next generation of home networks will offer flexible service configurations by linking multiple devices on a home network. This article introduces the architecture of Home Service Harmony, a platform for next-generation home network services. It achieves user-oriented service control by fully managing multiple services and devices.

1. Next-generation home network services

The widespread use of optical fiber and ADSL (asymmetric digital subscriber line) is encouraging the use of home networks. Conventional home networks are local area networks (LANs) that connect broadband routers to the user's personal computers (PCs). These days, however, various home appliances (audio/visual (AV) equipment, white goods, etc.) can also be connected to them. Typical services available on current home networks include remotely controlling digital home appliances (e.g., turning an air conditioner on and off) and monitoring the surroundings (home security). In addition to these services, many new services are expected to become widely available via home networks.

NTT Cyber Solutions Laboratories has been studying these next-generation home network services to create higher value-added services by combining appliance functions as shown in **Fig. 1**. Conventional services are provided by the appliance features themselves. Since most devices are digital these days, they can be remotely controlled and their status can be checked via home networks. Therefore, by combining the functions of multiple devices, we can flexibly create advanced services that cannot be provided by any single device. For example, a videophone service can be created without dedicated equipment or PCs, by combining a user's existing TV (monitor) with a video camera. A new automated home service can be made by combining the window blinds, lights, and air conditioners, etc. The scope of cooperation will spread beyond localized combinations of home equipment to services that use the Internet.

This kind of cooperation among appliances depends on the standardization of home network protocols, such as UPnP (universal plug and play) [1] for AV equipment and ECHONET (energy conservation and homecare network) [2] for white goods. As standardization advances, it will become possible to control and monitor more and more appliances, and it will become practical to provide services by combining the features of different devices.

2. Service management

Various services are provided in homes, and their control functions vary widely from service to service. For example, the functions for a TV broadcast service include "turn off TV" and "turn down the volume", while those for telephone service include "transfer" and "switch to answerphone". As the varieties of services available via home networks increase, their control functions will increase in number and kind.

In addition, the services are often provided as a set rather than individually. Sometimes a user consciously requests multiple services at the same time and sometimes he/she unintentionally receives multiple services as a result of external events. For example, if a visitor arrives while the user is watching TV, the images from the door-phone can be displayed on the same TV monitor. In this case, the user needs to select

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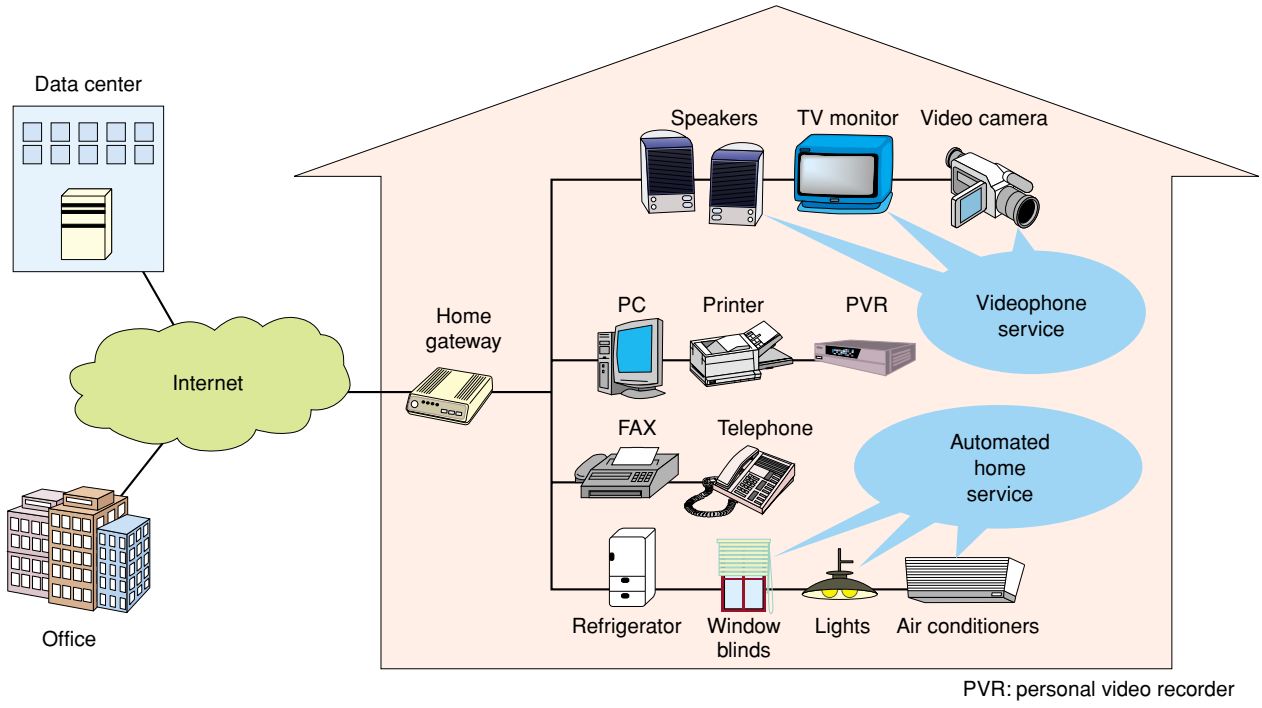

Fig. 1. Next generation of home network services.

the service because the TV broadcast and door-phone services will both try to use the same TV monitor. If the TV program is important, the user could display the door-phone image in a sub-window or record the TV broadcast on a personal video recorder for later viewing. If the user is not really paying attention to the program, he/she could let the door-phone image take over the whole screen.

If these related services could be controlled automatically, their user-friendliness would be increased. However, the status of the user and service are constantly changing. The traditional service management system covers fixed services, so it cannot handle collaboration among independent services. Moreover, the service control is uniform because the contexts that determine the priority are also fixed. Therefore, uniform control, like always giving priority to the door-phone, is not an appropriate solution. We need to provide total management of the services provided in the home so that we can determine who uses the service and for what purpose.

3. User-oriented service control

There are two situations where service control requires the comfortable use of multiple services at the same time. One is where there are conflicts among the devices, home network bandwidth, power, and so on. The services should be controlled to avoid such conflicts. Here, we call resources that can actually be assigned to services (such as devices and network bandwidth) “actual resources”.

The other situation is where the user cannot receive the services at the same time. For example, if a telephone call arrives while the user is watching TV, although there is no appliance conflict because the services use different appliances, the user must usually take some action, such as turning off the TV, turning down the TV volume, or switching to answerphone. This indicates the need for control. We can regard this as a conflict in human reaction capabilities: watching, listening, and speaking, which we call “user functions”. In addition, some combinations of services (e.g., cooling and heating services) are illogical. We regard these as conflicts in the home environment. Resources that cannot actually be assigned to a service, like the “capability to react to service” and “home environment” are called “abstract resources”, as seen in **Table 1**. As mentioned above, when abstract resources conflict, we must control the service to avoid conflicts, even if there are no conflicts among the actual resources. For example, the TV broadcast service involves user functions such as watching and listening, and the telephone service

Table 1. Services and abstract resources.

Service	Abstract resources
TV broadcast	Watch and listen
Telephone	Listen and speak
Visual telephone	Watch, listen, and speak
Home security	Secure indoor environment
Automated home	Temperature environment and lighting environment

uses the "listen" and "speak" user functions. In this case, we control these services to avoid a conflict in the "listen" user function. How to implement the solution depends on the status of the service usage. We could turn down the volume of the TV broadcast service or pass the incoming call to an answerphone (i.e., not assign the "listen" user function to the telephone service).

By introducing the concept of abstract resources and avoiding conflicts, we can achieve user-oriented service control, which cannot be achieved simply by focusing on conflicts in actual resources. Moreover, we can check the relationship among independent services by comparing the types of abstract resources that they require, allowing us to integrate the different services.

4. Home Service Harmony

We have developed Home Service Harmony: a service control platform for providing the next generation of user-oriented home network services [3]. As shown in **Fig. 2**, Home Service Harmony consists of four program module layers. Actual resources, such as home equipment, network bandwidth, and a person's schedule and address book, and abstract resources such as user functions are indicated as resource objects. These resources are centrally managed in the resource management layer. Each module in the service generation layer constructs services by combining multiple resources, and these services are fully managed in the service control layer. The implementation of these program modules complies with the OSGi Alliance* specifications [4]. OSGi is the standard for open service platforms for home net-

* See the footnote on page 14.

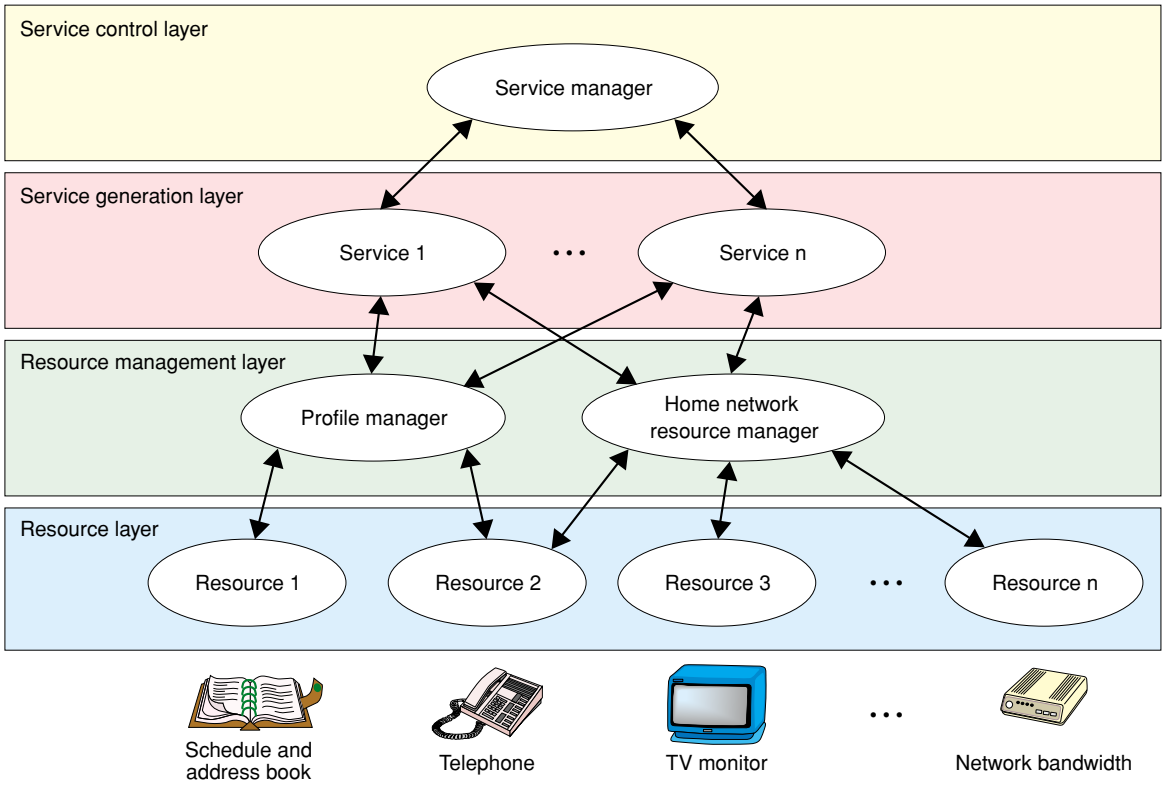

Fig. 2. Structure of Home Service Harmony program modules.

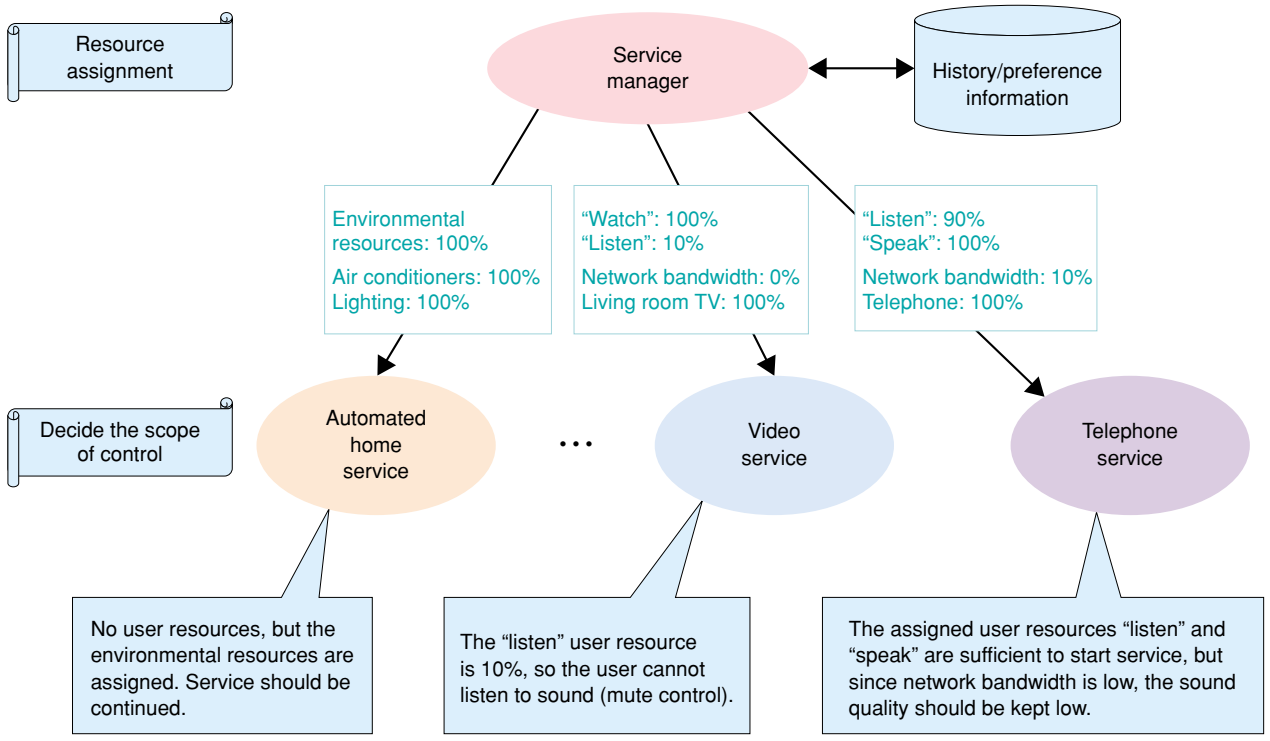

Fig. 3. Service control and autonomous decision of scope of control according to resource assignment.

works, and it enables the dynamic addition/deletion/updating of program modules during system operations. Therefore, we can dynamically add/enhance services and resources to achieve a high level of maintenance performance/operability.

The service control of Home Service Harmony is achieved through resource assignment by service management, as shown in **Fig. 3**. As the home network connects the various devices and sensors, etc., we can identify the appliance status, environmental information, and the user's location in real time. For example, we could use RFID (radio frequency identification) readers and tags to identify the user's location. Based on this information, we can check for conflicts in actual and abstract resources and estimate the importance of each service by considering the usage history and preference information. For example, the usage history indicates the user's control pattern, so the service manager can judge the importance of a service from the frequency of the service control. The service manager then assigns the resources to services according to the importance of each service, so conflicts between those resources can be avoided. In other words, the service management does not issue commands unique to each service like "replay" and "stop". It just allocates the amount of actual and abstract resources available to each service. Each service then autonomously decides the specific control operations, based on the assigned resources. In the current version, the service manager allocates resources in proportion to the service's importance. Thus, the adequacy of the resource allocation depends on the estimation of the importance.

Because the service manager just coordinates the abstract and actual resource services, its overhead is very small. In addition, because its control method is general and independent from the unique control commands of each service, it can be easily enhanced to handle new services.

5. Future plans

Home Service Harmony now controls AV appliances using abstract resources, such as user functions, but it cannot handle white goods. Furthermore, it is difficult to handle controls when several users are receiving the same service. In future, we will incorporate technologies for learning and recording the user's actions and making this information available to all types of appliances. We will develop a service generation tool that complies with this method.

References

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