Integration Model for Location-Based Services in iDTV Applications

Vandecia R. Monteiro Fernandes, Geraldo Braz Junior,
Carlos de Salles Soares Neto, Anselmo Cardoso de Paiva
Applied Computer Group
Federal University of Maranhão
São Luiz - Brazil
vandecia@ufma.br, geraldo@nca.ufma.br,
csalles@nca.ufma.br, paiva@nca.ufma.br

Hugo Feitosa de Figueiredo,
Claudio de Souza Baptista
Department of Systems and Computer
Federal University of Campina Grande
Campina Grande, Brazil
hugoff@gmail.com,
cdsbaptista@gmail.com

***Abstract*—The new Digital TV (DTV) standards offer not only a significant improvement in picture and sound quality but also create the ability to run applications sent over broadcast direct to the consumers. Additionally, DTV can be watched from mobile devices, which creates a new comprehensive niche for large scale applications based on location services. This paper proposes an architectural model for integration of Location Based Services (LBS) and interactive DTV applications running on mobile devices. In particular, this work extends the middleware Ginga giving him the ability to support interactive applications based on location trough a integration layers using OpenLS to make the communication of a context server and the Ginga application. The architecture has been evaluated using real scenarios and the analysis shows promissing results.**

***Keywords*-DTV; Location Based Services; Mobile Computing; Ginga.**

I. Introduction

Location-Based Services (LBS) are information services through a mobile network, which use geographical location to provide some specific functionality [1]. The use of user location information enables the design of innovative services, offering information increasingly accurate, precise and useful. For example, the system can provide weather information adjusted to the region where the user is or even create a free advertising-dependent environment based on locations around the user. Besides the location, other information can be monitored such as heartbeat and temperature, or environment information, such as traffic and weather condition. The information that can be collected from the situation in which the user is contained is defined as context. So context is defined as any information that can be used to characterize the status of an entity [2].

Some works have investigated the use of LBS applications and its usefulness. Among these, the LBS Framework proposed in [3] has the objective of providing mechanisms that allow the use of two separate databases as if they were a single source of information, based on the existence of two data sets: geographical and content associated to locations. However, the LBS Frawework has no location management in the mobile device and the users position is only provided upon request to the server services. FRAGIL - Framework for Information Management Localization [4] [5], is another framework that aims to provide a reusable set of location information protocols and a mechanism to allow the obtaining of location based functionalities for the development of LBS applications. Also, [6] [7] [8] present various kinds of location based applications and facilities for the development of LBS services on addressed to portable devices.

Given the mobile nature of human beings, the combination of Location-Based Services with mobile phones becomes an attractive approach for consumers and businesses. With the advent of mobile devices that allow the Digital TV (DTV) reception, the processing of the location information of devices opens doors for the development of a new niche of applications, which associate broadcast transmissions with the possibility of interactivity based on elements around the device. The interactive Digital TV (iDTV) provides to the user the ability to shop, participate in surveys, custom programming, join a class and more. The papers [9] [10] [11] present applications using a iDTV platform.

Interactivity depends on the hardware and software that are available in the mobile device. The coordination between hardware and software is done by a software layer called middleware. The middleware adopted as the standard for the Brazilian DTV, in accordance with specifications of the International Telecommunication Union Telecommunication Standardization Sector (ITU-T) for IPTV is called Ginga [12]. The main function of the Ginga middleware is to ensure interoperability in the development of iDTV applications, providing a standardized virtual machine on which to run interactive applications.

This paper proposes an integration model for Ginga applications and Location Based Services (LBS) on mobile devices, extending the range of applications and information that could be treated by users on the move. Specifically, the proposed architecture aims to provide mechanisms of self-triggering using the geographic context for mobile applications on the middleware Ginga. As a result, iDTV applications may be extended to location-aware capabilities.

The remainder of this paper is organized as follows. Section II focues on the background concepts needed for the proposed architecture presented in Section III. In Section IV, we address usage scenarios of the architecture from the perspective of mobile digital TV. Finally Section V concludes the paper and discuss further work to be undertaken.

II. BACKGROUND

This section presents the theoretical background needed for the construction of the proposed architecture. Subsection A presents the VadeMecum framework, used to manage the information of user's context. Subsection B focuses on details about the Ginga middleware, which is extended by this work to support Location Based Services. And, the final subsection presents the OpenLS, that aims at promoting interoperability for the proposed architecture.

A. VadeMecum

It is common in context based applications to have one module or component responsible for managing rules and actions that must be taken whenever a particular client has satisfied given conditions.

The VadeMecum uses a model-based inference rules to monitor the contextual states of users in the system. Thus, you can add rules that will launch actions if these are met. A rule in the VadeMecum is like E-C-A (Event-Condition-Action), in which the event is to update some contextual information monitored; the condition and description of a state contextual and action is the operation to be performed when the condition is satisfied. For example, a possible rule is: when you have some close contact geographically, this location should be shown on the map on the mobile device user. A user can have multiple registered rules and can either activate or disable them at any time.

In this proposal, the component that performs this task is called *ContextServer*. Its basic functionality is to manage a database of rules and actions previously registered. As the client application is used, a context database is fed and accessed by the *ContextServer* that checks whether any rule or action should be taken according to the context in which the customer is located. A server implementation of the *ContextServer* is VadeMecum, formed by the tool CARE (Context Aware Rule Editor) and the server itself, proposed in [13] and visualized in Figure 1.

This server is responsible for storing context, perform inference and monitor contextual information. Its operation is based on contextual rules implemented using ontologies, which indicate what actions should be implemented in applications when a particular contextual state is reached. The addition of the rules in the server is performed by the end user through the CARE tool that assists the user in the process of specifying such rules and provide a lightweight and intuitive graphical user interface, so that it is easy for users to express their rules.

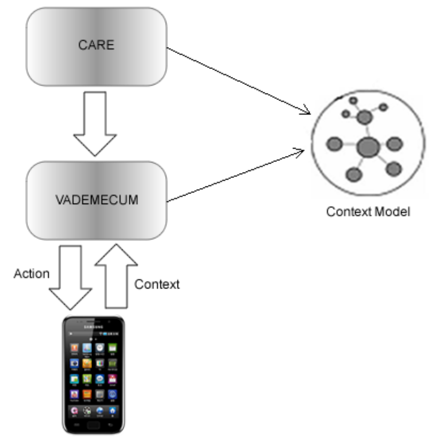

Figure 1. Context Server VadeMecum

After creating the rules, using the VadeMecum, they should be sent to the context server that will monitor them along with the state of the contextual user. The storage and retrieval of contextual information is made via a context model that logically describes how information is stored, following the specification of an ontology created previously. The insertion and retrieval operations are performed by a communication protocol that follows the HTTP (POST and GET) and languages SPARQL and SPARQL Update [14]. In order to monitor the server state there is a contextual inference engine based on rules. Once the rule is activated, this will be accessed every time that the subset contained in the contextual state condition is changed. When the condition is satisfied, the action is executed and the rule will be disabled until the contextual state is no longer valid in the condition.

In the VadeMecum there are three possible actions:

- ShowMultimedia that receives as a parameter the user who receives the action and a multimedia file,
- ShowOnMap that receives as a parameter the user who receives the action and an object that will be shown on the map location,
- SendMail, that receives an e-mail and sends a message to the recipient.

However, it is possible that the actions in VadeMecum trigger external services so they send some action itself, which may be executed in a user's mobile device.

B. Ginga Middleware

Ginga middleware is the name of the Japanese-Brazilian Terrestrial Digital TV System and ITU-T standard for IPTV. The Ginga middleware was developed entirely in Brazil providing two types of programming environments: a

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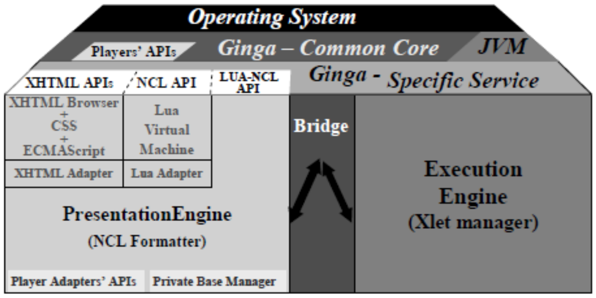

Figure 2. Ginga Archicteture [15]

declarative, represented by Ginga-NCL, and an imperative, represented by Ginga-J [15].

Ginga-NCL uses a declarative language based on Nested Context Language (NCL). Through this language, an author can describe the temporal behavior of a multimedia presentation, associate hyperlinks (user interaction) to media objects, define alternatives for presentation (adaptation) and describe the layout of the presentation on multiple devices. The Ginga-J, is a logical subsystem of the Ginga system responsible for processing active content. A key component of the execution environment is Ginga machine for implementing the mandatory content, comprising a Java virtual machine.

The architecture (Figure 2) and Ginga facilities are designed to be applied to broadcasting systems and terrestrial broadcasting receivers. Additionally, the same architecture and facilities can be applied to systems using other data transport mechanisms (such as satellite systems and cable systems or IPTV). For more information about Ginga, its applications and models see [15].

C. OpenLS

Interoperability is one of the key points to be considered in developing location-based systems, since these should be available on different platforms and operating systems. The OpenGIS Consortium [16] defines a set of computational patterns that aim to promote interoperability between Geographic Information Systems (GIS).

The GIS automated systems are used to store, manipulate and analyze geographic data. In the 80s, with the advent of personal computing, there has been a rapid development of these systems, as well as for military use and environmental planning. Since then, GIS has evolved to make technologies most effective and affordable.

The OpenLS specification [17] was adopted by the OpenGIS Consortium, and is focused on the development of interface specifications that facilitate the use of location and other forms of spatial information about the environment of wireless Internet. The goal of this initiative is to specify a set of interfaces, standards and protocols on which developers can use to integrate geospatial data and geoprocessing resources into location services and telecommunications infrastructure, providing these capabilities for a variety of applications.

The OpenLS is used to allow access to mechanisms for location of the network and a set of services called OpenLS Core Services. The specified services are Location Utilities Service, Directory Service, Presentation Service and Route Determination Service. The applications use the interfaces of OpenLS to get the content needed to perform their functions. Such content would be: data maps, route networks, addresses, navigation information, directories of places with information, products or services.

III. THE GINGA-LBIA ARCHITECTURE

The proposed architecture, named Ginga-LBiA, aim to integrate Location Based Services and iDTV application under the Ginga middleware. The architecture is divided into three modules: Context Server, Gateway and Client, as shown in Figure 3 below.

The Context Server manage rules and actions to be analyzed according to the DTV client context. This module includes the Client Service Listener, Service Context Notify application and mobile digital TV. To link the two platforms: server and application Context Digital TV, we implemented a translator module represented using the Gateway. Each module and its composition are described in more detail in the following subsections.

A. Service Context

This component aims to store and perform inference rules based on the user contextual information and to propose an action to be taken through the VadeMecum. However, VadeMecum was extended to communicate with the Ginga Digital TV. An important aspect of the proposed architecture is that it can be easily extended by other server implementations of context. To obtain a model that is implementation independent, it is necessary to create an interoperability layer. The same is proposed in this architecture by implementing a communication layer, independent of context server, using OpenLs as the standard protocol for information exchange. This component comprises the Gateway.

B. Client Module

The client module consists of three components: the DTV application, Service Listener and Service Context Notify, as presented in Figure 3. The application runs on a mobile device, emulating the Ginga middleware, according to the proposed implementation defined in [18]. It is necessary to extend the same support to the management of context information such as the geographical location. Thus, the application itself, through the Ginga middleware, informs the device location. The Notify Context Service Component is the component responsible for periodically updating data

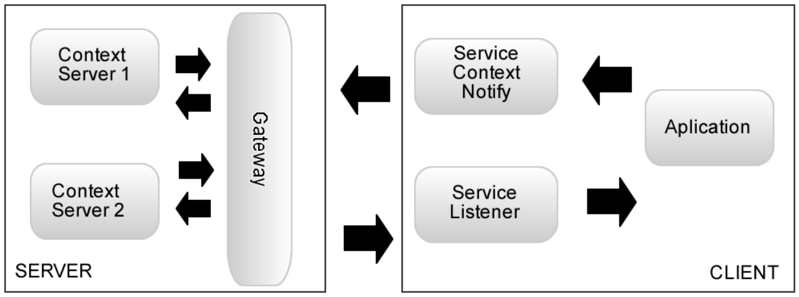

Figure 3. Proposed Architecture: the Ginga Location Based iDTV Architecture (Ginga-LBiA)

in the context server with client information. To accomplish this task, the Service Context Notify receives the information from the application and sends it to the Gateway module according to some update policy to be defined.

Once the context server evaluates the information given by the previously created rules, if there is any action to be taken, it forwards the action to the application through the Gateway explained on next section. The component responsible for managing the actions received by the server context is the Service Listener. If the action is accepted, it is forwarded to the application where an event is triggered for the user.

C. Gateway

The Gateway module is responsible for communication between the server and the client module context. It is implemented according to the OpenLS specification [17], which defines service interfaces that facilitate the development of location-based applications. In the OpenLS specification, the service request occurs via a SLIR (Standard Location Immediate Request). The result obtained is sent to the user via a SLIA (Standard Location Immediate Answer). The Gateway has different functions according to the type of architecture that is used. In the model which uses WebServices, the request has to be dealt with SOAP technology. If the model is adopted using the server VadeMecum, which uses a model-based inference rules, the Gateway will have to turn the request of the application in a triple, such as subject, predicate, action, using a language as SPARQL [14].

IV. Scope of the Proposed Architecture from the Viewpoint of Digital TV Applications

Figure 4 presents a common scheme for application distribution on interactive digital TV. The TV broadcaster transmits to every device the same application multiplexed with the main video and audio. This interactive application can be received by fixed terminals in either set-top boxes or mobile receivers. In both cases, the applications are running on top of a middleware layer. In this content distribution environment , applications can also provide information back to the TV station using the Internet as a communication channel, which allows that information about the users are collected.

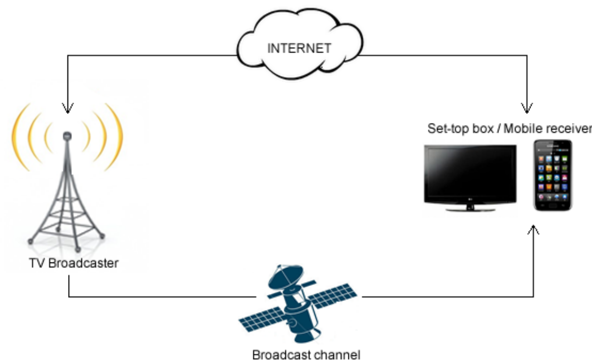

Figure 4. Common scheme for applications distribution over interactive digital TV

The components of the Ginga-LBiA to support location service can also be distributed among environments and TV broadcaster mobile device. There are three main ways on how this architecture can be distributed, which characterizes the supported location application profile being performed.

1) Fully Broadcast Applications: In this category of applications, all message exchanges occur in the client that acts only like a receiver. It is not necessary to have return communication channel to the TV broadcaster, which makes this category the most common. The iDTV application is transmitted to all viewers by the broadcast channel. It is through this same channel that the entire contents of the application is received on the client side. This means that all alternatives that may be displayed depending on the location must be communicated to all customers alike. Figure 5 shows the architecture that uses only the broadcast transmission.

As an example of possible fully location-based broadcast applications is a scenario of location based advertising. In this category, there is no request of content made by the application, it only receives content. Suppose a user walking in a shopping center. In this case, the station can transmit an specific advertisement just to the users that are near that mall. Thus, the application is adapted according to

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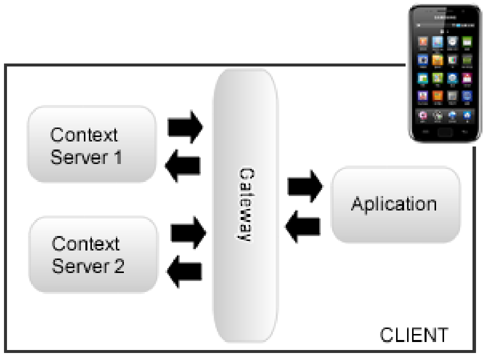

Figure 5. Fully broadcast applications using Ginga-LBiA architecture

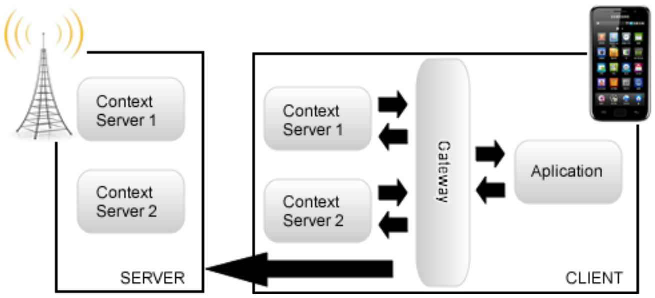

Figure 6. Illustration of message exchanges for hybrid application using Ginga-LBiA architecture

the location. In other words, the advertisement is presented depending on whether the user is close or not to the mall. The same scenario can be applied, for example, on public transportation such as subways and buses. If the tube is equipped with a TV running the application of digital TV, when it pass through certain areas, the application will conveying advertisements about those areas.

2) Hybrid Applications: In hybrid applications, the content traffic has the jointly responsibility in client and server. The iDTV application will be running on the client, and when asked for additional content, will communicate with the server to answer the request. Figure 6 presents a illustration of message exchanges of the architecture in this category.

3) Applications without Broadcast: In this category only iDTV application is resident on the client, all requests are answered by queries to the server context. In this category we can cite tour guides. In tourist towns, for example, tourists can see detailed information about buildings and historic sites. In the user mobile device, just the iDTV application was running. When the user moves, the application will pose a query to a server and receive audiovisual content specific to the location where he is. Figure 7 exemplify this kind of application.

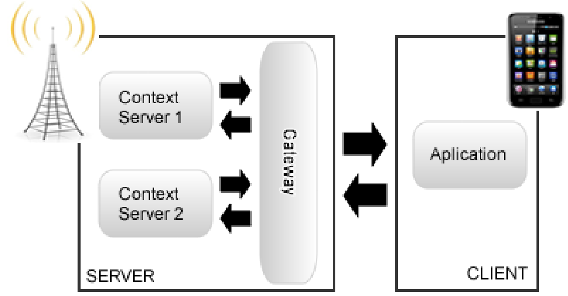

Figure 7. Illustration of a application without broadcast using Ginga-LBiA architecture

V. Conclusion

Digital TV is an important mechanism for transmitting information. Television is known as the principal communication vehicle that reaches all the social classes and regions of the world. Interactive applications in Digital TV allows for the implementation of further tools, regardless of location or culture.

By joining DTV with Location Based Services it is possible to enhance the interaction through regionalization solutions, which provides a custom activity and content. Thus, applications on advertising, social media or government could be extended to deal with specific and localized cases.

With this goal, this paper presented the Ginga-LBiA architecture for integration of location based applications on the Ginga middleware. The integration was performed using a methodology that uses the OpenLS standard in order to achieve interoperability between different applications and servers.

The architecture was analyzed on the main scenarios of applications in DTV, which correspond to the following categories: applications with or without broadcast and hybrid. In all categories, the architecture was adequate to provide appropriate services independently of application kind. The proposed architecture treats location features in a transparent manner and provides interoperable and adaptable communication mechanisms. Thus, this architecture could also be applied for others midlewares DTV just changing Ginga midleware by the appropriate one. This could be reached because all the communication interfaces are based on OpenLS and the Gateway layer is independent of the midleware choosen.

Finally, this approach shows promising to integrate Digital TV services with location-based services. With this architecture, it becomes possible to build interactive applications that can capture the context of the client to provide mechanisms to adapt the content appropriate. However, it is understood that there are other context information beyond the location that could be handled by the architecture, such as wheather conditions, temporal and social contexts. As further work, we intend to incorporate new extensions to the Ginga to incorporate this contextual information. We also intend to develop security and privacy features as well compare this architecture with other that would exists to capture the keys advantages and disavantages and provide a better interoperability to our approach.

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