2005－UBI－8（75）
2005／6／10

Distributed and Cooperative Service Platform “UKARI-Kernel” Plan for Networked Appliances

Tatsuya YAMAZAKI[1] Atsushi SAWADA[1,2] Toshikazu NISHIMURA[1,3] Masanori TAKAOKA[4] Yosuke TAJIKA[5] Michihiko MINOH[1,2]

[1]National Institute of Information and Communications Technology
[2]Academic Center for Computing and Media Studies, Kyoto University
[3]College of Information Science and Engineering, Ritsumeikan University
[4]NEC Communication Systems
[5]R&D Center, Toshiba Corporation

Abstract In recent years, networked appliances, which are the home appliances with a networking function, have been opening a new gate for home ubiquitous environments and services implemented on them. Although it is important to regulate data formats, protocols and so for interoperability, the service scenarios portrayed by just connecting stand-alone appliances are limited. For users, it would be useful to construct their own service dynamically by combining the individual functions in the appliances. The UKARI-Core, a communication middleware platform for networked appliances, has been developed to make the flexible and dynamical service construction based on the individual functions a reality. This paper describes a plan of extension of the UKARI-Core by adding XML descriptions for sensor functions, a service scenario description framework and a user accessibility control mechanism to the functions. The extended middleware platform is called the UKARI-Kernel.

Key words　networked appliance, home network, service description, accessibility control

ネットワーク家電のための機能協調型基盤ゆかりカーネル構想

山﨑達也[1]　沢田篤史[1,2]　西村俊和[1,3]　高岡真則[4]　多鹿陽介[5]　美濃導彦[1,2]

[1]独立行政法人　情報通信研究機構
[2]京都大学　学術情報メディアセンター
[3]立命館大学　情報理工学部
[4]日本電気通信システム（株）
[5]（株）東芝　研究開発センター

あらまし　家庭の情報化を既存の機器・住宅設備（住設）のデジタル化・ネットワーク化の観点に加え，環境センシングのための各種センサやユーザインタフェースとしてのロボットの導入が進んでいくという想定のもと，家電，センサ，ロボットなどのアプライアンスがその機能を互いに協調させてサービス構築を行うメカニズムを提供する分散型機能協調基盤ミドルウェア「ゆかりコア」を開発した．またそのようなサービスの実証実験を行うことを目的とした，実生活型ユビキタスネットワーク実証実験テストベッド「ユビキタスホーム」を構築した．本稿では，「ゆかりコア」および「ユビキタスホーム」を紹介し，実アプライアンスを用いてサービス実現を行った例に関して報告する．

キーワード：ネットワーク家電，ホームネットワーク，機能協調，実環境テストベッド

1. Introduction

In these days, networking of home electrical appliances is becoming widespread and it enables us to transfer digital contents from one appliance to others or to control the appliances remotely. Although the home appliance networking would make our life more comfortable and enriched, the services provided are constrained one way or another. Many attempts to apply distributed computing and networking technologies to home appliances [1]-[4] have also been taken since the home is viewed as the most promising place for their applications

The first point is that networking is closed within the same category of home appliances, e.g. a category of white goods or a category of audio and visual appliances. Networking beyond different categories is desirable.

In the present circumstances, the services provided by the networked appliances are almost the same as a stand-alone appliance can provide to the users. Such lacking of dynamic service construction might become a reason to make the users feel the home appliance networking unappealing. The dynamic service construction and provision according to the user situation must be an essential point to accelerate the home appliance networking.

So far, we have proposed a home networking middleware platform for networked appliances, "UKARI-Core" (UKARI: Universal Knowledgeable Architecture for Real-lIfe appliances) [5]. The UKARI-Core supports to provide an integrated service according to the users' context dynamically in a home network environment. One feature of the UKARI-Core is to simplify appliance functions and integrate appliance functionality over a network. A distributed collaborative infrastructure will make it possible to build virtual equipment that links only necessary functions, allowing for efficient sharing of various network-linked functions and optimizing the usage environment for individual users. Users will be able to receive a new, superior type of integrated services rather than a mere aggregate of separate appliance functions, while eliminating the difficulty of controlling and operating multiple appliances.

In this paper, a plan of extension of the UKARI-Core is described to adapt it to a possible and actual situation. The extension includes adding XML descriptions for sensor functions, a service scenario description framework and a user accessibility control mechanism to the functions. The extended middleware platform is called the UKARI-Kernel.

2. UKARI-Core

The UKARI-Core constructs a service dynamically to integrate simplified appliance functions, that is, function elements (FEs). FEs are classified based on media type and processing manner. In other words, Types of FE are defined based on what kind of media type it deals with and how it can process the media information. For example, AudioGenerate is a type of FE meaning that it creates audio-type media information. In the UKARI-Core, it is assumed that a networked appliance (NA) has a single FE or plural FEs and each FE can be used in specific way separately via networks.

From the viewpoint of the UKARI-Core, there are two kinds of FE: a service constructing NA and an FE providing NA. The service constructing NA multicasts or broadcasts a Bid command to find FEs written in a service description. When an FE providing NA receives the Bid command, it returns an Offer command to the service constructing NA. If multiple Offer commands return, the service providing NA selects one among them and returns an Agree command to the selected one. These Bid, Offer and Agree commands are transmitted along control paths established between the service constructing NA and the FE providing NAs. Once needed FEs are found, a data path is established among the FE providing NAs that are selected.

Figure 1 shows the architecture of the UKARI-Core, where an initiator corresponds to a service constructing NA and responder does to an FE providing NA.

In Fig. 2 and Fig.3, the architectures for the service constructing NA and the FE providing NA are depicted respectively. The architecture of the FE Manager is also presented in Fig. 4.

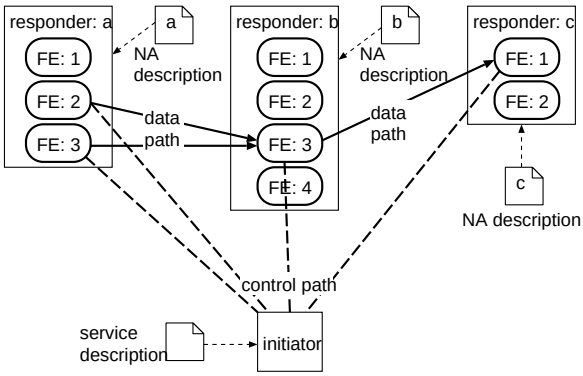

Fig.1. Architecture of the UKARI-Core

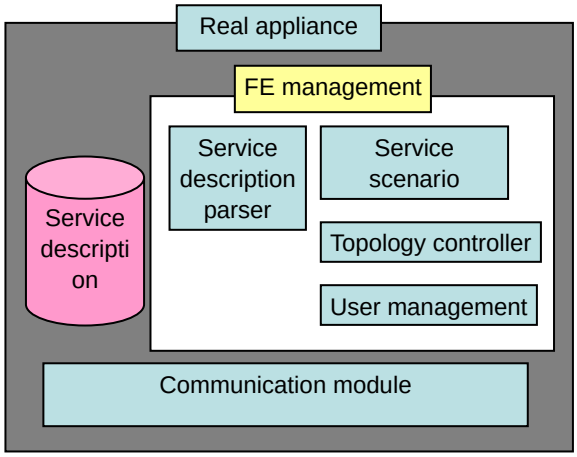

Fig.2. Architecture of the service constructing NA

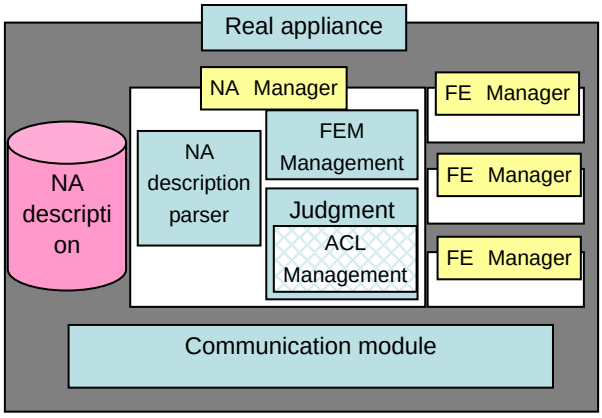

Fig.3. Architecture of the FE providing NA

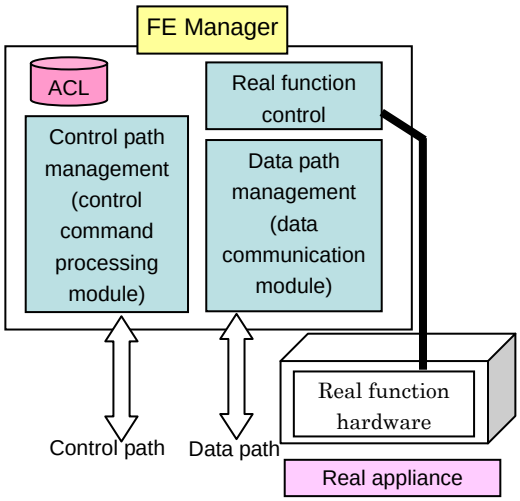

Fig.4. Architecture of the FE Manager

3. UKARI-Kernel

3.1. XML schema for sensor functions

The output data format of conventional sensors is generally simple. It is only numeric or text-based. Recently progress of sensor network studies is very rapid and kinds of sensors are in rich in variety. In consequence, sensor output data format cannot help becoming more complicated. For instance, range of sensed data should be described for some sensor. In UKARI-Kernel, the XML schema is extended to accept such various sensor output formats. In addition, treatment of formatted data is also considered. These considerations are needed to facilitate adaptation of the middleware to a future sensor networked home environment.

3.2. Service scenario description framework

Simple XML files are currently used for descriptions of services in the UKARI-Core. To support more complex description of services, utilization the Business Process Execution Language (BPEL) is promising as a service description language for the UKARI-Kernel. The BPEL provides several advanced features to describe business processes as follows:

- Control flows: sequence, loop, conditional branch
- Asynchronous conversations: correlation
- Event handling

• Fault handling
• Concurrent execution of operations

The BPEL is typically used for creating a new web service by composing web services. It is called as the BPEL4WS (BPEL for Web Services).

Description ability of the BPEL or the BPEL4WSA seems to be too rich for home use, because service utilization is limited in a home environment when the user directly manipulates the appliances and the users can directly negotiate to resolve a service confrontation.

Figure 5 shows the relationship of the service scenario description in the UKARI-Kernel. The process located in the center corresponds to the service scenario for an application. The service process describes a control transit order by the links that represent interdependent relationship of control between the activities. The data obtained as a result of exchanging between the process and its external environment or the users are stored into the containers. The data stored in the containers can be referred by the activities in the service process. The containers correspond to the variables in BPEL4WS version 1.1.

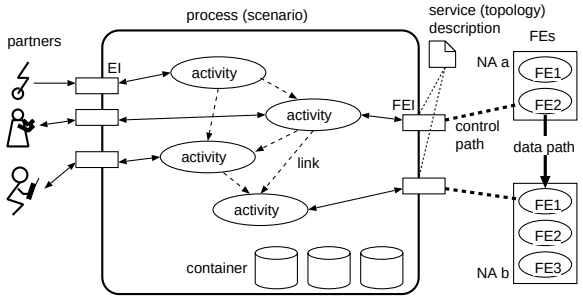

Fig.5. Relationship of the service scenario description in the UKARI-Kernel.

3. 3. User accessibility control mechanism

In the present implementation of the UKARI-Core, the services are provided as the way of first-come-first-serve. This may prevent execution of emergent services or may cause function occupation against the appliance owner.

The access control list (ACL) is introduced into the UKARI-Kernel to solve the above-mentioned issues. An element of ACL consists of user ID, service ID, appliance ID and a priority value, where the priority value is a non-negative integer. Namely, the element of ACL can be presented as (user ID, service ID, appliance ID, a priority value) and it shows the degree of priority when the user uses the appliance because of the service. Each ACL element is stored in a corresponding FE in a distributed way.

4. Conclusion

We have developed the UKARI-Core as a communication middleware for networked home appliances, which constructs a service dynamically by integrating necessary and distributed FEs via a network. In this paper, the UKARI-Kernel plan is unveiled to extend the UKARI-Core with a view to adapting it to a possible and actual situation. The main three points of extension are the XML descriptions for sensor functions, the service scenario description framework and the user accessibility control mechanism to FEs. The UKARI-Kernel implementation is just in progress.

References

[1] Peter Tandler, "Software Infrastructure for Ubiquitous Computing Environments Supporting Synchronous Collaboration with Heterogeneous Devices," *Proc. of UbiComp 2001*, pp.96-115, 2001.

[2] Hiroo Ishikawa, Eiji Tokunaga, Tatsuo Nakajima, "A Case Study of Implementing Home Appliance Middleware on Linux and Java," *Proc. of the IEEE SAINT-2002 Workshop on Linux and Internet Appliances*, pp.31-34, 2002.

[3] Y. Tajika, T. Saito, K. Teramoto, N. Oosaka, M. Isshiki, "Networked Home Appliance System using Bluetooth Technology Integrating Appliance Control/Monitoring with Internet Service, " *IEEE Trans. on Consumer Electronics*, Vol. 49, No. 4, pp.1043-1048, Nov. 2003.

[4] Soko Aoki, Yukihiko Kirihara, Kenichi Nakanishi, Akiko Iwaya and Hideyuki Tokuda, "ACE: A Software Framework for Autonomic Appliances Computing," *Proc. of the Inter. Conf. on Consumer Electronics (ICCE 2003)*, pp.190-191, Jun. 2003.

[5] Tatsuya Yamazaki, Hirotada Ueda, Atsushi Sawada, Yosuke Tajika, Michihiko Minoh, "Networked Appliances Collaboration on the Ubiquitous Home," *the 3rd Inter. Conf. On Smart homes and health Telematic (ICOST 2005)*, July 2005 (to be appeared).