Developer guide

Hint

Welcome to the developer guide for the SVG whiteboard. The table of contents may seem huge, but many sections are really short. You can always click on section titles to come back to the contents table.
A short description of the contents and why to read them:

- Code structure: read this to understand the general structure behind the current code and get a first orientation
- Data structure: refer to this section (especially the Whiteboard database section) to understand the structure of variables that are accessed and modified. This section is useful as a reference even after you are confident with the code structure.
- Specific solutions: a place for reminders for taken project choiches and technology findings

Contents

Chapter 1

Main principle

The leading idea behind the application is a lightweight interaction model which, combined with the capabilities of vector graphics, allows to support a shared whiteboard through the exchange of few textual messages.

The textual representation of vector graphics is common knowledge, and is easy to understand how this can enable to transmit graphic data with short communication messages (although in some cases this advantage may fail). I will focus now on the overall sharing model, thought to provide each client with an updated state of the whiteboard.

The fundamental event that triggers the evolution of the application, is an user **action**, that is a change on the user whiteboard that is supposed to be propagated to all other clients. To mantain an updated state, the actions get propagated one by one when executed, even if some of them could nullify the effect of some others (like for a deletion of a created object).

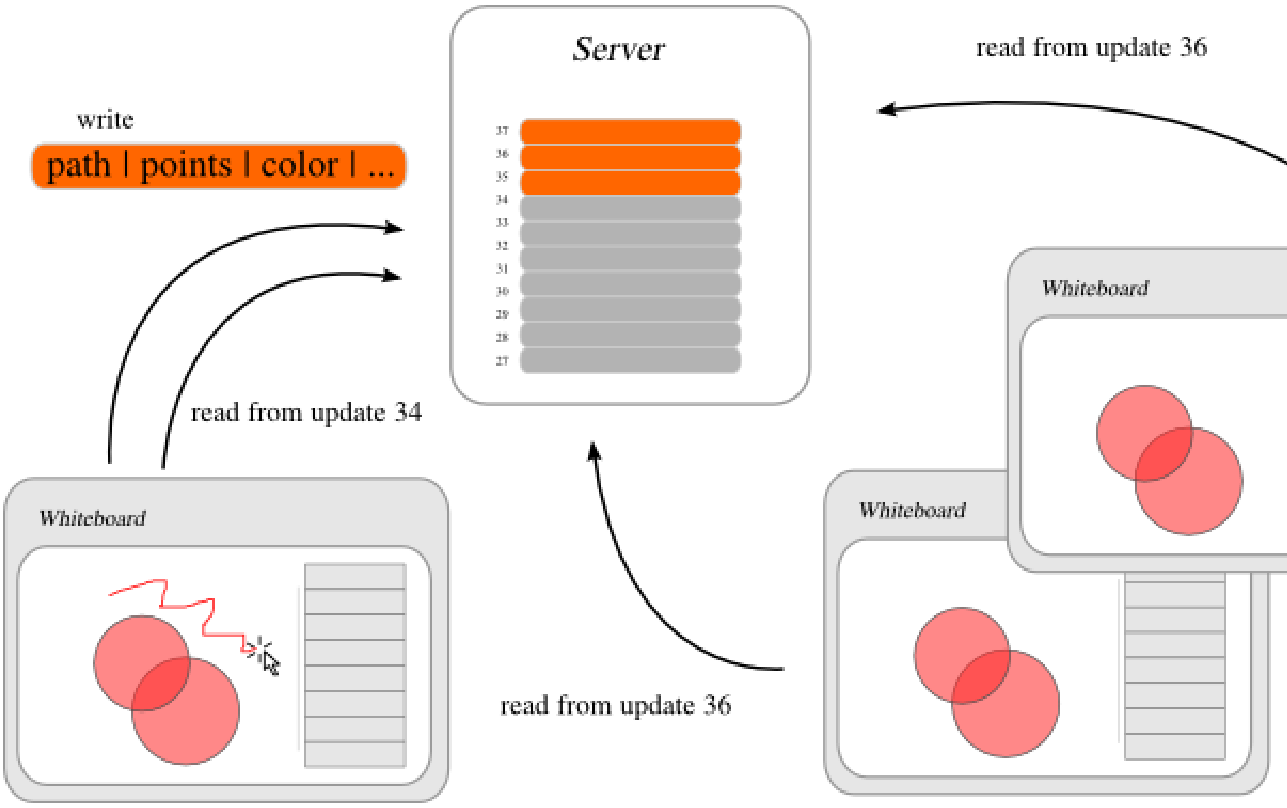
Each **action** is represented by a textual **update** which contains all relevant informations about what the user did. The main purpose of the server side of the application is to manage the distribution of these updates.

The web technology prevents the client side code to directly communicate with other clients, so an extern server is compulsory. Moreover, the same technology prevents the clients to directly receive updates in a *push* manner (websockets in html5 are going to provide push methods to client in the future), so a server is needed to provide updates in response of *pull* requests (see Emulating a client push behavior with the http technology for performance details).

So the server role is to manage an **update database** so that each client can ask for new updates, depending on his own state. With the access to a writable storage device, that is very common even on the smallest web servers, the server can manage a bigger update database, and mantain all the state of a whiteboard, since its creation, in this action-oriented form.

The following image illustrates a simple case of update management. Here you can immediately see some important elements that constitute the application's internals:

- The **update database**, that is the main data structure on the server
- The two principal requests made from the clients to the server, that are the **read** and the **write** requests



The update is sent, usually, when the user terminates an operation, be that a move, create or edit action. Then the update is sent to the server (this is a request with the `mode` parameter set to `write`), which gives it a numerical incremental identificator and adds it to the database. At the same time, several clients are asking for updates sending a request with `mode` set to `read`, including the identificator of the next update which they are interested in.

1.1 Elements involved

In this case, the main parts of the software which are running are:

- for the addition of a new update, the global **sender** object (`g['sender']`) on the client side and the `write` **mode** on the server side
- for the request about new updates, the global **receiver** object (`g['receiver']`) on the client side and the `read` **mode** on the server side

1.2 Server `mode` parameter

I mentioned above the server's `mode` parameter, this is the main query field determining the kind of the server's response.

The server side code is structured following a functional programming paradigm, on the purpose of making the execution flow as clear as possible. We have the two certain boundaries of this flow, that are the start by a user request, and the end by a response to the user, so the different server behaviors are conceived like parallel ways on the same path, in a few words they are the branches of a big `switch` control structure, and the `mode` parameter is the one that determines which way will be taken. Take a look at the `main.php` file to easily verify what explained.

1.3 Principal division of the application

The main elements constituting the application's structure are:

- Client side code (`client/` directory)
- Server side code (`server/` directory)
- Stored data (`data/` directory)

All of them reside on the webserver, in a form optimized by the makefile, but their original structure is intended to help a developer to move through the code and clearly understand what is being done. I will write here about the server side and client side code, while for the form of the stored data see the section Stored data under Data structures.

The client and server side of the source code are documented into the following section, Code structure, while the data are documented into Data structures, together with the meaning of complex variables used into the code.

Chapter 2

Code structure

In this section I will present the main structures thought to organize the code. The order of the subsections reflects the importance of each topic. The first two subsections deal with those structures limited to the client or the server side, while the following sections present topics which involve both sides of the application.

2.1 Client side

Following a general rule of network protocols, I've tried to move the biggest part of the computational load towards the network boundaries, that means towards clients, leaving it off from the server.

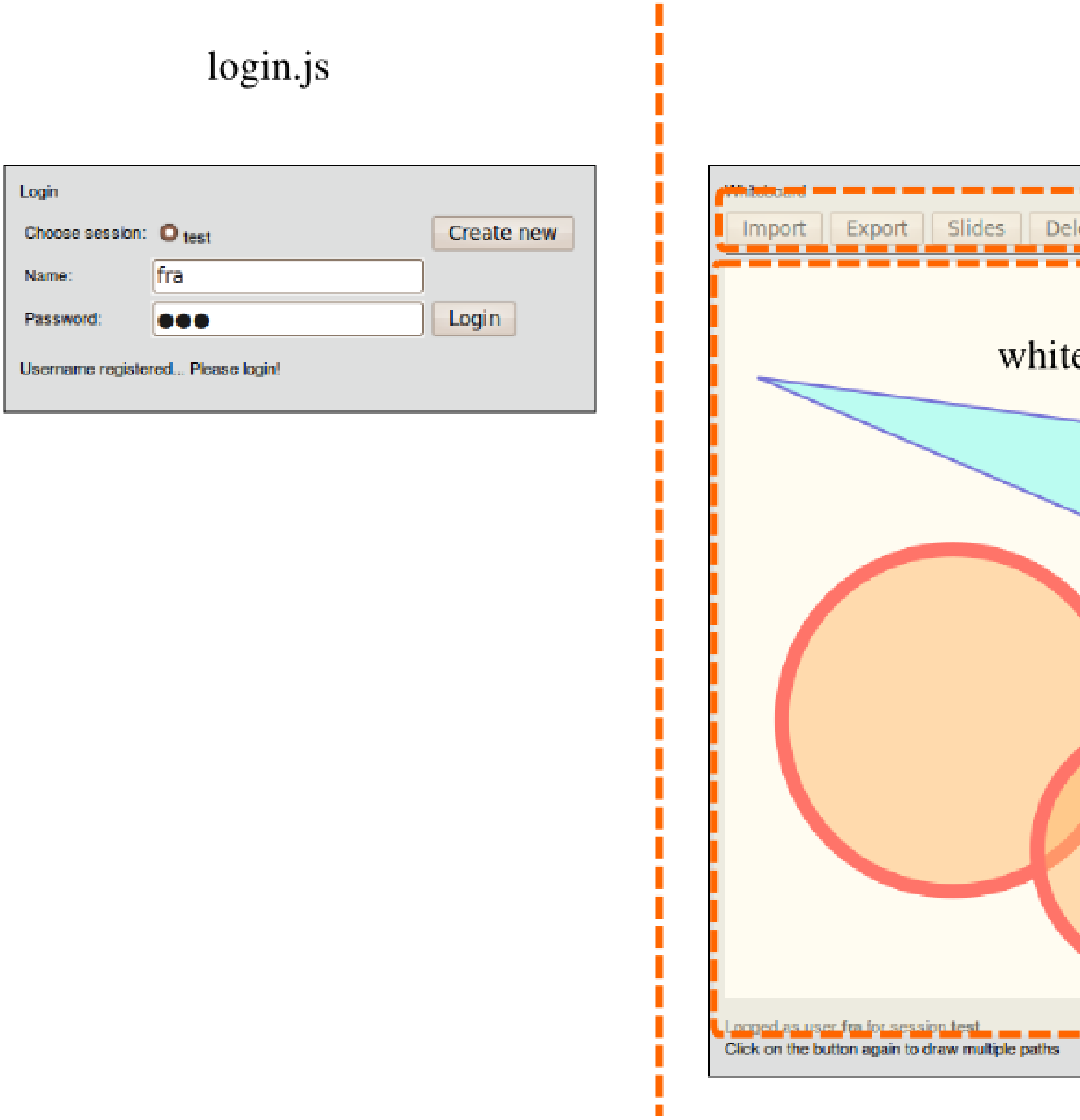
Current hardware performances for an average web browser aren't an heavy limit for this kind (strongly interactive) of applications, or at least I couldn't observe any performance problem related to javascript on the testing machine (and virtual machine), which runs on quite old hardware (see Hardware).

The biggest problem I met was therefore that of readability and decomposition of the client side code.

The starting code was all based on global variables, and I choosed to proceed by steps, instead of trowing away the existing structure. The resulting code has an hybrid programming paradigm, being object oriented just in some of his parts[1].

The javascript code is divided among files in a way that follows the graphical division of the user interface, as shown in the image below:

[1] While a complete rewriting of the client code would probably be convenient, there wasn't a strict need to perform it, and I was unable to evaluate the benefits of such an expensive work. So I decided to use the object oriented paradigm for the newly developed parts, and to convert only the more complicated and important parts of the existent code, that means the core whiteboard logic (resulting into the shape object) and the ajax channel management (resulting into the channel object).



Login

Choose session: ○ test

Name: fra

Password: ●●●

Username registered... Please login!

Logged as user fra for session test

Click on the button again to draw multiple paths

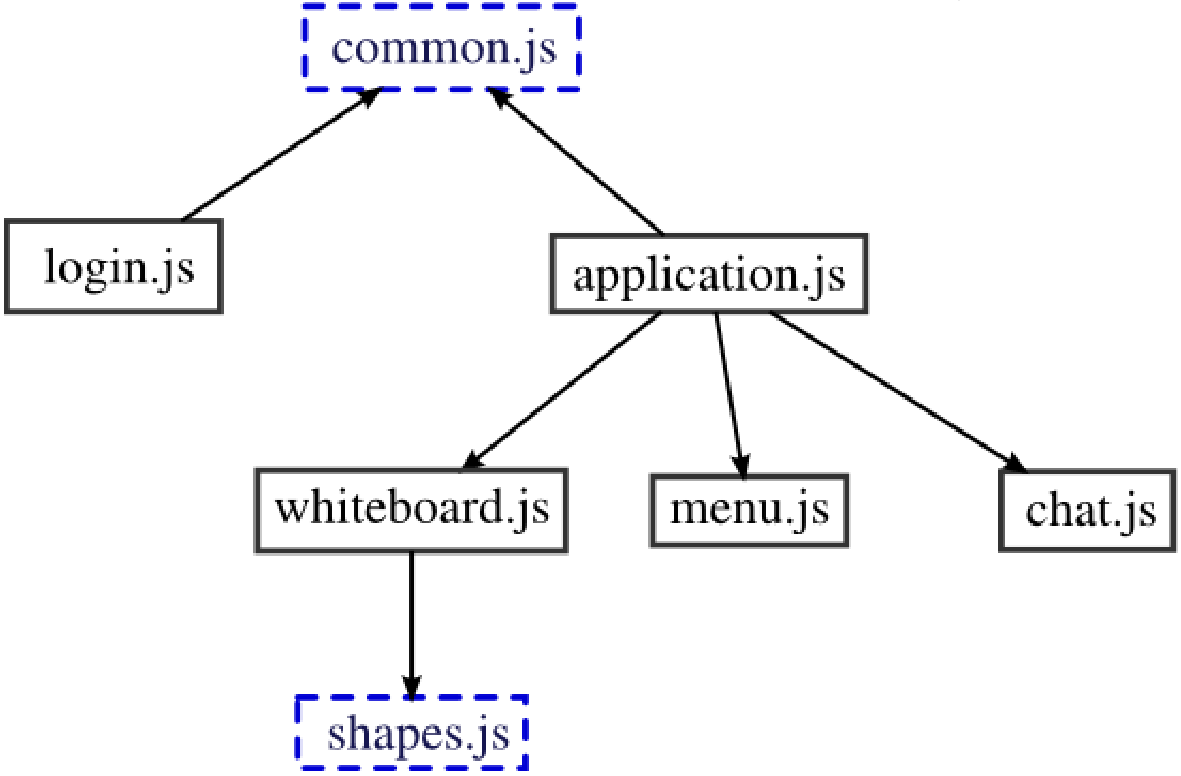
The javascript function definitions can be found on the file corresponding to the zone of the page containing the html element to which the method is associated. For example, this html code can be read about the "Import" button, which is contained into the menu:

```
<button onclick="show_div('menu_import', true)">Import</button>
```

Since the "Import" button is contained into the menu, the programmer will find the `show_div` function declaration inside menu.js.

Another consequence of the shown division is that there are two javascript files, `login.js` and `application.js`, which are associated to a whole html page. Thus the initialization functions for each page are contained into the corresponding file; see the next section for details about the one contained in `whiteboard.js`, which is the more complex.

To be complete, it's better to immediately consider another image which introduces also those javascript files not directly associated to a visible surface of the user interface. The image illustrate the use relationships between the javascript files, a very useful information while browsing the code:



An arrow from a start file to an end file means that the code of the start file calls some functions which are defined into the end file. Two new informations come from the structure of the diagram:

- the role of `common.js` that is like a little shared library for common tasks (the most important thing, it contains the channel class)
- the presence of the `shapes.js` file (containing the shape class and all shape objects derived from that), which is used exclusively by functions into `whiteboard.js`

The introduced division of client side code it not totally rigid, there are still dependencies, here and there, between variables defined into different files. I've tried to collect into common.js the variables, functions and objects used by several files, like the global object `g` holding all global variables, and the `channel` and `signer` objects.

2.1.1 Dispatching the execution flow through the files

On the purpose of decomposing the client logic, also global variables are defined within the files where they are used. When the client side state is initialized, several functions are called, each one to initialize the variables belonging to a file.

The main initialization function is defined into `application.js`; it initializes the variables defined into `application.js` and than calls the initialization functions for the file `whiteboard.js` and `menu.js`:

```
window.onsvgload = function() {
    ...
    initWhiteboard();
    initMenu();
    ...
};
```

A similar approach is used when an update is received by the client. The `receiver_handler` function (into `application.js`) calls the specific functions belonging the the files `whiteboard.js` and `chat.js`, since within those files the developer will found all functions needed to process the update of the right type:

```
function receiver_handler(){
    ...
    if (action == 'chat')
        chatServerUpdate(madeBy, objId, parameters, time);
    else{
        ...
        whiteboardServerUpdate(objId, page, action, parameters);
        }
    ...
}
```

Note that the approach used for the initialization and for the processing of an update is a total waste of resources, from the computational point of wiew. It is just an effort to organize the code for the developer.

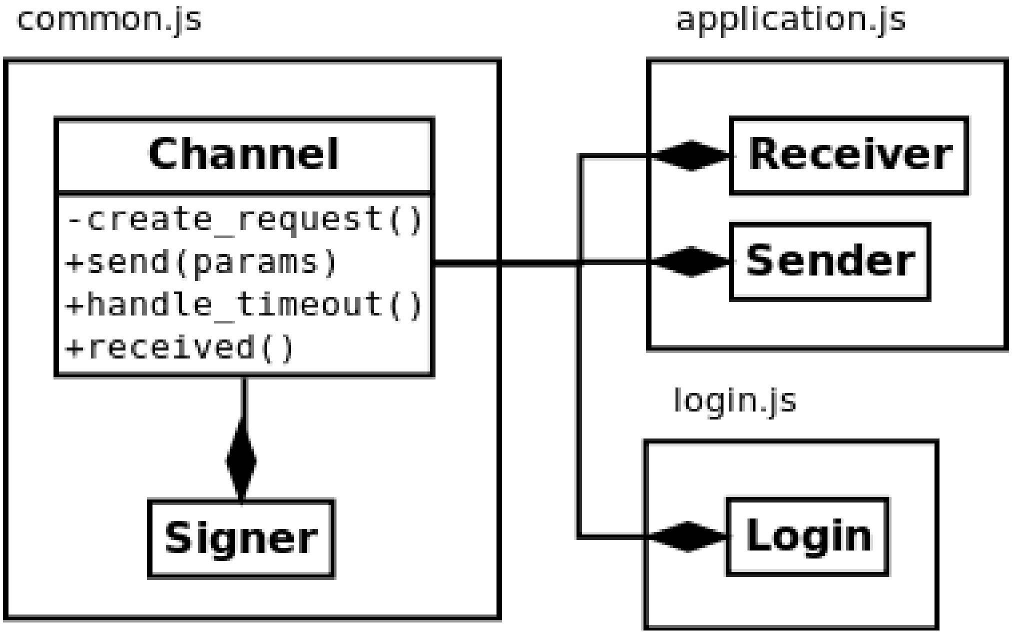
2.1.2 Object implementation on the client side

The javascript language is very flexible when it comes to object or class definition, due to his prototypal model and the possibility of dynamically add member functions and internal variables to the objects. Although an uniform programming style is important for readability and to avoid mistakes, the few javascript objects are defined in different ways, depending on their lifecycle.

All the objects that will be created dynamically (`line`, `circle` and all the shapes, and the `shape` and `channel` classes) are defined through their constructors, while permanent singleton objects (`g['signer']`, `g['sender']`, `g['receiver']`, `g['pages']` and `g['size_adapter']`) are directly built and assigned to the global variable where they will remain.

2.1.3 The channel class

The channel class provides an ajax channel to the server, with some functions to send the request, handle errors, and retry the request after a timeout. A channel object is contained (and used) by all other objects which need to exchange data with the server in an asynchronous manner.



The responsabilities of the channel class are:

- Create, send and receive an ajax request in a way which is supported cross-browser
- Handle the case of timeout of the sent request, sending again the same request

These functions are used by the `login` and `sender` objects to send individual messages, and by the `receiver` and `signer` objects to send messages in a cycle.

The structure of objects using `channel` is a little messy, because the channel object needs methods which are exposed on the global scope, in order to assign them as handlers for timeout and ajax statechange events. For example, the `g['sender']` object defines two global methods that are assigned to the channel object during its initialization (code taken from `application.js`):

```
// Sender initialization
g['sender'].channel =
    createChannel(sender_handler, sender_timeout, 10000, send_par);

// Sender object and methods
g['sender'] = {
    ...
};
function sender_timeout(){
    g['sender'].channel.handle_timeout();
}
function sender_handler(){
    ...
}
```

The methods must be defined outside of the object, which is not very elegant, but it is the only way. Moreover, you can observe that the `sender_timeout` method just calls a method into the channel object. This is even less elegant and this is done by all objects that use a channel object, because it is difficult in javascript to assign an inner method of an object as handler for an event like the timeout.

Client send buffer and the `sender` object

The channel class is used by two important objects, the *sender* and the *receiver*; both of them are defined into the file `application.js`. The channel class itself handles the failure and resend of ajax requests, but the sender object needs anyway a buffer to temporarily store the updates produced by the user.

The function that adds a new update to the buffer (server_add) has the following interface:

```
sender_add(action, parameters, varidObj, async)
```

All parameters but `action` are optional, and the last (`asinc`) is useful to add a new update line into the database without trying to flush it. Indeed, `sender_add` usually tries to flush the buffer right after it's execution, but when the user edits a shape, for example, it is better if the old shape's deletion and the new shape's creation are sent to the server at the same time.

The sender channel (like all other objects that use the `channel` class) waits that an old ajax request has succeeded before sending a new one. When the `sender` object receives a response from the server, it checks its buffer for updates collected in the meantime since the request was sent.

Here it is the relative code (into application.js). The response handler (sender_handler) can call again the send function (line 7):

```
1  function sender_handler(){
2      var response = g['sender'].channel.received();
3      if(response !== false){
4          // If still have data to send (added while waiting the server
5          // response)
6          if (g['sender'].line_buff.length > 0)
7              sender_send();
8      }
9  }
```

For all objects which use the `channel` class, the handling of a failure (a `false` response received by the channel class) is a delicate matter. A `false` response is returned every time that, for example, the readyState of the response is not the right one, so the handler receiving from `channel` should simply ignore the call and do nothing. This interface, however, is likely to be changed because explicit errors (see next section) are better handled by the specific handler receiving from channel.

Handling of AJAX errors

The `channel.received` method is called by `channel` users each time that the XMLHttpResponse object changes its state, and the `ready` state is only the forth, so many times the method simply returns the `false` value to tell to its caller that the moment isn't already arrived.

Besides receiving a correct ready response, several kind of errors can occurr while the *channel* class is awaiting. First I will present the different kind of errors, and then I will tell how they are handled.

- **malformed XML** This can cover a variety of errors: during the development these are usually php errors which output the details of the error instead of the XML response. Sometimes, with explorer (6), these errors can be due to a malformed ajax request, which occurs randomly and which is not repeated by the browser if the request is resent.

  A problem in the handling of this errors is that there isn't a method to verify the valid XML structure of the response (into the class XMLDocument), so an exception could be risen when upstream code tries to parse the received response. Thus to try to locate XML errors, I try to access to the last nodes or to the whole first level of child node, but this method is not sure, it depends from the parser implementation:

  ```
  try{
  ```

```
        var response = this.request.responseXML.documentElement;
        // These are used to force explorer (and other
        // browsers) to parse the XML document to spot errors
        response.lastChild;
        response.childNodes;
    }
    catch(e){
        // *malformed response*: this could even be a php
        // error. Firefox raises an exception on
        // this.request.responseXML while Explorer should raise an
        // exception on response.lastChild
        var msg = 'A server error occurred:\n\n'+this.request.responseText;
    }
```

- **Http errors** They are signaled to the client side code with a request whose state is 'ready' but whose 'status' is different from 200. This includes the case of an unreachable server (http status '0').
- **Timeouts** When the response doesn't comes within the timeout.
- **Explicit errors** These are errors sent on purpose by the server to the client, in order to show an error message client-side or to impose a behavior (for example: logout). This is told to the client through an `error` XML tag.

About the handling of these errors, the first distinction is about the **explicit errors**: they are different within different channels, so they are handled outside of the channel. Other kind of errors may occur with all channels and are handled within the `channel.received` method.

A **malformed XML** response or an **http error** are handled the same way: a message is prompted to the user, trying to be as clear as possible, and he can decide if to repeat the request or to give up (in this case he will be logged out from the whiteboard). This behavior works well with the case of a server complaining for a malformed ajax request, which occurs randomly with explorer (this triggers a malformed XML error). This works well also when an http error is given due to a server not responding (the user may notice, for example, that his network is down and retry).

A **timeout** error simply triggers a new send with the same parameters, and the user is warned with a subtle notification but he doesn't has to decide anything.

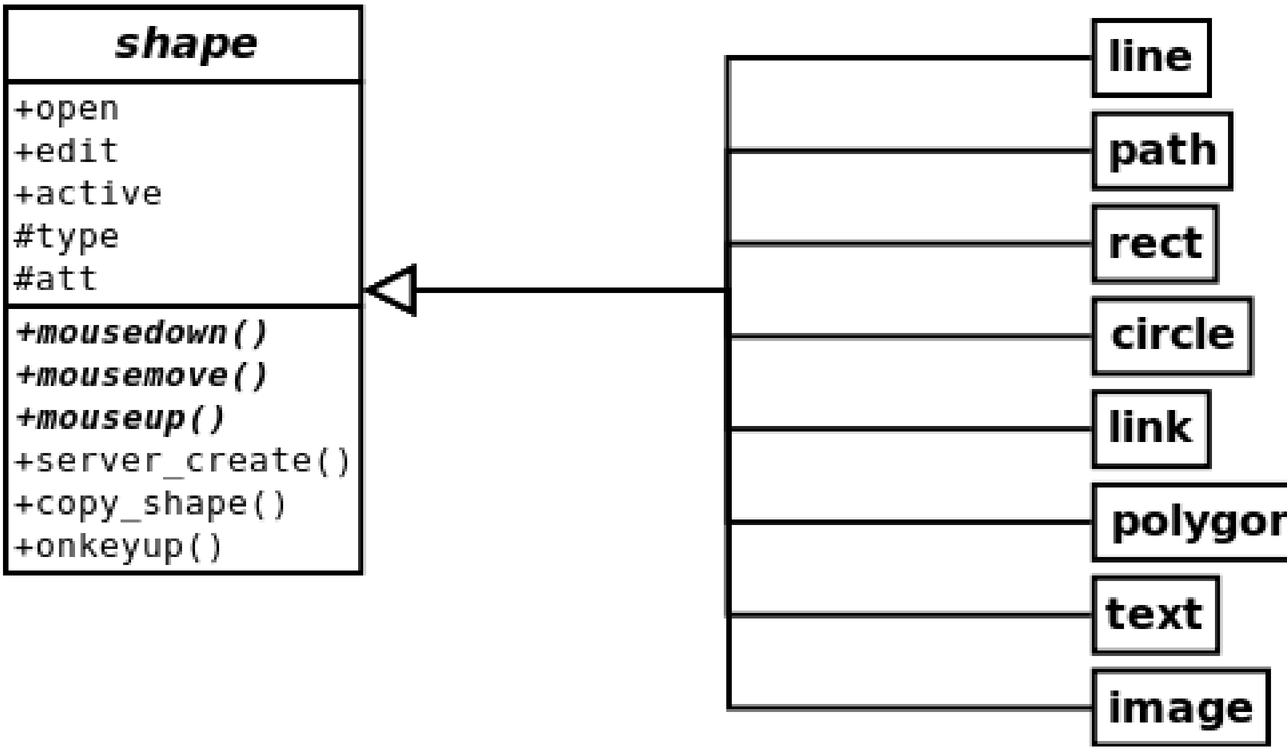
The deletion of a whiteboard on the client side

The deletion of a whiteboard while several users are working on it is an event which can lead to the failure of several server side operations. Simultaneusly, several ajax requests made from the client side may fail, and I decided to not take care of each one of these failures, but to rely on the failure of the whiteboard's heartbeat: the 'receive cycle'.

The whiteboard is almost[6] always awaiting for a response from the server, because of the `g['receiver']` object and the receive cycle it manages, so I demanded to this object the handling of the `whiteboard deleted` **explicit error** (see section above), which leads to the logout of the user from the whiteboard. Other client-side failures due to a deleted whiteboard are simply ignored, relying on a prompt reaction of the receiver object.

2.1.4 The shape class

The **shape** class came from the attempt to simplify the code running into the whiteboard. This class is used only through its derived classes (it can be seen as an abstract class) and by the functions into the file `whiteboard.js`.



This diagram shows only the public methods, for the protected ones see the next figure. The shape class has mainly three virtual methods (mousedown, mousemove, mouseup), which must be overridden by the derived shapes, even if the language syntax doesn't provides any keywork to indicate virtual methods.

The idea behind this class is that when an user chooses a tool that corresponds to a shape, all mouse (and keyboard) actions inside the canvas get forwarded to the corresponding shape class, and the class decides how to handle the mousedown, mousemove, and mouseup events. This structure aims to achieve both modularity and flexibility in the definition of classes.

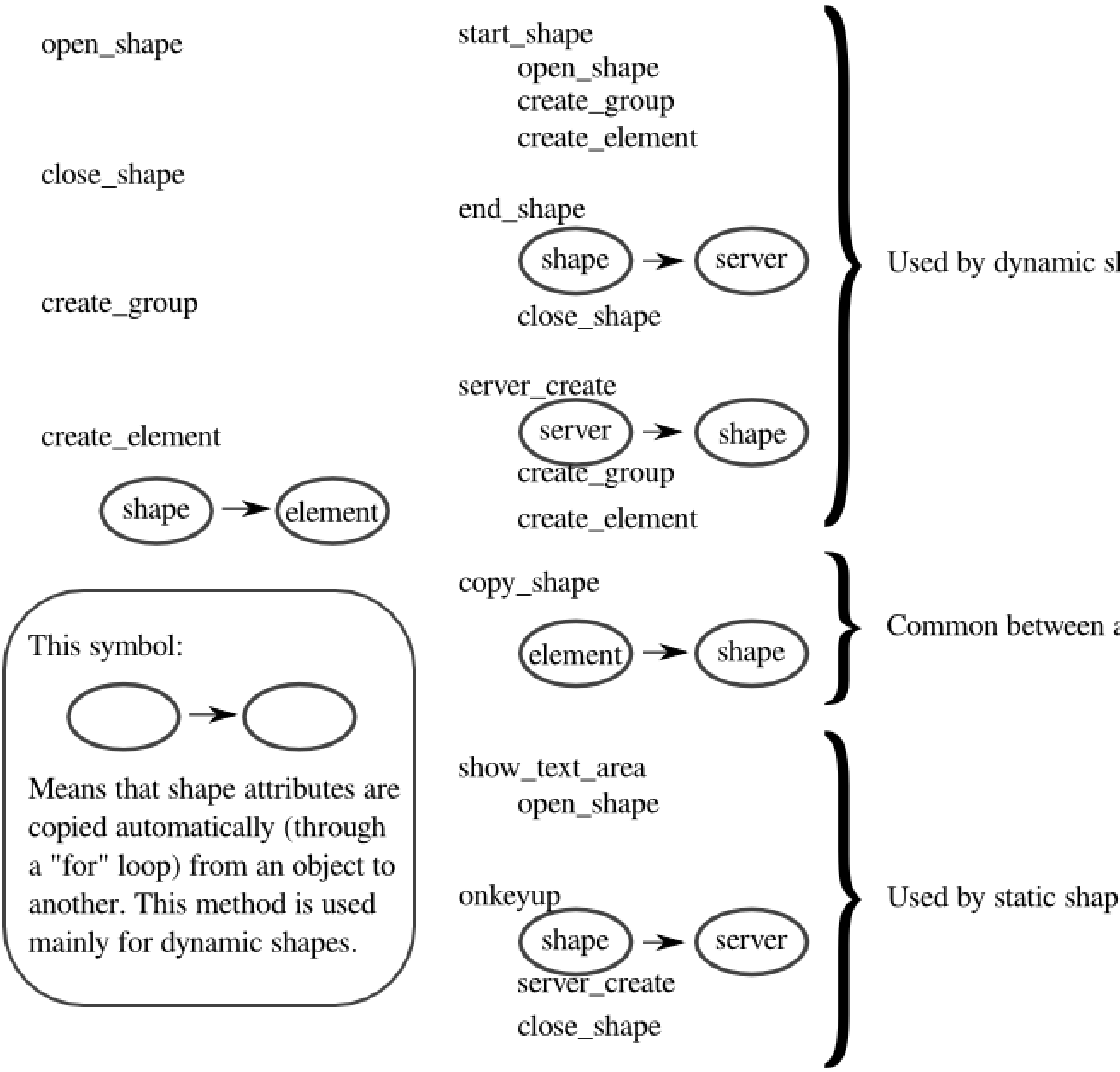
There are two kind of shapes derived from `shape`:

- **dynamic shapes**: they are the most part. In this case a shape corresponds tightly with an SVG element, and many methods can automatically copy attribute values from the shape to the server or to the SVG element. The aspect of these shapes changes while the user is creating them, but they are created all together on the canvas of the other users receiving the update.

- **static shapes**: these are the **text**, **link**, and **image** shapes. They are created within a single function, because the intermediate state is constituted by a text that the user changes into the textarea. For these shapes, the correspondence with an SVG element is less tight, because their actual structure on the svg canvas is more complex; this is the reason why all static shapes override the `server_create` method.

This distinction doesn't corresponds with any structure into the code, but it helps to understand the different use of `shape` protected methods on part of his derived shapes. These protected methods are the part of the base class which can be used by several shapes with a similar behavior.

`shape` protected methods are defined on two levels, a first level of methods which is used by the second level. Usually, derived shapes use the second level, but sometimes they can need customization and rise up to the first level (this is the case of the *path* shape, which needs to build custom groups to handle the creation of multipaths). This simple diagram shortly describes the relationships between the protected methods into the shape class:



The methods on the first column can be thought as a first level, and the ones on the second column as a second level. These are not all protected methods (some are public), but they are all methods which are reused inside the derived shapes.

The meaning of the words into the ellipses is:

- shape: the shape object (has attributes as object properties)
- element: the SVG element (his attributes correspond to visual properties)
- server: the server update (attributes are encoded as an ordered array)

This skecth can be useful to get an idea of the overall structure, but many details are missing which can be found in the code.

Random remarks on the structure of the shape class

The methods `open_shape()` and `close_shape()` handle the `open` flag; this is read upstream to know if the shape is open (an user can't change his tool if he has an unclosed shape).

The method `copy_shape` sets also the `edit` flag true. All derived shapes can change their behavior when the shape is in edit mode.

Usually a shape remains alive during all the time while the corresponding tool is selected, continuously generating new elements and server updates. On the other hand, with the edit tool a shape is copied by an existing one, and it shouldn't generate new shapes after that the editing is finished. For this reason, when an edited shape is closed, its `active` flag is set to false, so that the upstream code can understand that no more shapes of that type should be created (`close_shape` method).

2.1.5 Concurrency

Even if I couldn't find a clear specification of the behavior of the javascript language with respect to concurrency, from several articles found on the web and from the practice it results that javascript doesn't supports preemption, thus an event is handled after that the current block has ended.

To avoid concurrency problems, is thus necessary to mantain the coherence of global variables within each function that changes them. This is easier for the new parts of the code which are structured following the object oriented paradigm.

Sometimes (`sender_handler` function inside `application.js`, `login_handler` function inside `login.js`) when receiving an ajax response from the server, the underlying datas are checked, to be sure that the response is still valid or to know if a new request should be sent.

2.2 Server side

The server side is decomposed following a procedural paradigm, which I think is better to describe the control flow in this case. However, to reduce the complexity of function interfaces, some of their parameters have been packed into an associative array (see The client identifier).

The choice of a procedural decomposition came from the consideration that the server code doesn't actually follows complex control flows, but instead the whole logic is started with each user request and ends with a response to that user, changing eventually the database as an important side effect.

2.2.1 The main switch

The execution flow is described in its principal steps into the `main()` function, where I tried to balance the readability (that means hiding the code by incapsulation) with the expression of the underlying logic.

To achieve this goal, there is a separation of functions into groups, and the structures into `main()` do the association between the user request and the corresponding functions.

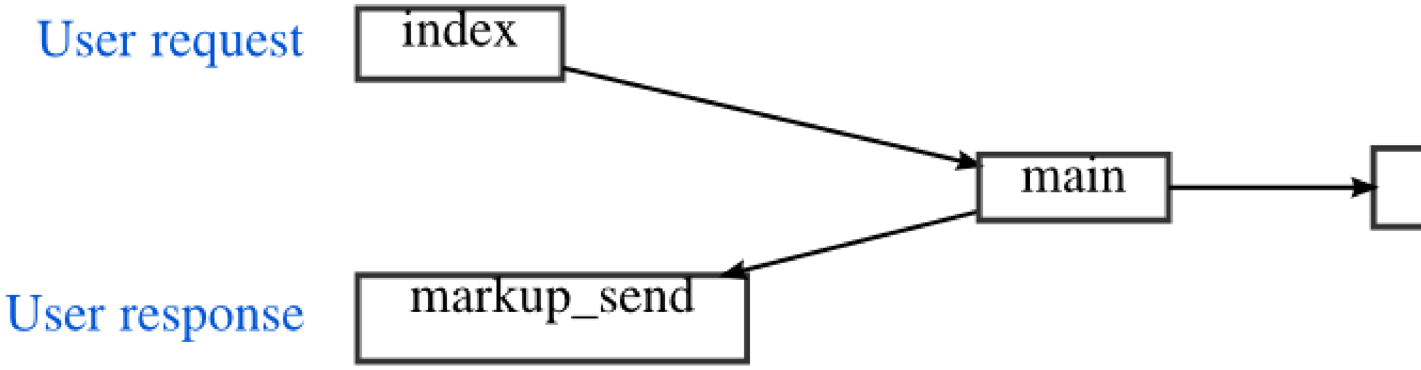
2.2.2 Function groups and server side files

The function used by `main()` are mainly grouped into two types:

- modifying the database (file `updates.php`): The functions that modify the database are all defined into `udpates.php`, so that the database structure is somehow encapsulated into this file. The file contains the functions called by `main()`, but it contains also functions called just internally, and defined to reuse the code or to improve the readability
- formatting the output (file `markup_send.php`): Here, all the functions that write HTML or XML are defined, to wrap the data received upstream by `main()`, and to send them to the user.

Sometimes, this division turns into an excessive rigidity, and sometimes (in the case of `export_chat`) a function into updates.php also cares for formatting, but this remains a guideline into the structure of the server side code.

With the grouping of functions into the files and the procedural decomposition model I used, it is easy to follow the execution flow through the various files that compose the server side code. The following diagram shows the use relations between server side files (the `.php` extension is omitted) when an user sends a request. An arrow starting from a file and arriving into another file means that the first file is using a function from the second one.



As can be seen, from the `main` file the execution flow goes to the `update` functions, which in turn call the functions from `file_access` to read and write the update database copy on the disk. When the `update` functions give back the control flow to the `main` file, it uses the returned values to call the functions into `markup_send`, to send back the response to the user.

2.2.3 Steps for the server response

The presented function groups correspond also with two steps of the server operation, and so they can be found used into two successive switches inside `main()`: a firs one based on the `mode` parameter that chooses among which *update* function to use, and a second one based on the `$o['type']` (output type) parameter that chooses among which *markup send* function to use[2].

The *markup send* step is born to collect formatting functions that were common between several *modes*, so the output functions for the `export` mode remain outside from this step: they stay into the `export` branch of the *update* switch, since they are used just there. The `export` mode is quite different from the others, and the Export mode and draw_image section covers its characteristics.

2.2.4 The client identifier

The drawback of a procedural decomposition paradigm is that many functions belonging to the same processing step could require the same data set, resulting in big and redundant function interfaces. For example, the functions belonging to the *update* step often need informations about the user which sent the request, his user id (to improve performances reducing database search), and the name of the whiteboard where he is operating.

I packed all these variables into the variable `$client_id`, which is a parameter of all the functions of the *update* step. The variable is sent by the client or produced by the `login` function in the form of a joined array with the structure:

```
<user id> . '_' . <user name> . '_' . <whiteboard name>
```

And it is parsed by `parse_client_id` into an associative array, to provide textual keys to the functions. This array can be found as a parameter of almost all *update* functions.

2.2.5 Export mode and draw_image

This mode deserves a specific coverage, because is more complex than all the other methods and requires a whole file (`draw_image.php`) just to accomplish the operations required to export the whiteboard contents.

The complexity arises from two factors:

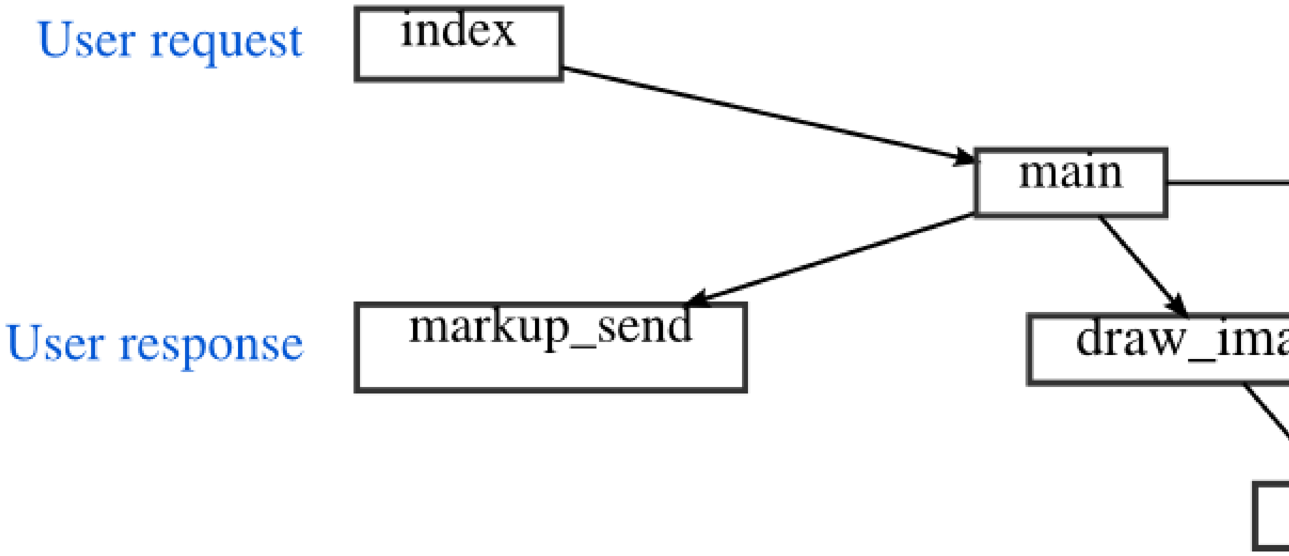
Database structure The server doesn't actually sees the current state of the whiteboard, but it simply keeps the received updates. Thus, only for this mode, it must walk through the whole database and transform the update list into a structure reflecting the status (the `$objects` variable). This task has been incapsulated into the `export_whiteboard` function (`updates.php`).

Format encoding A change from one format to another, which is simple a matter of changing a form value for the user, entails whole sets of different operations into the server side code, since the functions may change for each object type. This task has been incapsulated into the `draw_image` function (`draw_image.php`).

The `export_whiteboard` function does also all operations which will be useful for every kind of export format, for example it parses complex action parameters and it translates the sizes from global units to local units (see Global and local measure units); this makes the two tasks (the production of the `$objects` variable and its output as a file for the user) tightly coupled but the division between them seems reasonable to me to organize the code.

All the code for the export mode is strongly dependent by the position of the parameters into each update string. This is a problem for readability and maintainability, that I discuss into Joined arrays for the action parameters, where I introduce some ideas to change the current structure.

Now that this mode has been presented, I can show the full use diagram between server side files, including even those files which are secondary and related to this specific mode:



2.2.6 Concurrency

On the server side, concurrency problems arise for the access to the shared files on the disk. As seen into the section Function groups and server side files, all the functions that read and write disk files are grouped together into the file `file_access.php`, and they are called just by the functions defined in `updates.php`.

The files which present concurrency problems are the **passwords** file and the **database** file for each whiteboard, since the *permissions* file is read-only (writable only by hand by the administrator) and the *log* file is write-only. The rest of shared data are folders with imported images.

The files mentioned above are accessed through the following four functions[3]:

- protected_file_exists
- protected_file_create
- file_get
- file_put

These functions handle the concurrency, and they carry out also the task of encoding and decoding of php complex variables into the file. Indeed, the files that present concurrency problem share also the feature of being an encoded form of php variables.

File get and put

Both the definition and the use of `file_get` and `file_put` are straightforward[4]. Into the file `updates.php`, all actions executed between a *write file_get* and a file_put can be thought as acting on an exclusive locked version of the database. I wrote *write file_get* because this function can be called with a read (`r`) or a read write (`rw`) value as mode argument; when it is called with a `rw` mode, it returns also an handler, which must be given back to file_put to terminate the critical section.

```
list($h, $d) = file_get($wb_file, 'rw');
...
file_put($h, $d, 'update');
```

The third parameter of `file_put` is useful to tell to the function that data has been modified, and so they must be written on the file. Sometimes, functions into `updates.php` can open the file with the `'rw'` mode but don't actually modify the data, in this case they will use `file_put($h, $d, 'close')`.

Protected file create and exists

For file creation, an extern lock file is used to have mutual exclusion between different calls of protected_file_create. The mutual exclusion between protected_file_create and file_get/file_put functions must be granted by the upstream code into updates.php, which checks for file existence before trying to access it, or doesn't checks the existence if it should be sure at a given point of the code.

Whiteboard existence and automatic logout

All functions into `updates.php` which read the whiteboard database are subject to failure if the whiteboard has been deleted. Usually when a whiteboard is deleted the first function which fails is the `read` function which is waiting reading the database.

When the `read` function fails, an explicit error message is sent to the client functions which handle the XML response, and those functions force the logout of the user.

This is the reason why it is very difficult that another function can fail for an unexistent whiteboard, because usually users are forced to log out as soon as the whiteboard is deleted. This is the reason because error handling is not very important for a missing whiteboard, for all functions different but the `read` function.

Permission file access

This file is accessed just through the function `check_permissions`, and if the file doesn't exist the function creates on its first invocation.

The concurrent access on this file can in the worst case create it two times with the same default content, while for the rest of the application life the file is accessed just for reading.

2.3 Emulating a client *push* behavior with the http technology

When using a pull update technique, there is a trade-off on the frequency of client update requests. Frequent requests improve the responsiveness to changes made from other users, but increase the network load, and the server and client overhead (although the latter is negligible).

In this application, a behavior similar to a pull-like one is achieved simply delaying the response send to the client that asked for updates. If an updates request comes to the server while no new updates are available, the response is delayed by a configurable amount of time during which the server process periodically checks the presence of new updates, until a new one is found or the number of retries becomes too high. After a given number of retries with no new updates, the server replies to the client with an empty response.

The cost of this technique is that of a suspended server process for each client, that periodically wakes up and opens the database for reading.

Here it is a simplified snippet of code taken from the server side function 'read', which handles the response to a client update request. At lines 2 and 4, `$server_update_retry` and `$server_update_timeout` are two parameters configurable into the file `configuration.php`.

```
 1    // The time interval between each check
 2    $update_wait = (int)$server_update_timeout/$server_update_retry;
 3    // wait until we find new ids, or until maximum retry number
 4    for ($i = 0; $i < $server_update_retry; $i++) {
 5        // Read the database and retrieve the latest id
 6        $d = file_get($c['wb_file'], 'r');
 7        if ($d['next_upd_id'] > $id)
 8            break;
 9        usleep($update_wait);
10    }
11    // After the cycle, respond with the new lines or an empty response
```

This technique is quite common for ajax applications and it is called also **long polling**.

2.4 Global variables directly sent from the server to the client

There is an amount of client-side global variables that must be set by the server side code. These are usually variables depending on the specific user or on the specific session, so they may change each time an user makes a new login.

There is a sort of channel, a way of transmission of all these variables from the (server side) database record for the specific user to the client side global scope.

the variables are read from the database record into `updates.php` by the following function:

```
function get_user_vars($c, ...){
    $user_id = $c['user_id'];
    ...
    $d = file_get($c['wb_file'], 'r');
    ...
    return build_user_vars($user_id, $d['uids'][$user_id]);
}
```

Some variables are directly read from the database, some others must be built by `build_user_vars`. The function is called inside `main.php`, before sending the application page to the user:

```
app_page_send(get_user_vars($client_id), $o['content']);
```

Inside `app_page_send` (defined into `markup_send.php`), the variables are encoded like input fields into an hidden form:

```
<!-- Client side session variables read by init() into common.js -->
         <div class="hidden">
           <form id="session_datas">';
foreach ($client_vars as $name=>$value)
    $content .= '
            <input type="hidden" name="'.$name.'" value="'.$value.'">';
$content .= '
           </form>
         </div>';
```

Finally, during the client-side initialization of the application page (function `onsvgload` into `application.js`), these variables get read and exposed on the global scope, into the `S` object (the main global object together with `g`):

```
// Get client-side variables from server-side ones embedded into
// document nodes
var server_vars = ['user', 'client_id', 'width', 'height', 'svg_w', 'svg_h',
                  'slides', 'user_id', 'obj_prefix'];
var form = getById('session_datas');
for(v in server_vars)
    S[server_vars[v]] = form[server_vars[v]].value;
```

This channel is useful also to send server-side configuration variables on the client side; for example, it would be easy to unify the server side `debug` configuration variable with the client side one.

2.4.1 Role of `build_user_vars`

I encapsulated the building of user variables into this function because sometimes the user variables are needed also on the server side (when acquiring an image, for example, whe need the svg sizes for a given user). In these cases, `build_user_vars` can be called to process an user data array and obtain the user variables without further database access.

2.5 Global and local measure units

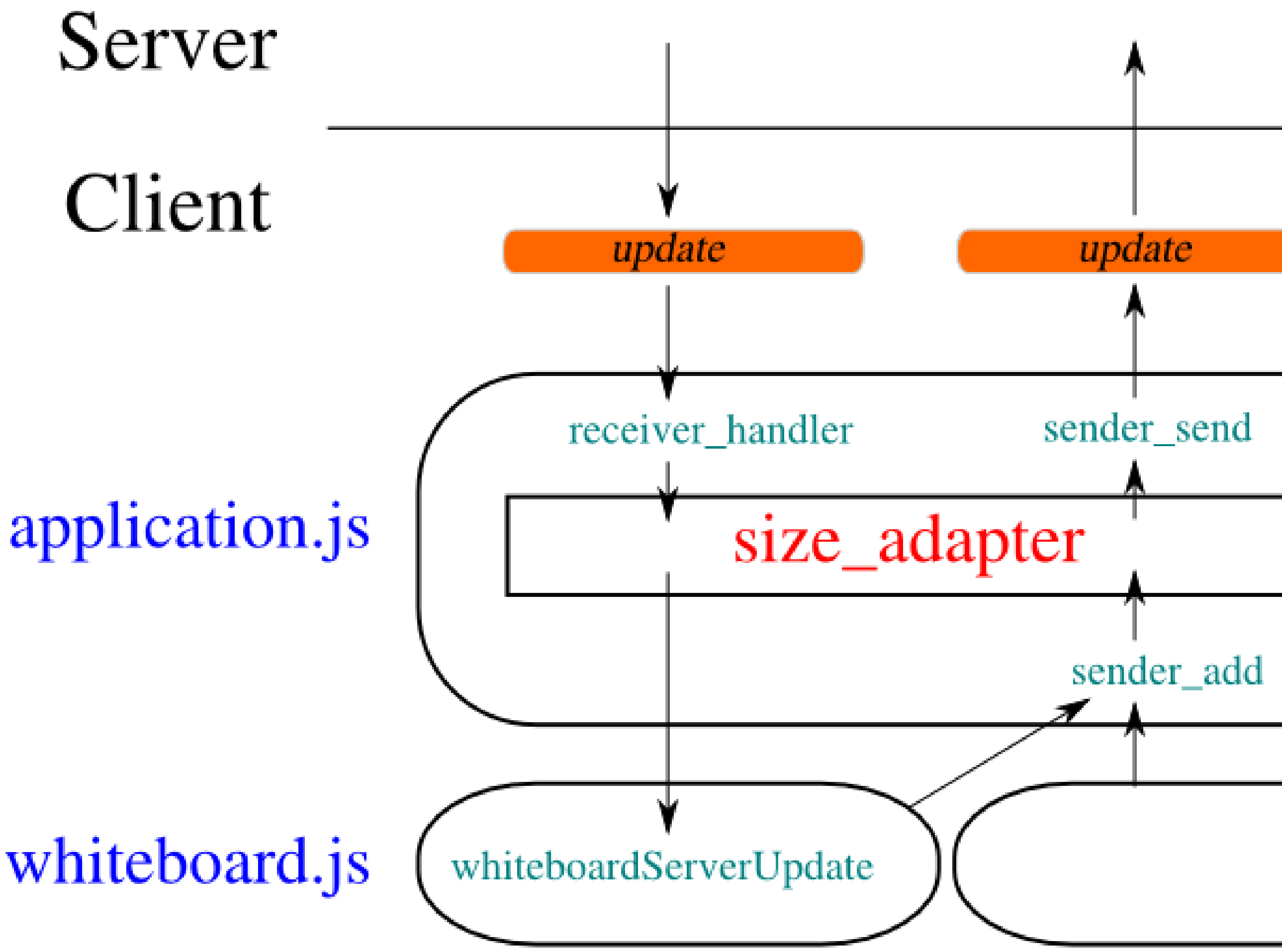
At one point of the project, it was decided that all users should see the same content on the whiteboard, regardless of the actual sizes in pixes of each own's whiteboard.

To accomplish this, the size and position of each object is expressed, on the server side, with a "global" measure unit, that gets translated to pixels just before the objects are drawn on the client. Also the action of create, move or edit a shape on a client must translate the local pixel units into global measure units[5].

The definition of the global unit is as such: the whiteboard's width and height measure always 100 global units. So each point within the canvas has an abscissa and an ordinate that ranges from 0 to 100, when expressed in global units, and every distance into the whiteboard can be translated from local to global units and vice-versa with simple proportions, knowing the sizes of the local canvas.

Currently, the resize is incomplete, since the circles aren't translated to ellipses, and since the aspect ration of images into the SVG isn't changed. Also the text size isn't changed.

The translation of measure units is demanded to the client-side object `g['size_adapter']` object, which is like a filter for all updates regarding the whiteboard. The followind diagram shows the relation between this object and the functions handling the updates:



A translation between global units and pixels is performed also on the server-side, when exporting the whiteboard content to a pdf or image file.

2.6 Security measures

Some weak security measures were taken, just to discourage users to try to stole the identity of others, but the taken measures present several limits so they are intended to provide a reduced level of security, suitable for an informal use environment, where the trust isn't a problem, and where the possible damage done by an attacker is reduced.

2.6.1 Request signature

The main security measure is to not send the plain text form of the user password with each request, but instead to *sign* each request with the user password on the client side, so that the server can use his stored password to verify the signature.

This is accomplished by the `g['signer']` object on the client side, and by the `verify_credentials` function on the server side. This kind of signature get done just for those modes which require an authentication, which are defined into the `$known_modes` array. Both the `$known_modes` array and the use of `verify_credentials` function can be found into the `main.php` file.

The only moment when the password get transmitted in plain text form through the http channel is when the user registers himself, associating that password with his name.

2.6.2 Reply attack

This kind of security mechanism is prone to a reply attack, because the signed part of the request is the same for different requests. To reduce this problem, there is a continuous exchange, between the server and the client, of a time-dependent value, which makes requests not reusable after a given time interval.

This time-dependent value is a timestamp, generated and signed by the server (function `update_salt` into `updates.php`), which becomes part of the data signed from the client (function `get_signature` within the `g['signer']` object into `common.js`), and then is checked by the server for each authenticated request. The `g['signer']` object has the responsability of keeping the server timestamp (also called *server salt*) updated, using an ajax channel.

The variable ruling the timestamp validity is `$server_timestamp_validity` into `verify_credentials` into `updates.php`, the variable ruling the interval used by the client for updating the timestamp is `cycle_timeout` into the `g['signer']` object into `common.js`. If this parameters shall become configuration variables, the client `cycle_timeout` value should be sent from the server to the client (see Global variables directly sent from the server to the client).

2.7 Timeout effects

A timeout is a problem that must be handled at both ends of the communication, the server and the client. Indeed, the natural handling for a timeout is a retry, and when retries are in play a protocol problem arises, to avoid message duplication.

Actually, considering the operations handled through asynchronous (ajax) requests, it can be seen that many of them don't have server-side effect, so their duplication is not important. These are the requests sent with modes: `read` (`g['receiver']` object), `update_salt` (`g['signer']` object), `checkuser` (`g['login']` object).

2.7.1 Sender requests and the `send_id`

The **only problem** comes with a request sent by the `g['sender']` object with the `write` parameter: this is a request carrying an **update**, and repeting it is not safe, so the server must detect and nullify a duplicated request.

To made the update requests detectable, it is necessary to assign an identifier to each of them. A new unique identifier must be created on the client side and verified on the server side, so the two sides must be synchronized from the client side initialization and through all request attempts.

This application doesn't mantains a (server side) session state, but just a whiteboard and an user state, so the *current update identifier* must be an user variable, sent with the other variables as seen into global variables directly sent from the server to the client.

The identifier is a variable called `send_id`. Its value is sent as a query field with each `write` request, and incremented separately by the client and the server in case of success.

2.8 Parametric layout

Just a short mention about the layout configuration variables. Through all the code, I tried to refer to those variables as much as possible, but the layout is not fully parametric currently, and it would be difficult event to simply state what kind of layout feature should be modified by the administrator and how. However I always try to refer to global variables (on the server side) and to server variables (on the client side) in order to have, at least, a good level of internal coherence when referring to the same values.

Chapter 3

Data structures

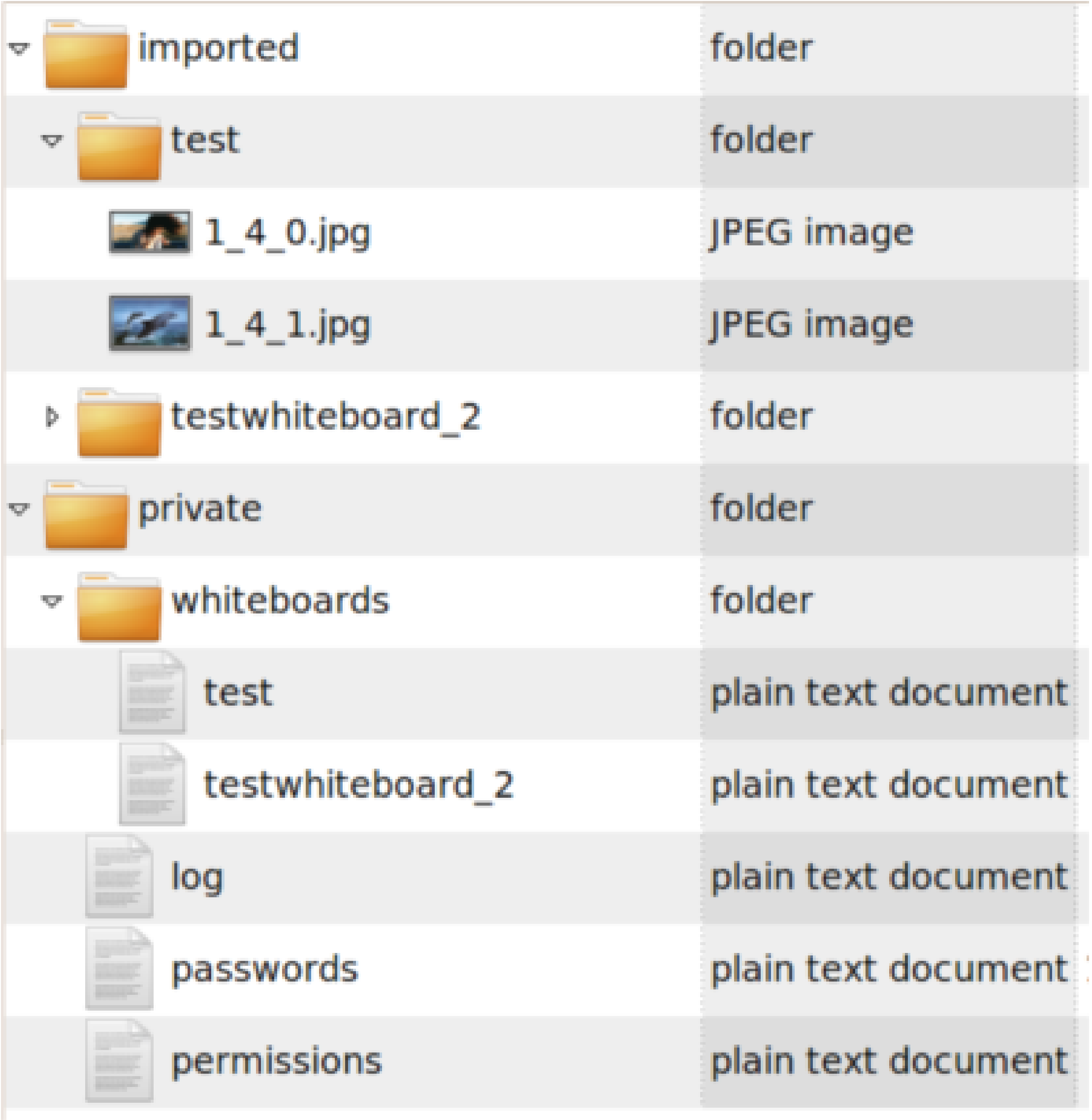
This section is very important for the developer, due to the lack of incapsulation that can affect some data structures. It is important to mantain a centralized reference for data structures, to preserve their coherence while they get accessed by several peripheral functions both in the client and the server side.

3.1 Stored data

Stored data are those which get wrote on the disk by the server side code, into the files choosen through the configurable variables into `configuration.php`.

When the server configuration variable `$debug` is set to `true`, for each file read by the server (function `file_get`) a readable copy of the content is written on the disk, with the suffix "-debug". This can help in fixing issues and for a better understanding of data structures.

The stored data reside into the `data/` folder, even if all position can be configured. This image shows the default structure of the data folder:



imported	folder
test	folder
1_4_0.jpg	JPEG image
1_4_1.jpg	JPEG image
testwhiteboard_2	folder
private	folder
whiteboards	folder
test	plain text document
testwhiteboard_2	plain text document
log	plain text document
passwords	plain text document
permissions	plain text document

In the image you can see the folders `imported` and `whiteboards`, which get filled and emptied by the server with the creation and deletion of new whiteboards. For each whiteboard, a file is created into `private/whiteboards`, while the corresponding folder into `imported` is created just when (and if) an image is actually imported.

The files **permissions** and **passwords** are essential for the application's operation, so if they are missing they get created automatically and filled by the server side code with default content. For this reason, the files aren't present into the application's distribution (see Permission file for some details). Also the `log` file is created by the first server log message.

As you can see, the imported images stay into a public folder, while all other data should stay into a private one (although folder's names can't actually say which permissions were given to those folders).

Two types of data get stored on the server, which are very different:

- textual data, usually an encoded form of complex php arrays
- images

the textual data are often a serialized form of php variables, except in the case of the permission table (`$permission_file`) which has a precise format in order to be easily used from the administrator.

The images are those imported from a pdf file for a user *import* request, or those grabbed by the web after a user *image create* action. They are deleted by the server when the user requires the deletion of the corresponding whiteboard object.

Imported images reside in a folder which is specific for each whiteboard. The folder is created when there is the need to import the first image (function `acquire_image` into `updates.php`), and deleted with all its content when the whiteboard is deleted by an user with the right permissions.

3.1.1 Whiteboard database

The whiteboard database is the most important data repository for the application. It is specific for each whiteboard, so it can be created and deleted like whiteboards can be. It contains mainly:

- few variables which are global for the whiteboard (mainly counters)
- the update database, presented in the initial section Main principle
- user data relative to the whiteboard, like size customizations

The database is a serialization of a php array whose structure (with the correct key names) is the following:

- database
  - `next_upd_id`: identifier for the next update that will be stored
  - `next_usr_id`: identifier for the next user that will join this whiteboard
  - `delete_count`: the number of objects deleted since the last cleanup
  - `updates`[7]: the update database; each update contains the following fields (those with the star * symbol are added by the server):
    - `update_id` *: it is the key of the update in the database array
    - `time` *: timestamp when the server added the update
    - `madeby` *: user *name* (not user id) of the user from whom the update came
    - `page`
    - `objid`: see Object id under Joined arrays
    - `action`
    - `parameters`: see Action parameters under Joined arrays
  - `uids`: the array of user data pertaining a whiteboard, which is indexed with each user's id
    - `username`: a string with the name of this user. This is unique like the user id, because it is the value the user fills in to identify himself at the login page.
    - `session_id`: a counter which is incremented each time the application page is sent to the user. This will be used to build unique object ids on the client side.
    - `client_id`: the client identifier, a variable sent by the client to the server (see The client identifier for details). It is not strictly necessary to store this value, it could be easily built each time it is needed (function `get_user_variables` and function `login` into `updates.php`).
    - `slides`: the addres that the user has loaded into the iframe panel
    - `send_id`: a sequence number for client `write` requests (see Sender requests and the send_id)

    The following parameters are the layout parameters which a user can personalize, and which must be kept server side because they affect the sizes of the root svg element which can't be modifyed client side. The parameters are set to default values when a new user is created (function register into updates.php).

    - `width`: total width of the whiteboard
    - `height`: total height of the whiteboard
    - `side_w`: width of the right side pane containing the chat and the iframe

serialize and json_encode

During the development, I switched from the use of `serialize` to the use of `json_encode` to store the php variables on the disk. I did this because I found that even the simplest arrays were encoded by `serialize` including their indexes, like into the example below:

```
'updates' =>
array (
  1 =>
  array (
    '0'=>1,
    '1'=>1287411219,
    '2'=>'fra',
    '3'=>'0',
    '4'=>'1_4_1',
    '5'=>'image',
    '6'=>'...'
  ),
  2 =>
  array (
    '0'=>2,
    '1'=>1287411224,
    '2'=>'fra',
    '3'=>'0',
    '4'=>'1_4_1',
    '5'=>'move',
    '6'=>'-21.4|-14.9',
  ),
  3 =>
  array (...
```

While the string produced by `json_encode` is more compact (spaces and newlines added here for readability):

```
"updates":{
        "1":[1,1288003041,"fra","0","1_1_0","path","..."],
        "2":[2,1288003041,"fra","0","1_1_1","path","..."],
        "3":[...
```

3.1.2 Permission file

This file is necessary for the application to run, because it rules the behavior of the application when it comes to give to any user the permission to do fundamental actions, that are creating, accessing or deleting any whiteboard.

The file is conceived to be manually edited by the application's administrator, so it is structured as a "delimited separed values" file, with a single space as delimiter. The form of each row must be the following:

```
<user> <whiteboard> <permissions>
```

Where `<user>` and `<whiteboard>` can be two regexp, and `<permissions>` is a string composed by the letters `a`, `c`, `d`, each one giving, when present, the permission to access, create or delete, to the given user regexp on the given whiteboard regexp.

This file is missing into the application package, so the administrator can write one by himself. If he doesn't, the server side code will create a file with the default rule of allowing everything to everyone (see function `check_permissions` into `file_access.php`), that is a rule like this:

```
.* .* abc
```

This file is just read by the short function `check_permissions` into `file_access.php`, so check out that function to retrieve detailed informations, as the use of the library functions `fgetcsv` to read the file and `ereg` to evaluate the regular expression.

3.1.3 Password file

The passwords file is read and written with the same functions used for the whiteboard databases, in order to store a php variable into it. The structure of this variable is very simple:

```
array('server_pass' => 'password_s',
      'user_pass'   => array('username1' => 'password_1',
                             'username2' => 'password_2',
                             'username3' => 'password_3');
```

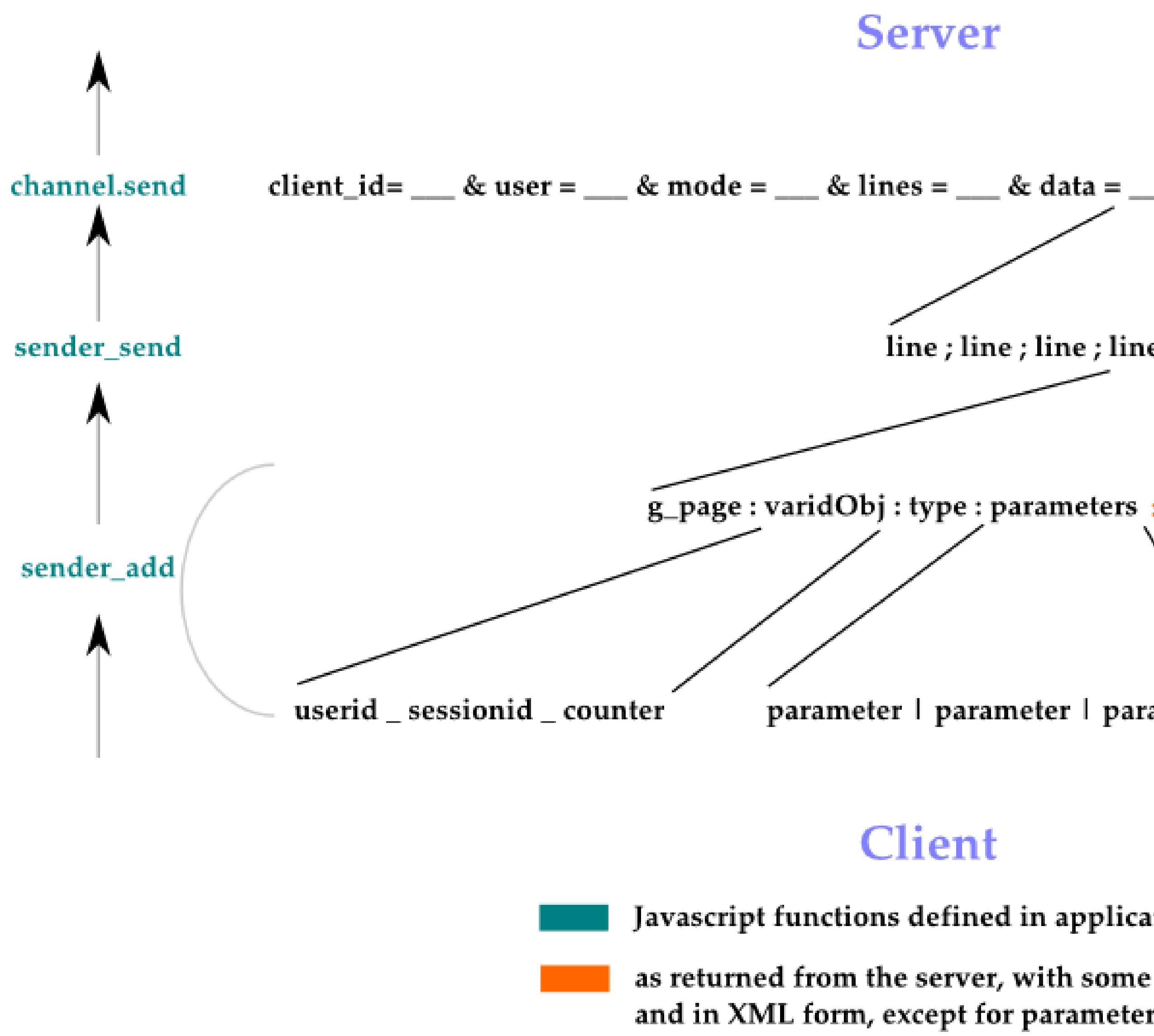
The passwords are written when each user registers himself (that is also the only moment when they go through the http channel in plain text form).

The `server_pass` is generated and used by the server to sign the salt.

3.2 Joined arrays

The whiteboard makes wide use of joined arrays to handle complex data structures. This means that an array is translated into a string (with one-character separators between his elements) at one side of the transmission, and this string can be split again at the other end, where the details of the data structure must be read or changed.

For example, this diagram shows how the parameters and other data pertaining a new action get sent to the server, packed with the use of `|`, `:`, `;` separators.


Server
channel.send
client_id= ___ & user = ___ & mode = ___ & lines = ___ & data = _
sender_send
line ; line ; line ; line
g_page : varidObj : type : parameters
sender_add
userid _ sessionid _ counter
parameter | parameter | para
Client
Javascript functions defined in applica
as returned from the server, with some
and in XML form, except for parameter

Data are encoded on different levels to allow the expansion of certain fields; for example, the object id structure could (and did) change over time, and the update parameters change with the different action type.

The text inserted by the user (for example, into a `chat` action update) is escaped (using *urlencoding*) to prevent its content from interfering with the separators.

3.2.1 Object id

Each object Id must be unique value into a whiteboard database; it has the following structure:

```
<user id> _ <session id> _ <object counter>
```

like as "3_35_12"

user id The user id (they start from 1, the value 0 can be used by the server if it needs to build objects not associating them to any user).

session id The session id is incremented each time a user receives the application page, and transmitted to the client where it remains as a global variable. This is the main value that grants the unicity of the object ids because it is different for each initialization of the javascript environment (for a given user on a given whiteboard).

object counter It starts from zero when the javascript is initialized, that is with each new session id.

Server object id

The server doesn't have an user or session id, however there is a case where it has to build objects with an unique object id. This happens into the function `import` (file `updates.php`), where several pdf pages are turned into images and inserted into the whiteboard.

The object id used this time has the form:

```
<user id> _imported_ <page counter>
```

And it is unique anyway, because when the import operation is performed, each page that will be fill with a pdf page is cleared before, so two objects named `_imported_` with the same page counter can't exist (the `<user id>` is thus not strictly necessary).

3.2.2 Action parameters

The handling of action parameters is quite unconfortable for the developer: here I will describe the current state of the code, while in the next session I will discuss drawbacks and alternatives to the use of joined arrays to encode this data.

The parameters can change depending on the type of action, and must be accessed in a coherent way through all the code. The actual order of parameters for an action is decided when the update string is created, that is on the client side, in all the places before the `sender_add` function is called.

Shape action

Each shape defines its list of parameters, wich it will use to read updates to the server, to send them, and sometimes to clone an existent shape for editing. Here is a snippet of a shape defining its attributes (taken from the file `shapes.js`):

```
function line(){
    var att = ['opacity','stroke-width','x1','y1','x2','y2'];
```

These definitions must be taken as the reference for the meaning of parameters for shape actions (line, path, rect, circle, polygon, polyline, etcetera), but remember that the actual index must be incremented by two, because each shape has two default attributes defined into the parent class `shape`, as can be seen into this snippet taken by that class:

```
// The colors are common attributes between all shapes
var colors = ['stroke', 'fill'];
object.att = colors.concat(att);
```

For example, the final positions of parameters in a `line` action will be:

```
stroke | fill | opacity | stroke-width | x1 | y1 | x2 | y2
0        1      2         3              4    5    6    7
```

Other actions

I will summarize in a table the parameters for all actions which are not shapes (line, circle, rect, path, etcetera are excluded). For each action, I include the file from where the corresponding `sender_add` function is called (this can be easy wiewed using `grep sender_add *.js`). Actions `clear` and `delete` don't have parameters.

Table 3.1: Parameters for not-shape actions

Action	Parameters	File
move	translation_x | translation_y	whiteboard.js
chat	escaped_text	chat.js
slides	escaped_url	menu.js
clear	*clear*	whiteboard.js
delete	*delete*	whiteboard.js

You can see that the files roughly correspond to the position of the user interface element that the user activates to perform a given action.

For actions without parameters, usually a copy of the action type (for example `delete` for the *delete* action) is used as parameter, to avoid problems found while parsing empty XML fields with Internet Explorer (there is a comment on this into the main `for` cycle into `receiver_handler` into application.js). The copy of the action type is filled automatically by `sender_add` when the `parameter` argument is missing or it is an empty array.

3.2.3 Drawbacks and alternatives to the use of joined arrays

The use of joined arrays has several advantages, like easiness of implementation and an efficient use of storage space, but it also presents severe drawbacks when considering readability and maintainability of the code, since the developer has to use positional parameters in a coherent way each time he tries to parse the format.

Joined arrays for the update structure

The handling of this joined array has been eased introducing a variable which associates labels to positional indexes. This is the global variable `$u_keys`, defined at the top of `updates.php` and used just within this file. This variable is used to grant the coherence of functions which access the update on the server side (all these functions stay into `updates.php`), while the database remains free of redundant labels; however, the syntax can sometimes turn messy like in this example (taken from function `cleanup`):

```
...
// Second pass: remove cleared or deleted objects
foreach ($updates as $upd_id => $update){
    $page  = $update[$u_keys['page']];
    $objid = $update[$u_keys['objid']];
    $remove = false;
    if (isset($clear_collection[$page])){
        if ($clear_collection[$page] > $upd_id)
            $remove = true;
    }
    else if (isset($delete_collection[$objid])){
        // Check if we have to remove the image from the filesystem
        if($update[$u_keys['action']] == 'image')
            delete_image($update[$u_keys['parameters']], $wb);
        $remove = true;
    }
    if ($remove)
        unset($updates[$upd_id]);
}
```

...

There is another coupling between the client and the server related to the order of update fields: it occurs when an update is first sent from the client to the server. It is the programmer, this time, that must ensure the coherence between the client side function `sender_add` into `application.js` and the server side function `write` into `updates.php`. These functions are at the two end points of the transmission of a new update. This coupling could be eliminated using JSON as data format for update upload.

With regard to the last transmission of the update from the server back to the client, XML is used due to the ajax technology, so some textual labels must be given into `read`, which will be transmitted to the client together with the data in XML form; so there are no problems with the positional parameters in this case. The encoding and parsing for update download could probably be simplified using JSON as data format.

Joined arrays for the action parameters

The use of positional parameters is quite a problem with the action parameters handling, because action parameters get accessed by different parts of both server and client side code, and the developer has to check manually if each index is the right one.

The parts of the code that are depending on the parameter positions range from the shape (and chat message) creation functions on the client side, to the server side functions which export the whiteboard contents in different formats, to other server side functions (for example, the acquisition on the server of a newly inserted image).

The alternative would be to have textual labels associated to each field, this would be much readable and much maintainable, but this would come at a cost: how to store these labels when the actions get written into the database?

It is clear that all actions of a given type stored into the database should have the same format, so there's no reason to repeat the format; a centralized reference should exist to hold the appropriate labels.

This *label reference* would be an array with the form:

```
line:    'stroke', 'fill', 'opacity', 'stroke-width', ...
polygon: 'stroke', 'fill', 'fill-opacity', ...
```

This label reference should be either transmitted between the client and the server, or defined two times, once on the client and once on the server side. I think the latter is the best solution, but the two structures should be syntactically as similar as possible, to be easily compared and updated by the developer in case of change

As already seen, on the client side, each shape defines its parameters (in the file `shapes.js`). This comes from the object oriented paradigm, in an effort to make each shape opaque and independent from the rest of the code.

Wheter is better or not to define shape parameters within each shape, I think it is a subjective matter; however, a centralized *label reference* could be added to the server side, and this would probably be a maintainability improvement.

Until now I have done without a label reference, but I find that the necessity could come in the future to use textual labels instead of numerical parameters in the server side, that's why I included this short analysis into the documentation to explain how to add it.

Chapter 4

Specific solutions and workarounds

In this section I collect several solutions that don't came from the project of the application, but just from the efforts of implementing such project. If an issue is spotted and fixed and his solution is worth writing, or if a workaround is used to avoid a specific problem, this is the place where to write it.

4.1 Use of svgweb

These are some techniques used into the client side (whiteboard.js), to allow svgweb to do is work, translating svg functions and objects to flash ones. Some of these recommendations can also be found on svgweb official documentation.

4.1.1 Generic notes

The variable svgns is provided by the library, containing the svg namespace.

On the "svg" node, width and height must be specified as svg attributes, not into the svg style attribute.

Dom method "getElementsByTagname" must be replaced with "getElementsByTagNameNS(g_svgNS, " and "createElement(" with "createElementNS(g_svgNS, "

Instead of using '.setAttribute' for event listening, and instead of using html "handler" attribute, use '.addEventListener' for event listening.

Svgweb requires a boolean in svg createTextNode invocation (a 'true' as last argument), but this boolean must be omitted if the script is writing a regular html text node outside the svg.

Svgweb ("gelatinous cube" version, at least) **doesn't support the "stopPropagation" method**.

To update the text, element.textContent="new text" doesn't works; it is necessary to create a new text node with document.createTextNode, to delete the previous content with element.removeChild, and to append the new node with element.appendChild.

Text nodes don't inherit event listeners from the "svg" root node, so we need to add the handlers to a text node when it is created into 'createGroup'. Doing this way however svgweb forwards the 'mousedown' event to the text node but also to the "svg" node behind, so I added a check in "handleMouseDown" that nullifies the second call made by the "svg" node (this can be related to issue 497 that was fixed into the latest svgweb release, owlefant, so I'm not sure this problem still stands).

4.1.2 Image and anchor support

Google chrome shows images only outside a text element, and shows anchors ('a' tags) only inside a text element but not into a tspan element. This is the reason why there are tree different buttons: text, link, image, which correspond to a different structure of the included SVG elements.

The following list is a set of reasons why links have been implemented like text nodes, with an hidden empty <tspan> inside to identify them, and they are opened with javascript window.open()

- Anchors can't be correctly moved with flash: when trying to move them the browser navigates them, so it must be avoided their default handler (but preventDefault at the beginning of handleMouseDown seems not to be enough, and stopPropagation is not supported by svgweb).
- Anchors appear black with flash renderer (it doesn't honor style attribute).
- With the firefox native renderer, links get opened in a new window, while with flash they get opened into the same window

Image attributes are set together with the setting the xlink attribute. While I was trying to reorganize the code I kept these assignments always near, because it seemed to be the only way to make flash actually show the images. Maybe with the new versions of svgweb this won't be a problem, but I write this remainder to help in case of weird problems.

4.1.3 Resize the SVG root node

Currently, all user interfaces which resize the SVG canvas require a refresh of the whole page: this came from the impossibility to dinamically resize the SVG root element (the `<svg>` tag), and I will summarize briefly the attempts made in this direction.

Dynamically change the sizes of the svg root works fine with firefox/native, but doesn't works with the flash renderer, as it confirmed also by the issue 427 (see the svgweb issues), at list at the date of November the 3dh, 2010.

I tried a different way, deleting and rebuilding the svg root node, but there were errors with sizes (the height was always wrong) and some contents of the root node were not showed properly. Svgweb doesn't even allowed to copy the content of the root node on a temporary variable to append them to a new root node, and so a `refresh` request to the server was needed in any case.

From the test made I considered the library support for this kind of features as unstable, and to speed up the development I decided to use the simplest method, refreshing the whole page with a new request to the server. This came also from the consideration that the resize action is quite infrequent.

4.2 Coordinates within the svg canvas

This section mainly describes the kind of work done by the function `skew` defined into `whiteboard.js`, to adapt coordinates into the svg environment. Many of the outcomings written here derived from direct testing.

Types of coordinates on which to apply an offset:

- coordinates from mouse events (target.clientX and target.clientY)
- coordinates from nodes position (target.getAttribute)

Browser to consider when applying offsets:

- firefox/native
- chrome/native
- flash renderer (mainly on explorer)

Effects that modify the position:

- the origin of the svg root node
- the scrolling state of the page

Operations involved:

- object creation (pure mouse coordinate)
- **object moving (coordinates from position plus difference between** mouse coordinates)
- object editing: edited point (pure mouse coordinate)
- object editing: other points (coordinates from original nodes positions)

4.2.1 Browser behavior for svg offset

Firefox (native renderer) (3.5.9): Mouse coordinates (retrieved with target.clientX and target.clientY) are absolute, so we must subtract the position of the svg root, before assigning those values to attributes of svg nodes. Also other target.getAttribute (used into init_start) values are absolute.

Chrome (native): Mouse coordinates (target.clientX and clientY) are absolute like in firefox/native, but nodes coordinates (target.getAttribute) are relative to the svg root and shouldn't be changed. For this reasons, the function "skew" needs to know if it is adapting a node coordinate or a pointer coordinate (boolean parameter "pointer").

Flash renderer (tested on firefox): Mouse coordinates (target.clientX) and target.getAttribute are relative to the svg root, so no further change has to be made.

4.2.2 Browser behavior for scroll state

Explorer(6)/flash: Page scroll state is written into document.body.scrollLeft or .scrollTop. This must be applied to every type of coordinates.

Firefox/native: Page scroll state is written into window.pageXOffset or .pageYOffset. This must be applied to every type of coordinates.

Chrome/native: Just apply scroll skew to pointer coordinates

Firefox/flash: Doesn't need any skew due to the scrolling state

Chapter 5

Testing environment and methods

5.1 Browsers

The test is quite a problem in a project like this, with several kind of execution environments. The amount of possible execution conditions is made up by the number of different browsers, but also by the renderer in use (about two choiches for each browser, the native renderer and the flash one), and by the different versions of the flash renderer.

The used method has been to choose a main browser for initial tests, and then try other browsers with a lower frequence. The browser used mainly was firefox (3.5) with its native renderer, due to the advantage provided by the "firebug" plugin (but also google Chrome offers some developement tools with the same functionalities).

The second browser for test frequency has been Internet Explorer with the flash renderer. While firefox has quite a stable support to web standards through its versions, the support provided by Internet Explorer can change strongly between different versions (many features can be missing on older versions), so I used an old version (6) in the purpose of having good code portability.

The third browser was google chrome, with its native renderer. It behaved mostly like firefox, but the renderer showed some differences in the handling of svg (pointer coordinates inside the svg canvas, syntax for polygons/polylines).

These browsers have been used for the tests during the developement, while I left Opera, Safari, and Explorer 7 and 8 just for a final test.

5.2 Debugging Javascript in Explorer

The debug difficulties with Explorer often imposed to proceed by little steps. Javascript errors are showed generically in Explorer, with a line number that doesn't corresponds to any file (and the javascript file from which the error comes is not showed).

Since the adoption of the "microsoft script debugger", the spot of javascript errors on Explorer has speeded up a lot, but with complex object structures (and function literals), the debugger can still lose its usefulness, becoming unable to locate and show the correct error line. A very cautious approach to the developement of new client side functions must therefore still be used.

Given that many javascript errors occurred only on explorer (for the implementation differences, and because this is the environment where svgweb comes in play), the debug process for such errors became occasionally very slow and imposed a tight test cycle when developing new client side features.

A bigger problem comes with the use of the flash renderer with svgweb, when a behavior is different from that of the native renderer. Usually, the first step I did when I found problems was to set the `svg.render.forceflash` flag to `true`, to use the flash renderer also with firefox (this flag is set through a `meta` included before the `svg.js` script, see the function `common_frame` into `markup_send.php`).

Using firefox, even if the actionscript objects are not accessible, it is possible to use the methods provided by svgweb through the javascript console, and to follow the javascript execution flow (and variable changes) in details. The flash renderer run under firefox behaved *almost* always like the one run under explorer.

5.3 Hardware

The machine upon which all test have been made has the following characteristics:

- processor: Intel Pentium M 1.70 Ghz
- memory: 1 GB

Which where (obviously) widely sufficient to run the client side code, even with several open browsers or with explorer running into a virtual machine.

5.3.1 Performance problems

One performance problem concerned explorer, inside the virtual machine, that randomly showed an excessive slowness while showing the page served by apache on localhost; in this cases, a restart of explorer fixed the problem.

The server reaches performance limits when handling with graphic functions (import and export), that indeed work in an asynchronous manner with respect to user activity on the whiteboard. Especially, the import of a long (many pages) pdf file into the whiteboard may take some time and requires full processing power and a substantial amount of memory (200MB of memory needed to convert a 715KB pdf file to 27 jpeg images whose cumulating size was 1.7MB).

Chapter 6

Directions for further development

6.1 Prepare for HTML5

In an application like this, that makes a wide use of the front-end web technologies, an innovation like HTML5 can't be ignored and instead must be looked as an important opportunity to improve the quality of the application. A deeper analysis is required, but I can list here a short set of HTML5 features which can impact on this application.

- the local storage can allow to eliminate the `window.name` hack for passing state through different pages
- the availability of an offline cache could allow users to make their drawings while disconnected from the server, and keep them safely until the moment for sharing it comes[8]
- the form validation would be eased

But the feature that could completely change the application architecture is the incoming of **HTML5 websockets**. These would at least eliminate the trick used for Emulating a client push behavior with the http technology, but their real potential is the possibility of a *peer to peer* communication model between the clients, with the server acting as a coordinator.

Even if this possibility is exciting and may lead to a true revolution for many web applications, websockets are currently supported just by the Safari and Chrome web browsers, and are still under strong development. Even their bare specification is still a draft.

6.1.1 The canvas element

A mention must be done to the `<canvas>` element which is going to be widely supported by the browsers which will support HTML5. The fact that the application is based upon SVG can look like a wrong choice from this point of view, but please consider that also SVG will be supported by the same browsers, so it's not so easy to decide which technology is better. Several articles on the web debate about the differences between the two methods, and I think that here is better to speak about the application structure and how much is it binded to the SVG standard.

The two files that handle the application drawing functions are `whiteboard.js` and `shapes.js`. The first is influenced by the SVG standard only for the application of move actions and the use of SVG groups to handle the objects on the whiteboard.

The second file, `shapes.js`, is tightly binded to the SVG standard, given that many operations automatically copy the attributes from the *update* array to an SVG element, and vice-versa. To change the structure of *update* strings is possible and it will have consequences, on the server side, mainly on the export functions.

These considerations could be valid if we wanted to switch from SVG to another vectorial format, but **the main problem** is that **vector graphics** is the obvious choice for having elements that user

can change over time. It looks to me that the `<canvas>` element is thought for drawing and overlay the space with consecutive drawing actions, but not for the interaction or manipulation of a shared content. However my knowledge of `<canvas>` use is rather limited, and considering that its use and support may evolve with time, this is an alternative to keep in mind.

6.2 Administration panel

Until now, some complex functions (add users, add and delete whiteboards) have been embedded into the present controls, and some others (define user permissions) have been moved to a text file to be manually edited, but an administration panel will be surely needed to allow a better management of the application.

For example, a function which is currently missing is an easy way to reset the password of a specific user. The passwords are encoded in JSON format, and using `base64_encode` so it's not possible to edit them by hand.

The current structure of the application uses very few pages so it is not straightforward to add a new one, however I write here some steps to follow in order to add this functionality:

- `passwords` or `configuration.php` should hold the superuser name
- The `checkuser` server-side function should return a third value (other than `used` and `notused`), `superuser`.
- The login page should show a different button to access to the panel
- The contents of the panel should be added, that means:
  - new modes inside main.php
  - a new `markup_send` page
  - a new javascript file

  Otherwise the controls for operations limited to the administrator could appear directly into the login page, but this isn't a coherent design of the login page.

Make sure to check again the superuser identity also on the server side.

6.3 Execution of the whiteboard as a CGI

Initially, the whiteboard was conceived with the idea to execute it also like a CGI, if needed.

The main solution on this purpose was to parse the query string in two ways, introducing a function that retrieved the query fields either from the $_REQUEST php global variable, or from the $_ENV global variable.

The capability of being executed as a CGI was considered less important later, and the initial query string parsing was removed from the code.

Chapter 7

Web resources

dottoro web reference Contains informations about the support of each browser for each aspect of css, html, and javascript languages. It is very useful to avoid spending a lot of time for debug. Unfortunately, it doesn't covers SVG.

Be warned that, although this reference can be very useful the most of the times, some attribute may still be missing (for example I didn't found the innerHTML property as belonging to an iframe object).

svgweb issue page Together with the svgweb mailing list, this is the first place to search for parts of the SVG standard which are not fully supported by the library

Chapter 8

Notes

[2] The definition of these two steps seems quite logical and clean, but it presents a performance weakness: when the login page or the application page is sent into the *markup send* step, another database access must be performed. This comes because the login page requires a new salt, and the application page requires data which must be specific for each user; the problem is that the database access was likely already made during the *update* step, by a function that doesn't cares about the kind of page that will be sent as output. The *update* functions could be changed in order to retrieve directly the data also for the output, but I think that the problem is negligible currently, because the login and application pages get sent quite seldom to the user, comparing with other server modes.

[3] Note that the concurrency hasn't been tested adequately due to the technical difficulties implied into this kind of tests. The current solution is based on **`flock`**, but the php manual page for flock tells about several limitations, of which the biggest is with multithreaded server API. However, if flock will result unadeguate to grant an exclusive lock on the desired files, it will be sufficient to change the method used by the `protected_file_create`, `file_get` and `file_put` functions into `file_access.php`. The overall architecture will remain valid.

[4] Into the function `file_get` into `file_access.php` I use file_get_contents because I had a problem with fread. It turned out that filesize($file) wasn't giving a good value, so junk bytes were read and the parser of 'unserialize' showed errors while reading again the file. The errors occurred just when the file got opened with the 'r+' mode, while with the 'r' mode no errors were made on unserializing. The problem has been avoided using function file_get_contents instead of fread. Maybe the problem was caused by a wrong use of ftruncate and rewind into database_put, and is fixed now because file_get_contents does some kind of parsing. ftruncate fills the file with NULL ASCII bytes until it reaches the given length, I give length zero, anyway. All these problems appeared while I was using `serialize` to store the data; actually, I use `json_encode` instead, because it uses a format which is more compact.

[5] Another possibility would be to use SVG relative (percentual) measure units, but this isn't supported for paths (maybe there is a workaround manipulating the viewport), and the overall support of svgweb for this feature must be tested (at the 22 october 2010 there is just the issue 512 related to the use of percent units). Even using the percentual units, two conversions should be done for the mouse input and when exporting the whiteboard content.

[6] How much does *almost* means depends from the ratio between the `cycle_timeout` value defined into the `g['receiver']` object and the overall cycle time, including the `server_update_timeout` defined into `configuration.php`.

[7] Currently, the assumption is made that updates are ordered. This must be considered if a real database is going to be used in place of the current file. For example into the server side `import` function (file `updates.php`), a page is cleared (`clear` update) before a new image (`image` update) is inserted in the page. Inverting the order of these two updates will lead to a result which is completely wrong.

[8] Actually it should be quite easy to implement. The objects which implement a channel into the application page (`g['receiver']`, `g['sender']` and `g['signer']`) should handle the error condition of an unavailable server asking to the user if he wants to work in *offline mode*. With a clear signalation of this condition to the user, It could freely draw and his updates would be stored into the *sender buffer*. The application should remember its state, and when the client asks to look for the server again, the `g['signer']` object should be the first to operate, asking for an updated server salt.