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In recent years, home networks are becoming increasingly more complex. Historically, communication between electronic devices using protocols such as UPnP and DLNA has increased. Furthermore, wireless communication protocols such as Bluetooth and ZigBee are gaining in popularity because they can be used to control wireless devices. Moreover, energy management systems are being introduced to the home with a rapid pace. To accommodate the above use cases, home networks that do not make use of IP have appeared, making home networks much more complicated.

In order to improve the maintainability of devices in such complicated home networks, HTIP has been proposed as a method to gather the connection information of home devices. Although there is a prior research proposing a mechanism that enables remote device setting using this protocol, HTIP uses Ethernet and does not function on protocols that do not use this protocol. In order to transmit Ethernet frames over IP, a previous study that introduces virtualization technology using GRE tunneling exists. In this way, the flow of another protocol is virtually overlaid on top of another transfer protocol, enabling a wealth of management and operation options, but this also increases the complexity of the home network. In such complicated home networks as described above, there are different requirements for each device, and various data link technologies are being used. Therefore, it is not easy to support the entire home network with just a single management technology. It is necessary to consider multiple technologies as well as the type of information necessary for the management and operation of home devices.

In this research, our objective is to develop an information integration technology for the home network which can handle management and operation information collected by multiple management technologies in a unified fashion. In the home network, different requirements and physical / data link technologies are used depending on the devices, and each has its own management and operation technology. In addition, management and operation information on devices and services is required along with communication technology, and it is necessary to collect information of different OSI layers. However, in the past, there was no management and operation technology which integrates multiple management and operation technologies. It is possible to implement new protocols and

functionality in home devices, but this is not a realistic approach, since home devices have limited computational resources and the development cost would be prohibiting. Therefore, in this study, we focus on many management and operation technology and develop a system that integrates multiple methods of collecting information as well as various types of collected information. We consider and develop a method to integrate basic information acquired by various management and operation technologies used in the home network. This approach makes it easier to manage and operate the home network, thereby adding value and increasing reliability. It is also possible to provide the infrastructure necessary for management and operation such as remote settings and fault detection without depending on a specific management operation technology and communication protocol. Furthermore, by having the integrated information as a database, it can be further used for other purposes such as visualization, statistical analysis, etc.

For the proposed system, we investigated ZigBee and HTIP, which are administrative and operation technologies used by wireless devices in the home network. In ZigBee, because each node operates autonomously and ZigBee can respond to changes in network configuration flexibly, there are only a few problems regarding its management and operation. In addition, the nodes that perform routing hold detailed information on their neighboring nodes, and it is easy to grasp and manage the network configuration. HTIP is a protocol designed for identifying the connection configuration of devices in a complicated home network. This information can help to improve maintainability of home devices. HTIP Manager and Agent software is installed on the managed devices. The Agent transmits management and operation information to the Manager, through which the Manager can identify the home network topology. These protocols provide excellent management and operation mechanisms and are utilized by the proposed system.

In order to integrate the management operation information, we investigated the BBF TR - 181 device data model which can unify model information of many devices that use various different protocols. This model is standardized for the remote management of target devices in the home network.

The proposed information integration system of management and operation is installed on the home gateway. The system collects information from the managed devices in the home network. In this system, HTIP is used when collecting information from devices in Ethernet and IP communication area network. To collect information from devices of non-Ethernet and non-IP communication area networks, agent functions that can communicate with the protocols used in the network are installed in relay devices. We also present use cases of connection patterns between area networks of different communication technologies such as Ethernet & IP communication and non-Ethernet & non-IP communication, and present methods of collecting information in those use cases. After collecting the information from the target device, the information is held in a database. We propose two types of databases, a dedicated DB for each protocol used in the home network and integrated DB capable of representing information of various different protocols in a unified fashion. The integrated DB is realized by using the XML device data model standardized by the aforementioned BBF TR-181. We chose this model that is optimal for an integrated database in this system because it is possible to describe multiple protocols in a unified way. However, at present mandatory information of management operation is missing. Therefore, we add mandatory information for management and op-

eration which is missing in that model. Ultimately, we examined the implemented system in the customer support use case described in TTC TR - 1062 and evaluate it.