A proposal for a metadata-based framework for interactive GINGA digital TV applications

Carlos Silva, Victor Machado, Hugo Kuribayashi, Antonio Jacob Jr, Edvar Oliveira, Marcos Seruffo, Carlos Francês
Federal University of Pará
Rua Augusto Corrêa, 01 - Guamá
Belém, PA, Brazil
+55 91 3201 8112
{cns,victoram,hugo,jacob,edvar, seruffo,rfrances}@ufpa.br

Nandamudi Vijaykumar
National Institute for Space Research
Av. Dos Astronautas, 1758
São José dos Campos, SP, Brazil
+55 12 3208 6549
vijay@lac.inpe.br

Celso Hirata
Aeronautical Institute of Technology
Praça Mar. Eduardo Gomes, 60
São José dos Campos, SP, Brazil
+55 12 3947 5987
hirata@ita.br

ABSTRACT
The GINGA middleware enables creating applications that are usually known as interactive GINGA applications. The development of these applications shares some requirements that can be explored jointly, such as reusability, standardization, maintainability and extensibility. This work proposes a framework that addresses the shared requirements, beyond integrating other specific-purposes frameworks. The metadata-based framework approach is used to provide the declarative configuration. This framework extends functionality of some pre-existing components of GINGA and allows easier implementation of new components.

Categories and Subject Descriptors
D.2.13 [**Reusable Software**]: Reusable libraries.

General Terms
Standardization, Design.

Keywords
Frameworks, Digital TV, Metadata, Interactivity, GINGA.

1. INTRODUCTION
There are some problems that have to be dealt with in GINGA-based present solutions. A serious problem is that each application is designed to solve one specific problem [1]. However, the developed applications are (nearly) the same over several releases for different customers, and the developers are not able to capture and explore the commonality [2].

The development of interactive GINGA applications is an area that requires a new approach to address specific-purpose applications [3]. The success of GINGA platform depends on many factors, such as ease of development, quality of available API's and wide adoption of GINGA-embedded devices.

The GINGA applications have many needs; however some of them are hard to be met due to their high complex implementation. One example of the hard requirement is the scalability in terms of number of users, for the various applications. Another example is the need for a web-based administration tool that collects user data and generates user data reports, that is not considered in most of the developments [4].

The use of frameworks is a growing alternative adopted worldwide in development of various software solutions. Some frameworks propose very high quality solutions that inspire declared innovations and modifications in the language patterns [5].

This work proposes a new framework for the development of interactive GINGA applications. Using new approaches, the idea is to integrate some specific-purpose frameworks to create architecture, extend pre-existing components of GINGA and implement new components. The use of metadata allows highly configurable behavior of framework components to process their logic [5].

This work is organized as follows: in Section 2.1 we define the interactive GINGA applications, the main target of this paper. In Section 2.2 an approach about metadata-based frameworks is presented. In Section 2.3 the related literature is presented. In Section 3 the methodology used to create the framework, the proposal, the case study and the preliminary results are presented. Section 4 concludes the paper.

2. GINGA, Metadata-based Frameworks, and Related Work
In this section we present the main concepts related with this work: Interactive GINGA Applications and Metadata-based Frameworks. Moreover, the main related works are shown.

2.1 Interactive GINGA Applications
The Terrestrial Integrated Services Digital Broadcasting (ISDB-T) enabled the creation of a new type of applications: the interactive GINGA applications [6]. The interactivity is one of the main reasons for choosing and creation of the standard adopted in ISDB-T [7]. The applications run in set-top boxes with GINGA

WebMedia'11: Proceedings of the 17th Brazilian Symposium on Multimedia and the Web. Short Papers.
October 3 -6, 2011, Florianópolis, SC, Brazil.
ISSN 2175-9650.
SBC - Brazilian Computer Society

middleware and allow users to interact with different contents and media through TV. The set-top boxes can be embedded in many types of devices, like mobile phones and traditional TV's [8]. Generally, the applications need an Internet connection, also known as return channel, and it is used to retrieve data of Internet servers and present dynamic content [9]. Through return channel the interactive application can send user's data to Internet, allowing a rich interactivity.

2.2 Metadata-based Frameworks

Metadata-based frameworks are those that process their logic in runtime based on metadata of the classes whose instances are being used [5][10]. Metadata-based frameworks allow configuring several behaviors of the used framework, reducing programmatic configurations. There are many types of metadata that can be used, among them, XML (eXtensible Markup Language) files, annotations, databases and others [5].

2.3 Related Literature

Development with framework provides higher productivity than development without framework. The study shown in [2] evaluates the impacts of use of frameworks in the learning, and consequently in productivity and defect density. They demonstrate that frameworks impact directly in the final quality of applications, or at least in the productivity of developers.

Frameworks are used in development process in order to achieve high level of reuse and be adaptable to the application needs [5]. A framework that enables speeding up the development phases by reducing the majority of repeating programmer routines is presented in [1]; however, metadata are not used. In [11] a framework for t-learning is presented, to provide a multiuser and distributed service over European standard. Furthermore, these approaches were developed for the European standard, which is not fully compatible with the Brazilian standard.

For dealing with games, [3] propose the Ginga Game framework, whose goal is to ease the development of games for Digital TV and to make this task more similar to the development used in a personal computer. In [12] a framework for t-learning applications in GINGA is presented, focusing on structures that facilitates the development of educative content. Again, metadata are not used in their approach either.

To create more standardized metadata-based frameworks, Guerra et al. [5] propose a pattern language to serve as a guide to framework developers. The patterns are classified in structural, metadata reading and logic processing patterns. The main known types of metadata used are listed, and framework architectures are shown, and some of them are used in this paper.

3. METHODOLOGY

In this section we show the proposal, case study and preliminary results.

3.1 Proposal

The objective of the proposed framework is to help the development process of interactive GINGA applications through the use of metadata to configure some of the behaviors of the application and framework itself. The interactive GINGA applications can be implemented using two different programing languages: NCL/Lua and Java. This work uses only the Java language, because only Java offers full support to object oriented programing, being better to implement the framework functionalities.

The requirements of a metadata-based framework in the Digital TV environment bring a series of issues, mainly in the client-side. The first is with the processing capacity and the limitations of environment and devices where GINGA run. From these problems a series of others may arise, including which types of metadata can be used in this framework, when this metadata will be processed to reduce the load on the system and the least possible impact on application performance. Thus, the first study point is the limitations of the environment.

It is necessary to create a new layer of visual form components, extending the existing and implementing new components in the client-side to enable new features of the framework, like input validation, correlating view fields and database fields. This last feature is possible due to the relation created between an input field and a model class property. After, this property is persisted in a database field through ORM (object-relational mapping).

One of the new components is *Wizard*, which can be used when the developer wants to create a step-by-step process. This component receives a list of frames or screens to be shown in each step. Another component is *Message*, which can be used to inform the user about some status like success, error or progress of the system. To achieve these features, the components override some key listeners of the GINGA application environment, and features of these components are defined in metadata file accessible in the class path, like the key to be used to move between the screens, the key used to exit the *Message* or the timeout of the displayed messages.

Server-side framework has no limitations found in client-side, because it can be executed in a different and more powerful environment. In this case, the selected environment is Java Enterprise Edition 6, as many required patterns can be reused in this framework. Thus, the server-side framework integrates a set of other specific-propose frameworks. Among these frameworks are JPA (Java Persistence API), JSF (JavaServer Faces), JAX-RS and CDI (Context and Dependence Injection). This component is responsible for listening client-side requests, to persist data in database using ORM, to process their business logic and return required and parsed data to client.

An overview of architecture is shown in Figure 1. The stereotype *newcomponent* identifies the framework components, and read information from files to configure them. Client-side framework works between GINGA middleware and client application. This component is responsible to send and retrieve data to server-side framework.

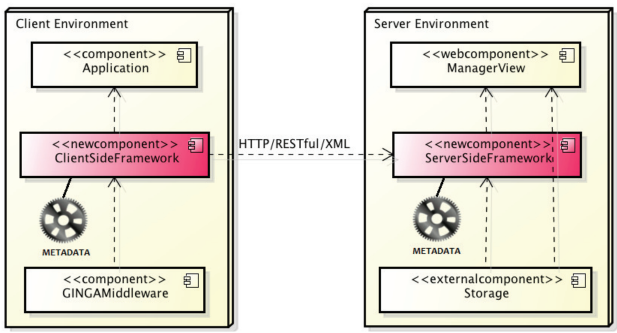

Figure 1: System Overview

The server-side framework listens the requests of the client-side and interacts with a data storage system and a view framework. The stereotype *externalcomponent* identifies the data storage. This component can use several pieces of solutions. One option is Relational Data Bases Management Systems. But, to support the probable load in Digital TV systems, the framework is able to connect with document-oriented databases, known as non-relational databases, enabling replication and high availability of systems. The stereotype *webcomponent* identifies the web interface to manage the system. This component can use a variety of view frameworks, but JSF 2 is recommended, as it is a part of JEE 6 specification.

3.2 Case Study

In order to evaluate and guide the framework creation and specification, an interactive GINGA application has been developed. This application is similar to the one proposed in [13], that is general purpose. In our case study, we deal with a specific purpose, i.e. the application is used to systematic monitoring and interacting remotely with patients suffering from arterial hypertension. This approach could be used for exchanging health condition data between family homes and health professionals [13].

The main collected data are height, weight, heart rate, blood pressure, temperature and waist circumference. These data follow the recommendations of [14]. Moreover, the date of each data input is persisted. The persistence system needs reliability, database sharing and high availability, and we used a non-relational database to provide such requirements and to replicate the database around some hosts.

Data can be provided in two forms: directly by patient or by connected sensors in the set-top box [15]. This work tests only with the patient providing data through inputs in the application user's interface. The health professional has a possibility of setting up various issues to be answered by patients, and these issues can help the medical professional to monitor more closely the patients' conditions and life. In order to make the system more flexible, the issues and options are fully configured by the professional. The Wizard component is used here to collect data in each step, i.e. in each screen and the Message component is used to notify the users of the system status.

3.3 Preliminary Results

The use of metadata-based framework in Digital TV environment is a challenging task, due to limitations previously mentioned. One limitation is the use of annotations in framework, because the version of JVM (Java Virtual Machine) used in GINGA does not allow it, as well as the platform JME (Java Micro Edition), used in the environment. Thus, the metadata format chosen is XML.

To parse the XML data we chose kXML API[1], because it is developed to run in constrained environments, similar to GINGA environment. The metadata documents are parsed on demand, to reduce the impacts on the system performance.

A study in GINGA Common Core component is necessary to get better details that the specific GINGA services can provide to applications and, consequently, to framework. Figure 2 shows the reference architecture of GINGA middleware and applications. Some services are interesting. The asynchronous message system is a feature provided by *Network* component, which can be used in the framework to reduce the server load delaying no urgent communications and distributing these messages accordingly.

[1] http://kxml.sourceforge.net/

The *Wizard* and *Message* components extend the *GUI Presentation* layer of the middleware. In Figure 2, the created frameworks works inside the *Execution Engine* block, joining services among *Service*, *Execution Engine* and *Application* layers.

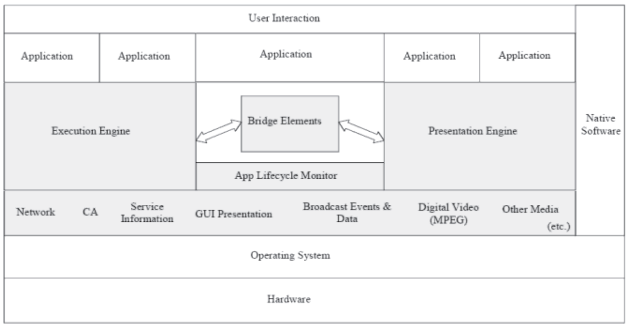

Figure 2: Reference Architecture of GINGA middleware

The *Message* component offers two static methods. One of them is used to show a message dialog, which has only one button representing "Ok" action. The other is used to show a confirm dialog, that has two buttons, representing "Cancel" and "Ok" actions. Both display time and can be configured in XML configuration file. One example of the message dialogs with a success message in case study application is presented in Figure 3. The colors of the buttons can be related with the colors existing in the default remote control of set-top boxes.

Figure 3: Message Component

To ensure availability and high performance on query operations, a non-relational database is used to persist all data of the patient. The replication technique causes more than one database server answering queries, and replicas can be distributed to decentralize the system. This arrangement proved efficient in internal tests, achieving high fail tolerance when network is down among the database servers.

4. CONCLUSIONS

The metadata-based frameworks are solutions to ensure reuse and increase the productivity in Digital TV projects. This approach allows SBTVD to have more attractive features and help to improve the use and success of the platform. Some components to specific-purpose are useful to create new range of GINGA applications, like *Message* and *Wizard* proposed components. These new components can reduce the development time and, consequently, the cost of the projects.

The initial results are satisfactory, showing feasibility on the implementations of this framework. Some limitations in the platform are found, among them the non-use of annotations to ensure metadata in classes. This limitation was overcome using XML files. The moment of parsing these files is an important question, which may be decisive on the application performance.

The new components presentation method has to be reviewed, as they are image-based and in some resolutions the adaptation of size does not work perfectly. In future, it might be interesting to by vector-based so that the framework is more portable and better presented in any screen resolution.

Although the GINGA specification brings more compatibility among devices, some implementations may show some differences of behavior. When the developed case study is deployed in other middleware implementations, then we will be able to confirm the correct execution of inter-implementation. It will occur naturally according to the adoption of the framework by developers and companies.

The next step could be a full implementation of this framework extending GINGA components and creating new components to increase middleware features. The use of other known patterns can improve its functionality.

Tests to quantify the gains in use of framework are a challenging task, and can be used to decide when to use or not this framework. A proposal of a model able to show the gains in numerical factors is something to think about.

The interactive GINGA applications development process presents some specific points that may be used to update a known development process, considering these points.

5. REFERENCES

[1] Vrba, V., Cvrk, L. and Sykora, M. 2006. Framework for Digital TV Applications. In *International Conference on Networking, International Conference on Systems and International Conference on Mobile Communications and Learning Technologies* (April 23-29, 2006). DOI= http://dx.doi.org/10.1109/ICNICONSMCL.2006.102.

[2] Morizio, M., Romano, D. and Stamelos, I. 2002. Quality, Productivity, and Learning in Framework-Based Development: An Exploratory Case Study. In *IEEE Transactions on Software Engineering* (September, 2002). DOI=http://dx.doi.org/10.1109/TSE.2002.1033227.

[3] Barboza, D. C. and Clua, E. W. G. 2009. Ginga Game: A Framework for Game Development for the Interactive Digital Television. In *Proceedings of the 2009 VIII Brazilian Symposium on Games and Digital Entertainment* (October 8-10, 2009). DOI= http://dx.doi.org/10.1109/SBGAMES.2009.26.

[4] Silva, C. N., Machado, V. A., Seruffo, M. C. R., Francês, C. R. L. 2010. TVD-Educ: Um estudo de caso de aplicação educacional interativa para TV Digital. In *IADIS Ibero Americana WWW/Internet 2010 Conference* (Algarve, Portugal, December, 10-11, 2010).

[5] Guerra, E. M., Sousa, J. T. and Fernandes, C. T. 2009. A pattern language for metadata-based frameworks. In *Proceedings of the 16th Conference on Pattern Languages of Programs* (Chicago, IL, USA, August 28-30, 2009). DOI= http://dx.doi.org/10.1145/1943226.1943230.

[6] Prado, G. M. and Zorzo, S. D. 2010. Interactive Service Provider Architecture for Interactive Digital Television Systems. In *International Conference on Computer Information Systems and Industrial Management Applications* (October 8-10, 2010). DOI= http://dx.doi.org/10.1109/CISIM.2010.5643510.

[7] Alencar, M. S., Lopes, W. T. A. and Madeiro, F. 2010. History of Television in Brazil. In *Second IEEE Region 8 Conference on the History of Telecommunications* (November 3-5, 2010). DOI= http://dx.doi.org/10.1109/HISTELCON.2010.5735326.

[8] Saleemi, M. M. and Lilius, J. 2010. Interactive Applications for Mobile TV. In *International Conference on Multimedia Computing and Information Technology* (March 2-4, 2010). DOI=http://dx.doi.org/10.1109/MCIT.2010.5444859.

[9] Margalho, M., Francês, R. and Costa, J. C. W. A. 2007. Return Path in Brazilian Digital Television with Interactivity Based on Continuous Signalization Mechanism and QoS Bandwidth Control. In *IEEE Latin America Transactions* (September, 2007). DOI= http://dx.doi.org/10.1109/TLA.2007.4378530.

[10] Guerra, E. M. and Fernandes, C. T. 2008. A Metadata-Based Components Model. In *Proceedings of Doctoral Symposium at 22nd European Conference on Object Oriented Programming* 08 (Paphos, Cyprus, July 7 -11, 2008). ECOOP 2008.

[11] Pazos-Arias, José J. et al. 2006. ATLAS: a framework to provide multiuser and distributed t-learning services over MHP. In *Software – Practice & Experience*, v. 36, n. 8, p. 845-869 (March, 28 2006). DOI= http://dx.doi.org/10.1002/spe.719.

[12] Marube, N. N., Tavares, D. C. 2010 Ginga Edutainer: A Framework for the Development of T-Learning Applications on Ginga – The Brazilian Digital Television. In *Workshop on Interactive Digital TV in Emergent Countries – European Conference on Interactive TV and Video*. EuroITV.

[13] Oliveira, M., Hairon, C., Andrade, O., Moura, R., Sicotte, C., Denis, J-L., Fernandes, S., Gensel, J., Bringel, J. and Martin, H. 2010. A Context-Aware Framework for Health Care Governance Decision-Making Systems: A model based on the Brazilian Digital TV. In *IEEE International Symposium on a World of Wireless Mobile and Multimedia Networks* (Aug. 2010). WOWMON'2010. DOI= http://dx.doi.org/10.1109/WOWMOM.2010.5534979.

[14] Ministério da Saúde. 2011. Coordenação de Avaliação e Acompanhamento do Departamento de Atenção Básica. Access in June, 2011. Available in http://dab.saude.gov.br/caa/.

[15] Oliveira, M., Cunha, P. R. F., Santos, M. E., Bezerra, J. C. C. 2009. Implementing Home Care Application in Brazilian Digital TV. In *Global Information Infrastructure Symposium* (June 23-26, 2009). GIIS'2009. DOI= http://dx.doi.org/10.1109/GIIS.2009.5307042.