Universal multimedia framework for online videoconferencing

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CONTENTS

Abstract

The Radical Chat multimedia videoconferencing framework (MMVCF) presents the first real suitable solution for managing and mastering live audio-video communication over RTMP protocol (used by Adobe Flash), from such programming languages as PHP or ASP.NET (C#). Multimedia videoconferencing framework is designed and implemented by universal way to enable almost any platform and programming language to use it. Officially supported technologies are PHP and ASP.NET. Integration and cooperation of all components together in this highly heterogeneous environment is supported by Web Services technology, SOAP protocol and Real Time Messaging Protocol.

This solution allows (PHP, ASP.NET, Java, ...) developers to create live Flash multimedia applications, without any knowledge about Flash, ActionScript 3.0, RTMP protocol or media server API written in Java. It extremely speed up the process of development and deployment of final applications with an increased emphasis on the performance of the system. Two main programming languages (Actionscript 3, Java) are used for framework implementation and another two (PHP and ASP.Net – C#) for demonstration, how to write applications in this universal multimedia videoconferencing framework. Client or end user of this framework may be anyone who has internet-capable device compatible with plug-in Adobe Flash Player 10.

1 RADICAL CHAT SYSTEM (*THEORY*)

This chapter is divided into two sections. The first section presents the idea of Universal Multimedia Videoconferencing Framework in general as well as a basic overview of the designed API. The second section, starting with paragraph 1.4, deals with the solution of selected (most interesting) parts of this MMVCF.

1.1 Three-tier architecture

The entire universal multimedia videoconferencing framework (codename Radical Chat) is divided into three parts (See Figure 2).

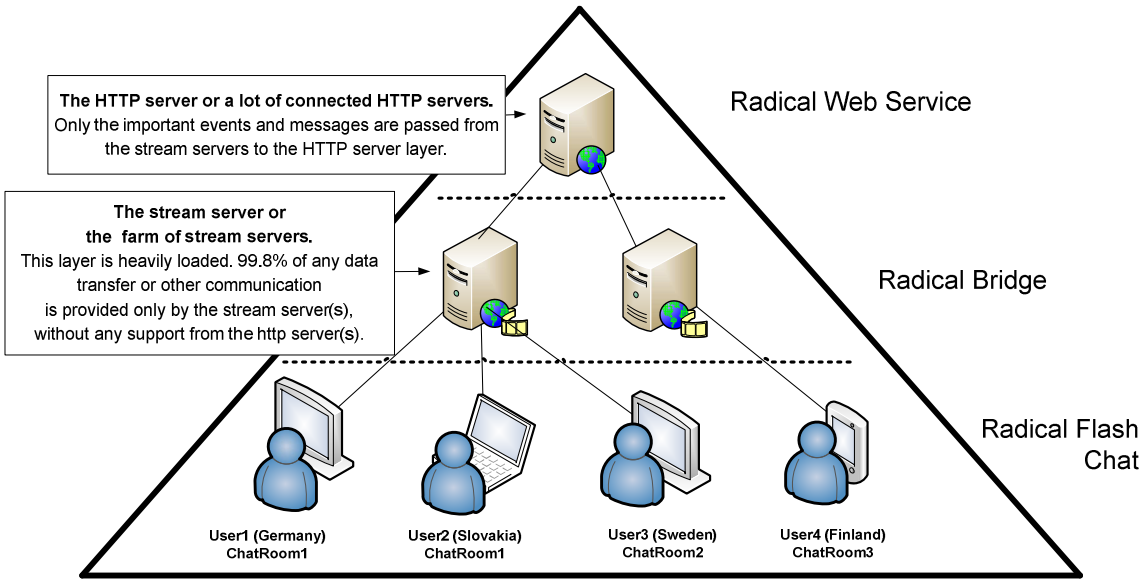


FIGURE 1. Radical Chat architecture

The first (bottom) level contains the client part of the system (codename Radical Flash Chat) implemented in Action Script 3 for Adobe Flash Player 10. The behavior of the Radical Flash Chat is controlled by a lightweight application written in Java, API for Wowza Media Server & RED5 (codename Radical Bridge). Its main task is to filter out or respond for less important client requests and to forward the really

important requests to the PHP, or ASP.NET web service on the top of the system hierarchy. Of course, when started, Radical Bridge is running only in system memory as quickly as possible. It is not connected to any database or a file stored on a hard drive (except for logging, which could be turned off). The most important and unique part of whole framework is the top level of the system, where the chat rules are implemented. This highest level is a very complex web service with an exactly defined structure described by WSDL document. It may seem obvious to use web services technology for communication with an external part of the system implemented by other developers. In this case, customers (developers) do not implement "web service consumer", but "web service server". That allows the Radical Chat to be used by almost any programming language/platform. On the other hand some clients (developers) may be annoyed by such policy where the customers must spend a weeks, or months by implementing the correct, precise web service server (provider) before they can use the purchased product. That is the reason, why Radical Chat is delivered together with pre-implemented, tested **Radical Web Service for PHP and ASP.NET** (C#) programming languages. Radical Web service is an abstract web service with an attached suitable API, which allows the developers to create their own videoconferencing systems or chats in a few hours or days without any further knowledge about Flash, Action Script 3, RTMP protocol or stream server API.

1.2 System Logic

All online videoconferences or chats have some common elementary rules and structures. Radical Chat is not an exception. The system recognizes two basic types of objects - a chat room and a client. Each client, before he/she enters the system receives a globally unique identifier – clientUID. This identification string is assigned via FlashVars variable. Each Adobe Flash Player with Radical Flash Chat application in the web browser must be recognized by exactly one unique clientUID. Each client is associated with just one room specified by globally unique identifier roomUID. That does not mean that a client from one chat room cannot contact any other

clients from another chat room of the system. The entire structure looks like a simple tree diagram. (See Figure 3).

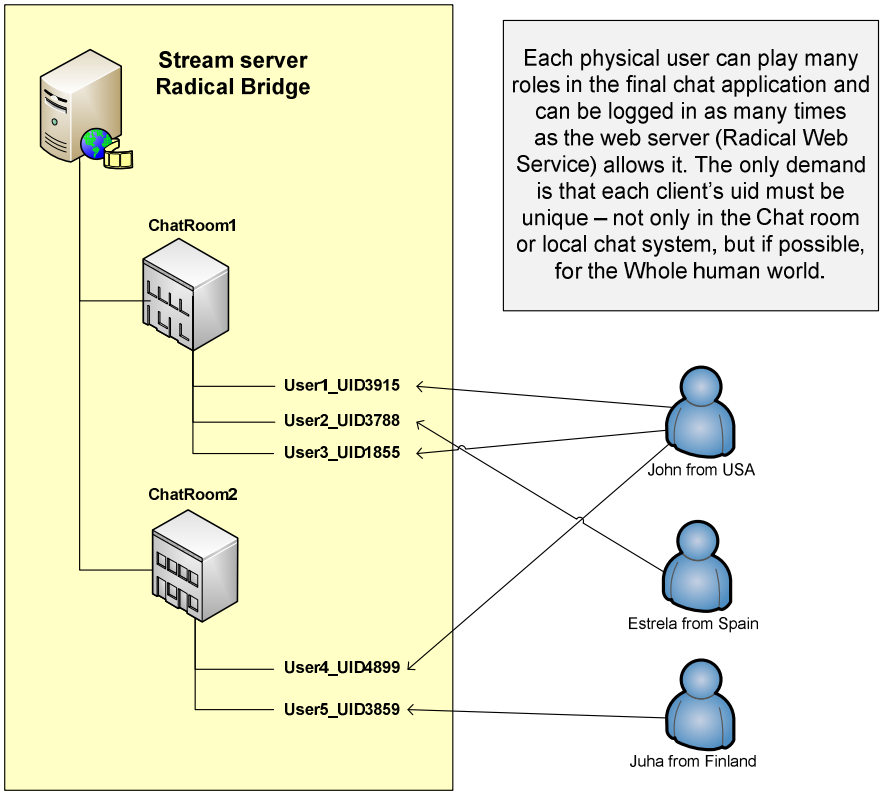


FIGURE 2. Hierarchy

When the SWF application is loaded into the Flash Player, Radical Flash Chat tries to download configuration XML file including design specification (Skin), description of the user interface behavior and some other eventualities like stream server IP address, port, Radical Bridge app. name etc. For heavily loaded systems, the entire RADICAL BRIDGE stream server farm can be used. The same applies to Radical Web Service on the HTTP server. After all skin images and sounds are loaded, Radical Flash Chat tries to establish connection to the Radical Bridge and log client into the chat room with specified roomUID.

If the client requests an access to the chat room, which does not exist in the memory yet, then the chat room is automatically created. Lately, when the last client leaves the chat room - the system will recognize it and immediately remove the room and other dependent resources from the memory. It should be remembered that the whole Radical Bridge runs only in RAM memory of the stream server computer. It is true, that stream server knows the status of all clients and

chat rooms and automatically creates (updates) all necessary data structures, but when the last client leaves the room - dependent allocated memory is released. When the next client enters the same chat room (even if the interval between the last client disconnection and the new client connection is extremely small - a few milliseconds), than the whole new chat room is created and eventually all properties must be set again. It is very important to have enough available RAM on the stream server computer as well as sufficient network bandwidth capabilities. (See Figure 4).

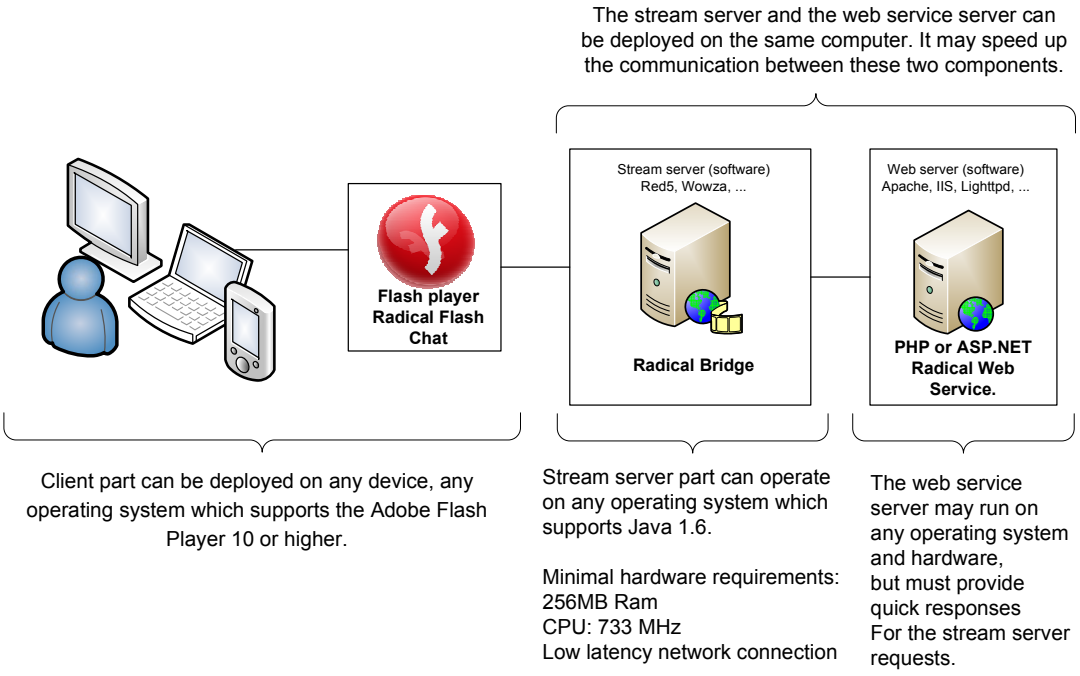


FIGURE 3. Radical Chat deployment

Although Radical Bridge handles 99% of data communication and 95% of client's requests, the most important core functions of each videoconferencing chat (such as logging in/out, configuration of privileges for playback or video publishing, ...) and another additional rules (like kicking out, private chat invitation, ...) are mostly wanted to be implemented by final developers (users of the MMVCF). However, which way is the most appropriate for this task? How should this part of the framework be created to enable developers to interact with the system from different programming languages? The answer is: by web services technology. In

this case, the customer's part is a web service server (provider) instead of a web service consumer as obvious. (See Figure 5).

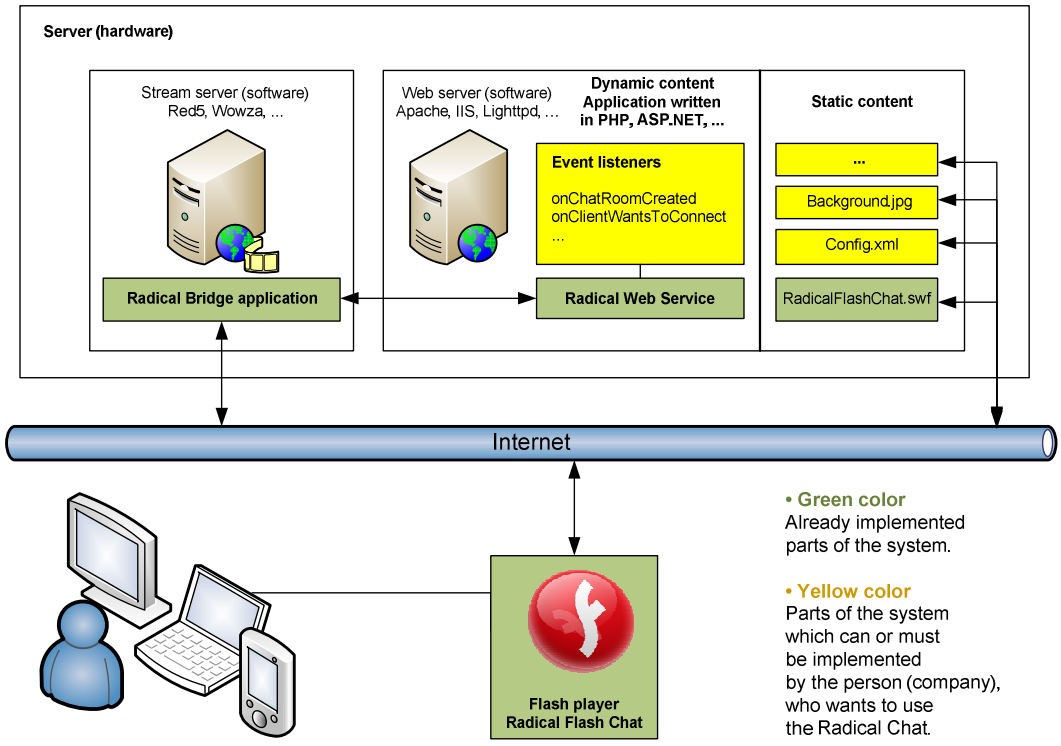


FIGURE 4. Radical Chat basic interactions

Because such a strategy would never have any chance for success on real market, Radical Chat in enterprise edition contains "Radical Web Service" for PHP and ASP.NET (C#). "Radical Web service" is an abstract web service with attached suitable API. Any time when pre-implemented Radical Web Service is called by Radical Bridge - exactly one of following 18 events (functions in service.php) is triggered.

1.3 List of events

1.3.1 Global events

Global events are dispatched directly by the stream server, when it is starting or stopping.

- **GetAPICode** event is triggered at the moment when the stream server (Wowza or Red5) is started. This function returns a string - version of the API interface implemented by the PHP (ASP.NET) Radical Web Service.
- **GetImplementedFunctions** is called after GetAPICode and returns a list of event names separated by comma that have been implemented by the developer (user of MMVCF). This function is triggered only once per Radical Bridge Application life cycle, just before onApplicationStarted. It is recommended to not mention any functions (events), which body have not been implemented - PHP Radical Web Service recognizes implemented, non-implemented events and assembles the list automatically. In other programming languages, it must be done manually.

1.3.2 Application events

The aplication events are dispatched by Radical Bridge application after its loaded to the system memory and started.

- **OnApplicationStarted** event is triggered when Radical Bridge application is loaded into the stream server memory.
- **OnApplicationStopped** event is triggered a few moments before Radical Bridge application is unloaded from the stream server memory. Typically it is just before the stream server is properly terminated, or also in case that there are no connected clients for a long time.
  WARNING: onApplicationStopped is not triggered if the stream server crashes down.

1.3.3 Logging in/out events

Logging in/out events are very important for successful chat management. They are dispatched before a client enters the system or afte he/she leaves.

- **OnClientWantsToConnect** event is triggered when a client attempts to connect to the Radical Bridge (before he/she is assigned into the chat room). Developers should always implement this function. “AcceptConnection” or “RejectConnection” method must be called somewhere in the body of this function.
- **OnClientConnectionWasAccepted** event comes after onClientWantsToConnect, but only if a client was accepted by “AcceptConnection” method. Usually it is not necessary to implement the body of this function.
- **OnClientConnectionWasRejected** event comes after onClientWantsToConnect If the client was fired (kicked out) by “RejectConnection” method. Usually it is not necessary to implement the body of this function.
- **OnClientDisconnected** event occurs when the client is disconnected by “RejectConnection” or if a connection is somehow terminated, for example because of network malfunction or because the client turned off the computer or closed the web browser.

1.3.4 AV stream handling events

AV stream handling events are dispatched by the Radical Brdige when client attempts to play or publish audio-video stream.

- **OnClientWantsToStartStreaming** event is triggered every time when any client wants to publish live audio or video stream. Mostly it is a live video from a web camera.
- **OnClientStoppedStreaming** is a notification event that indicates that the client stopped streaming.
- **OnClientWantsToPlayStream** event is triggered when some client attempts to play live audio or video.

- **OnClientStoppedPlayingStream** is a notification event triggered when some client stopped playing live audio or video.

1.3.5 Client related events

Other important client related events.

- **OnClientSendMessage** function is called every time when a client sends a text message, but only in case that the client's flag dispatchEventIfClientSendTextMessage is set to true.
- **OnCheckClients** - This event is executed by Radical Bridge at a periodic time interval, which depends on the property NextCheck of each client in the system. Every one second Radical Bridge decrements NextCheck value of each client in all stream server chat rooms by one. When NextCheck value is equal to 0, client's manipulator (handler) is pushed to the associative array and passed to the onCheckClients event (See Figure 6) - there the property NextCheck must be reset, otherwise the concrete client will never more call onCheckClients again. This function is very useful for such systems, where on the beginning each user has an account with some amount of money or credits and later, if he/she runs out of credit, then his/her connection to the chat is terminated.

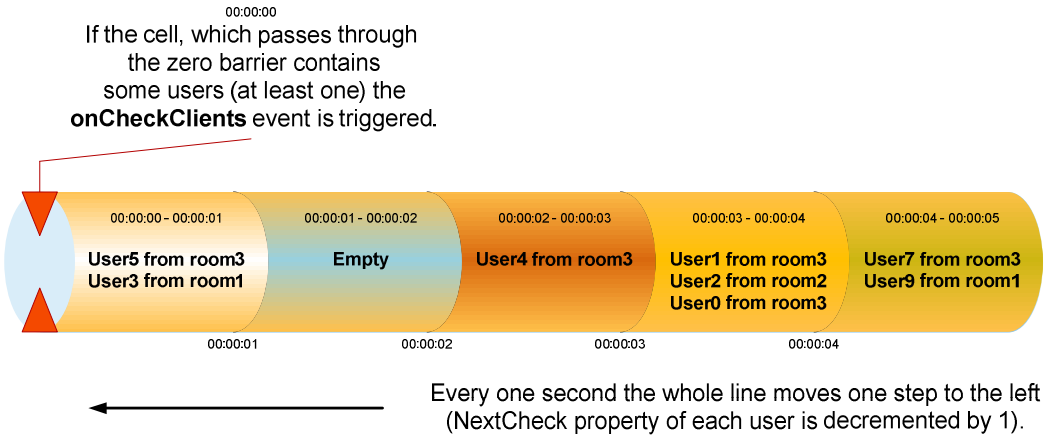


FIGURE 5. onCheckClients

1.3.6 Chat room related events

Events created for manipulation and management of a chat rooms.

- **OnChatRoomCreated** event occurs when new chat room is created just before first client attempts to enter it.
- **OnChatRoomClosed** event is invoked when a room is about to close, just after the last client left the room.
- **OnCheckChatRooms** - very similar to onCheckClients, but associative array contains chat room handlers instead of client handlers. This function is very useful for online SMS chats.

1.3.7 Universal events

Universal events are events designed for dynamic interactions with client's graphic user interface.

- **OnUniversalCall** event is triggered when custom BasicButton in "Radical Flash Chat" application (application in client's web browser) is pressed.

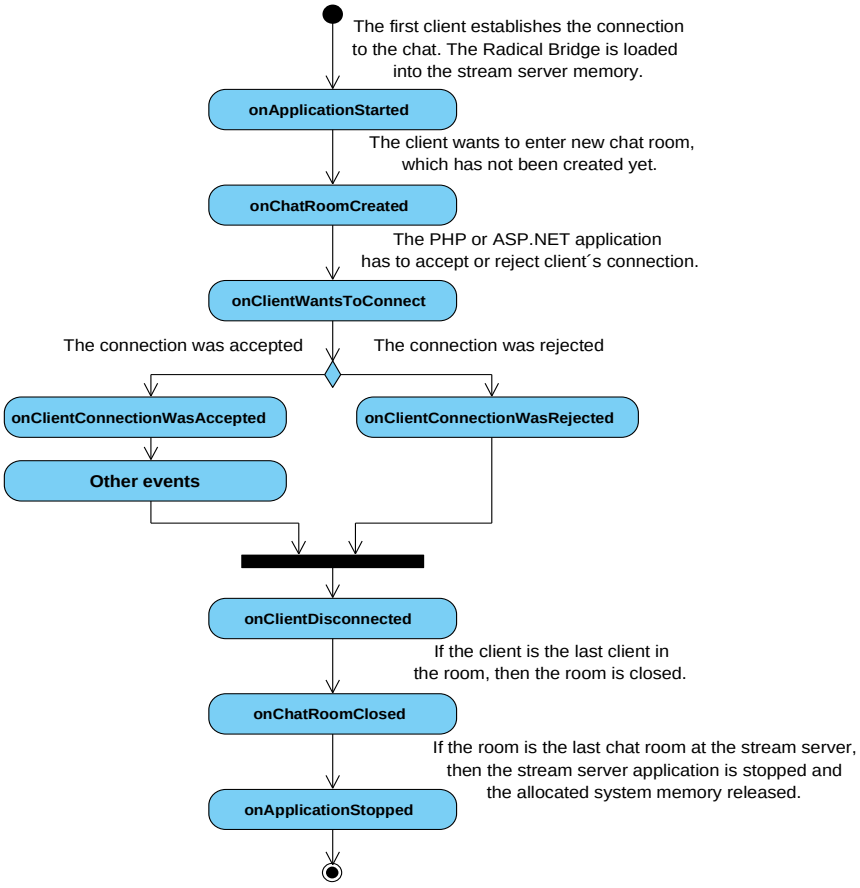


FIGURE 6. Sequence of events

The events (functions) and associated API above forms the highest level of the MMVCF Radical Chat. As was mentioned before, Radical Web Service is not an obvious web service provider, but uses the asynchronous event driven programming technology. It is possible that ordinary web developers (PHP developers, or ASP.NET developers), which have never got in touch with Actionscript 3 or Win32 API programming are not familiar with this technology. Therefore, it is described in the following paragraphs.

Programming languages and techniques for web pages programming are established on a very simple “request – response” mechanism. For any request - one instant response (which somehow changes user's web browser content) is sent. In the last years, MVC model (which separates web application appearance, data and code behind) has become popular. Also AJAX technology is getting famous and is used almost everywhere, if it is possible. However, in both cases the used technology is the same: (one) request - (one) response. This is about to change with the revolutionary conception of the Radical Chat.

1.4 Parallel, asynchronous, event-driven programming

The reader is encourage to a futuristic system, where the user can click on any button on the web page, and according to that action the content of a web browser of another user(visitor) is instantly changed. Another more unbelievable scenario - the user sends SMS message from the cell phone. Message arrives through the mobile operator's gate and executes the PHP or C# script causing an immediate change of the application skin and behavior for all logged users. Such a thing cannot be realized by the old request - response mechanism, but can be easily implemented using an asynchronous event driven programming in Radical Chat. Flash technology and Adobe Flash Player (since version 9.x and above) support programming language ActionScript 3, where any event (action/reaction) is basically asynchronous. When a connection between Adobe Flash Player and media server is established, Adobe Flash Player communication port remains opened until explicitly closed. That means the Flash Player may receive new data and commands from the stream server without any previous request (this method is called response without request). Moreover, each Adobe Flash Player request to the stream server is

basically sent by method request without response - when the request is sent, the response can arrive after a few milliseconds, seconds or never. Until this very moment the asynchronous, event driven programming was encapsulated only in the Adobe Flash technology (Adobe Flash Player and stream server). Multimedia videoconferencing framework Radical Chat brings it to the ASP.NET and PHP environment.

The communication between Radical Bridge and Radical Web Service is secured by the manipulators or handlers (client handlers, chat room handlers). Once Radical Bridge receives an important request from Radical Flash Chat, which must be processed by PHP or ASP.NET script, the Radical Bridge relays the request to the Radical Web Service with attached client handler, chat room handler or stream server handler. Handler virtually represents client, chat room or stream server structure. Subsequently Radical Web Service executes service.php or service.cs and triggers exactly one event (function) in the script file (see List of events 3.3). Handlers and enclosed set of methods are passed to the function(s) as parameter(s). If any handler's method or operation is called inside event function body, then nothing special happens immediately. All performed operations are stored in the command queue, which is processed lately after the PHP or ASP.NET script ends. Each request is processed in a separate thread to enhance Radical Bridge and Radical Web Service performance. It may happen that multiple events are executed in parallel at once. This fact may cause many unpredictable collisions. In case that data are stored in a database (like MySQL, MSSQL,…), it is highly recommended to use transaction lock for any operation. In other cases – semaphores alias mutexes should do the trick. The Mutex class is included in the kernel of" Radical Web Service API" for PHP.

1.5 The problems of parallel data processing.

Although Radical Bridge runs only in the memory, it must solve many problems related to parallel data processing. Most of these problems are solved only by partial synchronization, as for example text chatting or logging in/out events. Occasionally some specific problems like dynamic skinning are solved by the pseudo complete synchronization.

Partial synchronization is very fast and does not consume a lot of RAM or CPU time, but in rare cases may leads to very strange results. See the following implementation of onClientWantsToConnect event in PHP.

```
function _onClientWantsToConnect(&$client)
{
  Logger::func("onClientWantsToConnect");
  //accept client's connection
  $client->AcceptConnection();
  $client->SendPrivateMessage("Admin", $client->getUID(),
                              "000000", "Welcome in the room.");
  $client->SendRoomMessage("Admin", "000000",
                           "User \"" . $client->getNickName() .
                           "\" has entered the room.");
  $client->SendPrivateMessage("Admin", $client->getUID(), "000000",
                  "Please do not use unpolite words in this chat.");
  $client->SendRoomMessage("Admin", "000000",
                  "Remember this room will be closed at 9pm.");
}
```

What happens if two users enter the room exactly at the same time? Since the text chat is synchronized only partially, there are mixed public and private messages in the function above. The result in User1 and User2 web browser should look like:

User1:

```
Admin: User "User2" has entered the room.
Admin: Remember this room will be closed at 9pm.
Admin: User "User1" has entered the room.
Admin: Remember this room will be closed at 9pm.
Admin>> User1: Welcome in the room.
Admin>> User1: Please do not use unpolite words in this chat.
```

User2:

```
Admin: User "User2" has entered the room.
Admin: Remember this room will be closed at 9pm.
Admin>> User2: Welcome in the room.
Admin>> User2: Please do not use unpolite words in this chat.
Admin: User "User1" has entered the room.
Admin: Remember this room will be closed at 9pm.
```

How is it possible? Each Flash Player after its connected to the Radical Bridge attaches two Shared Objects (SO). A shared object is a data object dynamically shared between the stream server and Flash Player. The first one is a public – room SO and is shared for the whole chat room and all logged users, the second one is private - designed only for one client.

Once the Radical Bridge starts to process commands from Radical Web Service, and recognizes the private or public message signature, then that message is automatically inserted into the appropriate private or public shared object. Radical Bridge works in many parallel threads, so the requests and incoming commands could be processed at once in parallel (See Figure 8).

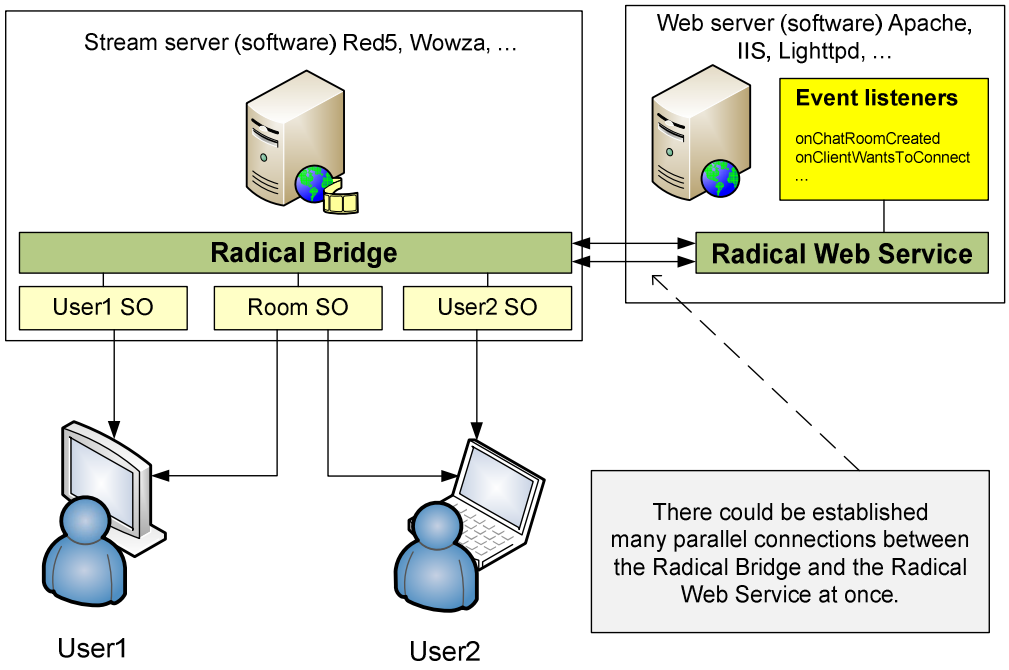


FIGURE 7. Parallel data processing problems

After that, the stream server immediately synchronizes the changed shared objects with Adobe Flash Players. Unfortunately, synchronization needs some time and usually public room SO is synchronized before private user SO. Since in example above private message is sent as the first, but room shared object with a public data and messages is synchronized with the Flash Player (Radical Flash Chat) before

private messages - the correct messages order is lost. That may leads to an unexpected strange results. Because this problem appears only in case, that a lot of users from one chat room send a lot of public and private messages in a very short time period, and because usually the order does not matter – this problem is solved only by a partial synchronization. The same way is used for publishing live audio and video – in case that two users turn on their web cameras at precisely the same moment - it does not matter if user2 is announced to the audience as the first online performer or as the second one. However, there exists one problem, which cannot be solved by a simple partial synchronization. The problem, where the order of commands and sequence of changes matters a lot – “dynamic skinning”. Its main idea is uncovered at the end of chapter 2.

2 CLIENT SIDE DESIGN AND IMPLEMENTATION

This chapter presents the client's part of Radical Chat multimedia videoconferencing framework – "Radical Flash Chat". It describes techniques, how to create an application user interface and its behavior.

2.1 Radical Flash Chat

Radical Flash Chat is the only part of Radical Chat system exposed to the final users and loaded directly into their web browsers. It is very stable, efficient and could be deployed on almost any device or computer, which is Adobe Flash Player 10 compatible, yet still, allows the developers to manage issues and control the chat without any further knowledge about Flash Technology or RTMP protocol.

2.2 XML configuration file

Radical Flash Chat (radicalflashchat.swf 74KB) does not include any pre-implemented skin, text labels or set of concrete behavior. Everything must be designed by final developers or graphic designers. Fortunately, Radical Flash Chat provides an incredibly simple way to easily make application skin and basic functionality. Everything is base on XML configuration file inspired by modern UI (user interface) techniques as Windows Presentation Foundation or Flex. The complete description of all possible options of the configuration file is on www.cze.cz.

2.3 Static skin

The user interface, based on (standalone) XML configuration file, is called static skin. Its construction is somewhat similar to the construction of an HTML document. Static skin is loaded into the web browser memory before Flash Player establishes connection to the stream server. Static skin is independent on Radical Bridge (see figure 5). Radical Chat preserves MVC design patter - application user interface is strictly separated from the code behind. Therefore, graphic-designers can work separately of PHP and ASP.NET developers.

The whole application skin (element <Skin> in config.xml) is divided into three layers BG (background layer), ML (main layer, or middle layer) and FG (foreground layer).

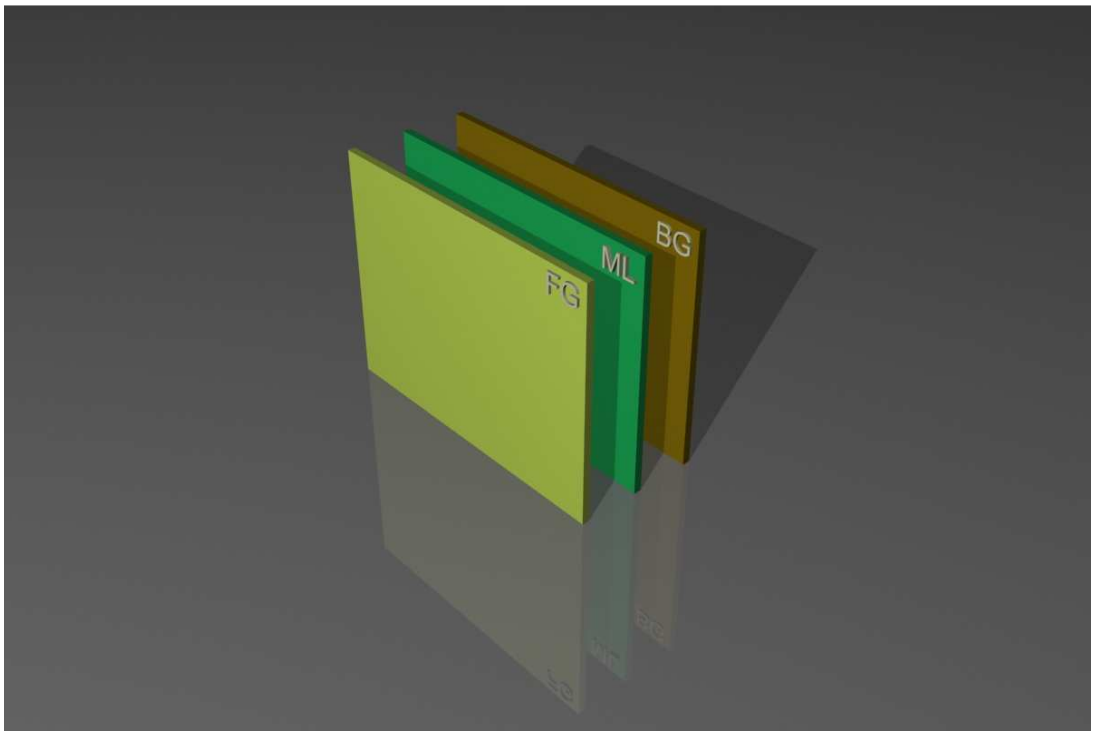


FIGURE 8. Layers

Layers BG and FG support universal set of components (classes) derived from SkinObject. Practically layers BG and FG are subjects to the same rules and features. All elements there (images, buttons, ...), can be subsequently modified or re-designed by “dynamic skinning”. On the other hand the main layer ML that lies in front of the layer BG and behind the layer FG, contains support for only a few specialized classes (TextChat, ListOfUsers, ChatInput), which cannot be instantiated more than once at a time.

All visible components (alias types or classes in this terminology) in all layers are derived from one basic abstract parent called SkinObject. SkinObject contains a set of essential properties common for all derived subclasses. Some of them are obligatory and a value must be explicitly assigned to them (in config.xml), the others are optional.

Following code demonstrates, how many properties SkinObject has:

```
<RadicalChat>
...
  <Skin>
  ...
    <BG>
      <SkinObject>
        <!--
          Type specify which derived subclass of SkinObject
          will be used at this place. Type is obligatory parameter.
        -->
        <Type></Type>
        <!-- Name of the object – obligatory parameter. -->
        <Name>Panel1</Name>
        <!—Visibility (optional, default value true). -->
        <Visible>true</Visible>
        <!-- Relative position – obligatory section. -->
        <Position>
          <Left>0%+10+{AnotherObject.Right}</Left>
          <Top>0%+10</Top>
          <Right>100%-10, min=400</Right>
          <Bottom>100%-10, min=300, max=900</Bottom>
        </Position>
        <!-- Basic effects – optional section. -->
        <LookAndFeel>
          <!-- Alpha value – real value between 0 and 1 -->
          <AlphaBlend>1</AlphaBlend>
          <!--
            Blend mode, like in Adobe Photoshop.
            Allowed values: normal, multiply, etc...
          -->
          <BlendMode>normal</BlendMode>
          <!-- Color transformation -->
          <ColorTransform>
            <Color redMultiplier="0.1" greenMultiplier="0.4"
                   blueMultiplier="1" alphaMultiplier="1"
                   redOffset="128" greenOffset="128"
                   blueOffset="128" alphaOffset="0" />
          </ColorTransform>
        </LookAndFeel>
      </SkinObject>
      ...
    </BG>
   ...
  </Skin>
</RadicalChat>
```

Basic obligatory parameter <Type> determines which class will be instantiated in place of the <SkinObject> element. Type may be a BasicPanel, BasicButton, HtmlTextArea, ... All these classes are described in the text below. If <Type> is specified, SkinObject usually gains a lot of new parameters and properties. Some of

them might be obligatory. For example: if type is basic panel <Type>BasicPanel</Type>, then "Pattern" or "NineGrid" element must be set in section <LookAndFeel> - so LookAndFeel XML element is no longer optional for all components derived from BasicPanel.

Example:

```
<LookAndFeel>
  <NineGrid>
    <SliceImgSequence>
      ./skin/panels/rsqshadow1_0{1-9}.png
    </SliceImgSequence>
  </NineGrid>
</LookAndFeel>
```

Another obligatory parameter <Name> contains the local object identifier (identifier unique for entire <Skin> element). The name is extremely important for “dynamic skinning” and also for innovative “RPSF positioning system” built in Radical Flash Chat core.

2.4 RPSF positioning system

RPSF is an acronym for Relative Position Specified by Formula. RPSF technology was invented and described in year 2008 by the author of Radical Chat Framework. RPSF gets rid of “align” parameter from HTML language and simplifies the graphical design process. Although anybody may think that positioning of rectangular objects is a simple, many times implemented software gadget - the truth is that RPSF comes up with a completely different idea than the one used in HTML or in Win32 API. This solution is partially compatible with CSS, but enables developers to do much more.

The basic idea is that any rectangular object can be placed into the document by a set of six values (left, top, width, height, right, bottom), where only four of them must be specified. The remaining two are dependent and may be calculated later by the formulas below, please see Figure 10.

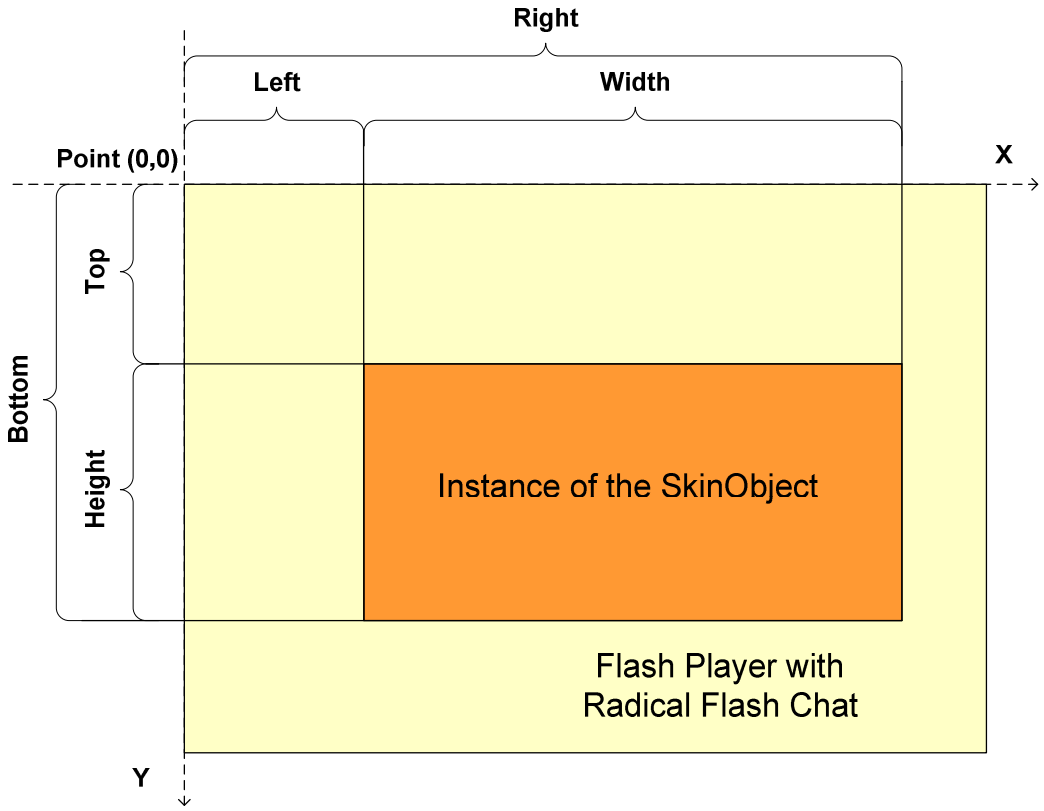


FIGURE 9. RPSF positioning system

$$\text{Width} = \text{Right} - \text{Left}$$

$$\text{Height} = \text{Bottom} - \text{top}$$

What is very important in RPSF system is the fact that variables are not only a simple numbers but complex expressions with a constraints like min or max. For example:

```
<left> 80% - 50 + {Panel1.Left}, min = 10% + 70, max = 500 </ Left>
```

The calculation process of the expression above, in case that the width of the Flash Player (Web Browser) is 800 pixels and Panel1.Left is 100 pixels is following:

1 Compute expression base:

$$\text{Left}_{\text{Base}} = 80\% - 50 + \{\text{Panel1.Left}\} = 80 * \frac{800}{100} - 50 + 100 = 690$$

2 If specified, compute minimum, otherwise min is set to -(2 * 10^9).

$$\text{Left}_{\text{min}} = 10\% + 70 = 10 * \frac{800}{100} + 70 = 150$$

3 If specified, compute maximum, otherwise max is set to (2 * 10^9).

$$\text{Left}_{\max} = 500$$

4 Compute the result.

$$\text{Left} = \text{Min}(\text{Max}(\text{Left}_{\text{Base}}, \text{Left}_{\min}), \text{Left}_{\max}) = \text{Min}(\text{Max}(690, 150), 500) = \\ = \text{Min}(690, 500) = 500$$

2.5 Strict rules for RPSF positioning system.

RPSF system is very powerful, flexible and easy to learn. On the other hand, it does not tolerate any mistakes. Components, placed into the document using RPSF positioning system must follow following rules:

i. It is allowed to combine percentages, pixels and inches, but only using operations addition or subtraction (sign plus or minus). If the target device is a screen, then the result value will always be in pixels.

ii. It is possible to use min or max constraints. If it is so, then the result value will always be from interval <min; max>.

iii. It is allowed to refer to properties (Left, Top, Width, Height, Right, Bottom) of other objects, but the final dependency graph must always be an oriented graph without any loop (See Figure 11).

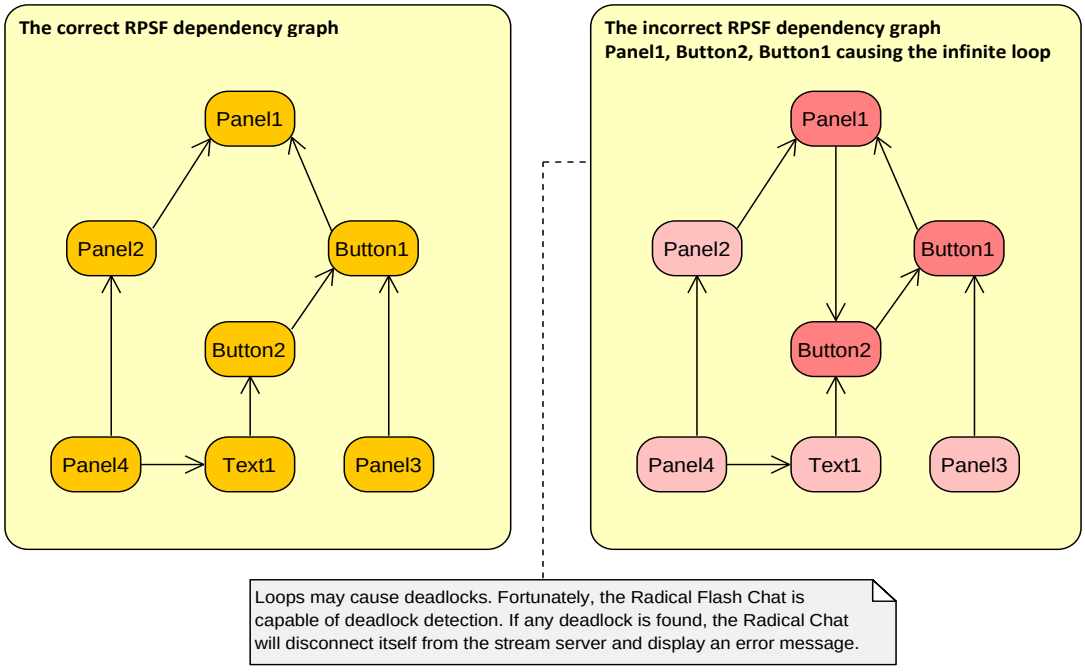
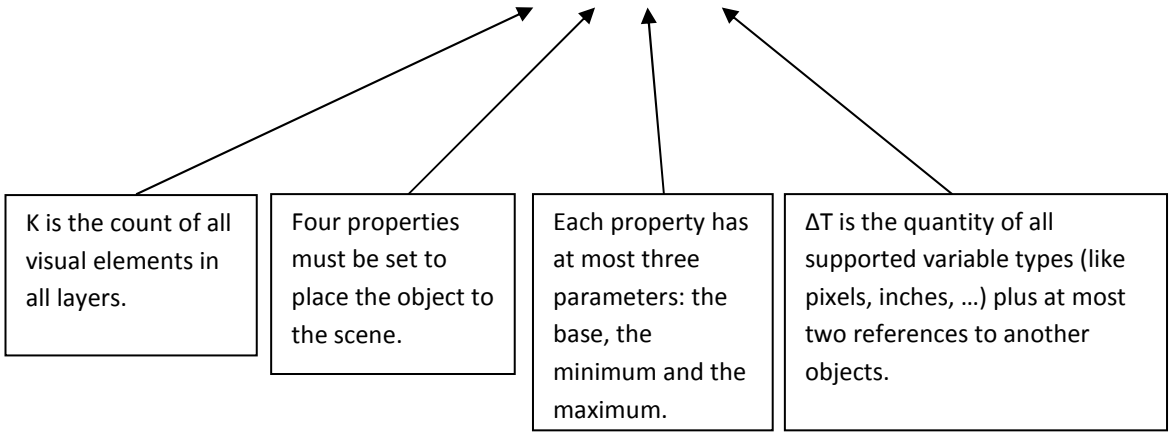


FIGURE 10. RPSF dependency graph

2.6 RPSF implementation.

RPSF positioning system time complexity is linear. **It works with the same speed as the outdated HTML positioning**. If the position of any object is dynamically changed or the web browser resized, then positions of all dependent components are recomputed.

$$\mathrm{T}(n) = \mathrm{O}(\mathrm{K} * 4 * 3 * \Delta\mathrm{T})$$



2.7 SkinObject class extensions.

SkinObject is a general abstract class inherited and implemented by many other subclasses. Those subclasses are divided into two main groups - universal components and specialized components.

2.7.1 Universal components

Universal components (BasicPanel, BasicButton, HtmlTextArea, LiveStream, MyCamera) - can be used in layers <BG> and <FG>. There is no default limit for them, so any class (component) can be instantiated as many times as graphic-designer consider it necessary. Default behavior and appearance are strictly determined only by the graphic-designer. New objects can be dynamically added, updated or destroyed on the fly by “dynamic skinning”. The appearance and behavior may be interactively modified. Some components have specialized “Look And Feel” section with some new properties (See Figure 12).

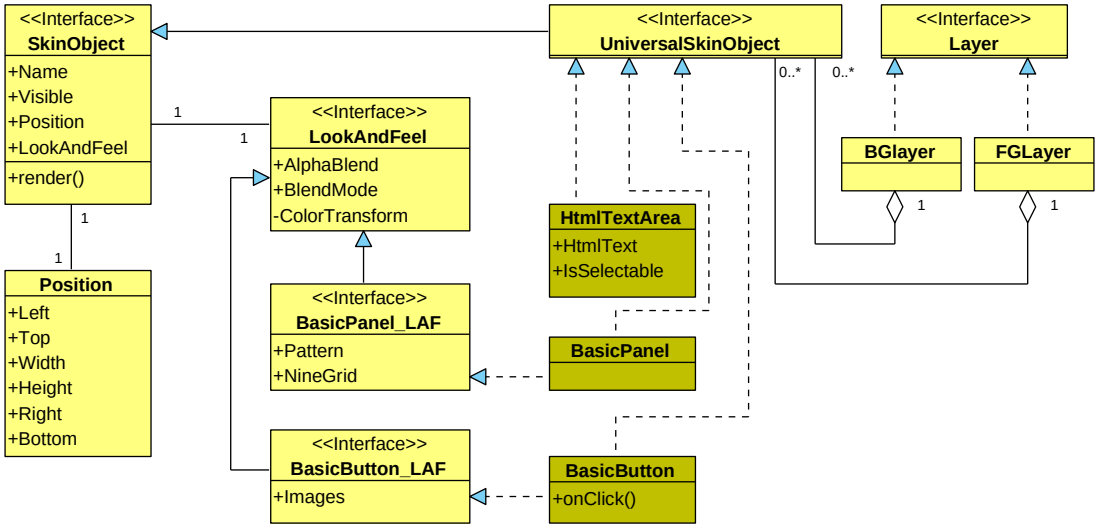


FIGURE 11. Universal components

2.7.2 BasicPanel

Specialized type(class) BasicPanel is derived from the SkinObject and extended by two new features: `<Pattern>` and `<NineGrid>`. Only one of them must be used, when an object is instantiated. Basically, BasicPanel is a very sophisticated image.

Mode <Pattern>

If mode is <Pattern>, then the area specified by `<Position>` is filled by texture `<LookAndFeel> <Pattern> <Image>.` In the example above, the picture is walltexture.jpg. Mode pattern is usually used for backgrounds and watermarks. To preserve a nice look and feel it is recommended to use seamless images. Please see the source code below.

```
<SkinObject>
  <Type>BasicPanel</Type>
  <Name>Panel</Name>
  <Position>
    <Left>0</Left>
    <Top>0</Top>
    <Right>100%</Right>
    <Bottom>100%</Bottom>
  </Position>
  <LookAndFeel>
    <Pattern>
      <Image>walltexture.jpg</Image>
    </Pattern>
  </LookAndFeel>
</SkinObject>
```

Mode <NineGrid>

If mode is <NineGrid>, then area specified by <Position> is filled by seamless graphic shape composed of 9 parts (slices - see Figure 13 below).

```
<SkinObject>
  <Type>BasicPanel</Type>
  <Name>Panel</Name>
  <Position>
    <Left>0</Left>
    <Top>0</Top>
    <right>100%</Right>
    <Bottom>100%</Bottom>
  </Position>
  <LookAndFeel>
    <NineGrid>
      <Slice1>Slice01.png</Slice1>
      <Slice2>Slice02.png</Slice2>
      <Slice3>Slice03.png</Slice3>
      <Slice4>Slice04.png</Slice4>
      <Slice5>Slice05.png</Slice5>
      <Slice6>Slice06.png</Slice6>
      <Slice7>Slice07.png</Slice7>
      <Slice8>Slice08.png</Slice8>
      <Slice9>Slice09.png</Slice9>
    </NineGrid>
  </LookAndFeel>
</SkinObject>
```

It is not necessary to state all nine slices, but at least one slice must be set. Also, It is allowed to use short description:

```
<NineGrid>
  <SliceImgSequence>slice0{1-9}.png</SliceImgSequence>
</NineGrid>
```

The expression {1-9} or {0-8} is replaced by a sequence of consecutive numbers.

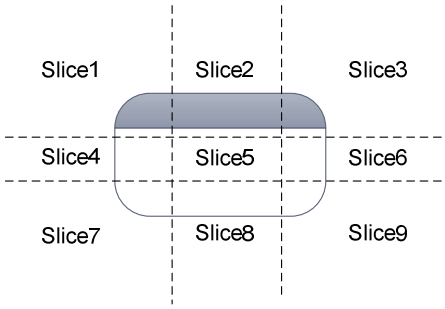


FIGURE 12. NineGrid

2.7.3 BasicButton

BasicButton is a specialized class derived from SkinObject. BasicButton is a multifunction button. Its behavior is set in `<OnClick>` element of XML configuration file. Any click on BasicButton is considered as a "**time protected action"**, which means that no other button can be pressed during one second time interval after the previous button click - it is a safety regulation to protect heavily loaded systems. Of course, the button's look and feel may be adjusted by the graphic-designer using properties `<NormalImage>, <OverImage>, <DownImage>.` See an example of BasicButton definition below:

```
<SkinObject>
  <Type>BasicButton</Type>
  <Name>Button1</Name>
  <OnClick>
    <Action>onUniversalCall_WithSelectedClient</Action>
  </OnClick>
  <Position>
    <Left>10</Left>
    <Top>100%-40</Top>
    <Width>80</Width>
    <Height>30</Height>
  </Position>
  <LookAndFeel>
    <Images>
      <NormalImage>./skin/images/private_btn_01.png</NormalImage>
      <OverImage>./skin/images/private_btn_02.png</OverImage>
      <DownImage>./skin/images/private_btn_03.png</DownImage>
    </Images>
  </LookAndFeel>
</SkinObject>
```

The action is specified in element `<OnClick> <Action>` and determines the behavior after the user presses the button. Radical Flash Chat currently supports the following set of actions:

onUniversalCall bubbles through the system and triggers onUniversalCall (Radical Web Service) event, if implemented. The size of an array `$clients` is always one and the first item contains the manipulator of the client who pressed the button. See the following "code behind" for Button1 (used language PHP):

```
function _onUniversalCall(&$clients,$senderName,$eventName,$value)
{
  if($eventName==ChatEvents::$EVENT_BASICBUTTONCLICKED)
  {
    //if Button1 was pressed
    if($senderName=="Button1")
```

```
    {
      //retreive manipulator of the client who pressed the button
      $client = $clients[0];
      //send a message to the client's chatbox
      $client->SendPrivateMessage("Admin",$client->getUID(),
                                  "000000","Button1 was pressed.");
    }
  }
}
```

onUniversalCall_WithSelectedClients is very similar to onUniversalCall action above, but in this case the parameter `$clients` contains (from index 1 to index n) handlers of all clients selected in the component "ListOfUsers". Besides $clients[0] is still the manipulator of the client, who performed the button click. This action is very useful for operations such as "kicking out" or "private chat invitation".

```
function _onUniversalCall(&$clients,$senderName,$eventName,$value)
{
  if($eventName ==
        ChatEvents::$EVENT_BASICBUTTONCLICKED_WITHSELECTEDCLIENTS)
  {
    //if Button1 was pressed
    if($senderName=="Button1")
    {
      //get manipulator of client who performed this action
      $clientWhoIsKickingOut = $clients[0];
      $clientWhoIsKickingOut->SendPrivateMessage(
          "Admin",
          $clientWhoIsKickingOut->getUID(),
          "000000",
          "You are attempting to KickOut some clients."
      );
      //kickout all clients selected in ListOfUsers
      for($a = 1; $a<sizeof($clients); $a++)
      {
        $clients[$a]->SendPrivateMessage(
            "Admin",
            $clients[$a]->getUID(),
            "000000",
            "You were kicked out by " .
            $clientWhoIsKickingOut->getNickName()
        );
        //disconnect the user
        $clients[$a]->RejectConnection();
      }
    }
  }
}
```

If action is **ShowDialog_SelectEmoticon**, then after the button is pressed a dialog with a set of smiles or emoticons is shown.

ShowDialog_SelectColor forces the Radical Flash Chat to display a dialog, where the user can choose a text color - used only for the chat message text. The color palette must be explicitly defined by the graphic-designer. The minimum number of colors is 1, the maximum number is 20.

```
<OnClick>
  <Action>ShowDialog_SelectColor</Action>
  <!-- Palette can contain at most 20 colors -->
  <Palette>
    <Color>990000</Color>
    <Color>FF0000</Color>
    <Color>CC9933</Color>
    <Color>FA9100</Color>
    <Color>000000</Color>
    <Color>006600</Color>
    <Color>00CC00</Color>
    <Color>99CC00</Color>
    <Color>000066</Color>
    <Color>0000CC</Color>
    <Color>0099FF</Color>
    <Color>9933FF</Color>
  </Palette>
</OnClick>
```

ShowDialog_SelectCamera - display a dialog, where the user can select the camera, microphone and configuration of the multimedia stream. The designer-graphic must specify all properties of all available stream configurations (element `<StreamingConfiguration><AVOption>` - at least one AVOption must be defined). If the user decides to enable web camera capturing by selecting one of the streaming configurations and clicking on apply button, then event onClientStartStreaming (Radical Web Service, See paragraph 3.3.4) is triggered. Subsequently the live audio video stream is published.

```
<OnClick>
  <Action>ShowDialog_SelectCamera</Action>
  <!--
    Dialog could be shown immediatelly after
    XML configuration is loaded into the Radical Flash Chat
  -->
  <AutoShowDialog>false</AutoShowDialog>
  <!-- Configuration for the streaming -->
  <StreamingConfiguration>
    <!-- Name of the stream -->
    <StreamName>Stream1</StreamName>
    <!-- Is user able to stop streaming? -->
    <AVOption_NoCamera>false</AVOption_NoCamera>
    <!--
      User could select one of the following AVOptions
      in modal dialog. There must be at least one AVOption.
    -->
```

```
    <AVOption>
      <!-- Short text representation of this option in dialog -->
      <Title>Standart configuration</Title>
      <!-- Longer description of this option -->
      <Description>
        Standart configuration 320x240 pixels, 10 FPS, high quality.
      </Description>
      <!-- only one AVOption could be default -->
      <IsDefault>true</IsDefault>
      <!-- audio setup -->
      <Audio>
        <!-- Audio kilobit rate -->
        <Kbitrate>32</Kbitrate>
        <!-- Silence level, int number in interval from 0 to 100 -->
        <SilenceLevel>5</SilenceLevel>
      </Audio>
      <!-- video setup -->
      <Video>
        <!-- Resolution of the video broadcasted to the room -->
        <Resolution>
          <Width>320</Width>
          <Height>240</Height>
        </Resolution>
        <!-- Video kilo bit rate -->
        <Kbitrate>320</Kbitrate>
        <!-- Video frames per second -->
        <FPS>10</FPS>

        <!-- Quality of the video. Min value 10, max value 100. -->
        <Quality>80</Quality>
        <!-- Interval of the video key frame -->
        <KeyFrameInterval>30</KeyFrameInterval>
      </Video>
    </AVOption>

    <AVOption>
    ...
    </AVOption>

    <AVOption>
    ...
    </AVOption>
  </StreamingConfiguration>
</OnClick>
```

Action **SendTextMessage** performs “send chat message” operation, which transfers the text from `<ChatInput>` component to the chat room `<ChatText>` component.

2.7.4 HtmlTextArea

HtmlTextArea is a sophisticated text label. The text inside may be formatted by HTML tags and some other rules typical of hypertext documents. Since it is strictly

denied to use characters as "<" lower, ">" greater in XML element body - the graphics-designers must use substitution "{{" lower, "}}" greater instead of "<", ">". HtmlTextArea example is below:

```
<SkinObject>
  <Type>HtmlTextArea</Type>
  <Name>HtmlText1</Name>
  <Position>
    <Left>15</Left>
    <Top>100</Top>
    <Width>400</Width>
    <Height>100</Height>
  </Position>
  <HtmlText>
  {{FONT SIZE="12" FACE="_sans" COLOR="#FFAA00" LETTERSPACING="0"}}
     SOME TEXT
  {{/FONT}}
  </HtmlText>
  <IsTextSelectable>false</IsTextSelectable>
</SkinObject>
```

2.7.5 Specialized components

Specialized components (ListOfUsers, ChatText, ChatInput) may be used only in layer <ML> and instantiated only once at most. Obviously specialized objects cannot be dynamically created or deleted and the possibility of theirs interactive changes by dynamic skinning is very limited.

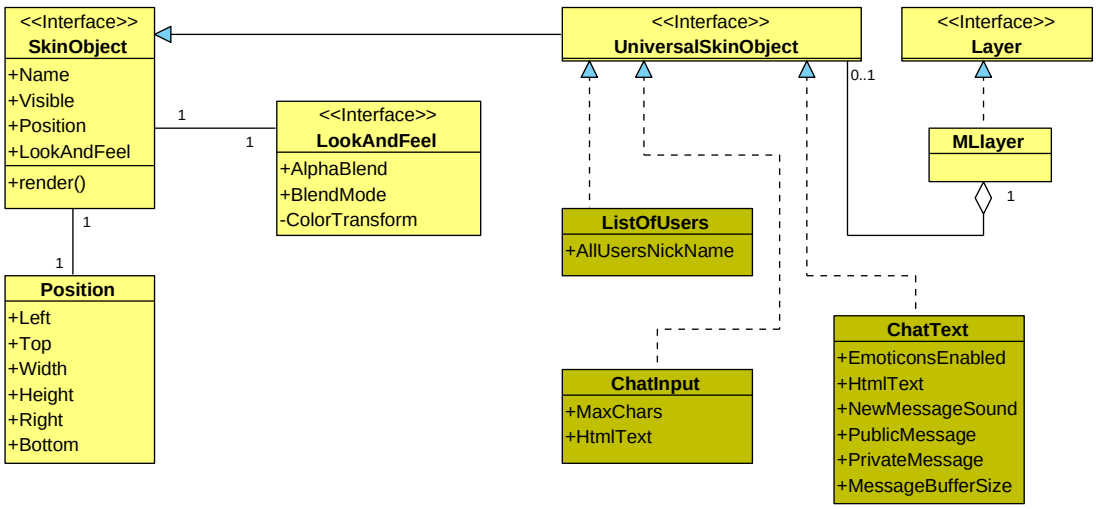


FIGURE 13. Specialized components

2.7.6 ListOfUsers

ListOfUsers is a rectangular widget with an optional scrollbar. It contains a list of all users in the current chat room.

```
<SkinObject>
  <Type>ListOfUsers</Type>
  <Name>ListOfUsers</Name>
  <Visible>true</Visible>
  <AllUsers>
    <NickName>All users</NickName>
  </AllUsers>
  <Position>
    <Left>15</Left>
    <Top>410</Top>
    <Right>125</Right>
    <Bottom>100%-15</Bottom>
  </Position>
</SkinObject>
```

2.7.7 ChatText

The most important specialized component in the main layer is ChatText. It is a dynamic read only text field designed for displaying public or private text messages. ChatText contains included HTML text shader technology. The text shader enables the graphic-designer to determine how the text messages will look like, when they appear in the ChatText. A reminder here is: chat text messages can originate only at Radical Flash Chat or at Radical Web Service, but through Radical Bridge they pass in a plain message format. After that, they are relayed to the client(s), transformed from plain format into HTML format and finally, displayed in the web browser. The plain message format is always encoded in UTF-8 character set. The message packet has enclosed information about the client, who wrote the text, addressee and the message significant color. This information can be used by text shader to shift message from plain format into the HTML formatted text. Everything is controlled by `<PublicMessage><Template>` and `<PrivateMessage><Template>` elements. See following example:

```
<SkinObject>
  <Type>ChatText</Type>
  <Name>ChatText</Name>
  <Visible>true</Visible>
```

```
  <Position>
    <Left>430</Left>
    <Top>45</Top>
    <Right>100%-10</Right>
    <Bottom>100%-15</Bottom>
  </Position>
  <EmoticonsEnabled>false</EmoticonsEnabled>
  <!-- Default invitation text -->
  <HtmlText>
    {{FONT SIZE="12" COLOR="#FFAA00"}}Welcome in the room.{{/FONT}}
  </HtmlText>
  <!-- Sound which is played, when a new message arrive. -->
  <NewMessageSound>./skin/sounds/newmessage.mp3</NewMessageSound>
  <!--
    Public message HTML text shader.
    You can use:
    {message.getColor()} - return color of the message,
    {message.sender.getNickName()} - return nick name of the sender,
    {message.sender.getUID()} - return uid of the sender,
    {message.getText()} - return text of the message
    {datetime.format("string")} - format actual time
      %a - lowercase am or pm,              %A - uppercase AM or PM
      %d - day of month 01-31 (leading 0),  %D - day of month 1-31
      %g - 12-hour 00-11 (leading 0),       %G - 12-hour 0-11
      %h - 24-hour 00-23 (leading 0),       %H - 24-hour 0-23
      %i - minutes 00-59 (leading 0),       %I - minutes 0-59
      %m - numeric month 01-12 (leading 0), %M - numeric month 1-12
      %N - month (January),                 %n - month (Jan)
      %s - seconds 00-59 (leading 0),       %S - seconds 0-59
      %y - 2-digit year,                    %Y - 4-digit year
  -->
  <PublicMessage>
    <Template>
    {{P ALIGN="LEFT"}}
{{FONT SIZE="12" COLOR="#{message.getColor()}" LETTERSPACING="1" }}
  {{B}}{message.sender.getNickName()}{{/B}}
{{/FONT}}
{{/P}}

{{P ALIGN="LEFT"}}
{{FONT FACE="_sans" SIZE="12" COLOR="#{message.getColor()}"}}
  {message.getText()}
{{/FONT}}
{{/P}}

{{P ALIGN="RIGHT"}}
{{FONT FACE="_sans" SIZE="8" COLOR="#000000"}}
  {datetime.format("%Y.%m.%d %h:%i:%s")}
{{/FONT}}
{{/P}}
    </Template>
  </PublicMessage>

  <!--
    Same options as for public message element
    with following new options
    {message.receiver.getNickName()}
    {message.receiver.getUID()}
  -->
  <PrivateMessage>
    <Template>
{{P ALIGN="LEFT"}}
{{FONT SIZE="12" COLOR="#{message.getColor()}" LETTERSPACING="1"}}
```

```
{{B}}{{I}}
  {message.sender.getNickName()} &amp;gt;&amp;gt;
  {message.receiver.getNickName()}
{{/I}}{{/B}}
{{/FONT}}
{{/P}}

{{P ALIGN="LEFT"}}
{{FONT FACE="_sans" SIZE="12" COLOR="#{message.getColor()}"}}
{message.getText()}
{{/FONT}}
{{/P}}

{{P ALIGN="RIGHT"}}
{{FONT FACE="_sans" SIZE="8" COLOR="#000000" }}
  {datetime.format("%Y.%m.%d %h:%i:%s")}
{{/FONT}}
{{/P}}
    </Template>
  </PrivateMessage>
  <MessagesBufferSize>15</MessagesBufferSize>
</SkinObject>
```

2.7.8 ChatInput

ChatInput component is a simple text input field, where the user can type a message and later send it. This input field can be styled by HTML tags. There is a <MaxChars> property to limit the maximum count of letters the user can type. The example below illustrates this feature:

```
<SkinObject>
  <Type>ChatInput</Type>
  <Name>ChatInput</Name>
  <Visible>true</Visible>
  <MaxChars>512</MaxChars>
  <SendTextMessageWhenEnterKeyPressed>
    true
  </SendTextMessageWhenEnterKeyPressed>
  <HtmlText>
    {{FONT SIZE="14" FACE="Courier" COLOR="#FFAA00"
    LETTERSPACING="0" KERNING="0"}}
  </HtmlText>
  <MessageSentSound>./skin/sounds/sending.mp3</MessageSentSound>
  <Position>
    <Left>145</Left>
    <Top>410</Top>
    <Right>405</Right>
    <Bottom>100%-125</Bottom>
  </Position>
</SkinObject>
```

2.8 Dynamic skinning

2.8.1 Introduction to dynamic skinning

Dynamic skinning is the last revolutionary innovation in the current version of Radical Chat. Dynamic skinning enables developers to change the application design and its behavior on the fly. Moreover, the data flow is designed "upside down" - changes can originate only on the server (Radical Web Service) and are passed down to the client'(s) web browser(s) without any previous interaction or request from the user(s). That means: application skin and logic could be changed any time and for many clients at once (e.g. as a response to mobile call, mobile SMS, or as a scheduled task). For convenience of users, the dynamic skinning technique was encapsulated only into two functions.

To alter the skin of any Radical Flash Chat application the developer needs a kernel class Skin (included in servicehandler.php), which contains two important methods: updateSkinObject and deleteAllSkinObjectUpdates. See the following demonstration (used programming language - PHP):

```
function _onClientWantsToStartStreaming(&$client, $stream)
{
  Logger::func("onClientWantsToStartStreaming");
  //client can publish the stream
  $client->setStreamingAccepted();

  //get StreamServerCommand class for communication
  //with Radical Bridge
  $ssc = $client->getStreamServerCommands();
  //try to retrive Skin manipulator for $client
  $skin = $ssc->client_getSkin($client->getUID());
  //update or create SkinObject Panel5 in client's web browser
  $skin->updateSkinObject("
    <Skin>
      <BG>
        <SkinObject>
          <Type>BasicPanel</Type>
          <Name>Panel5</Name>
          <Visible>true</Visible>
          <Position>
            <Left>50</Left>
            <Top>-40</Top>
            <Right>410</Right>
            <Bottom>360</Bottom>
          </Position>
          <LookAndFeel>
            <NineGrid>
              <SliceImgSequence>
                ./skin/panels/rsp1_0{1-9}.png
              </SliceImgSequence>
```

```
            </NineGrid>
          </LookAndFeel>
        </SkinObject>
      </BG>
    </Skin>
  ");

  //get room skin manipulator
  $room_skin = $ssc->room_getSkin($client->getRoomUID());
  //destroy dynamically created object ButtonStartStreaming
  $room_skin->deleteAllSkinObjectUpdates("ButtonStartStreaming");
}
```

These two functions are absolutely sufficient for any skin and behavioral dynamic changes, but there are some rules which must be followed:

I. updateSkinObject method can update only one SkinObject at most. If the developer wants to update more SkinObjects, then updateSkinObject must be executed several times or they can use updateSkinObjectsFromFile.

II. The given XML path must be the full path to the SkinObject including XML elements <Skin> and layer(<BG><ML><FG>).It is possible to change all properties of SkinOjbect at once. If SkinObject with a given <Name> does not exist in the Radical Flash Player, then it is dynamically created, otherwise the existing object is updated. <Type> of the old and new SkinObject must be the same.

III. deleteAllSkinObjectUpdates function returns SkinObject back to the stage before Radical Flash Chat established connection with stream server. That means - if an object was created dynamically, then it is deleted, otherwise the object is restored to the state specified in XML configuration file (see paragraph 2.3 Static skin).

2.8.2 Threats and limits of dynamic skinning

The maximum number of all dynamic skin updates, which can be done in one PHP or ASP.NET triggered event is 32 (by default). All other updates are ignored.

It is not recommended to use relative links to dynamically created objects (in RPSF positioning system), because RPSF system has higher priority and is used before skin updates are put into the correct order – that may occasionally cause unexpected errors and illogical infinite loops in dependency graph (See figure 11).

It is not recommended to use dynamic skinning for one client, or whole chat room in intervals lower than three seconds.