Join The Board, a new way of collaborative learning

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ABSTRACT

This chapter presents an application, Join the Board (JTB), which provides shared and collaborative work environments between digital iPhone and iPad devices through a Network of Local Area (LAN) over a Wi-Fi connection. JTB allows using two connection types in the board: an off-line board (the user has a local and individualized work) and an on-line board (the user can create sessions that each one gives a collaborative board. All the devices that are interesting to work in this collaborative board must be joining to this session with a specific role system and start working on it). All the workflow in a collaborative board is through a turn management that is controller by a moderator device. JTB has only been developed for the family of iPad and iPhone version equal or higher than 5.1 operating system and behind using more than six design patterns and implementation. It has been developed three types of different and specific protocols that form the core of JTB application and its have been used for the encoding messages and managing the entire dialog between devices. This chapter shows a full case study that shows the potential of the functionalities

Keywords: Join The Board (JTB), LAN, Wi-Fi, iPad, iPhone, ICT, CSCL, App, Twitter, GUI

INTRODUCTION

Information and Communication Technologies (ICT) are an essential part of today's Society and have impact on almost all aspects of life. The rapid advance of ICT is flooding the modern world with implications for each of the branches of modern society by providing worldwide more and more advanced and powerful technological devices that open up new fields of innovation, provide opportunities to achieve higher development levels and reduce many traditional obstacles, especially those related to the time and distance.

The generation of smart mobile phones, which has flooded the technological consumer market in recent years, has given way to the tablets and touch tablets. These tablets are equipped with much more capacity for processing, communication and size than smartphones (Conde, Álvarez Rosado, & García Peñalvo, 2011; Conde, García-Peñalvo, Alier, & Piguillem, 2013; Conde, García-Peñalvo, Alier, Casany, & Piguillem, 2013).

The impact these technological devices have caused, with so good acceptance by the users, has led to the development of applications for this type of device to trip because that was considered a great success from the point of view of their marketing.

On the other hand, Computer Supported Collaborative Learning (CSCL) (Bruffee, 1999) is a strategy of teaching and learning that builds knowledge through a collaborative work supported by technological resources (Alonso de Castro, 2014; Sánchez Prieto, Olmos Migueláñez, & García-Peñalvo, 2014a, 2014b).

It is precisely in this context of technology and collaborative learning where the project Join the Board (JTB) merges (Álvarez Rosado, García-Peñalvo, Bravo Martín & Álvarez Rosado, 2013), an application developed for the families of iPad and iPhone devices that pretends to be a real technological platform that provides shared work spaces shared by a group of people in which to develop activities in a collaborative way.

Although JTB was born from the will to integrate the use of new technologies in teaching practice, it is not limited exclusively to this environment, but has a place in many and different areas of society, from the field of education, passing through the business world and reaching any task (whatever type that is) that needs interaction and collaboration among different people.

The application has been developed in the framework of a project of the degree course of Engineering in Computer Science at the University of Salamanca.

Following sections of this paper will explain in detail a complete description about the functional application. Also will present the Join The Board graphic user interface and then present a simple and complete case study. Finally, paper explains all the important aspects of JTB development like planning, design pattern, communication protocol, etc.

FUNCTIONAL DESCRIPTION

JTB is based on simulate digital boards that offer participatory workspaces to all devices that are connected. Each board is managed by one of the participants who has the role of moderator and that arbitrates access to the same for scripture through a shift system.

This functionality is achieved through the development of a complex protocol of communications and synchronization among devices. This protocol consists of a dialogue based on the passage of messages that are exchanged by all the users of each board on the basis of a Wi-Fi connection required for the operation of the application in collaborative mode (online).

JTB also allows the option of using a board locally based (offline), used as a single device and keeping all its functionality without the need for Wi-Fi connection. This allows local and individualized work to the user where there is no moderator. This operating mode is always available in the tool.

In the Figure 1 shows a general overview of the operating modes that presents the app JTB.

Figure 1. General description of the JTB

From a general point of view devices can create two types of boards:
- Public boards: the same access is permitted to all users.
- Private boards: access to them is restricted by the use of a password.

Each device can only create a board at the same time or join one of the available boards, already created by other devices. The list of accessible boards, together with its characteristics, is shown in the main session of each device, as shown in Figure 2.

Figure 2. Screen with the list of available boards JTB system startup.

Once the user has created or has joined an available board, you can take two different roles:

- Moderator: initially is designated moderator automatically the participant who created the board. The application allows the change of moderator to another device attached to the board. This participant initially has the writing permission on the board and the ability to manage the shift from access to the same list, so yields control of writing to one of the participants who has requested the shift.

- Participants: in principle are all users attached to the board. You will see the contents of the board and the changes that are taking place in real time. When they want to participate and write on the board they must request their turn and wait until the moderator grants it to make changes. At some point they can become moderators by delegation of functions of the current moderator.

The application is responsible for managing all communication and synchronization which takes place among different devices that participate in each board, in a way that allows at each time a shared, fluid, efficient and consistent workflow. Therefore, in the application you must start and log. For the management of communication among devices there is a management shift that is processed through the moderator. Users of the application should request and release the shift to have writing permissions on the board and at the same time, the moderator should delegate the shifts at his convenience.
JTB supports two languages: Spanish and English. In addition, application provides some basic functionality such as drawing tools:

- Select the color and thickness of the stroke.

- Select an object.

- Select shapes: line, rectangle, circle, ellipse and free drawing. You can also select text.

- Delete an object.

- Move an object.

- Scaling an object.

- It also expands its functionality to the connected users leaving the possibility of:

- Using a private chat for the participants.

- Configuring the profile user and the board, being able to assign the role of moderator to another participant.

Two features that are used to import and export the work done are attached to provide greater flexibility to the board. The export is carried out in three different ways:

- By electronic mail.

- An image .png stored in the library of photos of the device.

- By storing work in a local file on the device. In this way facilitates the resumption of any work that has been left incomplete.

Import that is allowed in the application may be in two different ways:

- By importing an image.

- By importing locally stored boards on the device.

For work in collaborative boards (JTB) there must be a Wi-Fi network that is connected to all the devices that wish to interact with the application. At least for a minimum functioning of JTB in a collaborative way, two devices must be connected. On the other hand, if you want to work in local mode, only a device participates.

JTB integrates with the Twitter social network so that the application users can interact during the workflow.

In addition, the application provides other features that complement the use of boards as, for example, put at the disposal of the participants a private chat room for each board.

The application is developed for the family of iPad and iPhone devices and is compatible with those using versions of operating system iOS equal or higher than the 5.1. Taking into account different technical characteristics that exist between both devices and taking as the largest screen size difference, certain functionality will have to be restricted on the device with the screen smaller (iPhone):

- iPad devices: will have all the features active.

- iPhone devices: behave only as listeners of the workflow shared due to its small proportions to be able to interact correctly and effectively with tapestry work, so they cannot actively participate in the design of the board. They may not create local boards due to limitations in the size of the screen.

BOARD MODES

Join The Board allow two different ways of work: an on-line mode and an off-line mode.

- On-line mode consists on create a collaborative boards and join it between at least two devices in the same network. The protocol in this mode supports create some collaborative board in the same network. This fact gives a JTB application a major diversity of collaborative work at the same time. Also this way can allow that other devices join it when the collaborative board has already begun. If a device connects into a collaborative board when it has already begun, automatically the JTB application downloads the workspace into the new boar device. Immediately this new participant device can works on the collaborative board.

  On this work mode JTB allow that the moderator device leave the board when it has already begun without lost the workspace. This moderator device gives its role to other device and leaves the board. With this fact, the context of the board isn't lost.

- Off-line mode consist on create an individualized board in a device without network connection. This mode allows work in a local board to realize new boards or works that they can import to in a on-line mode boards.

GRAPHIC USER INTERFACE (GUI)

To access to the JTB application it is only necessary to have it installed on devices that are going to be used.

It is important to highlight that, due to the differences in size between the two types of devices, different interfaces have been designed for each of them. Despite being different, they maintain the same structure of objects, so the two interfaces are as similar as possible to facilitate the work of users and that the use of the application in more limited devices cannot be seen conditioned by technical restrictions.

Figure 3 shows the different pop-up menus that can be observed in drawing and management of shifts of the board on an iPad device with settings in Spanish language.
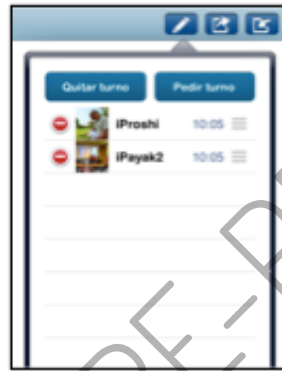
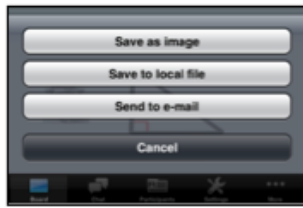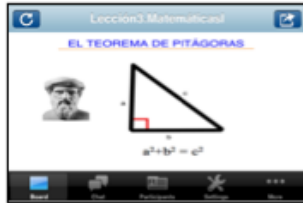*Figure 3. JTB Popup menus in a board for iPad devices in Spanish.*

Figure 4 shows examples of different features of the JTB application for iPhone devices with language setting in English.

a) Export at JTB

b) Import at JTB

c) work at JTB

d) Chat room at JTB

e) List of participants at JTB

f) Board settings at JTB

Figure 4. JTB Screenshots for iPhone devices in English.

CASE STUDY

This section shows an example of JTB application that is perfect for a Math class at a school.
Teacher can work on an exercise doing the following steps:

1. Make the board (offline mode).

Teacher must create and develop the exercise on local board and export it on device. This is made in an offline mode, because only the teacher works in the board. So, in this mode only allows draw on the board, export and import the board. Other functionalities like turn management are disable.

For example, Figure 5 shows an example of collaborative work on the board. The exercise bases on solve a simple geometry problem that consist of join the geometries shapes with their areas.
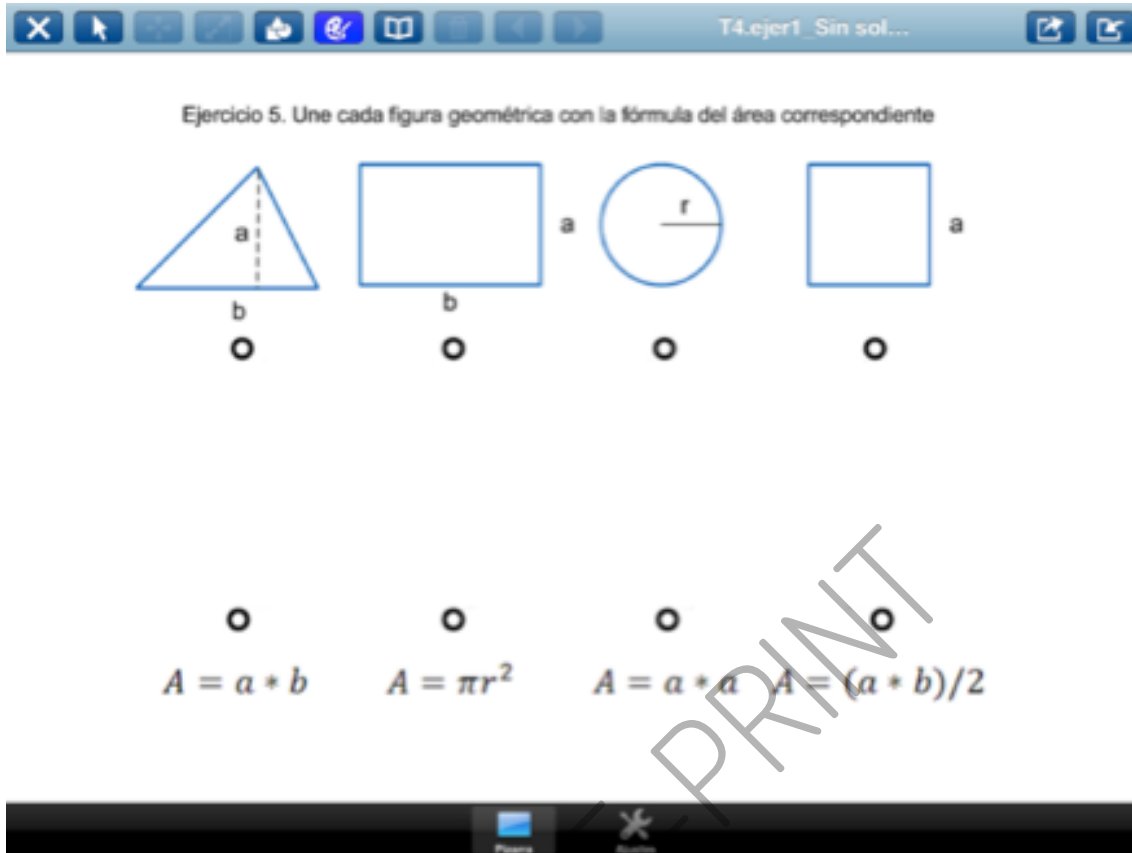
Figure 5. Example of collaborative works at Join The Board.

2. Publish the private board (online mode).

Teacher creates a private board and then appears on all users devices that are connected to the main session. Teacher is the board moderator. Figure 6 shows the available board. This list presents some board characteristics:

o   On top can see the created board name.

o   In the middle can see the board name.

o   In the bottom can see the date of the created board.

o   On the left can see a lock that denotes a private board.

Figure 6.List of available board at users devices.

Teacher imports the developed board (step 1) and wait for the users connections.

3. Join the board.

The users who want to join the board are needed to select the board at available boards list. Then the teacher checks to connection of users in the list of participants are available. Figure 7 shows all participants that are connected to the created board (step 1).

Figure 7.List of participants at JTB.

4. Work in the board.

Participants request the turn access to write on the board. Always that a user has write permissions he must release the turn correctly. By other hand, the moderator delegates the turn access to the board following his own opinion. See Figure 8.

Figure 8. Turn management.

This process repeats until complete the exercise or when moderator decides, see Figure 9.
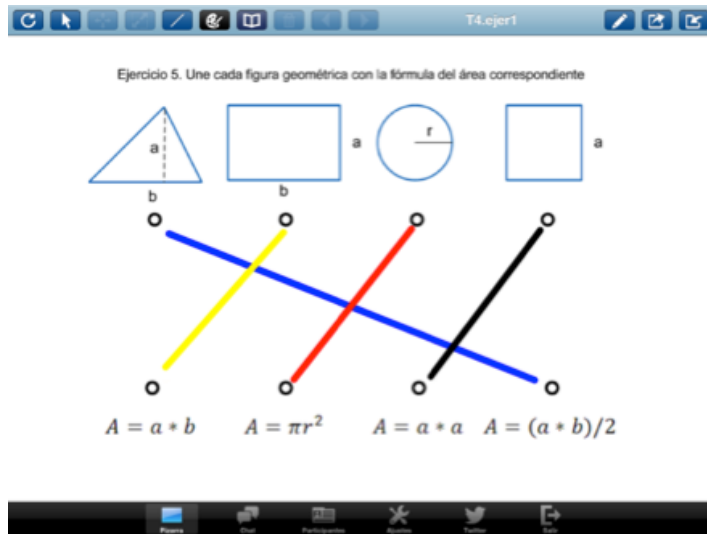
Figure 9. Solved example of collaborative works at Join The Board.

    5.   Close the board.

Participants can save the board with the solved exercise by three different ways (see Figure 10):
- An electronic mail.
- An image .png stored in the library of photos of the device.
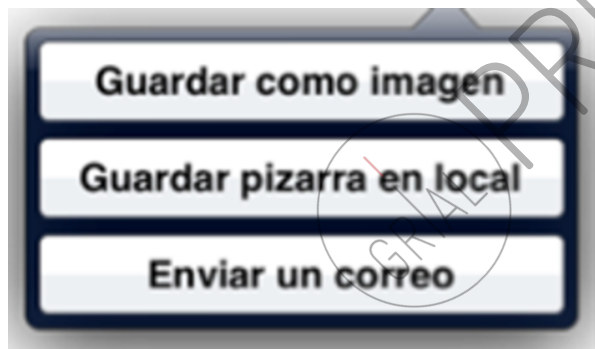- A storing work in a local file on the device.

Figure 10. Export at JTB.

By other hand the moderator changes the board name to don't overwrite it and exports it by the same way that the participant. Also the moderator can save it and, if he wants, publish the resolved exercise on a blog class, on a learning platform or a social network.

Once saved board all participants (included moderator) leave the board.
More examples can be displayed via the website http://jointheboard.grial.eu/.

RELEVANT ASPECTS OF THE DEVELOPMENT

The project is planned on the basis of the Unified Process (Jacobson, Booch & Rumbaugh, 1999) through an agile approach (Garzás, Enriquez, & Irrazabal, 2012) with influence of SCRUM (Schwaber, 2004). This choice is due to the need to incorporate changes in the project quickly and independently of the stage of development that is.

Álvarez Rosado, N., García-Peñalvo, F. J., Bravo Martín, S., & Álvarez Rosado, S. (2016). Join The Board: A New Way of Collaborative Learning. In D. Fonseca & E. Redondo (Eds.), *Handbook of Research on Applied E-Learning in Engineering and Architecture Education* (pp. 15-31). Hershey, PA: IGI Global.

Specifically, 8 sprints of 30 days each have been completed in which have been added are the different functions of the application. Each sprint was composed of four phases specified by the unified process and each stage had a heterogeneous workload based on the objectives of the sprint.

From the architectural point of view of the system, there have been used more than half a dozen design patterns and implementation (Gamma, Helm, Johnson & Vlissides, 1995), highlighting two of design (Peer-to-Peer and Broker), taken as the basis for the application. The use of Peer-to-Peer pattern is that the application is a network of devices in which all operate with the same role. You could say that each node acts simultaneously as client and server with respect to other nodes in the network. This pattern is used to be able to share and exchange information directly between two or more nodes. On the other hand, the Broker design pattern is the component responsible for completing the communications between the different nodes of the network.

In relation to the coding of the application, they have had to devise, implement and document three types of different protocols that form the core of the JTB application.

- A first Protocol of encoding, which allows you to send and receive objects of JTB, due to which the programming language used only lets you exchange messages in their own language-specific objects.

  The process of encoding objects has been to announce to the language that the object that is to be transferred is known. This is done encoding two methods that make the functions of serialization and deserialization of each object. So, before sending an object, it is necessary to serialize it and, on reception, prior to use, it needs to perform the opposite operation of deserialization. This Protocol has had much relevance, since it has been a part of the process of implementation of the communication of the application protocol.

- The second and third protocol was been made to manage all the devices communication and all devices synchronize. Each moment, this allows a shared workflow fluid, efficient and consistent.

  The division of two protocols to manage all devices due to decrease the network traffic in several moments. Also, this fact was made that the data packet are more organized and centralized depended on its functionality.

  o A second communication protocol is that which is responsible for managing communications and synchronization of the devices in the main session. It consists of 5 types of different messages.

  Those messages consist of:

  - *PacketTypeBoardAvailable*: you must send this message when user builds a board. It publics the created board like available to all users and send all information about it.

    All users receive this message. Automatically they must reload them board lists added the (new) received board information.

  - *PacketTypeBoardListRequest*: message sends to all users when user device wants to reload the available board lists.

    Only the moderator role responses that message who sends a message *PacketTypeBoardAvailable* with all information about the board. This message uses to confirm that the available board is on.

  - *PacketTypeBoardIsAvailable*: message sends from the user to the board moderator. It contains all the available connections depended on a public board or a private board.

The moderator role receives that message and processes all the sent information. If it allows coming in its board it must send a *PacketTypeBoardReady* message to the user that sent the connection request. If the access to the board is denied, it sends a *PacketTypeBoardInvalidPass* message.

- *PacketTypeBoardReady*: message sends from moderator role to user. With this message, the moderator allows the user join (it) the board.

  The user receives this message and acknowledges the access to the board.

- *PacketTypeBoardInvalidPass*: message sends from moderator role to user when it denies the access to the board because the user introduces an incorrect password to join it.

  The user receives this message because it introduces an incorrect password to join the board.

o A third protocol is responsible for managing communications and synchronization of devices at the session of the board. It is composed of 20 types of different messages.

Those messages consist of:

- *PacketTypeSendMensage*: message sends to all participants of the board. This message has a text of the chat room.

  All the participants receive the text message about chat room. All of them reload the received information on their chat room.

- *PacketTypeSendData*: message sends to all participants. It has one or more board object. This message sends to them when some participant paints something new on the board.

  The rest of the participants receive this message. They reload their vectorial objects list. Then, they repaint the board objects to show all the new information.

- *PacketTypeTurnRequest*: message sends to request a turn to write on the board. The participant sends this request message to moderator.

  The moderator receives this message and reloads his turn list with the new request.

- *PacketTypeTurnConfirm*: the moderator sends this message with the user identification to all participants of the board when it selects ones of its turn list to give it.

  All participants of the board receive this message. They receive the participant identification who is going to have the turn. That participant, who has the turn, turns on the painting tools. The other participants reload their turn list with that who has the turn at this moment.

- *PacketTypeTurnRelease*: message with two connotation

  The first is when the moderator sends to participants to releases their turns immediately because he wants the turn. All participants receive this message and free their turns instantly.

  The second is when the participant sends this message to communicate that it releases its turn. The moderator receives this message, reloads its turn list and recovers the turn.

- *PacketTypeTurnList*: The moderator sends to all participants this message with the turn list at this moment. Whenever there is a change in the turn list the moderator sends it.

  All participants received this message with the turn list, reload it and show it on the device.

- *PacketTypeTurnInformation*: The moderator sends this message to the participants. The message is about the participant who has the turn. Whenever there is a change in the turn the moderator sends it.

  All participants receive this message with the participant who has the turn, reload their turn list and show it on the device.

- *PacketTypeRefreshRequest*: The participant sends this message to the moderator when touch the reload button of the board taskbar.

  The moderator receives this message and reloads the board. This message needs to send all the board objects to all participants through *PacketTypeRefreshResponse* message.

- *PacketTypeRefreshResponse*. The moderator sends this message to the participant who has request reload the board.

  The participant receives it, reloads all the board objects and repaints it.

- *PacketTypeNewModerator*: The moderator sends it to the participant to change to moderator role.

  The participant receives it, changes its role and sends to all participants its new role.

- *PacketTypeNewModeratorChange*: the moderator sends it to all participants to announce a moderator change.

  The participants receive it and reload all the moderator variables

- *PacketTypeConfigurationChange*: the moderator sends to all the participants to announce a change on the board configuration.

  The participants receive it and reload the configuration profile.

- *PacketTypeUserProfileRequest*: This message requests to reload a participant profile

  The participant receives it and response with the information through PacketTypeUserProfileResponse message.

- *PacketTypeUserProfileResponse:*the participant sends this message with its profile to the other participant who requests it.

  The other participant receives it, reloads this profile and shows it on the device.

- *PacketTypeRemoveDataIndication*: The participant deletes one board object and sends to all participants this message to communicate it.

  All participants receive it, reload their object list and show them on the device

- *PacketTypeChangeDataIndication*: The participant changes one board object and sends to all participants this message to communicate it.

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All participants receive it, reload their object list and show them on the device.

JTB boards are working with vector objects that have specific characteristics of the application. Each object that you can draw in Join the Board has its own characteristics based on their nature. The application maintains a list of vector objects for each board so that each object can be treated with different operations available on an individual basis.

They have had to design algorithms for selecting, moving and scaling of objects:

- Algorithms for the selection of vector objects of board have been designed so as to allow a small margin of error. This is because, by the nature of the iPad and iPhone devices, it is very difficult to guess to perfection at the point of the desired object. So that would be easier to make different algorithms for all types of ways of drawing (straight lines, text, rectangles, circles, ellipses, free drawing and images) most were treated as if they were contained in an imaginary rectangle.

- The algorithms created to carry out the movement of the individual objects are designed so that they simulate the movement of the rectangle that contains them. Not to hide the figure that is going to make the move, the lower left corner of the object has been taken as a reference point for the movement. This corner will be highlighted by the insertion of a square, which will disappear during the movement, to have greater vision and precision when it comes to move an object to the desired place of the screen.

- The algorithms created to perform scaling of the individual objects are designed in such a way that it be allowed to scale the object from different points, once it is selected. By default, the reference point, which is taken to scale the object, is the bottom left corner to the rectangles. This point will be highlighted, as in the movement of objects, by the insertion of a square that will disappear during the scaling, to have greater vision and precision at the time of the operation. Scaling an object is completed allowing the user to change the reference point, depending on the type of object to be treated.

Finally, we have to note that the JTB application use three file types:

- proflie.dat

- Name of the board.text

- Name of the board.bin

These files store and retrieve the information that must be interpreted with the Protocol of encoding that is detailed above.

The first used file is a profile.dat file that stores all the information relative to the user profile. In order that the user, whenever you use the application, does not have to modify his profile, they will automatically load the last profile used. The user data, which are stored, are threefold:

- The call sign name of the device

- The type of the device

- The avatar associated with that device

This file is loaded whenever the JTB application starts to pick up the profile of the user data. Information is updated when there is a change of avatar in the settings panel. If for the first time you access the application, this user profile file does not exist and is created with the name of the device and an avatar by default. It is stored in the space of the device associated with the application.

The data that are stored in this file are:

- The name of the board.

- The description of the board.

- The date of creation of the board.

Associated with this, is the third file, which is called just like it, but with .bin extension, i.e. name of slate.bin. This file contains all the objects of the board. This file is paired with the former.
Both files (second and third) are created when exporting a local board and will be stored in the space of the device associated with the application. Its contents cannot be modified. Only the moderator can delete it through the import of a local board panel, and then by selecting delete or by accessing the panel's charge of a local board.

PEER-TO-PEER (P2P) VS. SERVER-CLIENT ARCHITECTURE

Both architectures are a science computer structure that allows connecting some computers, at least two, and sharing resources through the network (Internet). So, all the information is available to all computers of the network. There architectures use a TCP/IP protocol to the network connection.
Due to the similar functionality, it was studied the most important characteristics for both architectures with the proposal to find the best choice to Join The Board.

- To a peer-to-peer architecture (see Figure 11) the most important characteristics are:
    - The computers have two different operation modes:
        - As a server
        - As a client
    - A computer can switch this two operation modes indistinctly.
    - To use this architecture only is needed two computers, without matter the operation mode.
    - All the information is saved into each computer.

Figure 11.JTB peer-to-peer architecture.

- To a server-client architecture (see Figure 12) the most important characteristics are:
  - The computers have two different operation modes:
    - As a server
    - As a client
  - A computer can use only one of these operation modes.
    - A server who responses all the customer requests.
    - A client who does request to the server.
  - To use this architecture always must exist at least a server and a client to complete the communication process.
  - All the information is saved into the server.

Figure 12.JTB server-client architecture.

At the beginning, Join the board wants to be a collaborative workspace where all devices can communicate themselves without matter whose connect them.

However, after research of these two possible architectures, was thought that the peer-to-peer architecture was the best to Join The Board because it was the most simple an easy to use in these cases:

- From a functional point of view, JTB must be connected with all devices by the same way without operation mode (client or server) because all devices must participate to the board without limitations. The peer-to-peer architecture allowed it but the server-client architecture always needed an operation mode, as a client or as a server, in each device that limited its functionality.

- From a network-traffic point of view, it was thought that all the devices must connect themselves directly. It mustn't exist a central device, like a server, that received all the device requests. This way generated a lot of network traffic because if for example, a client wants to write on the collaborative board must do three steps:

    1. The device o client must request to the server to write on the board

    2. The server responses to this device and saves the new information about the board.

    3. Each connected device must request the new information wrote on the board
    By other way if JTB used the peer-to-peer architecture it only wanted two steps:

    1. The device writes on the collaborative board

    2. All the connected devices update all the new information about the board.

- From a resource and network connection point of view, in server-client architecture always needs a server and a client to begin the communication. But in the peer-to-peer architecture only needs two independent devices, each one as a server and as a client. This architecture doesn't depend on any additional infrastructure (server).

IOSVS HTML5

After a research of the native application and HTML5 web application, in which was study the pros and cons of the use them.

- The native applications are applications that are developed to be installer on a specific platform, like iOS, using a specific software developer kit of this platform. All application characteristic depends on the platform where the application has been develop.

- The HTML5 web applications are applications that are developed to be use in a mobile browser. These applications are used in many platforms. The characteristic of a web application depends of the browser characteristic that you use.

Join The Board is a native application for the platform iOS. With this decision is wanted to take advantage of all libraries with some functionality that the software development kit has. Also, these native applications are more robust because they use the libraries of the specific platform and these libraries have been support a lot of test to be in the market. In fact, these applications offer faster performance and access direct to native device services. At last, a native application gives more security than the HTML5 web application, because all the information is protect with the same security of the device. However in HTML5 web applications, cache data or encrypted data in this language are difficult to protect them. In this language is so easier access to the code and corrupt it.

CONCLUSION

Join the Board aims to be a tool of support to teaching or any task that requires a collaborative work between two or more people. It should also be noted that JTB allows the possibility of working in local and individualized manner. This option allows you to create a new task that can be used in a future or even modify a task stored in the device.
One of the advantages of the application is that it allows import and exports work performed when working with boards in the future or to save it. Also the drawing tools and treatment of drawing functions give the application of a higher packing in the creation of works of any kind.
On the other hand, the design of the graphical interface of Join the Boards has been carefully designed so that it was common among the different families of devices from Apple. In this way, it facilitates the learning of the application.

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KEY TERMS AND DEFINITIONS

APP: is short for "Application". It is the same thing as a software program. While an app may refer to a program for any hardware platform, it is most often used to describe programs for mobile devices, such as smartphones and tablets.

CSCL: is short for "Computer Supported Collaborative Learning". It is a strategy of teaching and learning that builds knowledge through a collaborative work supported by technological resources.

GUI: is short for "Graphical User Interface". It is an interface that is used to issue commands to a computer by means of a device such as a mouse that manipulates and activates onscreen images.

ICT: is short for "Information and Communication Technologies". It refers to technologies that provide access to information through telecommunications.

iPad/iPhone: are mobile devices developed by Apple.

LAN: is short for "Local Area Network". It is a computer network limited to a small area such as an office building, university, or even a residential home.

Twitter: is an online service that allows you to share updates with other users.

Wi-Fi: is a wireless networking technology that allows computers and other devices to communicate over a wireless signal.

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