cogma :A Universal Middleware for Ubiquitous Information Environment

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The ubiquitous information environment is becoming true, where various information services can be used easily, always, and anywhere. By information technology and device technology in recent years, various devices are connected to information networks and various services have spread rapidly. In order to integrate various network information devices and services, a universal middleware for various types of devices (embedded, portable, appliance, etc.) is essential, which supports software development for a ubiquitous information environment. We describe the requirements for the universal middleware for building a ubiquitous information environment, and presents our middleware named "**cogma**" which satisfies them. We also introduce our test bed environment called "**cogma room**" in which we have installed various kinds of sensors and appliances using cogma.

For the middleware of ubiquitous information environment, we should take into consideration the following requirements to design a universal middleware for ubiquitous information environment. 1) Dynamic change, addition, and deletion of the devices, 2) Cooperative use of devices, 3) Integration of heterogeneous devices and heterogeneous network environment, 4) Minimization of the operation by the user, and 5) Minimization of the environmental load by information devices. Considering these requirements, we have developed a middleware named **cogma** (Cooperative Gadget for Mobile Appliances). Cogma has the following features.

(A) Lightweight middleware.
Small footprint implementation based on Personal Java/J2ME and intent.
(B) Dynamic code/state transfer.
Dynamic movement of code/state of software between nodes is possible while the other software components(named codget) are running.
(C) Simultaneous use of two or more different type of network-link.
Cogma can use heterogeneous communication devices, such as TCP/IP, Serial, HTTP, etc.
(D) Autonomous discovery mechanism of other nodes.
TCP/IP link utilize Hello Packet to discover the other nodes on the same network.
(E) Simplicity of management and communication mechanism of mobile software.
Easy to learn how to develop a mobile software.

In order to exemplify the usefulness of the middleware, we construct a smart space as a test bed named "cogma room"(Fig. 1). In cogma room, various sensors, such as temperature, humidity, human detection, brightness, and power monitor, are introduced. Temperature sensors are installed in 15 places, and can gain the temperature distribution in the 50-square meter room. Brightness of the 8 ceiling lights can be remotely controlled. The networked screen, projector, PDP, X10 devices, and the matrix switcher are also remotely controllable. Cogma room is designed on the assumption that it should be a live office to which people perform research activities daily in the real world. So, most of devices can be controlled from the user's note-PC or PDA. In this smart space, different kinds of networks, such as LonWorks (Echelon), 2-wire network (Matsushita Electric Industrial), and MicroLan(MAXIM), are simply integrated by cogma. Project URL: http://www.cogma.org/
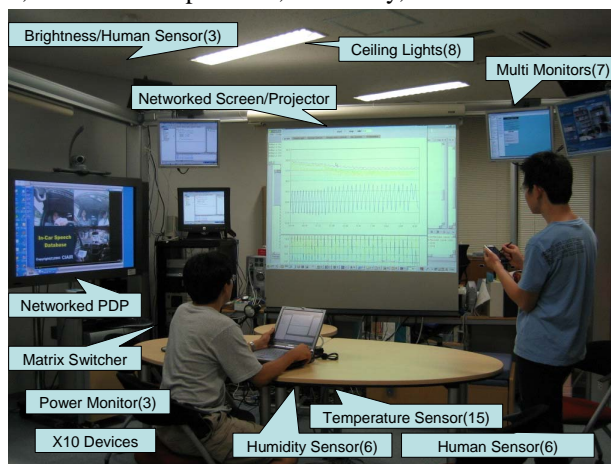

Fig. 1: cogma room: a smart space controlled by cogma