

# ***Ginga Game: A Framework for Game Development for the Interactive Digital Television***

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## **Abstract**

With the implantation of Brazilian's Digital Television System, a new software development platform has been created. Applications for the Digital TV are an important part of this new system, which aims, in addition to higher image and sound quality, the creation of an interactivity channel for the viewer. Among all possible applications for this new environment are the digital games, which every year attract a growing audience worldwide. However, game development isn't a simple task, and doing so in a limited platform such as digital receivers could be a complicated process. So, this paper presents a framework for game development for the Digital TV, which allows the developer to focus on content creation only, without concerns about technical issues or common tasks related to game development.

**Keywords:** Ginga, Digital TV, frameworks, games

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## **1. Introduction**

Brazilian Digital Terrestrial Television System (SBTVD-T) has three guidelines, in addition to its current analogue system: high-definition digital broadcast (HDTV); digital broadcast for fixed, mobile and portable reception; and interactivity [Brasil 2006].

SBTVD-T's interactivity channel allows the system to be expanded through applications built over a reference standard system. The main idea is to allow the digital receiver (set-top box) to run different applications, such as electronic guides, shopping channels, bank and educational services, among others [Barbosa and Soares 2008].

Digital games are an interactive application type that could help Digital TV become popular in the country, since the national industry is in an expansion and growing moment [Ferreira and Souza 2009].

In SBTVD-T, the *Ginga* middleware takes place between applications and execution infrastructure (hardware and operating system) [Ginga 2009]. For this reason, applications for the Brazilian Digital TV must be based on the *Ginga* middleware, using one of its supported programming languages.

This paper's main goal is to present a game development framework for the SBTVD-T, using *Ginga-J* (the procedural part of *Ginga* middleware that uses the Java language). The framework presents an application model and a set of classes that simplifies game development for the Digital TV as well as abstracts the process from a specific platform.

The idea is to use the framework to facilitate the game development for the Digital TV to the process of developing games to personal computers, except for some certain limitations imposed by the platform [ABNT 2008], such as hardware limitations concerning memory and processing capacity, and input issues related to the use of a remote control instead of mouse and keyboard.

The paper is organized as follows: section 2 presents some related publications to this paper's proposal. Section 3 presents the *Ginga* middleware and its structure. Section 4 describes the *Ginga Game*, the framework proposed in this paper, and also presents an example of its application. The last section presents the paper's conclusions.

## **2. Related Work**

There is some related work about game development for the Digital TV. Among these papers, the following could be highlighted: [Ferreira and Souza 2009], that presents a different approach to *Ginga Game*, but with similar purpose; [Lima 2007], that develops a communication protocol for network games within SBTVD-T; and [Junior *et al* 2009], that doesn't use *Ginga-J*, but makes an interesting study about game development for the Digital TV using *Ginga-NCL* with the *Lua* programming language.

In its master degree dissertation, [Valente 2005] presents the study about the development of a framework for computer games. This work isn't directly related to game development for the Digital TV, but has some interesting content about game development frameworks architectures, which some of them are used in this work.

## **3. Ginga Middleware**

*Ginga* is the middleware for running applications on the SBTVD-T. This platform was developed together by the research laboratories *Telemidia* [Telemidia 2009] and LAViD [LAViD], from PUC-Rio and UFPB.

The *Ginga* middleware is subdivided into two applications environments for Digital TV receivers and allows the application development following two distinct programming paradigms: the declarative (*Ginga-NCL*) and the procedural (*Ginga-J*).

The declarative environment allows the programmer to define a set of tasks to be executed without concerning who will perform these tasks and how they will be performed. This way, it is needed only the description of the desired results in a declarative language, instead of an algorithm [Barbosa and Soares 2008]. The SBTVD-T employs the NCL (Nested Context Language) language in its declarative environment [ABNT 2007] together with the Lua language, for non-declarative applications.

The non-declarative environment, or the procedural environment, requires the specification of each step to be performed by the program. In this kind of environment, the programmer has higher level of control over the application and its execution flow, but it's also required a higher language and algorithm knowledge [Barbosa and Soares 2008]. The Java language is employed in the SBTVD-T's procedural environment.

Figure 1 exposes *Ginga* middleware's architecture. The Presenting is the subsystem responsible for processing NCL documents, and the Execution Machine is in charge of processing procedural applications, i.e., Java *Xlets* [ABNT and CEET-00:001.85 2008].

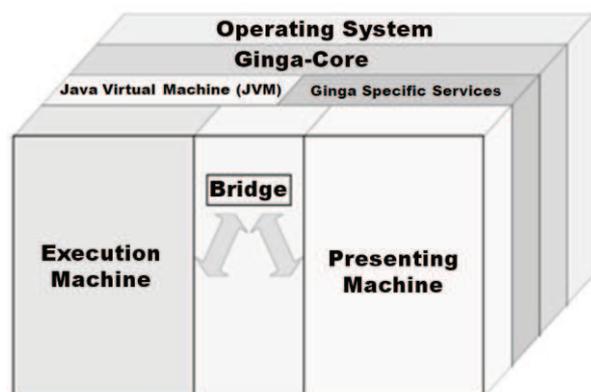


Figure 1 – *Ginga* middleware architecture [ABNT and CEET-00:001.85 2008].

This paper's scope doesn't enclose the *Ginga*'s declarative environment, focusing solely on *Ginga-J*. For further information on application development using *Ginga-NCL*, it is recommended [Barbosa and Soares 2008].

### 3.1 *Ginga-J*

*Ginga-J*, the procedural environment for the *Ginga* middleware, is currently under development and

doesn't have an official implementation. On may/2008, a draft version, without normative value, of *Ginga-J* specification was released by ABNT (*Associação Brasileira de Normas Técnicas*) and CEET-00:001.85 (*Comissão de Estudo Especial Temporária de Televisão Digital*) [ABNT and CEET-00:001.85 2008]. This specification defines *Ginga-J*'s architecture and execution environment, and is addressed to applications and digital receivers developers.

*Ginga-J*'s architecture is shown on Figure 2. In this architecture, user's applications (called *Xlets*) are placed on the top level and must make use of *Ginga-J*'s standard API (Application Programming Interface). Resident Applications, on the other hand, may use non-standard system resources, available from the operating system or a particular implementation of *Ginga*. This kind of application includes closed captions, system messages, receiver's menus, program guide, and others [ABNT and CEET-00:001.85 2008].

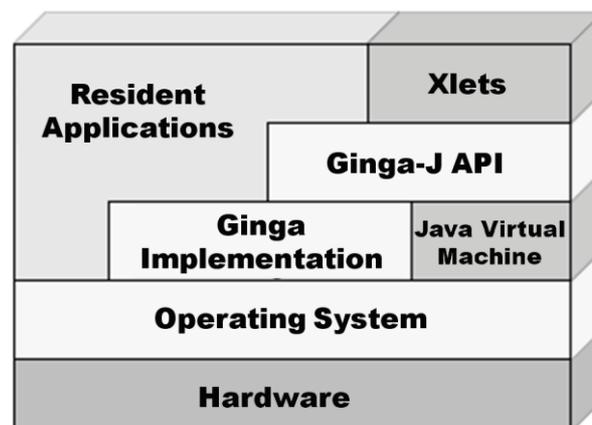


Figure 2 – *Ginga-J* middleware architecture [ABNT and CEET-00:001.85 2008].

The *Ginga-J*'s reference implementation document defines the *Ginga-J* API, a set of Java packages included in *Ginga-J*. This API includes packages from the following APIs:

- *JavaTV* [Sun 2009a]: an extension of Java platform to add support for Digital TV application development. It's main goal is to run applications abstracting the technologies used on the broadcast.;
- DAVIC [DAVIC 1998]: is a set of specifications aims to keep interoperability between platforms involved on execution of broadcasted audio and video;
- HAVi [HAVi 1999]: defines a home network interoperability standard between audio and video devices. HAVi packages' also provides resources for graphical users interface creation, extending Java's AWT 1.1 [Sun 1999];
- DVB [DVB 2009]: packages that extends features from *JavaTV*, DAVIC and HAVi,

and includes other features, such as *Xlets* communications, persistence, and others;

- *Ginga* Extensions: class set that includes channel tuning control, media flow API, and return channel API;
- ARIB STD B-23 [ARIB 2003]: API compatible with Japanese Digital TV standard specifications;
- *Ginga-J* Definitions: packages that offer functions to *Ginga* middleware-included devices, such as multi-user interaction, and the bridge with *Ginga-NCL*.

The full list of these packages is available from [ABNT and CEET-00:001.85 2008].

Due issues related to copyrights costs, this reference implementation of *Ginga-J* has not been included in any digital receiver marketed in Brazil so far.

In May/2009, the Board of the Forum of Brazilian Digital Terrestrial Television System (*Conselho Deliberativo do Fórum do Sistema Brasileiro de TV Digital Terrestre*) decided [Fórum SBTVD 2009a] for the implantation of *JavaDTV* [Sun 2009b] in the *Ginga* middleware, instead of the previous published draft [ABNT and CEET-00:001.85 2008]. This API is also based on *JavaTV* and is very similar to the reference implementation, but it replaces some proprietary solutions.

The *JavaDTV* binaries are unavailable on the time this paper is being written and only its documentation has been published [Fórum SBTVD 2009b].

This paper's elaboration uses the reference implementation so that it is possible to present a functional version of the project. The framework's structure has been developed in a way that platform specific details are isolated, making easier for the migration process to be done when *JavaDTV* becomes available.

### 3.2 Applications for the Digital TV

Applications for the Digital TV are called *Xlets*, just like Java applications for the web and mobile are called *Applets* and *Midlets*, respectively. An *Xlet* life-cycle is shown in Figure 3. As soon as the application is loaded to the set-top box, it will stay on the loaded state until it's started. Then it pass from the paused state to the started state (where it is actually running), and may be eventually paused and resumed again. Finally, the application manager destroys the *Xlet* when it enters the destroyed state [Burlamaqui *et al* 2008].

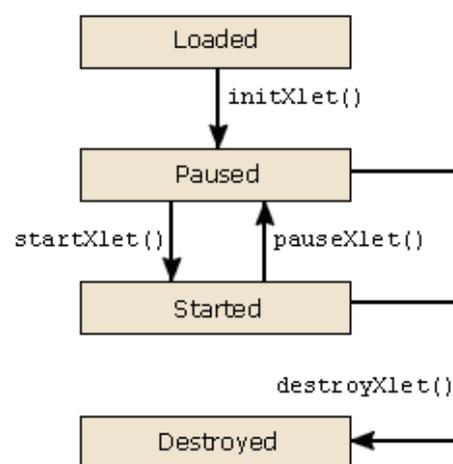


Figure 3 – The *Xlet*'s life-cycle [Morris 2005].

An important difference between an *Xlet* and an *Applet* is the possibility to pause and resume an *Xlet*. This is very important in a limited environment like the digital receivers, where many applications could be running at the same time and sharing the limited available resources. This way, it's possible to temporary stop an application that is not visible and release the resources to other applications [Morris 2005].

A Digital TV application is, therefore, an application that implements the *Xlet* interface provided by *JavaTV* [Sun 2006]. The following are the public methods of this interface:

- `destroyXlet`: signals the *Xlet* must be finalized and enter in the destroyed state;
- `initXlet`: signals the *Xlet* must be initialized and enter the paused state, which means it's ready to start providing a service;
- `pauseXlet`: signal the *Xlet* must stop providing a service and enter it's paused state;
- `startXlet`: signals the *Xlet* must start providing a service and enter it's started state.

The *Xlet* interface allows an application manager to create, initialize, start, pause and destroy an *Xlet*. Due its life-cycle, it's possible that several different *Xlets* are controlled at the same time by the application manager, and the runtime environment chooses which one should be active in a given time.

For the elaboration of this paper, while the *JavaDTV* is unavailable, the reference implementation [ABNT and CEET-00:001.85 2008] has been used. Tests with the built applications were held with the *XletView* [Sveden 2004], an *Xlet* emulation software that allows testing applications developed for the Digital TV [Carvalho and Araújo 2009].

## 4. *Ginga Game*

*Ginga Game* is a Digital TV game development framework proposed in this paper. Its goal is to provide a structure that makes it easier to develop games for the Digital TV and make this task more similar to the development for personal computers.

The purpose on the creation of a software framework for game development is to avoid that common tasks be implemented again every time a new game is produced. [Valente 2005] presents a similar approach, but focuses on the reuse of software components for computer game development.

*Ginga Game* provides an application model that automatically performs several recurring tasks concerning game development, such as resources loading and component management, and allows the developer to focus on its game specific code.

This approach is similar to the models provided by XNA [Microsoft 2009] and Unity 3D [Unity 2009], for instance. These tools provide a complete game structure and the developer must only write the code that defines the behavior of its game components and add them to the game scenes.

*Ginga Game* is subdivided in three different *Java* packages. This implementation was made in a way that classes that need platform specific resources are in a separate package from the classes that doesn't have this kind of dependency. So, the migration of *Ginga Game* to another platform could be made just by doing the required modifications in only one package, while the others remain unchanged.

The package *GingaGame* provides some abstract interfaces that must be implemented in a platform specific package. In this package are defined basic concepts of the framework, such as game objects and game components, scenes, and the application model that manages these objects.

The package *GingaGame.GameComponent* has a set of ready to use components. These components must be added to objects in a game scene. Among the developed components are *AnimatedSprite* (that allows the drawing of animated images), *StaticSprite* (for drawing static images), and *BoundingBox* (for collision checking using rectangles). More components will be developed over time.

Lastly, the *GingaGameJavaTV* package encloses all platform specific classes, in a *JavaTV* specific implementation. An example of platform specific resource is the window manager. *JavaTV* uses the class *HScene* (from the HAVi package) to access the application's windows. These classes are put apart from the remaining classes of the framework to make it easy to change the execution platform, if it's needed.

This way, only the platform specific code should be modified, but the interfaces remain the same.

The UML Package Diagram for *Ginga Game* is shown in Figure 4.

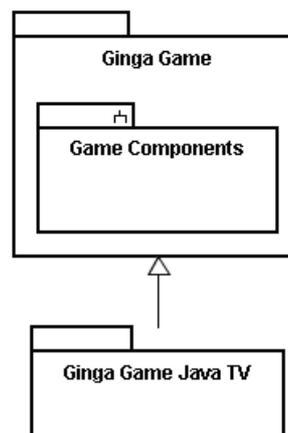


Figure 4 - *Ginga Game* Package Diagram.

### 4.1 How *Ginga Game* works

Games created with *Ginga Game* are made with a class that extends the framework's *Game* class. This is the main class in the framework, and it works as a starting point on the creation of new games, while it's also responsible for running the application model and the component management.

A game can be decomposed into logical units called scenes that are instances of the *Scene* class. Each scene is independent from other scenes and could be initialized and finalized at any moment by the game. It may also hold several game components and objects that are loaded and removed from the game at the same time of the scene. This division allows a simpler game organization, where each screen, stage or level can be described as a scene.

A scene or the game can hold a game object collection, where a game object is an instance of the *GameObject* class. These entities interact with each other and these interactions are what give life to the game. Characters in an adventure game or cars in a racing game, for instance, could be described as game objects. A game object may be added to a scene or the game (in this case, it will be a persistent object that will not be destroyed when the scene is finalized). A game object may contain one or more game component.

The game components are instances of the *GameComponent* class used to compose a game object. For instance, a car object can be composed by wheels, engine, lights and several other items. Each of these items can be represented as a game component.

It's up to the developer to use the components available from the framework or create its own. The *GameObject* and *GameComponent* classes can be extended so the developer can create its own content.

This approach allows software reuse at various levels. Depending on how the content was created, scenes, objects and component can be easily reused in other games. For example, a game options screen (a scene) can be shared between games that have the same user's options. Likewise, an object used to account player's scores can also be the same in several different games.

*Ginga Game* has classes to manage game resources and execute certain routine tasks. The *Screen* class is responsible for drawing images and text into the game screen, while the *ContentManager* class is employed to load and manage resources, such as images and fonts.

User interface is made through the *Input* class that must query the remote control keys' state e provide this information to the game components.

A collision manager verifies if a collision has occurred between solid objects in a scene and notifies the objects involved in the collision. This way, a solid object doesn't need to query if a collision has occurred at any time, when it happens an event is triggered and the object can treat it.

In future versions, more components will be available and the common content will be more and more separated from the specific content a game may need.

A simplified UML Class Diagram for *Ginga Game* is shown in Figure 5.

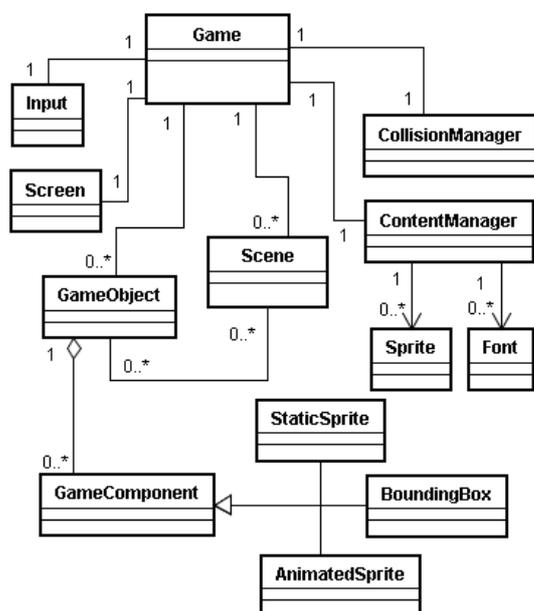


Figure 5 - Ginga Game Class Diagram.

#### 4. Validation of the *Ginga Game*

To illustrate the development of a game with *Ginga Game*, a simple quiz game has been elaborated. While it's a very simple game, it helps to illustrate the use of the framework, since many of *Ginga Game*'s features are employed.

The game works as follows: a question and four answers are shown to the player. The answers appear inside red, green, yellow and blue buttons, using the colors of the remote control button's to make the process more intuitive. For each question the player must press the correspondent button color that he thinks is the right answer. A component accounts how many right and wrong answers the player has given.

Figure 6 shows the game's project, where it's listed its classes and images. Following is a brief description of each class:

- *Botão* (Button): a game object that represents one possible answer to the question. A button is related to an image (a *StaticSprite*) and to a text (the answer);
- *Controle* (Controller): the game object that verifies if a remote control key was pressed and tests if the right answer was chosen. The controller tells the scoreboard if the answer was correct or not and requests a new question to the game;
- *GingaGameQuiz*: the application's starting point. This class creates the *Xlet* and a game instance;
- *Jogo* (Game): an instance of the *Game* class that is responsible for initializing the game scenes, as well as the scoreboard (a global object that controls the player's score);
- *Pergunta* (Question): a game object that represents a question in-game.
- *Placar* (Scoreboard): a global game object created by the game, not a scene, that controls player's score;
- *TelaDePergunta* (Question Screen): each question screen is a scene that contains a question, a controller and four buttons. In order to add more questions to the game, it's needed just to create more instances of this class.

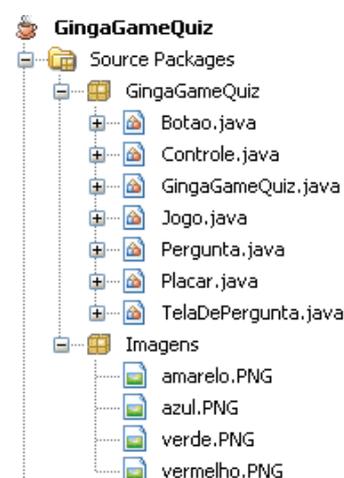


Figure 6 - Quiz Game classes.

This game exemplifies the use of *Ginga Game*'s classes in a very simplified way. In the game the game object, game component and scene concepts are used to divide the game in smaller logical units.

Figure 7 shows a game screen on the *XleTView* emulator. The area within the yellow lines are the game itself (a question on the top, the answer options on the right side using the colors of the remote control, and a scoreboard on the lower-left corner) and the remote control on the left side is provided by the emulator.

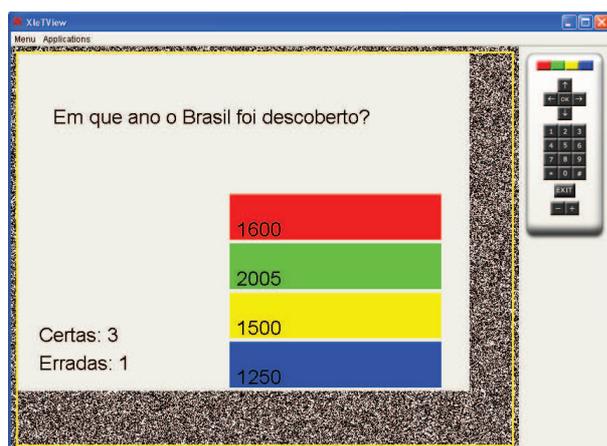


Figure 7 – Sample game developed using *Ginga Game*.

New features could be easily added. A win screen, for instance, can be created through a new scene that could be loaded after the player answers some correct questions.

## 5. Conclusion

The development of games for the Digital TV in Brazil, using the *Ginga* middleware, either within the procedural environment (*Ginga-J*) or the declarative environment (*Ginga-NCL*) is possible and the appeal the games have may help popularize the interactive content on SBTVD-T.

Software development auxiliary tools has great importance and the creation of frameworks that allows greater code reuse and reduces the needing to rewrite code for common tasks may help to make the process quicker and more intuitive.

With the elaboration of *Ginga Game*, it's expected to make the process of creating games for the Digital TV simpler, providing an environment that abstract the execution platform and allows the developer to focus only on the game's logic. Through its structure, *Ginga Game* proposes an environment that allows a high rate of software component reuse, reducing the creation time for new games, as previously created components can be reused in new projects.

Future versions of the framework could add current unavailable features, such as sound and video playback, as well as the integration with NCL documents.

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