Context-aware Multimedia Framework based on Software Agent Platforms

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Abstract

We address an integrated multimedia framework based on a software agent platform for context-aware multimedia computing. We adopt the FIPA (Foundation for Intelligent Physical Agents) platform which provides agent communications and management mechanisms. In order to express context information, we use MPEG-21 metadata for describing user characteristics and usage environment.

We encapsulate such context information as a FIPA message to be delivered between agents. Based on context information, appropriate multimedia content delivery becomes possible. We present our system implementation with a use case scenario and show that our proposed framework is effective for context-aware multimedia computing so that personalization of multimedia consumption can be possible.

1. Introduction

Personalized/customized usage of multimedia contents requires context understanding between a content provider and a consumer. In such an application scenario, context may include user characteristics on content consumption, user terminal characteristics and network resource condition, etc. Also, these kinds of context information need be delivered and exchanged between the content provider and consumer.

Context information can be different in terms of terminal resource capability and user's preference etc. It is necessary to adopt a common model to describe different user characteristics and usage environment characteristics. We employ MPEG-21 Digital Item Adaptation (DIA) scheme of describing the user characteristics and usage environment characteristics for context information.

For the delivery and exchange of such context information, we adopt the FIPA compliant agent platform, FIPA-OS. FIPA-OS implements the standard FIPA specification, which provides a multi-agent management platform where agents can be deployed.

This paper is organized as follow. In Section 2, we address a set of context description tools for describing characteristics on users, terminals, networks and usage environment which are specified in MPEG-21 DIA. In Section 3, we describe agent-based platforms, FIPA-OS and MicroFIPA-OS, which constitute the basis of our framework. In Section 4, we propose our context-aware multimedia computing framework. The implementation and experimental results of our framework are presented in Section 5. Finally, we conclude our work and address future works.

2. MPEG-21 Digital Item Adaptation

MPEG-21 part 7, Digital Item Adaptation (DIA) aims at providing universally accessible and uniquely consumable environment for multimedia under various different conditions such as user characteristics, network characteristics, and terminal capabilities etc [1, 2].

The current MPEG-21 DIA provides the tools for describing user characteristics, terminal capabilities, network characteristics and natural environment characteristics as depicted in Figure 1.

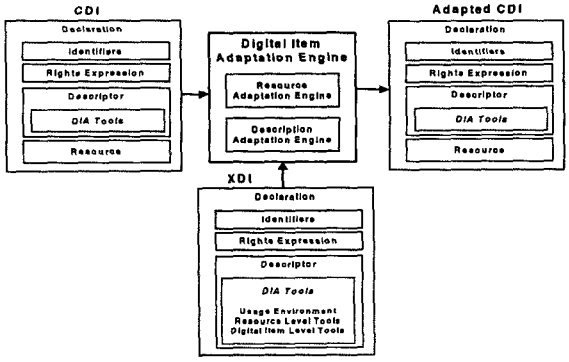

Figure 1. Illustration of Digital Item Adaptation [2].

Digital Item (DI) is a fundamental unit of distribution and transaction about content description and content itself. This digital item needs to be adapted according to the context regarding user characteristics and usage environment characteristics. When adapting the digital item, MPEG-21 DIA description (context information) can be utilized and may be used in a digital item adaptation engine.

The MPEG-21 DIA description tools describe: 1) user characteristics including preferences on specific contents, content presentation preferences, mobility characteristics of the user; 2) terminal capabilities including media resource encoding and decoding capability, hardware, software and system-related specifications, as

well as communication protocols that are supported by the terminal; 3) network characteristics including the capabilities and conditions of a network, bandwidth utilization, delay and error characteristics; 4) natural environment characteristics including the location and time of a user in a given environment, as well as audio-visual characteristics of the natural environment such as auditory noise levels and illumination properties; 5) resource adaptability including the adaptation of binary resources in a generic way and metadata adaptation; and 6) session mobility with the state of digital items from one user to another [1, 2].

3. Software Agent Platform

3.1. FIPA standard

FIPA targets at providing a set of standard specifications for inter-operable agent applications and agent systems.

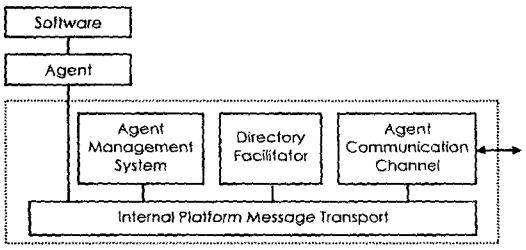

Figure 2. Normative components in FIPA standard [4].

In order to provide interoperable platform among agents and multi-agent management environment, FIPA specifies a minimal set of normative components: 1) message transport service (MTS) which consist of agent communication channel to route messages between agents within the platform to agents reside on other platforms and internal platform message transport to route messages among agents reside in the same platform; 2) agent management system that controls the creation, deletion, suspension, resumption, authentication and migration of agents on the agent platform and acts as a "white pages" directory for all agents resident on an agent platform. The mapping between globally unique agent names (or GUID) and local transport addresses used by the platform are maintained by this agent manage system: 3) directory facilitator that acts as a "yellow pages" directory for the agents. It maintains descriptions of the agents and their services [3, 4]. The visual description of all components are shown in Figure 2.

3.2. FIPA-OS and MicroFIPA-OS

FIPA-OS is a multi-agent platform which was designed and implemented to support the FIPA agent standards. It implements not only the mandatory components of the FIPA architecture but also provides an agent shell, a multi-layered agent communication scheme, message and conversion scheme so that agent applications can be easily built up on top of it.

MicroFIPA-OS was designed for small footprint devices such as mobile phones and PDA etc. It is a lightweight FIPA-OS. The agents that are deployed on MicroFIPA-OS has limitations in terms of processing power, memory capability and communication flexibility. The transport architecture of MicroFIPA-OS is optimized for small devices. It only allows either internal HTTP transport or the FIPA specified HTTP protocol for interoperability while the FIPA-OS supports RMI or CORBA [5]. The scenarios of deploying FIPA-OS and MicroFIPA-OS together are shown in Figure 3.

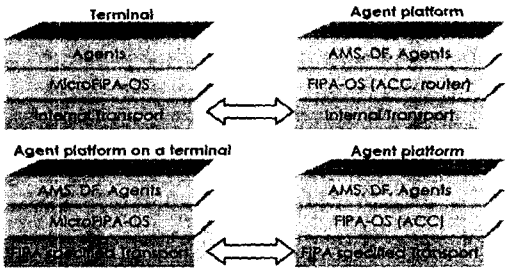

Figure 3. Deployment of FIPA-OS and MicroFIPA-OS [5].

MicroFIPA-OS can be configured such that it is a part of FIPA-OS or it runs an independent platform with AMS, DF and agents, and communications to FIPA-OS via FIPA specified transports [4].

4. Context-aware Multimedia Framework

4.1. System Architecture

The system architecture of context-aware multimedia framework is shown in Figure 4. At the initial step, a client agent sends to the server agent a context digital item (XDI) which is the MPEG-21 DIA context information.. The server agent parses the XDI information and creates and sends content digital item (CDI) information to the client agent. The CDI may contain information of available digital items with their titles, genres, cost, etc. After receiving CDI from the server agent, a user may select and request a preferred multimedia content to the server agent. The server agent then notifies the MPEG-21 DIA engine to output an adapted content according to the context information delivered from the client side as a user's XDI.

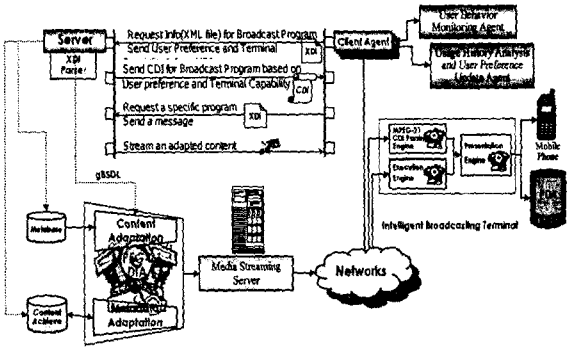

Figure 4. Context-aware Multimedia Framework

Then adapted content by the content adaptation engine is delivered to the client side. Figure 5 shows examples of the client GUI. A client agent may be connected to the several server agents and be

associated to several users as shown in the left part of Figure 5. Checking in a user name triggers to send the corresponding XDI of user and terminal characteristics to the server agent. Then the client agent receives the CDI information which is shown in the middle of Figure 5. In our application, we present the CDI information in a table form. Each row of the table is associated to a single information unit about digital item contained in the CDI. User may select one of the digital items to be consumed and application will use the necessary information to request the real content to the server agent. Digital item that is received from the server will be displayed as shown in the right of Figure 5.

All the messages such as registration to the server, information request, and deregistration are exchanged between the client and the server running on FIPA-OS and MicroFIPA-OS, respectively.

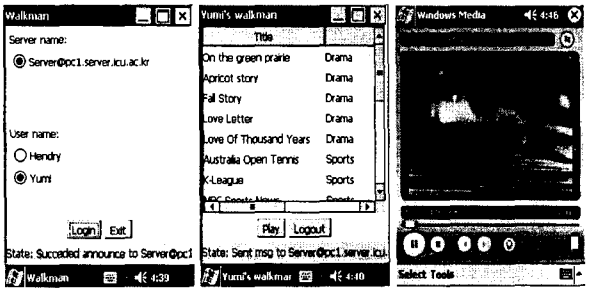

Figure 5. GUI examples of a context-aware multimedia terminal.

4.2. Delivery of Context Information

FIPA-OS and MicroFIPA-OS take the responsibility of information delivery in our system. Both of them use the same communication protocol defined by FIPA, namely agent communication language (ACL). ACL message representation is based on XML, text strings, and several other schemes [3].

ACL message contains a set of one or more message elements such as *sender*, *receiver*, *content*, *performative*, etc. The *sender* and *receiver* describe FIPA given addresses for the server and client agents. Both XDI and CDI are bound to the content element in the ACL message. A performative element defines what kind of message must be sent by the sender and is expecting at the receiver site. If an agent cannot recognize or process one or more of the elements or element values, it can reply with the appropriate *not-understood* message [3]. An action after receiving this kind of message will be taken according to application's behavior.

5. System Implementation and Experiments

Our context-aware multimedia framework was implemented in based on FIPA-OS and MicroFIPA-OS. In order to establish the context-aware multimedia framework, we installed FIPA-OS 2.1v on JDK 1.4.0v on a notebook PC with Pentium M 1.8 GHz, where the server agents are running at the content provider. We use Microsoft™ SQLServer 2000 as our metabase and JDBC as a bridge between the application and the metabase. We also employed JDOM-8 to process metadata. To play streaming multimedia content, JMF 2.1v is used. This kind of setting can serve both as server agent and client agent respectively.

We also deployed other client agents running in MicroFIPA-OS on a PDA as a client terminal. We used HP iPAQ PocketPC H5450 with Microsoft™ WindowsCE as its operating system. MicroFIPA-OS 2.1.0v runs on Jeode (java embedded system that came along with that PDA's software package). To play streaming multimedia contents. we use a Microsoft™ Media Player.

In our experiment, we succeeded to run the server agents in the notebook PC and to run client agents the PDA. The communication between server agents and client agents are successfully made so that the MPEG-21 DIA XDI data could be delivered as a FIPA message. Also appropriate multimedia computing was possible using the context information. This result shows that our agent-based platform is suitable for context-aware multimedia computing application for universal and transparent access to multimedia.

6. Conclusion

In this paper, we present an adoption agent-based platform for context-aware framework. We use FIPA-OS and MicroFIPA-OS as our agent-based platform for communication protocol to exchange context information between server agent and client agent(s) which is aligned to MPEG-21 DIA metadata.

The adoption of agent-based platform into this framework enables us to obtain universal and transparent access for multimedia consumption. In the future, we expect to put more intelligent component in our agents system so that more sophisticated tasks can be easily developed.

References

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