Title	Cloud-based Solution for Connecting Multiple Home Networks using universAAL Space Gateway
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Citation	Proceedings of the 2017 IEICE Society Conference, 2017: ROMBUNNO BS 7 15
Issue Date	2017-08-29
Type	Conference Paper
Text version	publisher
URL	http://hdl.handle.net/10119/15507
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Description	

Cloud-based Solution for Connecting Multiple Home Networks using universAAL Space Gateway

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1. Introduction and Background

universAAL (uAAL) stands for **univers**al open platform and reference for **a**mbient **a**ssisted **l**iving which derives from European Union funded R&D project [1]. The uAAL is the platform for building assistive systems by connecting heterogeneous devices to a single, unified network and also delivering the means to control these distributed systems. The core of uAAL is built up by modules in uAAL Middleware [2], which take care that all uAAL nodes in a Space can cooperatre with each other. The uAAL Middleware (uMW) establishes peer to peer communication between nodes so that they can share the different kinds of uAAL semantic information.
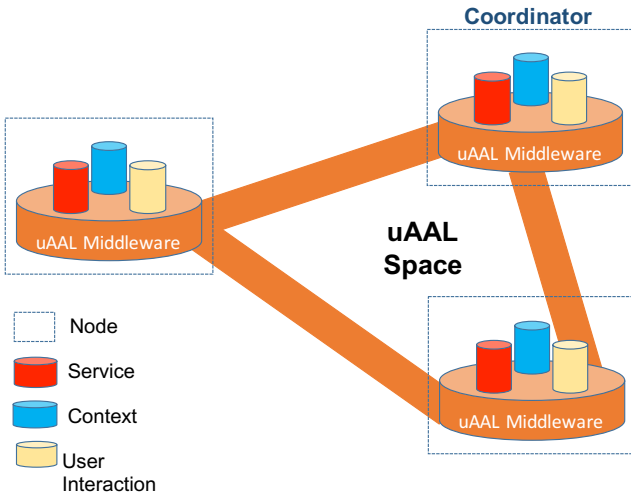

Figure 1: uAAL Space Components

uAAL Space is a logical environment where uAAL nodes can communicate to each other through same buses, seamlessly and regardless of the node. However, communication across spaces is not possible except through a special manager called universAAL Space Gateway (uSpace Gateway), which takes care of information exchanges and authorization between different spaces. Unfortunately, by the time of writing this paper, there is no official implementations or applications that applied the uSpace for connecting across uAAL spaces.

As shown in Figure 1, a home network(HN) can be mapped to an uAAL Space where devices and the Home Gateway (HGW) are connected via uMW and the HGW can be a Coordinator node that takes care of creating the space for the first time, keeps track of Space information and acts as the entry point for new nodes. Moreover, the HN itself also can not connect to other HNs without special services.

In scope of this paper, a system which utilizing uSpace to connect multiple HNs so they belong to the same uSpace to enable the cloud-based solution for exchanging context information, services between multiple HNs was implemented.

2. Proposed System Architecture

To enable uAAL in a HN, the HGW must be integrated with uMW and act as the coordinator. Devices can be connected to the HGW by using uMW or by their own protocols. At this point, we can connect multiple HNs by connecting these HGWs into the same uAAL Space by utilizing the uSpace Gateway . The proposed system architeture is shown in Figure 2.
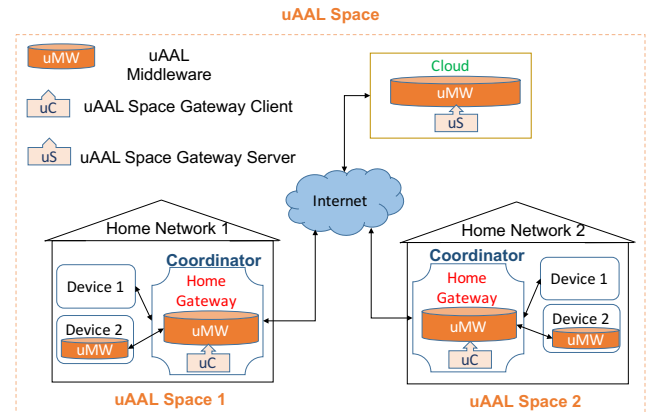

Figure 2: Proposed Architecture

1. *uAAL Space Gateway Client*
    The client deployed in the HGW represents for one local uAAL Space to receive messages from server side and to forward messages from HN to server side.
2. *uAAL Space Gateway Server*
    The server manages multiple clients, receives messages from client and sends messages to a specified HN or a set of HN or all of HN.
3. *Merits of the proposed architecture*
    By connecting multiple HN into a one uAAL Space, context information and services can be easily shared between multiple HNs in different locations and the

distribution between different HNs is hidden from each other.

3. Implementation

To prove the feasibility of the proposed architecture, a system which connects and uses services from different HN was implemented and the implementation model is shown as in Figure 3.
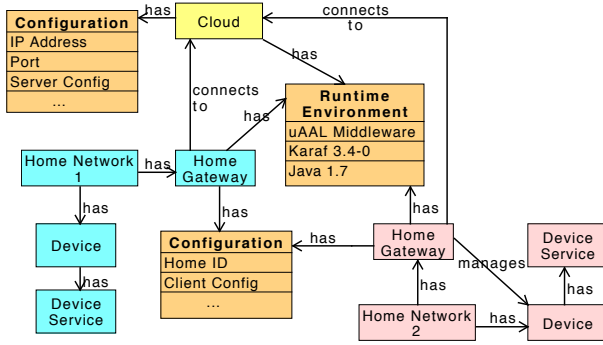

Figure 3: Implementation Model

In this implementation, the uAAL Space Gateway is included in uAAL platform v3.4. In order to enable client and server, configuration is needed. For the server side, IP address and connection port are needed, home specified id is needed for client side, and the HGW acts as the connecting point between HNs. Devices and HGW from each HN can use device resources, device services and HGW services from each other. This enabled a seamless integration of heterogeneous devices from heterogeneous HN to the same uAAL Space without taking care about the distribution of each other.

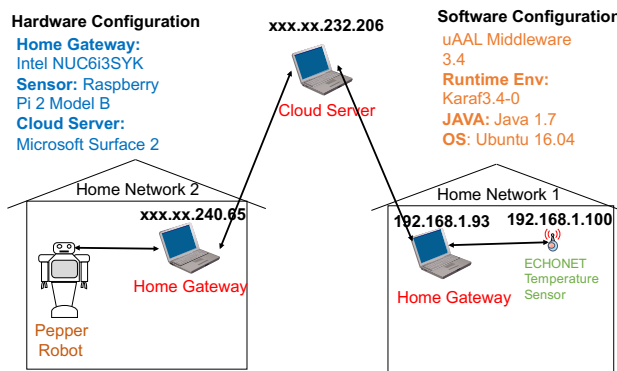## 4. Results and Conclusion

Figure 4: Deployment Diagram

Evaluation was made using the deployment information as shown in Figure 4. The result shown that Pepper robot from HN2 can control the ECHONET temperature sensor from HN1 successfully. Devices (included the HGW) from HN1 and HN2 are in the same uAAL Space.

This paper has presented a solution to seamlessly connect multiple HNs into the same uAAL Space to be able to utilize advantages of uAAL Platform for ambient assisted living. Further works are required to verify the proposed architecture with a large number of devices and home networks.

5. Acknowledgement

6. Reference

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