INTERACT-DDM

A Solution For The Integration Of Domestic Devices On Network Management Platforms

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Abstract: This paper presents *Interact-DDM*, a solution that integrates domestic devices with traditional computer networks. The architecture proposal is based on TCP/IP network management standards: SNMP protocol and Management Information Bases, MIB. The centralized management operation has been enhanced with additional capabilities integrated on the agents. The design has been performed permitting a very flexible device definition and dynamic configuration. This is achieved by the *meta-definition* of devices in the system MIB. A laboratory experiment has been deployed to check and validate the design proposed, where multiple configurations have been tested, and the design modularity has been proved.

Key words: Ubiquitous Computing, Domestic Networks, SNMP management.

1. INTRODUCTION

The evolution of the electronics industry gives the possibility of inserting programmable control devices into home appliances at an affordable price. This simplifies their design and enhances their functionality [1], allowing their integration on a *domestic appliance network*. Additionally, their integration into a standard communication network opens a new scope of possibilities [2]. Some work have been done to provide this connection, using new communication architectures [3][4], or integrating the appliances into IP networks [5][6]. Some standards are emerging on this area, such as the Universal Plug and Play, the VESA Home Network initiative, and the Open Services Gateway Initiative. These architectures present a complete solution, well suited for complex devices, but expensive for low-end devices, which are important in the domestic environments.

The present work describes *Interact-DDM (Interact - Domestic Device Management)*, a solution for doing this integration that is based on IP network management standards and SNMP. It is built according to three basic principles: The meta-definition of the devices being controlled on the system MIB; the existence of a single focal point to act as a gateway between the domestic network and the user interface applications; and the autonomy of the device agents to perform some simple functions without the intervention of the central management application.

Interact-DDM is being used on the *Interact* project, which is being developed by a multidisciplinary research team at the Computer Engineering College of Universidad Autónoma de Madrid [8]. The project objective is to develop the technology to implement an intelligent domestic/office environment (*domotic environment*), where the user interaction with the system is performed in a natural way (speech, signs, actions…), taking into account the context of the task.

2. ARCHITECTURE AND DESIGN

Interact-DDM is based on SNMP. We consider SNMP a very good approach to solve the network management problem, especially in domestic environments, for the following reasons. First, SNMP is *simple*; SNMP agents are simpler than, for example, web servers, that are used in other domestic solutions [7]. Simpler agents reduce the total cost of the solution. Second, SNMP agents can send notifications to the clients if a special situation is detected, while other solutions (such as web servers) can't. Third, UDP datagrams used by SNMP as transport mechanism are well suited to communicate in a domestic network, where the media reliability is very high; connection oriented protocols are not needed. Fourth, the polling mechanism used by SNMP, that in some applications can consume a broad communications bandwidth, is not a problem in domestic environments, where the interactions with the system will be mainly done as results of human actions: the frequency of SNMP messages will be low. And finally, SNMP allows the integration of domestic devices in a more complex network management platform.

The basic system structure is presented on Figure 1. Devices and agents are connected to a Local Area Network, that is the domotic communications backbone. Depending on the location or specific characteristics of each device, an agent manages a single device or a group of devices. The agent and all the devices that are under its control are called an *Area*. Each area has its own IP Address.

The *Central Point of Control* (CPC) is the manager application. It interacts with the agents to query or modify the status of the devices. CPC can be used to control the devices by itself, or as gateway by Intelligent User Interface Applications to link to the *real world*.

The managed objects of an area are contained in the *Interact MIB*. The structure of the MIB is common for all the agents on the system, independent of the devices attached to it. The MIB has been defined to provide a very high level of flexibility on the definition of the environment. In the case of devices, for example, the MIB contains not only the value of the different parameters or attributes that define the status of a device, but also *the definition of the device*. In this way, the MIB can store any kind of device. Additions of new device types can be done without modifying either the Agent or the CPC. Only the User Interface applications must know how the device operates and the meaning of its attributes. This information is stored in the MIB. The MIB contains the *meta-definition* of the managed objects, in addition to the objects themselves.

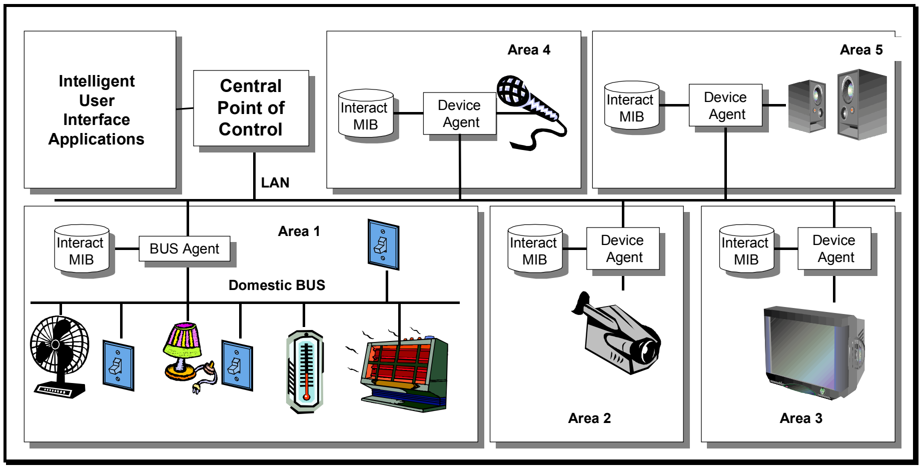

Figure 1. Basic System Structure

Agents have additional capabilities. They allow the definition of groups of devices and connections between them. Devices can be dynamically assigned to belong to a group. The whole group is then seen by the CPC as a single entity. When the value of an attribute is set for a group, the agent spreads this change to all the devices on the group. This reduces the workload on the CPC and the network traffic. A connection is a link between a sensor device that can receive an interaction from a user, and another device whose status can be changed remotely. An agent detects the user's interaction in a sensor, locates target devices or groups that should be informed of this modification, and sends them the appropriate command to modify their status. Agents send remote request to other agents to perform this function.

3. EXPERIMENTAL LABORATORY

To evaluate the proposed architecture and to prepare the MIB definitions for the devices that will be available at domotic environments, an experimental laboratory has been deployed. A World Wide Web access to the basic functionality and status of this laboratory is available [8]. The backbone of this laboratory is a 100 Mbps Ethernet network. Devices are connected directly to it or through a computer or an embedded computer. Devices currently connected are microphones, speakers, TV capture boards, VCRs, CD or DVD players, video screens, personal card readers, and simple domestic devices (lamps, switches, electronic locks, presence detectors, etc.) connected using the *European Installation Bus, EIB*, which is attached to the

Ethernet network through a gateway built on an embedded computer. An agent manages each area, and access to the devices by means of an Application Programming Interface (API), that is common for all the devices. For each device, an interface module has been developed to implement this API, converting standard calls into commands that are understood by the device. All the communications over the LAN have been implemented using TCP/IP protocols. Streaming services have been implemented using multicast transport technology.

4. CONCLUSIONS AND FUTURE WORK

Interact-DDM has an architecture that allows a dynamic definition and access to networked appliances, compatible with network management standards. As proof of concept, an experimental laboratory has been built. This experience has demonstrated that this architecture provides an easy method to perform the remote control of the domestic devices. Also, it can be considered the base for more complex applications developed to improve the man-to-machine interaction.

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