Smart House Testbed for both physical and cyber entities

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***Abstract*-- This paper describes an overview of our smart house and smart community development testbed which covers both of physical items like home appliances and sensors, and cyber entities like service providers and wide area networks. This hybrid organization enables the simulation of total systems for modern smart house systems that consists of network services as well as the digital home appliances and in-house networks. Our testbed provides the real houses for installation and evaluation of new equipments for home environment, and also provides a large scale network simulator which can run a server code over the VMs on IA servers and also emulate the network configurations for the system as well as the physical environment in the home.**

I. INTRODUCTION

As the development of home network system expands, the importance of the concept of high-level services is gathering more attention. Digital home appliances like DTV and air-conditioners with network interface are one of the most important parts of a smart home system, but in order to provide intelligent services using these equipments, a controller which has considerable capabilities for information processing like recognition of the event from the raw data collected by sensors is required. This kind of controllers are not an old-fashioned simple rule based ones, but requires access to various kinds of database and contents library, so implementation in the customer's home is not practical. Rapid growth of the 24-hour connected type of internet connection to homes enable the intelligent controller to be located somewhere else in the Internet. This kind of service provider and platform provider for services are the new and the most important part of the modern smart home systems now as shown in Figure 1.

We have developed a homenetwork testbed which covers both of physical environments of home and cyber part of the homenetwork systems. In the next section, we introduce the organization of the system, and features of our testbed are discussed.

II. STRUCTURE OF THE TESTBED

As the smart home system is a kind of real-world oriented or ubiquitous system which involves many physical data and direct physical interaction to users, it is important to have a real experimental house in the workbench. As shown in Figure 2, we have developed two kinds of houses: a CASBEE based two-storied house and two prefab houses in the same design.

CASBEE (Comprehensive Assessment System for Built Environment Efficiency)[1] is promoted by Japanese government mainly by MLIT (Ministry of Land, Infrastructure, Transport and Tourism), and standard designs for various kinds of buildings are given. We adopted a standard design for newly built residential house, and

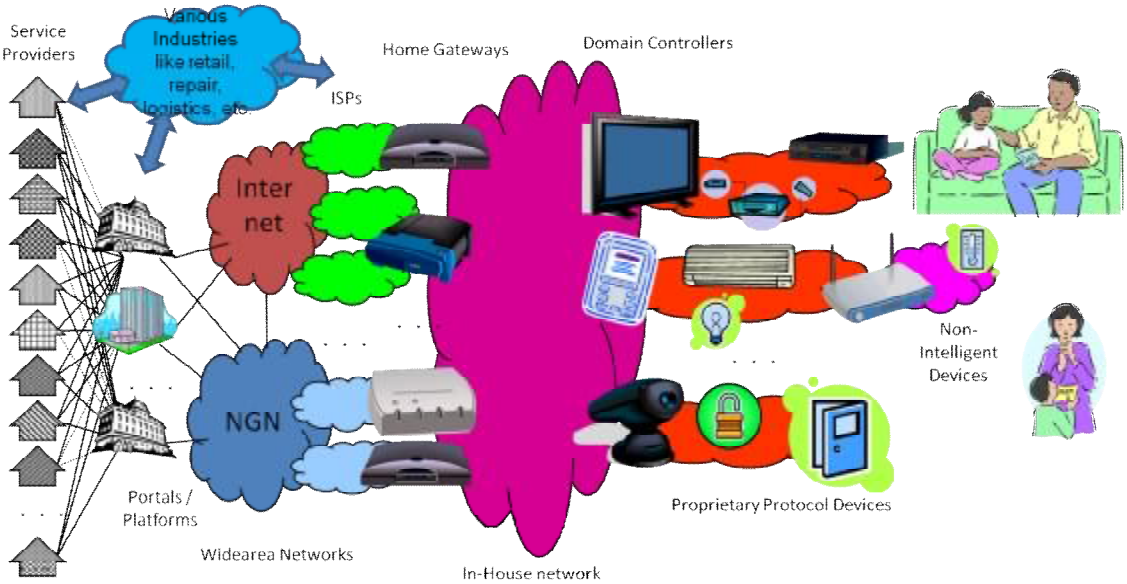

Figure 1. Components of modern smart home systems

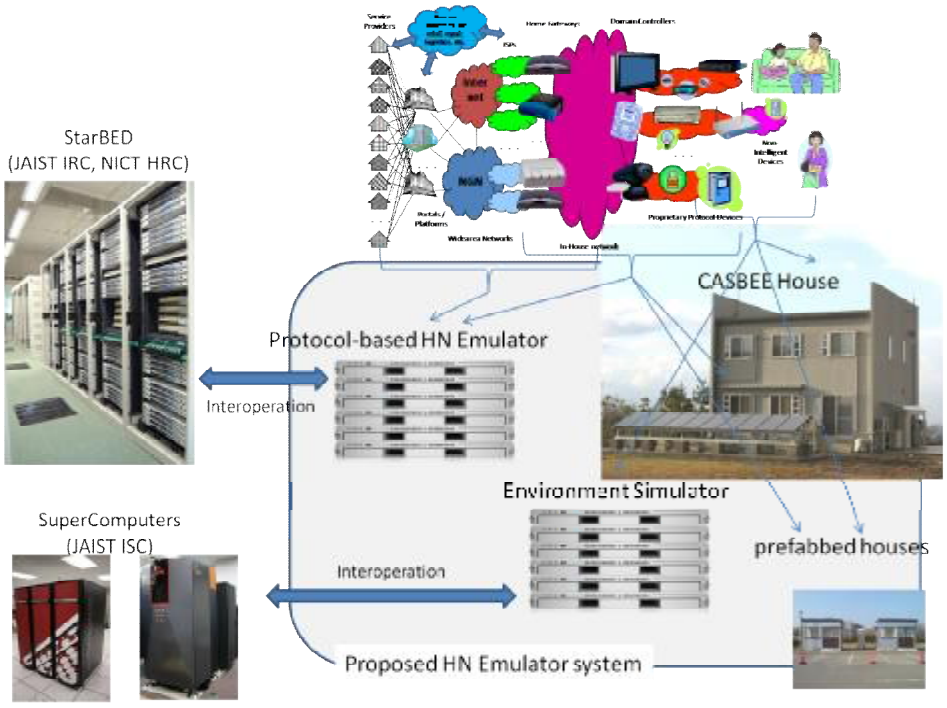

Figure 2. Structure of the smart home testbed

constructed a new experimental house in which examinee can live for a long period. This house provides a real environment for the experiments for organoleptic evaluation of new technologies for smart home systems.

Among the promising area of the smart house applications there are energy management services. The prefabs are suitable for this type of applications because we have installed the same equipments in the exactly the same designed two buildings. All windows, curtains and awnings as well as the air-conditioners can be controlled by ECHONET protocols and environmental data can be automatically obtained by ZigBee and ECHONET based sensors, so repetitive experiments in the different configuration can be made for each of these two houses enabling the qualitative assessment of energy management systems under development.

For the entities in the cyber space, we have constructed a protocol based homenetwork simulator on an IA server cluster using the technologies we have developed in the StarBED project[2]. StarBED is a Ubiquitous Network Simulator sponsored by NICT (National Institute of Communication Technologies) and provides simulation environment for various kinds of networking systems. Unlike NS or Qualnet, StarBED is an emulator based testbed rather than an event driven simulator, so target systems are ported on this system and runs just like the real system. We have developed some libraries supporting the wireless communication links and some processor emulator for embedded devices. Typical smart home applications can be ported using the middleware level emulation which supports major middleware for homenetwork like DLNA, UPnP, ZigBee, and ECHONET. The HN emulator has only dozens of server nodes, but StarBED has thousands of IA servers, so large scale emulation can be achieved by connecting these two testbeds.

Another component in our testbed is the Environment Simulator, which performs the numerical simulations for physical values like temperature or brightness. This part gives the simulation of the user-side physical environment in the home, and the performance of this function can be augmented by super computers in our university.

It is important to have the emulation / simulation environment for all parts of the smart house systems because interaction between components is essential. It is also possible for examinees to experience the service for 1 million homes in a real CASBEE house while other 999,999 houses are simulated in our testbed. This is useful for assessment of the system behavior under the disaster, or unusual situations like broadcasting the Super Bowl game over IPTV system.

III. CONCLUSIONS

A testbed for smart home technology development is presented. It enables quantitative and qualitative evaluation for both physical equipments and service functions in the net.

REFERENCES

[1] CASBEE: http://www.ibec.or.jp/CASBEE/english/index.htm
[2] StarBED Project: http://www.starbed.org/
[3] ECHONET: http://www.echonet.gr.jp/

[4] Y.Tan, *Homenetwork and Digital Home Appliance(In Japanese).* Ohn-Sha, Tokyo, 2004.