Diga Saúde - A Home Care Component of the LARIISA Based on the Brazilian Digital TV Model

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***Abstract*—GingaCDN (Ginga Code Development Network), a project supported by the RNP (Brazilian Research National Network). It aims to research and disseminate high-quality technological solutions and tools related to the development of components on the Ginga architecture, the middleware of the Brazilian DTV System (SBTVD). This paper describes solutions adopted in the Interactive Channel and the Data Persistence, two components of the Ginga's Common Module (Common Core), which supports the Presentation/ Declarative's model and the Execution/ Procedural's model of the Brazilian middleware. These solutions are been used on the Lariisa project, a governance decision-making support model for public health systems. Lariisa is a context-aware based system which the information paradigm is centered on the family. It uses the brazilian set-top-box for context detection on the house. An application scenario and the framework of the Larissa are presented and it is also described a prototype that illustrates how these two components can be used in developing interactive applications like these used at Lariisa.**

Keywords-Healthcare, context-aware, Digital TV, Middleware, Ginga,

I. INTRODUCTION

GINGA [1] is the middleware developed for the Brazilian Digital TV model [2]. It became, recently, a Recommendation H.761 of the International Telecommunications Union (ITU-T) [3]. In fact, this Recommendation gives the specification of the Nested Context Language (NCL) and of an NCL presentation engine called GINGA-NCL to provide interoperability among multimedia application frameworks [4].

GingaCDN [5], a project driving by the RNP (Research National Network), aims to research and diffusion of the technological solutions and tools related to the development of components on the Ginga architecture, the middleware of the Brazilian DTV System [6]. This work describes solutions adopted in the Interactive Channel and the Data Persistence, two components of the Ginga's Common Module (Common Core), which supports the Presentation/Declarative's model and the Execution/Procedural's model of the Brazilian middleware.

These solutions are been used on the Lariisa Project (Laboratoire Réseaux Intelligence Intégration Santé Aplication) [7]. It proposes a governance decision-making support model for public health systems, which the information paradigm is centered on the concept of family context. Based on the Dey's definition of context [8], we consider health context as "any information that can be used to characterize the situation of an entity in a health system. An entity is a family member, health agent, health manager, etc, that is considered relevant to the interactions between a health manager and a health care system in order to make decisions."

Lariisa uses the brazilian set-top box for context detection on the house. An application scenario and the framework of the Larissa are presented and it is also described a prototype that illustrates how these two components can be used in developing interactive applications like these used at Lariisa.

II. LARIISA INFRASTRUCTURE

The Lariisa project is a context-aware based system. It aims to research innovative technologies for Healthcare System using the Digital Belt communication infrastructure [9], allowing the use of multimedia services (voice, video and data) in a broadband infrastructure based on an optical ring and the capillary based on WiMax technology. It is expected also the set-top box of the Brazilian Digital TV used as a terminal in order to allow the people family to access some digital services (education programs, interactive advice, remote monitoring, emails, information servers, etc).

A. Belt Digital Design

The Belt Digital project is a computer network infrastructure that will provide broadband services to 82% of the population of the State of Ceara in 2010 [9].

B. Brazilian Digital TV

The impact of the new generation of television is much more significant than the simple exchange of an analogical system of transmission for digital, and much more than set top box improves of the quality of image and sound [2]. An important component is the ability to expand the functions of the system for applications constructed on the base of a system reference standard. Such applications are computational programs resident in a receiving device. New services are available, as electronic guides of programs, banking services (T-banking), health services (T-health), educational services (T-learning), services of government (T-government), etc. But the most important characteristics in the Digital TV technology is the interaction of the viewing user, which could be delegated the control of the flow of a televising program, determining if one content must be shown or not. The necessary computational capacity to the new system can be integrated in the proper display device: a device of digital TV, a cellular one, PDA etc.[10].

The main innovation is taking advantage of a break of a paradigm in the Brazilian scenario, when a Digital TV will take the place of the omnipresent analog TV, now available in practically all residences. Figure 1 presents the architectures of the digital TV where the Brazilian solutions/choices are highlighted.

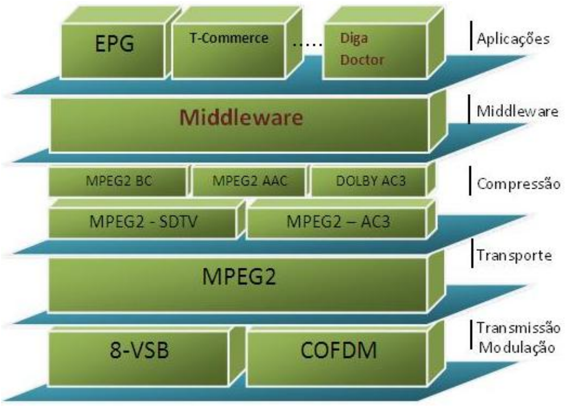

Figure 1. Architecture of the Brazilian Digital TV

The SBTVD-T [11][12], the Brazilian model, uses in the Compression Layer the H.264 video codec instead of ISDB-T's MPEG2 and an improved tuner[1]. DVB and ISDB also provide for other video compression methods to be used, including JPEG and MPEG-4, although JPEG is only a required part of the MHEG standard. In fact, Brazil is using ISDB for terrestrial broadcasting (ISDB-T). This video is encoded with MPEG-4 AVC (H.264) and the audio with MPEG2-AAC [13].

The ISDB-T modulation scheme, also called BST COFDM (Band Segmented Transmission Coded Orthogonal Frequency Division Multiplexing Coded OFDM), was developed to broadcast digital terrestrial TV with the use of flexible modulation. The BST-OFDM system proposed for the Japanese system improves upon COFDM by exploiting the fact that some OFDM carriers may be modulated differently from others within the same multiplex [14].

C. *Lariisa Communication Scenario*

Figure 2 shows the Larissa communication scenario where information from the health context information are detected by the set-top-box and sent to the system by the Digital Belt infrastructure.

Figure 2. Lariisa Communication Scenario

III. THE LARIISA FRAMEWORK

The Lariisa project will evaluate new technologies and architectures to provide a platform for delivery and management of integrated health services that allows users to customize and use multiple devices and services with minimal effort. Users need to use different terminals and devices to access different services in different environments including their homes, offices, public places or even in transit, being forced to deal with the complexity related to the change of context, network devices, computing power of devices, quality of service, communication, security, etc.

In the process of investigating new technologies for the Digital Belt, the Lariisa project aims to develop, to specify, and to design a framework for service-oriented broadband communication so that it can provide universal access to networks with sensitivity to context centered to the user (User Centric Environment Concept), using the concepts of personalization and adaptation of services or Context (Context Awareness Concept) [15].

Generally, the context is obtained from devices that operate at a lower level of abstraction, such as a GPS, accelerometer, thermometers, etc. Other contexts, however, are not so simple to be represented by having a higher level of abstraction. The representation of context by itself is not a trivial task. The total area of knowledge representation is extremely important for computing context-sensitive, which the concept of ontologies is considered a powerful approach. Such artifacts of knowledge, as the preferences of users, for example, are called profiles. These profiles are, in most cases, difficult to obtain from Boolean concepts of "true and false" from the low levels of abstraction (sensors). Therefore, logical constructs such as fuzzy logic, machine learning techniques or data mining can provide a great help in the representation of context [16]. Currently, the effective exploitation of various services is limited, since it requires access to multiple technologies and protocols, multiple devices and settings and multiple authentication mechanisms.

A. *Lariisa Core Framework*

Figure 3 presents the Lariisa core architecture. It incorporates classical components of ontology-based knowledge management systems, such as ontologies (OWL-

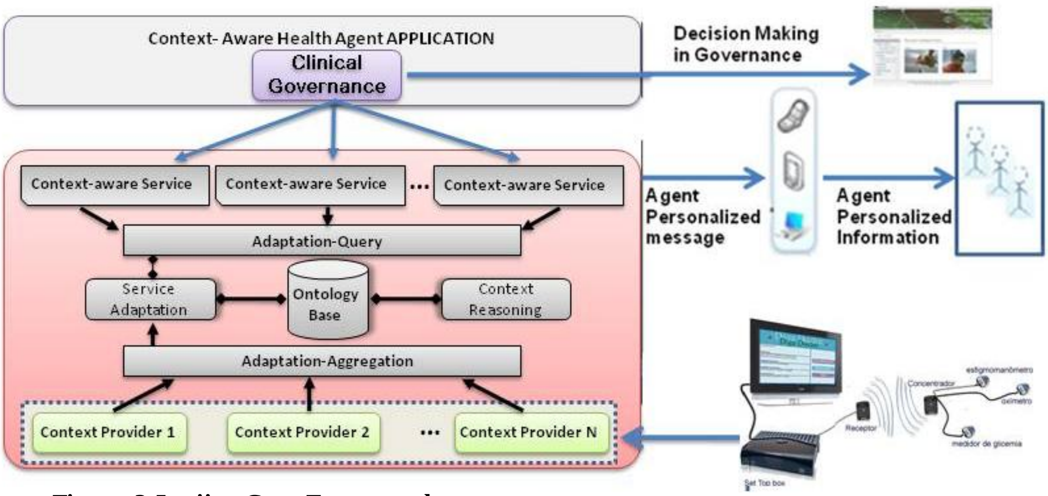

Figura 3 Lariisa Core Framework

ontologies), ontology instances, inference and derivation mechanisms, etc. [17]. Moreover, it proposes context-aware adaptation mechanisms, like the Service Adaptation component, that have an important role for the integration between Lariisa core framework and the health model [7]. Each entity of Lariisa framework is described below:

- **Context Provider**: this entity is in charge of gathering raw context data from the environment and mobile sensors, which will be sent to the adaptation-aggregation layer.
- **Adaptation – Aggregation**: this layer is in charge of receiving raw context information from various context providers and running context aggregation operations in order to have high-level context information.
- **Service Adaptation**: it manages the main adaptation processes of LARIISSA core framework. It is in charge of identifying context that is relevant to the three identified cycles: knowledge creation process, health decision-making process, and health context-aware actions. Moreover, it handles the following functions: (1) context-aware adaptation of health local rules taking into account governance decisions; (2) context-aware adaptation of health local rules taking into account the local context; (3) offering context-aware health indicators that describe local and global context to the knowledge creation entities and decision-making applications;
- **Context-aware Service**: it utilizes high-level context information obtained from the Service Adaptation in order to adapt their functionalities, taking into account changes of global and local situations. These context-aware services will compose health decision-making applications, which are designed according to the Application from the model illustrated in Figure 3.
- **Ontology Base**: it provides knowledge management operations, which is semantically represented by ontologies.
- **Context Reasoner**: it uses rule-based reasoning technologies in order to infer and derive high-level context information from gathered basic contexts for knowledge consistency in the Ontology Base;
- **Adaptation – Query**: it handles persistent context queries of context-aware services that are composing health decision-making applications, extracting desired context information from the Ontology Base via the Service Adaptation;

B. Health Agent Case Study

Figure 4 illustrates a context-aware health agent application. The using scenario is the Dengue disease epidemic occurred in Fortaleza (Brazil), in 2008. Consider a Health Agent as a professional that deals daily with users of the health system, visiting homes, communities, etc. Without an information system, the visiting schedule of Health Agents, for example, follows a linearity and not always efficient agenda, established for sometimes of poor historical and outdate information.

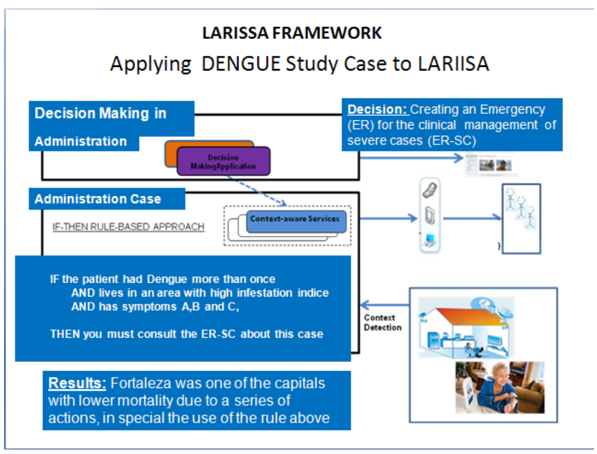

Figure 4. IF-THEN Rule-based Agent Health Personalization

The main idea of using LARIISA architecture in this case study is to improve the quality of health services provided by the agents. For example, Health Agents could be scaled for an area where there are insurgent signs and symptoms of the Dengue endemic or people that need more health care. Moreover, Health Agents with some professional specific profile could be allocated to local more adapted to their professional competences. Let us consider two flows in order to better illustrate this Health Agent scenario:

- The first flow is related to context information about several health end-users, captured by sensors at the house's users or inferred/derived by the LARIISA framework, for example. They could be sent, via set-top-box/Digital Belt or via Health Agent Mobile Application, to the LARIISA Architecture (Context Provider component). After all the middleware's inference process describes before, a Context-aware Service obtains the context information in order to adapt as soon as possible the changing situation, updating the Health Agent's agenda;

- A second flow considers the authentication process of the Health Agent, equipped with a wireless device equipped with Bluetooth, Wifi, and GPS, as shown in Figure 4.

Therefore, by using the set-top box the Heath Agent application is able of sending family data captured by sensors (detection of context) and to assist the routine of Health Agents.

C. *Data Persistence Component*

In computing, Data Persistence refers to non-volatile storage of data, for example, in a physical storage device such as a hard disk. Ginga-J Application model [18] allows applications to be stored and started from persistent memory. Thus, in one set-top box hosting the Ginga middleware, it is possible to store Java applications using javax.microedition.io and java.io packages, as well as the API "Persistent storage access rights and properties", described in API JAVA DTV [19].

- The Data Persistence component must perform the following actions:

- Manage access rights to files or directories: This action is based primarily on defining and verifying the rights to read, write and execute on a Java application, loaded by the middleware. The configuration of these access rights are defined according to the settings of Linux, as well as the types of users.

- Manage the available space on the platform: This action is basically to check the free space on the platform and set the maximum persistence file system.

- Define and check the properties of the persisted files: a platform where the storage capacity is scarce, it is necessary to adopt a persistence policy. An expiration date and a persistence level of a file are properties that can define a persistence policy. After its expiration date the file should be deleted from the file system and files with high persistence level would have higher priorities for its persistent storage. The Persistence component provides a means to define and verify these two properties files.

- Store Java application control data: Java applications received via data carousel must be controlled according to life cycle table of the application. These control data are described in a file which will store the Persistence component and provide a means for access to such information for application execution.

D. *Interactive Channel*

The convergence between the television and the computer should allow the Brazilian people the access to interactive contents offered by the TV broadcasters and government digital services, especially in the health and education areas.

In the context of the GingaCDN project [5], it will be defined and implemented a series of software components to compose the Ginga middleware, namely the Ginga Common Core. One of these components is the Interactive Channel. This component will provide a managing interface for connectivity capabilities of the digital signal receiver (set-top box or the Digital TV itself).

This management will be possible from the detection of the connectivity type supported by the device until the sending asynchronous messages through the channel of interactivity. There will be several types of connection interfaces in the digital receivers (set-top box) used to send data through the channel of Interactivity, such as ISDN, Ethernet and GSM-GPRS. The components developed by GingaCDN interact among themselves through provided interfaces and required interfaces. The Interactive Channel component requires no interface, but provides an interface as a management service. Other components of GingaCDN may require this interface to perform their activities.

The Interactive Channel component was specified by an architecture implemented in `C++`. This architecture describes all the classes and interfaces, their methods, and defines all behavior of the component. The architecture is based on package `br.org.sbtvd.net.rc`, of the Ginga-J specification. Inside of the component architecture, there is an entity responsible for managing of the receiver connectivity technology, called `ReturnChannelManager`. Its task is detecting all the interfaces of the existing connections. For the Interactive Channel component, there is a criterion that defines the type of interface detected: connection-oriented and connectionless. The component will also be able to determine the maximum data transmission rate presented by the connection interfaces detected in the receiver.

E. *Connection-oriented Interfaces*

They are represented inside the component architecture by the `ConnectionReturnChannel` interface. A 3G modem is an example of this kind of connection-oriented interface. These interfaces require an additional management layer. Another entity of the Interactive Channel component architecture is responsible for managing the connection-oriented interfaces detected by `ReturnChannelManager`. The `ConnectionRCController` interface is the way used by the component clients to send commands in order to connect and disconnect the interface. Once connected, the interface can be used to send messages asynchronously. To support this goal, it have been specified the following classes: `RCAsynchronous`, `RCMessage` and `AsynchronousMessageTable`.

F. Connectionless Interfaces

They are represented inside the component architecture by the `ReturnChannel` interface. As an example of an interface connectionless, we have the Ethernet interface. The client component of the Interactive Channel can be an application or even another component developed by GingaCDN. It can also choose to determine the existence of such interface, sending IP packets over the Interactive Channel.

IV. DIGA GINGA PROTOTYPE

In order to investigate new elements to improve the understanding of the components in the Lariisa project, we present in this section the resources of persistence and interactive channel used in Diga Ginga prototype.

The Diga Ginga [20] prototype is an innovative system for home automation and home automation (resource management areas) that aims to implement four modules: Diga Saúde, Diga Casa, Diga Mundo e Diga Aqui. It proposes to add functionality to GINGA middleware, such as monitoring and control in home automation, optimizing the use of set-top box that is being built for the model of the Brazilian Digital TV (SBTVD) [22]. To this end, the DIGA makes use of devices (sensors) that access the "set-top box" and Digital TV via wireless network (IEEE 802.11) in the residence. These added services to the set-top box (software and content) can also be accessed externally via the Internet or cellular technology. So, the idea of DIGA is to share the computational structure of the set-top box, adding services to citizens at home, such as monitoring the physical environment (safety of homes and businesses) personal monitoring (vital signs), automation residential and applications that stimulate the production of content between users, such as P2P applications between communities with common interest in the areas of the project area.

A. Diga Saúde

The Diga Saúde [21], component DIGA GINGA, integrates devices in order to perform service monitoring vital signs of people with diseases that require medical supervision intensive. Allowing, assess with the use of television, the physical status of patients and to make the follow up of a set of vital signs such as temperature, heart rate, pulse, respiratory rate and blood pressure also. In addition, the Diga Saúde provides access to services, for example, programming announcements on TV telling the exact time for taking medicaments, thus facilitating the lives of older people with problems of memory.

To retrieve the signs of health of these people, the idea is to make use of specific equipment (available in the market), as the Sun Spot and other devices (pulse oximeter, sphygmomanometer, blood glucose meter and accelerometer) that can be placed, if any, with the patient's body, allowing it to move normally. The information in these signals may be provided by this system at any health professional.

With Diga Saúde performing the monitoring via Digital Interactive TV, through sensors added to patient, the person, object tracking, may have a greater autonomy. Thus helping in their recovery within their own home. For patients that have suffered some type of surgery, for example, postoperative, these patients need careful attention, as the recovery and monitoring of certain variables (vital signs) in order to assess their health status (physical or psychological). Currently, people in these situations are usually admitted to health facilities (with high costs).

With regard to professional advice, this system contributes to a better doctor-patient interaction, even the latter being in your own residence.

Finally, the project Diga Saúde, represented by the prototype Diga Doctor, increases the potential of GINGA with tracking features in health, through their modules, sensors and other components, and serves as proof of concept for an extra set of applications that can be developed.

1) The Application

To perform the tests, a prototype called Say Doctor is being implemented and enhanced. This application integrates devices (Sun Spot, Set-top box and sensors) to conduct the monitoring of vital signs, i.e. Diga Doctor is a program (run on the Digital TV's platform) which joins the Application Programming Interfaces (APIs) with the Sun Spot GingaJ API (Digital TV) to provide services for Home Care [23]. As we can see in Figure 6, Sun Spot consists of two facilities, a hub/transmitter (concentrator, placed near the body of the patient) and a receiver, whose size is similar to a cell phone. The concentrator has digital and analog ports, which serve to connect devices and sensors (oximeter, sphygmomanometer, accelerometer and blood glucose meter). The receiver obtains data from the transmitter and passes them to a computational device (in our case, the set-top box) via USB port. Taking ownership of these data, the DIGA Doctor will use the channel of return of the set-top box and sends that information to a health professional (responsible for the care of the patient) to take the appropriated decisions.

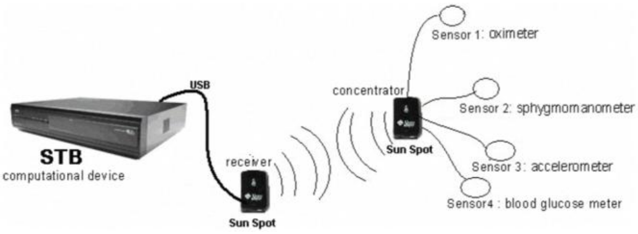

Figure 5. Integration of the devices DIGA Doctor.

DIGA Doctor also provides to users a sufficient autonomy to be at their residences without life risks. Otherwise, the user would have to be admitted to hospitals for long periods of time.

The objective of this experiment was to demonstrate the use of components and Persistence Channel Interactive procedural layer Ginga in an interactive system using the application of Home Care described in sections III.D.

2) Application of Component Persistence Data Diga Doctor

The persistence component specified in Java API DTV [19] is composed of two classes (`FileProperties` and `FileAccessRights`), located in the package `com.sun.dtv.io`, as described below:

- `FileProperties`: Used to associate properties (or meta data) with a file identified by its pathname on a given file system.
- `FileAccessRights`: Provides a means to define different group level access rights to a file or directory.

These classes were used in the method `loadAccessRights`, in class `StbMananger` of prototype Diga Doctor. This method, illustrated in Figure 7, sets the access rights of files persistently of Diga Doctor.

```
/*
 *Loads the access rights to file past.
 *Uso: loadAccessRights("/tmp/",
"horario_medicamento");
 * @author marcos.eduardo
 * @param path - pacote onde ficará armazenado o
arquivo.
 * @param file_name - nome do arquivo sem extensão
 * @throws IOException
 */
 private static void loadAccessRights(String path,
String file_name) throws IOException {
 //Associa metadados ao arquivo de em um determinado
sistema de arquivos.
 new com.sun.dtv.io.FileAccessRights(path +
file_name + ".txt", "rx;rx;rx");
 //Obtém o propertie que contém os metadados do
arquivo.
 Properties properties = new Properties();
 properties.load((new
FileInputStream(path+file_name+".properties")));
 //Define grupos de níveis de direito de acesso a um
arquivo ou diretório.
 com.sun.dtv.io.FileProperties fp = new
com.sun.dtv.io.FileProperties();
fp.store(path+file_name+".txt", properties);
}
```

Figure 6. Method that loads the access rights of the persistent file

Method `loadAccessRights` together with the classes and interfaces defined in the package `java.io`, provide the prototype Diga Doctor the possibility of persisting data in text files, which can be performed, written or read according to configuration defined in the method `loadAccessRights`. Figure 8 illustrates the use of classes `java.io.FileWriter` and `java.io.FileReader` methods `WriteFile` and `ReadFile`, created in class `StbMananger`, respectively to read and write content in text files.

```
public static void writeFile(String content, String
path) throws IOException{

     java.io.FileWriter fileWriter =
                     new java.io.FileWriter(path);

     for(int i = 0; i < content.length(); i++)
       fileWriter.write(content.charAt(i));

     fileWriter.close();

    }
    public static String readFile(String path)
                 throws IOException{
        String str = "";
        java.io.FileReader fileReader =
                      new java.io.FileReader(path);

        while(fileReader.ready())
            str += (char)fileReader.read();

        fileReader.close();
        return str;
    }
```

Figure 7. Method that loads the access rights of the persistent file

3) Channel Interactive Component Application DIGA Doctor

To make use of the interoperability of Interactive Channel Ginga-J, the Java API DTV specifies two classes (`Networkdevice` and `NetworkDevicePermission`) and an interface (`NetworkDeviceStatusListener`) located in the package `com.sun.dtv.net`, as described below:

- `Networkdevice`: Represents any physical instance (or device) network platform available in set-top box (STB) and can be reached by any type of IP communication (TCP, UDP). Provided you have permission, the object created by this class establishes a seamlessly connection with the network through any type of modem and/or network interface used by STB.
- `NetworkDevicePermission`: Contains a name (also referred to as a destination name) and a list of actions used to grant permissions relating to the lack of resources of the network used in the STB.
- `NetworkDeviceStatusListener`: Defines the listener interface of events related to network devices, or can be from the object, created from the concrete class that implements the interface `NetworkDeviceStatusListener`, whether the data rate of the device and whether the same is connected or is disconnected, for example.

V. CONCLUSION

The main difference between the Brazilian Digital TV model and others DTV standards is that it was developed with interactivity characteristic in mind [25][24]. The interaction of the viewing user, which could be delegated the control of the flow of a televising program, determining if one content must be shown or not. Because this, the impact of the Brazilian digital TV should be much more significant than the simple exchange of an analogical system of transmission for digital, and much more than set top box improves of the quality of image and sound. New services are available, as banking services, services of government, in especial the educational and health services [25][26].

This work described the solutions adopted in the Interactive Channel and the Data Persistence, two components of the Ginga's Common Module (Common Core), developed in the context of the GingaCDN project, supported by the RNP. These solutions are been used on the Lariisa Project. It proposes a governance decision-making support model for public health systems, which the information paradigm is centered on the concept of family context.

Health systems worldwide have to cope with a changing environment but they are not responding satisfactorily to these situations. Western society has built its healthcare systems centered in hospitals, where the output is coming back to the family. It turns out that traditional tools cannot handle this new scenario. It is precisely in this scenario that the LARIISA Project may represent a paradigm shift in access to health. The Brazilian model of Digital TV/Set-top box is contemplated strategically to serve as terminal access in the LARIISA, considering the universal soon, this equipment in households in Brazil. In this happening, LARIISA would allow the less privileged class in Ceará to have access to context-aware service-oriented applications for health care [7] [15].

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