



Saros Test Framework

“Getting Started” Guide

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1 Welcome to STF

This book will introduce the GUI testing tool STF and help you to quickly write your first robust JUnit test with it.

How to read this manual

This manual is divided into the following chapters:

- › The chapter “The purpose of automating GUI tests” explains why we need to automate GUI tests. We recommend this chapter if you don’t want to write tests for your code.
- › The chapter “Introduction to STF” provides a background and instructions to STF.
- › The chapter “What is SWTBot?” introduces the framework SWTBot. As STF is developed based on SWTBot and has the same design concept, it is useful to be familiar with its APIs.
- › The chapter “What is RemoteBot?” introduces the robot RemoteBot, which has the same APIs as SWTBot, so that if you’ve understood SWTBot, you will have no problem using RemoteBot.
- › The chapter “What is SuperBot?” introduces the robot SuperBot, which wraps some often-used operations supported by RemoteBot. If you quickly want to write your tests, SuperBot is the best helper for you.
- › The chapter “How to write robust tests” provides step-by-step instructions for writing JUnit tests with STF. This chapter is best suitable for test writers.

2 The purpose of automating GUI tests

This chapter provides an overview of the benefits and risks of test automation

What you'll Learn

This tutorial shows you:

The current test state for Saros.

What may be changed with automating GUI tests.

How to avoid the problems caused by test automation.

The benefit of best automation

Test automation has many benefits, including those listed below¹.

Frequent regression testing

Before

Regression testing is not really carried out in the Saros team now. At the moment, fixed bugs or new features are only manually tested by developers. I.e. we don't know exactly if the changes introduce new bugs, so it is highly possible that new software bugs may be integrated into the program.

After

Test automation minimizes the effort used to perform regression testing and can quickly check if the tests that worked with the previous version of the program should also pass on the latest version. There can be higher confidence that no unpleasant surprise shows up in the released version.

Run more tests more often

Before

At the moment, Saros is only manually tested every release week. For some test cases more than two testers are needed. During testing they need to follow the sequence of operations defined in a test case. If



Figure 2.1: Regression Testing
source: [F1]

¹ Fewster, Graham 1994, 9-10; Graham, Veenendaal, Evans, Black 2007, 185

someone does something wrong, all of testers need to restart. Testing only 10 test cases may take an entire day.

After

A visible benefit of test automation is the capability to run many tests in less time, therefore making it possible to run them more frequently. This leads to increased confidence in the system. And tests which are repeated automatically will always be repeated exactly in the same way, e.g. operations like connect, or share project, which are nearly run by every test case.

Execute tests which are difficult or impossible to do manually

Before

- › It is impossible to manually run the same tests in different test-environments.
- › Running some tasks simultaneously is impossible for a single tester, e.g. editing the same line simultaneously and simultaneously sharing sessions with multi-users.
- › It's difficult to run tests in different networks.

After

- › The same tests can be run on different hardware and operating systems.
- › synchronization can be easily simulated using automated tests.
- › In the later version of STF you can run tests on virtual machines with different network configurations.

Better use of resources

Before

To test some functions of Saros, we first need to build a suitable test environment. E.g. to test the “follow mode”, we first have to build a session; to test the “write access”, we need to do the same thing. Repeatedly doing the same tasks is very boring.

After

By automating such tasks the staff can put more energy into designing better test cases to be executed. Otherwise, automated tests can be run by someone who does not have to know all the complexities of the application, or even by another tool like Hudson.

Consistency

Before

A level of consistency that is very difficult to achieve with manual tests.

After

The same tests can be run on different hardware and operating systems. This can confirm cross-platform quality and consistency.

The risks of test automation

It is not always advantageous to automate test cases. A number of problems may be encountered with automatic testing. Knowing the possible problems can help us to avoid or overcome them. The most common risks are listed below².

Test maintenance

Problem

If the application's user interface will change considerably in the near future, it is often necessary to update some, or in the worst case, all tests, so that they may be re-executed successfully. If it's less time consuming to rewrite the tests than just updating them, the test automation is very likely to be ceased.

Defensive measures

In the near future we will confront this problem. To strategically deal with it, STF use the so-called design pattern "page objects" which models elements of the Eclipse workbench, such as views and main menus. E.g. the page object "SarosView" contains only the services to deal with actions in the Saros view. So if something changes in the view, the fix needs only be applied on place. Define a global properties file to manage all labels' names and messages, which should be referenced by both source code and STF.

False confidence

Problem

Only because a test suite executed successfully, it does not mean that the software is faultless. The tests themselves can contain defects or they can be just incomplete. There is always a chance that the tester has unconsciously implemented tests which can preserve the incorrect results for indefinite time.

² Fewster, Graham 1994, 9-10; Graham, Veenendaal, Evans, Black 2007, 186-187

Defensive measures

To avoid this phenomenon, STF will first be properly tested itself before writing tests with it. I.e. when you extend STF, it is generally advisable to write a test for your new extension.

Third-party software products contain bugs themselves

Problem

STF is developed based on SWTBot (UI/functional testing tool). SWTBot itself contains some bugs, if you don't know that the problem is coming from SWTBot itself, it will take a lot of time.

Defensive measures

STF has already fixed some known bugs contained in SWTBot. Continually update SWTBot version, which may already fix some bugs.

Poor testing practices

Problem

When the tests are of poor quality, badly organized and designed, with none or ambiguous documentation, with little chance to find any bug, than it makes no sense to automate them. The focus should be to improve the testing effectiveness first rather than improving efficiency. After automating chaos, all you get is a faster chaos.

Defensive measures

So it's very important to write robust tests. How to do it will be introduced in the last chapter.

3 Introduction to STF

This chapter introduces the GUI testing tool “STF” targeted for the Saros project.

Background

Motivation

The original motivation was to find an appropriate GUI testing tool for Saros. Our requirements were:

- › To test a minimal scenario of Saros, at least two Saros instances are needed, which may be not even at the same computer. So the GUI testing tool for Saros should support **distributed** testing.
- › The event source (activated by an application) and the event target (verified by another application) are not in the same application and possibly not even at the same computer. So the GUI testing tool should be able to control the test procedure **synchronously**.
- › Saros is an Eclipse plugin project, so the tool should also support high-level operations on widgets of Eclipse without great effort.
- › Saros developers are familiar with Java, so it would be better to write test scripts with Java, e.g. JUnit tests.

Evaluation

In his thesis³, the founder of STF Sandor Szücs intensively evaluated which methods and tools are most suitable for our testing needs. Refer to it for more information on thesis.

Conclusion

Based on these requirements the GUI testing tool SWTBot is outstanding among other candidates, which work with JUnit and can test SWT and Eclipse applications. It only does not support synchronization and

³ <http://www.inf.fu-berlin.de/inst/ag-se/theses/Szuecs10-DPPVI.pdf>

distribution. Finally, Sandor decided to write a tool himself that would overcome the shortcomings of SWTBot. The result is STF.

What is STF?

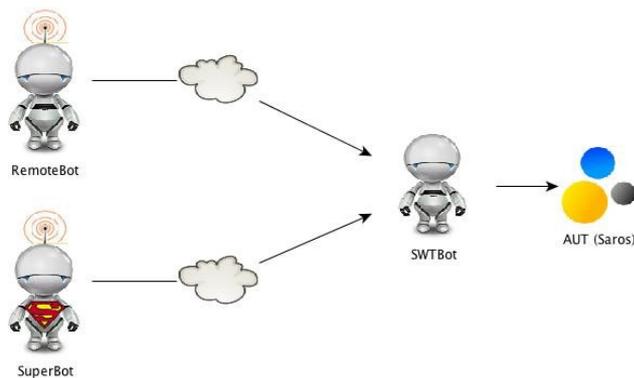
STF = SWTBot + distribution + synchronization

Introduce members and workflow to STF

Workflow with STF can be simulated as activities in a QA-Team.

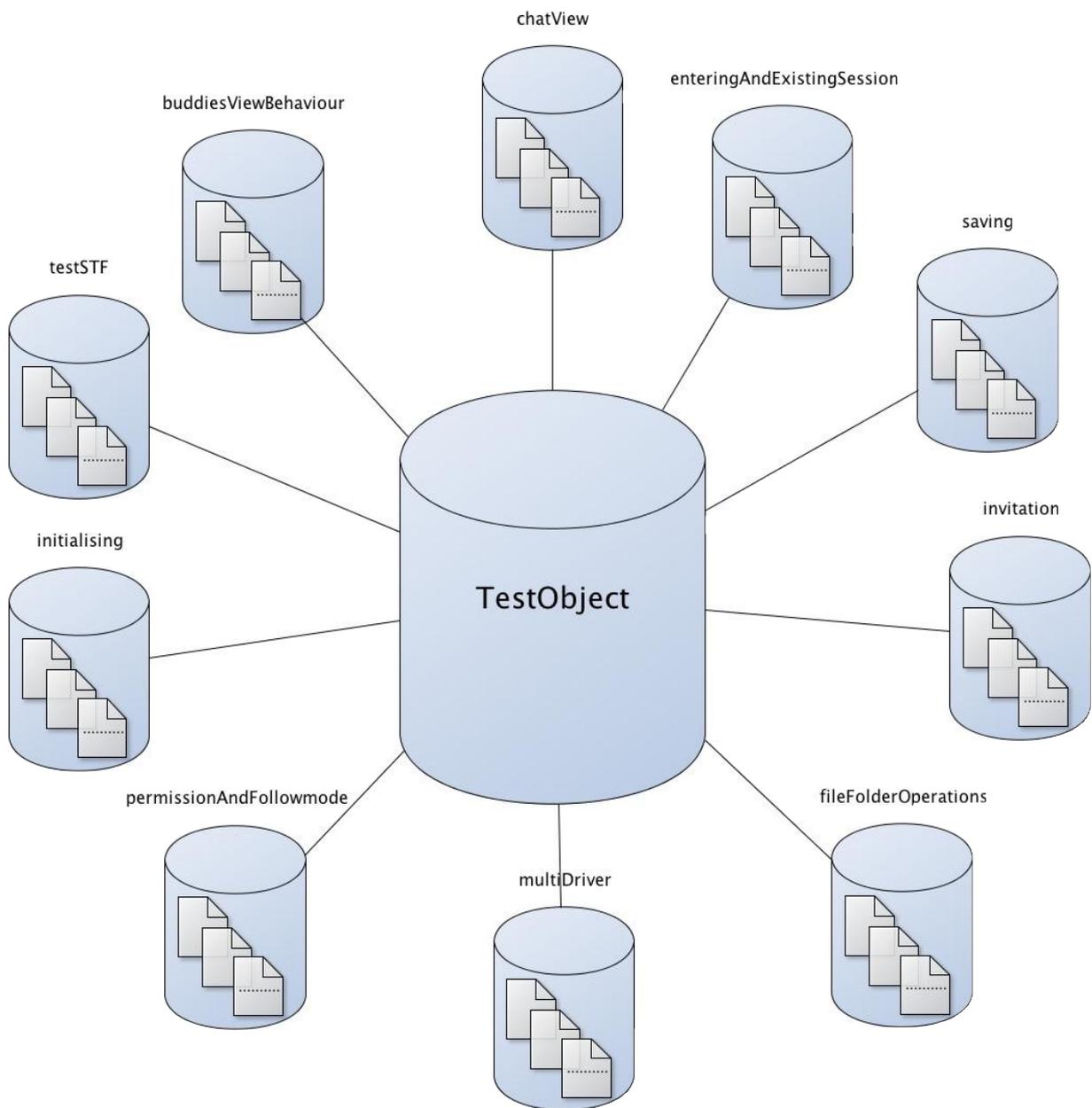
Staff and their activity in the QA-Team

- › In the team, there are the 5 skilled simulated testers Alice, Bob, Carl, Dave and Edna. Their Job is to test our application and find bugs for us.
- › To be able to remotely operate Saros instances, each tester owns two robots “RemoteBot” and “SuperBot”. The testers assign tasks to them and then send the commands to remote Saros instances and perform the commands on it. Actually RemoteBot and SuperBot, rather than performing the commands themselves, delegate them to the robot “SWTBot” (SWTBot is the framework used by STF). To the outside world it appears that RemoteBot and SuperBot are executing the commands, but SWTBot is the one actually doing the work (see the following picture).

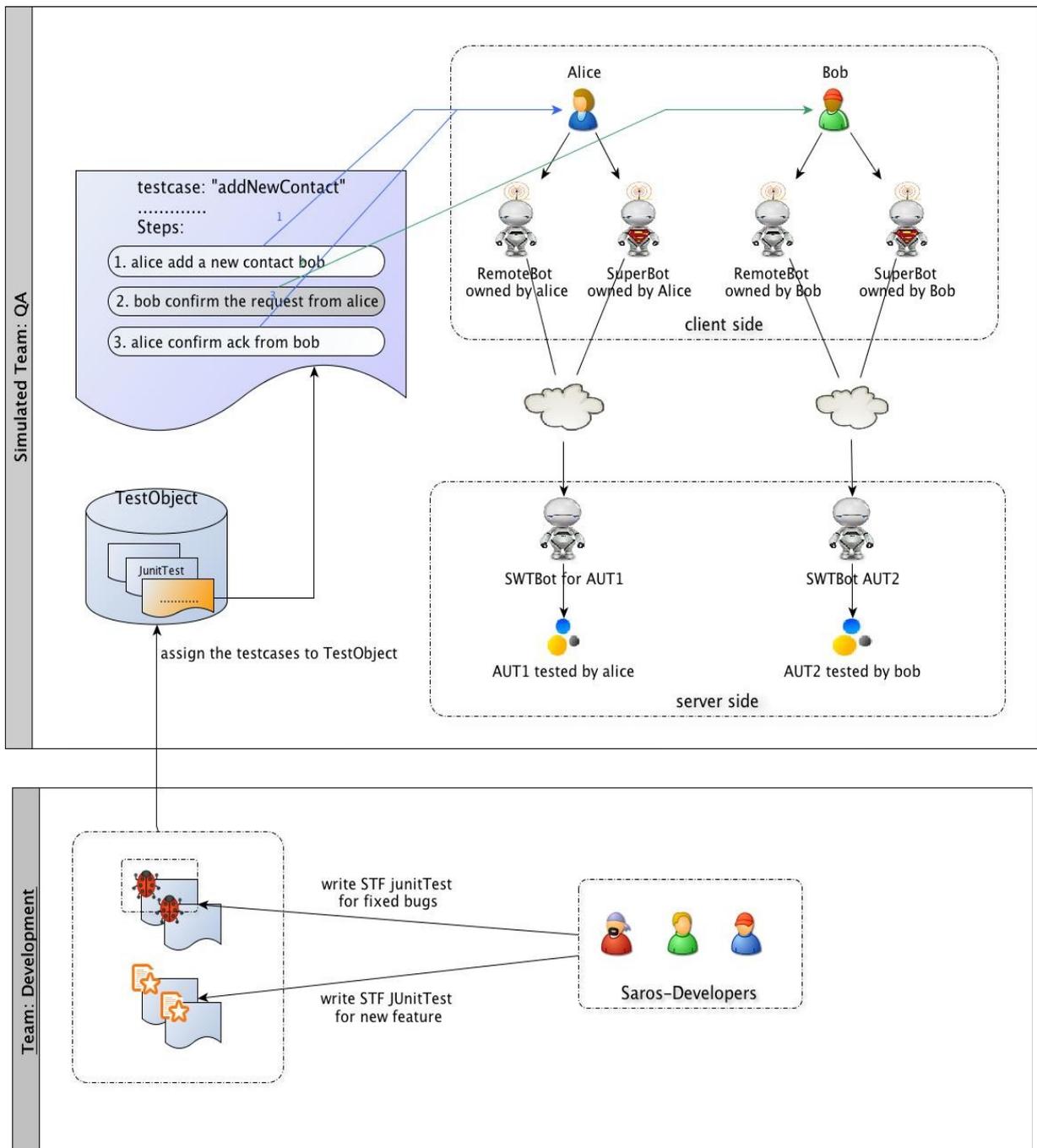


- › Most test tasks require at least two testers. Who has to complete a task and how they cooperate to finish it, is defined in the corresponding test case. This means that the other testers who are not assigned the task are idle.

All the test cases are collected in a corresponding test suit managed by a test project. Currently there are a total of 10 test suits, presented as packages. Every test suits contains the assigned test cases presented as class.



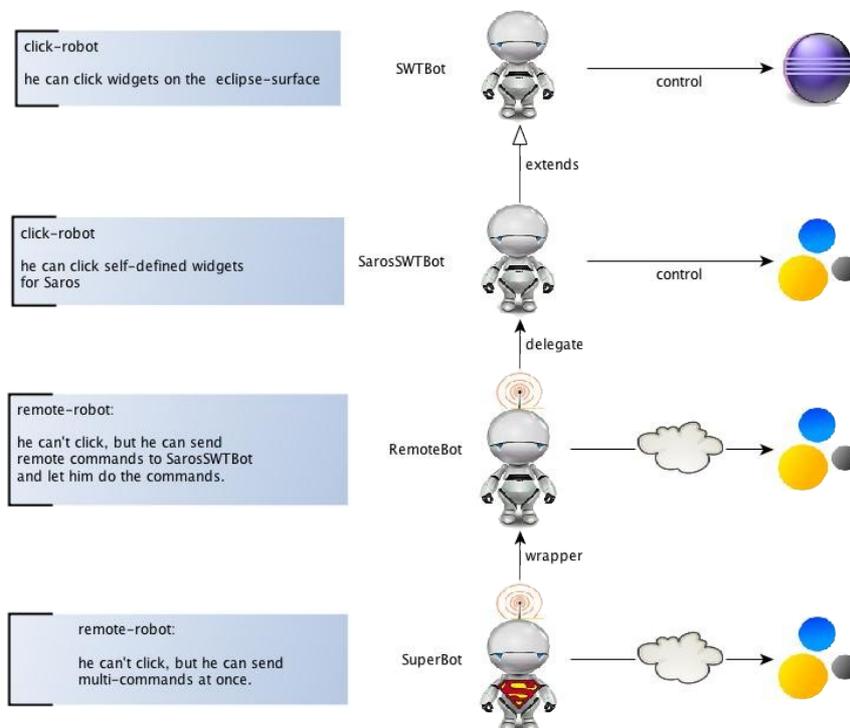
The following diagram describes the scenario in which the testers Alice and Bob run a test case “



4 Bot's family

To fulfill the test requirement of Saros, Bot's entire family is needed. Each member has his own special ability and drawback. To know their respective characteristics can help us efficiently write our tests. In the following chapter I will introduce them in detail.

Please note: This picture is outdated. Superbot no longer wraps Remotobot. Instead is uses SarosSWTBot or SWTBot directly.



5 What is SWTBot?

This chapter introduces the Java-based functional testing tool “SWTBot” targeted for SWT and Eclipse based applications. It is the nuclear part of STF, so it’s necessary to present the framework first.

SWTBot API introduction

SWTBot is a Open Source project which has the goal to provide a tool for testing SWT and Eclipse applications. It is a kind of click-robot and the click operations on the Eclipse surface are triggered by calling SWTBot APIs in JUnit tests. SWTBot integrates well with Eclipse and can run on any platform that SWT runs on, therefore also with Eclipse plugins.

Finding widgets

The main entry point in the SWTBot framework is the class SWTBot which contains extensive APIs to operate the SWT surface. For Eclipse plugin applications we use the subclass SWTWorkbenchBot, as the enhancement provides special services to operate the Eclipse workbench. Therefore you first need to declare a SWTBotWorkbenchBot in your test class (JUnit test).

```
private final SWTWorkbenchBot swtBot = new SWTWorkbenchBot();
```

Think of the SWTBot as something that can do tasks for you (e.g. find widgets, click on them, etc).

Muster to find a widget:

```
SWTBot[Widget] widget = swtbot.[widget][With][Matcher(s)] ();
```

Example:

```
SWTBotText textField1 = swtbot.textWithLabel("Name:");
```

```
SWTBotText textField2 = swtbot.textWithTooltip("Name:");
```

Finding obscure widgets

Internally SWTBot uses the so-called Hamcrest matcher framework to locate widget controllers. In addition to the matchers from Hamcrest, SWTBot uses its own matcher to evaluate the requirements by finding widgets. In SWTBot, the matcher would be instantiated with static factory functions in the class `WidgetMatcherFactory` and used to locate widget controllers. What you need is:

To create simple matchers such as

```
withText("Finish")  
withLabel("Username:")  
withRegex("Proceed to step (.*)")  
widgetOfType(Button.class)  
withStyle(SWT.ARROW, "SWT.ARROW")
```

And combine all matchers with

```
allOf(matchers...)  
anyOf(matchers...)  
not(matcher)  
allOf(anyOf(matchers...), matchers...)
```

At last put the whole thing together (the end user API)

```
public SWTBotTree treeWithLabelInGroup(String l, String g, int i) {  
    //create the matcher  
    Matcher matcher = allOf(widgetOfType(Tree.class), withLabel(l), inGroup(g));  
    //find the widget  
    Tree tree = (Tree)widget(matcher, index);  
    //create a wrapper for thread safety and convenience APIs  
    return new SWTBotTree(tree, matcher);  
}
```

Performing actions

The [Widget]WithLabel method finds the widget control specified with the given label, so you will get a SWTBot[Widget] object, on which actions can be performed.

```
//set text "hello world" in the text field.  
swtbot.textField1.typeText("hello world");  
  
//click a button  
swtbot.button.click();  
  
//chain methods to make them concise  
swtbot.menu("File").menu("New").menu("Project...").click();  
  
//delete myClass.Java  
swtbot.tree.expand("Project").expand("src").expand("myClass.java").contextMenu("Delete").click();  
  
//make a selection in a list  
swtbot.list.select("a", "b", "c");  
  
//make a selection using indexes  
swtbot.list.select(1,2,3);
```

Widgets within a component of the Eclipse workbench

With the additional methods defined in `SWTWorkbenchBot` the elements of the Eclipse workbench can be easily controlled, e.g. views and editors may be found by their ID or the rider title.

```
SWTBotView view1 = bot.viewById("someViewId");  
SWTBotView view2 = bot.viewByTitle("someTitle");  
SWTBotEditor editor1 = bot.editorById("someEditorId");  
SWTBotEditor editor2 = bot.editorByTitle("someTitle");
```

With such view- or editor object you can get the object `SWTBot` again, with which you can access the content limited within the view or editor.

```
SWTBot editorBot = editor1.bot();  
editorBot.textWithLabel("Name:").setText("hallo");
```

Furthermore, the API of SWTBotView and SWTBotEditor provides some functions to operate the tab itself. For instance, the editor can be saved or closed.

```
editor1.save();  
editor1.close();
```

Implement your own matcher

When you want to use your own logic in tests to locate controls, you can implement your own matcher, which would be passed to `SWTBot.wiget(...)`. Important: the implementation of matchers for SWTBot is done in such way that the testing of GUI elements are carried out from the UI thread, because access to the SWT objects is permitted only in the thread. SWTBot provides a helper class `UIThreadRunnable` for the process. E.g.

```

public class WithId<T extends Widget> extends AbstractMatcher<T> {
    private final String value;
    public WithId(String value) {
        this.value = value;
    }
    protected boolean doMatch(final Object obj) {
        String data = UIThreadRunnable.syncExec(new Result<String>() {
            public String run() {
                return (String) ((Widget) obj).getData(SWTBotPreferences.DEFAULT_KEY);
            }
        });
        return value.equals(data);
    }
    public void describeTo(Description description) {
        description.appendText("with id ").appendText(value);
    }
}

```

Implement your own SWTBot[Widget]

Thread safety(query state)

```
public class SWTBotCheckBox {  
    public boolean isChecked() {  
        //evaluate a result on the UI thread  
        return syncExec(new BoolResult() {  
            public Boolean run() {  
                return widget.getSelection();  
            }  
        });  
    }  
    ...  
}
```

Thread safety (change state)

```
public class SWTBotCheckBox {  
    public void select() {  
        asyncExec(new VoidResult() {  
            public void run() {  
                widget.setSelection(true);  
            }  
        });  
        notifyListeners();  
    }  
}
```

Handling long operations

Sometimes the `waitUntil(...)` method needs to be used. After confirming execution of some costly operation (e.g. creating a new file), this operation can take some time. If the next test would started to execute, it would crash because the focus would be still set to some dialog window or progress bar from previous tests.

To deal with such situation, there are two options

1. The first option is using the `sleep()` method. But how to know how long it will take for the program to finish the operation? Setting a fixed number of seconds seems very inflexible.
2. A much better option is using a SWTBot method designed specially to deal with such cases:

```
/**
 * Wait until shell 'shellTitle' closes.
 * Do nothing if it does
 * not exist anymore.
 * @param shellTitle
 */
private void waitUntilShellCloses(String shellTitle) {
    try {
        bot.waitUntil(Conditions.shellCloses(bot.shell(shellTitle)));
    } catch (WidgetNotFoundException e) {
        /**
         * This has to be in empty catch block because waitUntil
         * throws exception when window 'shellTitle' is not found.
         * This window could be automatically closed after
         * operation has finished.
         */
    }
}
```

Problems caused by the second option

But once in few executions an unpleasant situation occurs - the tests crashes. The reason is that if the operation will finishes quicker and the window will closes sooner than expected, then `bot.shell(shellTitle)`

will throw `WidgetNotFoundException`. The only way to deal with it is to catch it, write a description why it was caught and log it.

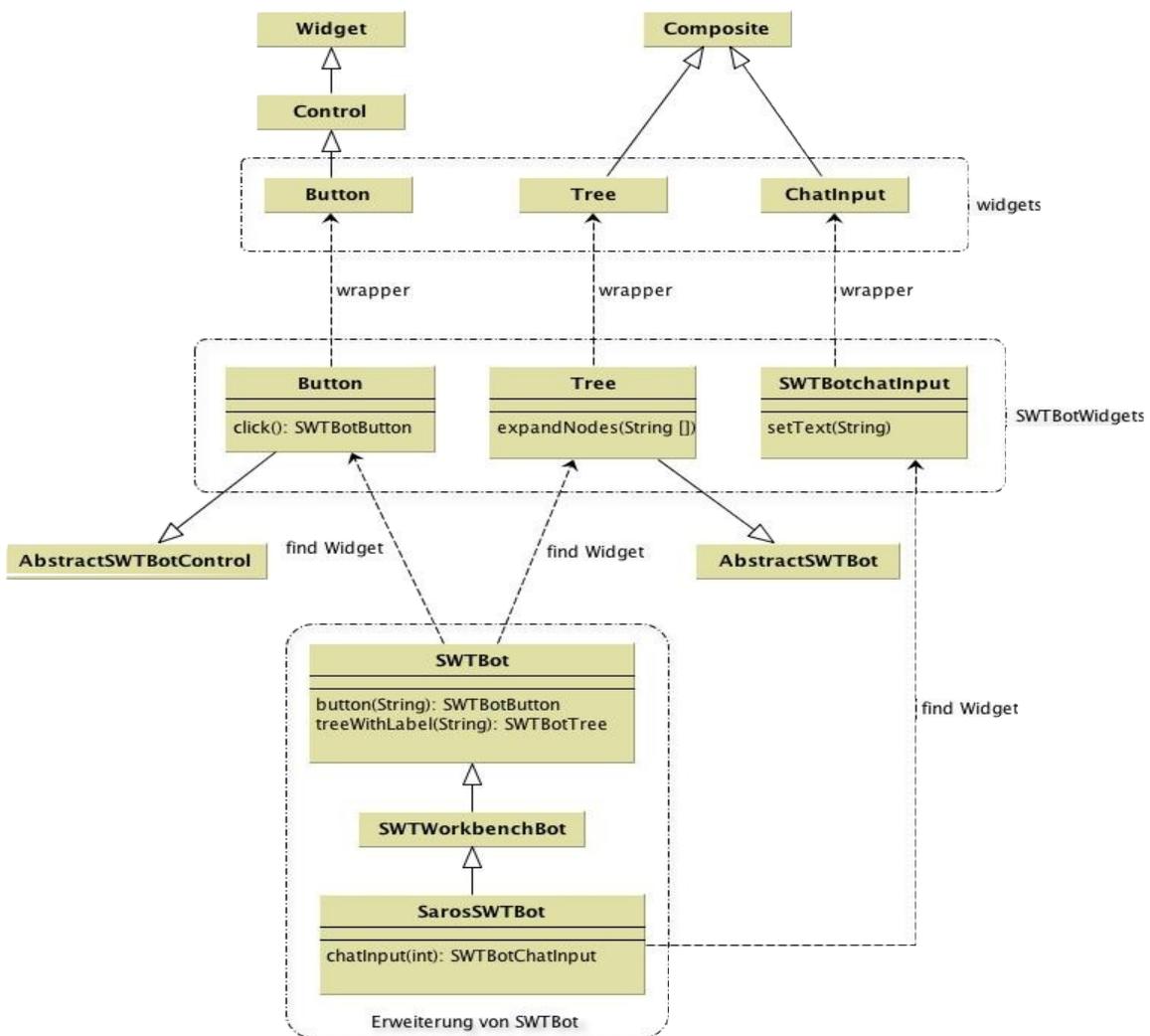
What cannot be tested with SWTBot

When writing SWTBot tests, a lot of time can be wasted while trying to do things that cannot be done (e.g. things that are not supported, or are not implemented yet). Therefore it seems a good idea to mention them in this document:

- › There is no support for native widgets (Open/Save File Dialogs, Color Dialogs, etc.).
- › When trying to test AUTs (Application Under Test) restart - it restarts also all the tests and goes into infinite loops.
- › You cannot access status bar text.
- › There is only partial support for the close button x in the top right corner of every window. One can use the close method for shells but it fails if there will be a confirmation dialog (which is a standard Eclipse behavior for the main window).
- › You cannot access the context menu's submenu items (e.g. in navigator view). There is a workaround - treat submenus as elements of the main context menu - but it fails when there are elements with repeating names (e.g. "Other...") in different submenus.

6 What is SarosSWTBot?

SarosSWTBot is an extension of SWTBot to support self-defined widgets specified for Saros.



Why and how to extend SWTBot?

Why

Some problems were encountered when writing tests for ChatView. The GUI developer used self-defined widgets by building the chat view, which do not belong to the SWT library, so they cannot be found by SWTBot. To solve this problem we need to extend the framework SWTBot.

Another reason to extend SWTBot is because there are some bugs contained in the original framework SWTBot which hinder the smooth tests writing. E.g. SWTBot can't click contextmenus.

How

To let SWTBot know about our own defined widgets, we need to do the following:

1. Define a corresponding so-called SWTBot[Widget] for the self-defined widget. E.g. define SWTBotChatLine for the widget ChatLine; the corresponding code looks like:

```
public class SarosSWTBotChatLine extends AbstractSWTBot<ChatLine> {  
    public SarosSWTBotChatLine(ChatLine w) throws WidgetNotFoundException {  
        this(w, null);  
    }  
    public SarosSWTBotChatLine(ChatLine w, SelfDescribing description)  
        throws WidgetNotFoundException {  
        super(w, description);  
    }  
}
```

2. Then define methods in the class SarosSWTBot to get the just defined SWTBotWidget with Matcher.

```
public SarosSWTBotChatLine chatLine() {  
    return chatLine(0);  
}  
@SuppressWarnings({ "unchecked", "rawtypes" })  
public SarosSWTBotChatLine chatLine(int index) {  
    Matcher matcher = allOf(widgetOfType(ChatLine.class));  
    return new SarosSWTBotChatLine((ChatLine) widget(matcher, 0), matcher);  
}
```

7 What is RemoteBot?

RemoteBot is a robot, who was developed based on SarosSWTBot, but different from SarosSWTBot, as he can remote-control SWT-widgets and support distributed testing.

How to realize distributed testing

I've already talked about the special test requirement of Saros, such as supporting distribution. To realize it, it was decided to utilize RMI technology.

How does RMI work?

Here is a brief description of how RMI works:

- › On the host machine, a server program creates services by first creating local objects that implement the services.
- › Next, it exports these objects to RMI. When the object is exported, RMI create a listening service that waits for clients to connect and request the service. After exporting, the server registers the object in the RMI registry under a public name.
- › On the client site, the RMI registry is accessed through the static class Naming. It provides the method lookup() that a client uses to query a registry. The method lookup() accepts a URL that specifies the server host name and the name of the desired service. The method returns a remote reference to the service object.

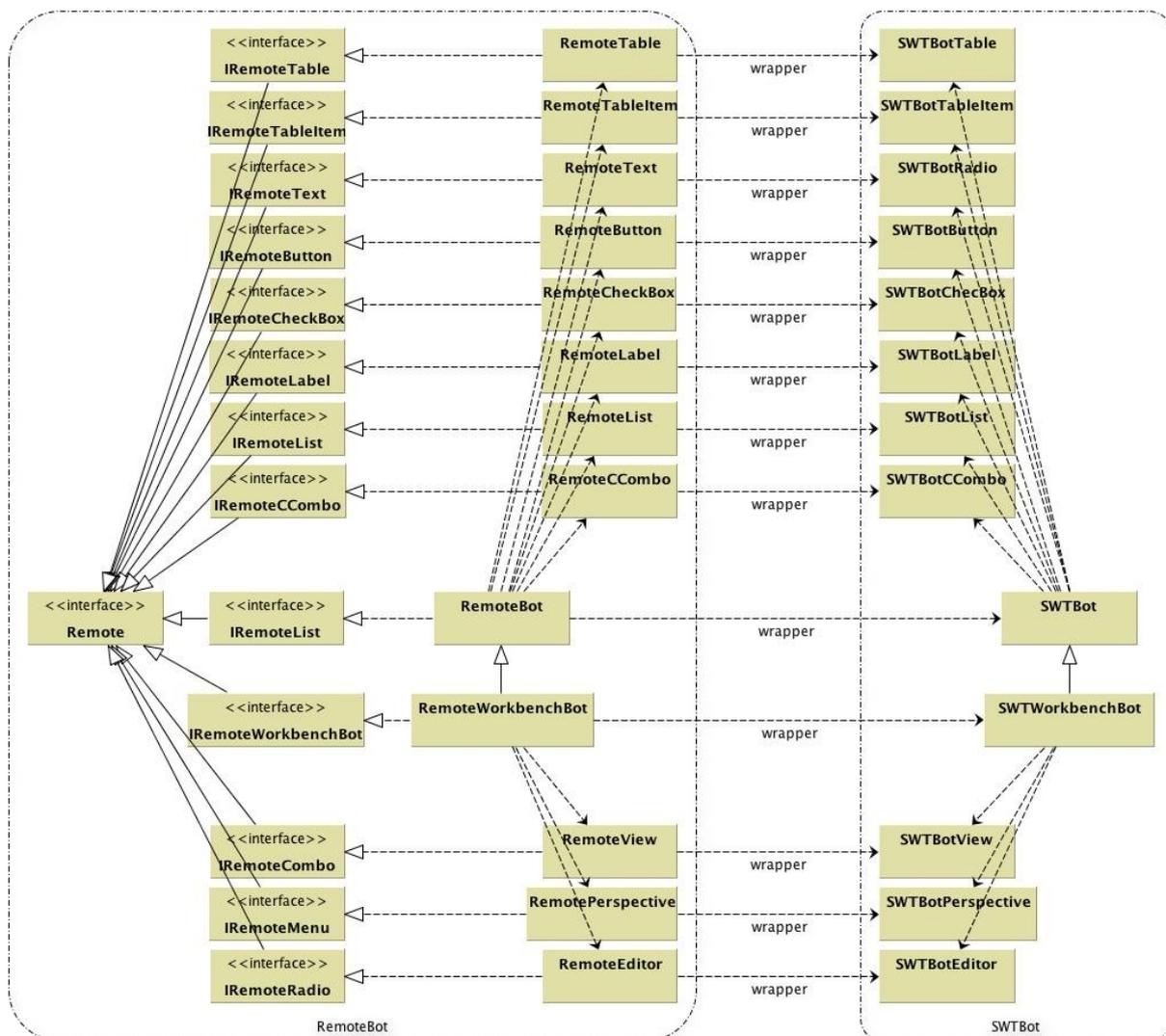
How do RMI + SWTBot work?

With the same principle we can see "Saros" as a server program and services offered by it are SWTBot APIs. Obviously the simulated testers are our clients, they can remotely operate Saros applications with references to the exported services.

Problems to directly export SWTBot APIs

Clients want to remotely operate Saros instances; a service offered by. This means we only need to define an associated remote object to which the SWTBot object delegates its tasks. The problem is that SWTBot is implemented as fluent interface and therefore it returns mostly SWT[Widget] objects. By default all RMI Objects are not serializable.

To be able to directly use SWTBot APIs on the client side, we also need to define delegates for all SWTBot[Widget] objects. The following class diagram shows the delegate relationship.



How to export RemoteBot - and RemotBot[widget] objects?

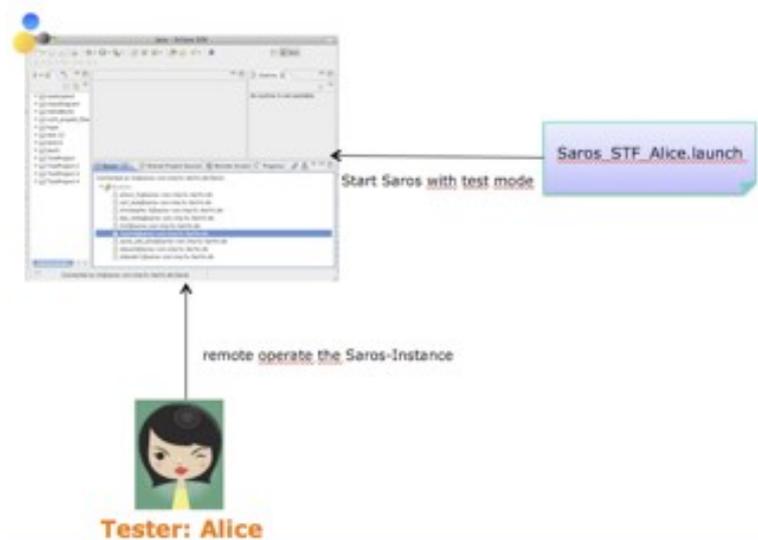
Ok, the whole SWTBot APIs are wrapped with RMI, but how to export them? This will be done when you start a Saros instances with Test-Mode. Test-Mode means that the VM arguments of run-configuration are configured with the following parameters:

```
-Xmx512m -ea -XX:MaxPermSize=256m  
  
//the path to the bin folder of the Saros project  
-Djava.rmi.server.codebase=file:${workspace_loc}/Saros/bin -Djava.security.manager  
  
//the path to the file "all.policy" which would be needed to export  
RMI-Objects-Djava.security.policy=file:${workspace_loc}/Saros/test/STF/all.policy  
  
//assigned port number, which is used by creating the RMIregistry  
-Dde.fu_berlin.inf.dpp.testmode=12345 -Dde.fu_berlin.inf.dpp.sleepTime=200  
  
//the IPaddress of the host machine of the server program, which is used by the client to get the RMIregistry.  
-Djava.rmi.server.hostname=localhost
```

Because of the convenience would 5 launch files are defined to run saros-instances with test mode, every launch file assigns a unique port number to the parameter `Dde.fu_berlin.inf.dpp.testmode`. With the unique combination of port number and hostname the tester can simply access the Saros instance which he wants to test. For example, with `Saros_STF_Alice.launch` you can start a Saros instance with the information: port number 12345 and hostname localhost. Since Alice is configured with the same informations(portnumber 12345 and hostname localhost), Alice can remotely access the Saros instance started by `Saros_STF_Alice.launch`.

Similarly for every tester there is a corresponding launch file:

- ▶ Bob -> Saros_STF_Bob.launch
- ▶ Carl -> Saros_STF_Carl.launch
- ▶ Dave -> Saros_STF_Dave.launch
- ▶ Edna -> Saros_STF_Edna.launch



All the parameters are passed to the method `StartupSaros#earlyStartup()` and `earlyStartup()` is automatically called by `IStartup` after loading the plugins during initialization of the workbench (`StartupSaros` is the implementation of `IStartup`). In the method `earlyStartup` the given parameter is checked if Saros is started normally or with the test mode. If Start wit test-mode the method `STFController#exportedObjects` is called, which is responsible for creating a registry and exporting all remote objects.

How to get the RemoteBot objects on the client side?

All a client has to do is call the registry to obtain a reference to the remote object, and call its methods. Note that the client receives an instance of the interface we defined earlier, and not the actual implementation.

```
IRemoteWorkbenchBot remoteBot = (IRemoteWorkbenchBot) registry.lookup("workbenchBot");
```

With the reference `remoteBot` tester can recursive access other `RemoteBot[Widget]` objects such as `remoteBot.view("Saros").toolbarButton("connect").click()`.

RemoteBot APIs introduction

Since RemoteBot is only a delegation and its job is simply passing on a duty to SWTBot, RemoteBot APIs are almost the same as SWTBot's. RemoteBot is also implemented as fluent interface and instead of returning SWT[Widget] objects it returns RemoteBot[Widget] objects which will be exported too.

The class RemoteBot delegate SWTBot and method button in it return Object RemoteBotButton.

```
public abstract class RemoteBot extends StfRemoteObject implements IRemoteBot {  
    private static RemoteBotButton button;  
    private static SWTBot swtBot;  
  
    .....  
    public IRemoteBotButton button(String mnemonicText) throws RemoteException {  
        button.setWidget(swtBot.button(mnemonicText, 0));  
        return button;  
    }  
    .....  
}
```

The class RemoteBotButton delegate SWTBotButton.

```
public class RemoteBotButton extends StfRemoteObject implements IRemoteBotButton {  
    ...  
    private SWTBotButton widget;  
    ...  
    public void click() throws RemoteException {  
        widget.click();  
    ...  
}
```

Finding widgets

Like an SWTBot we also define a subclass RemoteWorkbenchBot for RemoteBot, which calls the special services supported by SWTWorkbenchBot to operate the Eclipse workbench. To use the bot you first need to initiate testers in your test class (JUnit test). Then the tester can get the reference to IRemoteWorkbenchBot.

```
initTesters(ALICE);  
IRemoteWorkbenchBot remoteBot = alice.remoteBot()
```

RemoteWorkbenchBot uses the same Muster as SWTBot.

Muster:

```
RemoteBot[Widget] widget = remoteBot.[widget][With][Matcher(s)] ();
```

Example:

```
RemoteBotText textField1 = remoteBot.textWithLabel("Name:");
```

```
RemoteBotText textField2 = remoteBot.textWithTooltip("Name:");
```

Performing actions

You need to get a `RemoteBot[Widget]` object, which delegates the `SWTBot[Widget]` object, on which actions can be performed.

```
//set text "hello world" in the text field  
remoteBot.textWithLabel("Name:").typeText("hello world");  
  
//click a button  
remoteBot.button("Finish").click();  
  
//chain methods to make them concise  
remoteBot.menu("File").menu("New").menu("Project...").click();
```

Widgets within a component of the Eclipse workbench

With the additional methods defined in `RemoteWorkbenchBot` the elements of the Eclipse workbench can easily be controlled, such as views and editors may be found by their ID or the rider title.

```
RemoteBotView view1 = remoteBot.viewById("someViewId");  
RemoteView view2 = remoteBot.viewByTitle("someTitle");  
RemoteEditor editor1 = remoteBot.editorById("someEditorId");  
RemoteEditor editor2 = remoteBot.editorByTitle("someTitle");
```

With such a view- or editor object you can get the object RemoteBot again, with which to access the content limited within the view or editor.

```
RemoteBot editorBot = editor1.bot();  
editorBot.textWithLabel("Name:").setText("hallo");
```

8 What is SuperBot?

SuperBot is directly accessing the SWTBot API and also have the capability to access Saros Components during runtime. It gathers commonly used Remotebot methods calls to perform a task into a single method.

The structure of SuperBot

SuperBot is build based on SWTBot but different from RemoteBot as he can find the actual elements of Eclipse without passing detailed parameters and without checking it's state, For example you can focus on the packageExplorer view with

```
superBot().views().packageExplorerView();
```

In comparison RemoteBot needs many steps for it:

```
if(!bot().isViewOpen("PackageExplorer"))  
    bot().openViewById(.....)  
bot().view("PackageExplorer").activate();
```

The idea is that within the Eclipse UI there are compositions that your tests interact with. SuperBot simply simulate these often used elements as objects and simulates click-path with method chaining. To perform an action, the test writer only needs to translate the click-path with SuperBot.

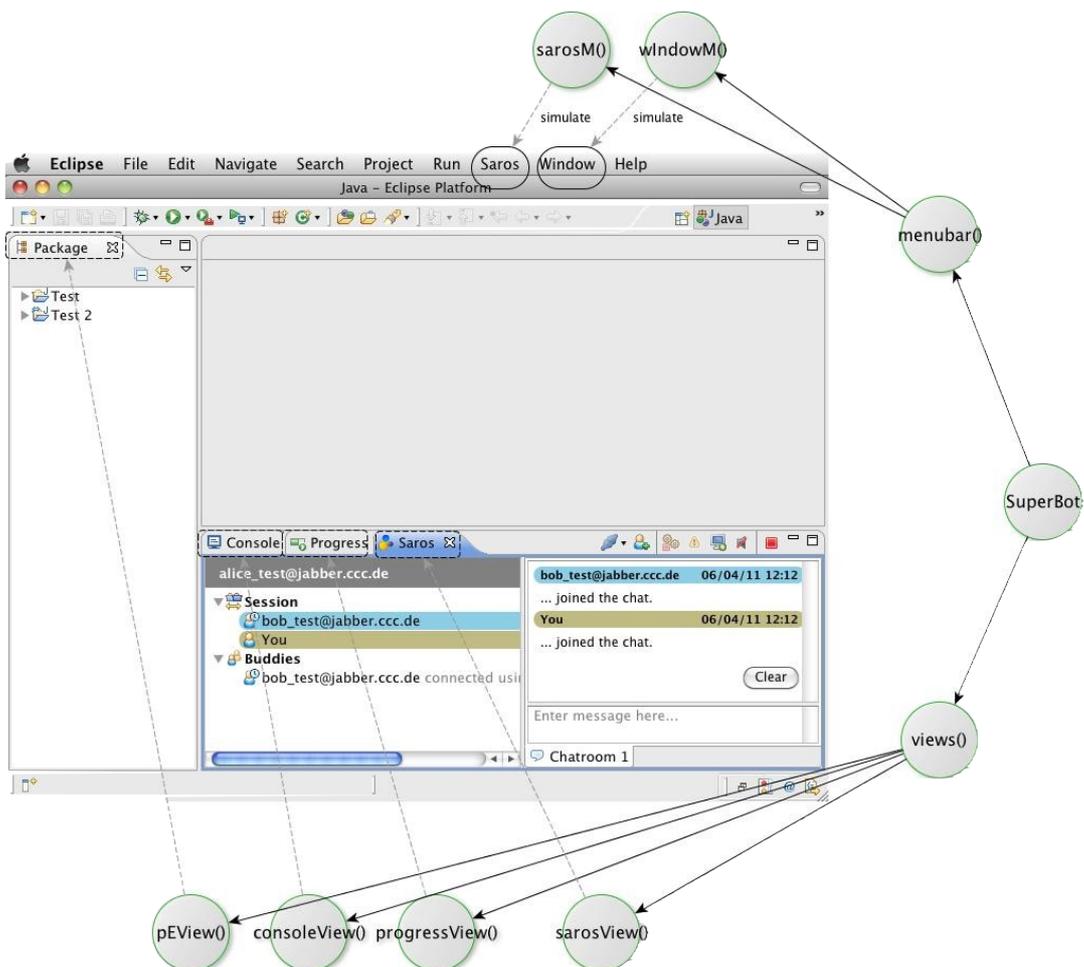
Rule: If the last click triggered another event, the corresponding method also needs to treat the event.

Simulate menubar and views

Currently, there are two menu objects SarosM and WindowM which represent Saros'- and Window's- main menus. They can be accessed with

```
superBot().menubar().Saros();  
superBot().menubar().window();
```

The other main menus' actions can be also be performed with contextMenus, so i have decided to implement them only in contextMenu objects. The reason for it is that our test framework should focus on Saros features not Eclipse, so only Eclipse actions needed by Saros are implemented. The following diagram shows you which elements of the Eclipse workbench are simulated with objects.



Simulate the contextMenu dynamically

The contextMenu is dynamically changed according to the currently selected widget. So I've defined two contextMenu wrappers: one is specified for Eclipse, the for Saros. They can only be called when you first selected a widget.

For example, to delete a project, you need to do the following:

1. Open and activate the packageExplorerView.
2. Select the Java project.
3. Click contextMenu "Delete".
4. Confirm the popUpWindow "Delete Resources" with OK.

The four click actions can be easily interpreted with the following method chaining:

```
superbot().views().packageExplorerView().selectJavaProject("Foo-Bar").delete();
```

The contextMenu "delete" is only called if the to-be-deleted project is selected. And according to the rule defined before the last contextMenu "Delete" triggers a popupWindow, so the function delete() needs to handle 3 and 4 steps.

Another example to create a project you need to do the following:

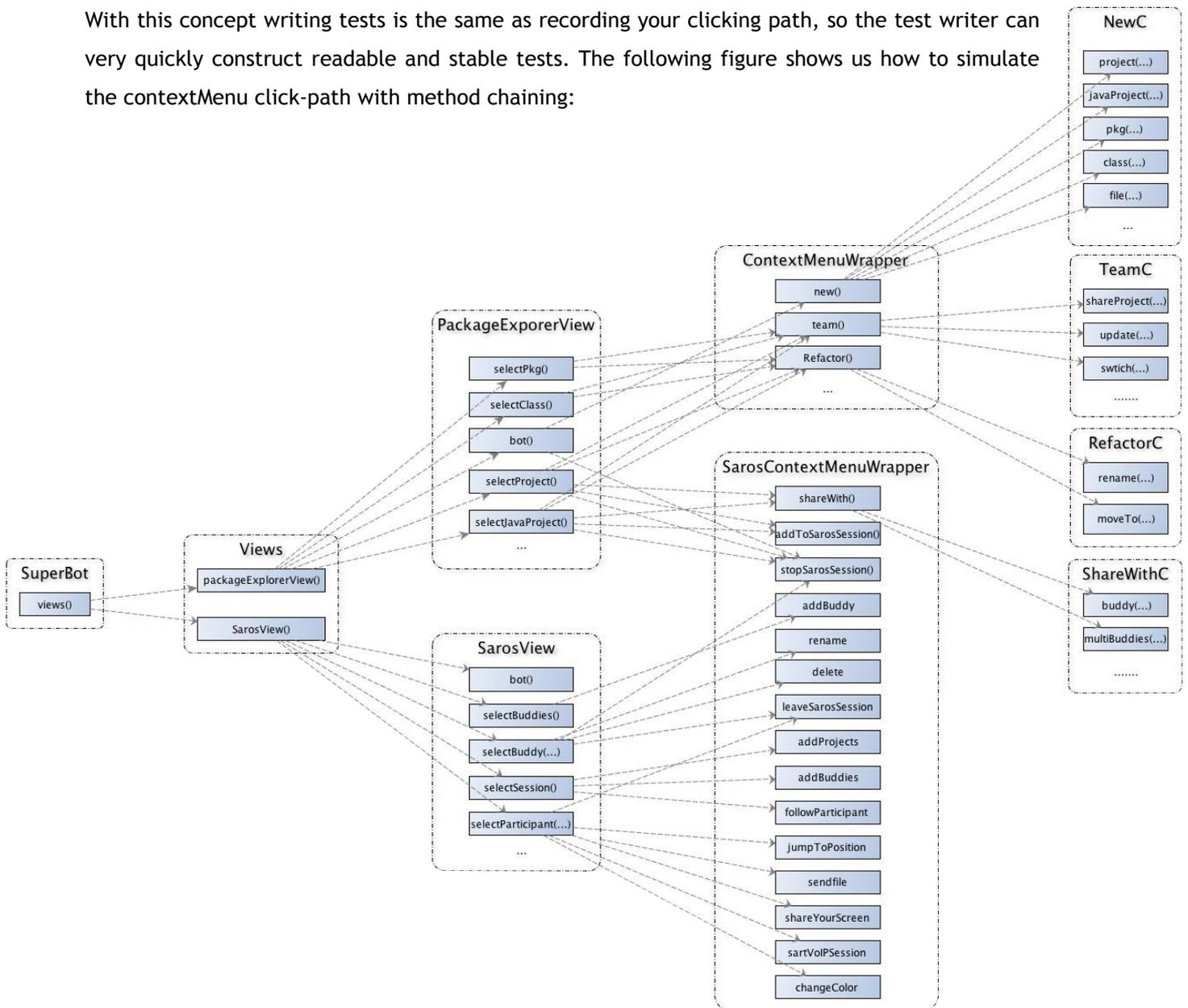
1. Open and activate the packageExplorerView.
2. Focus on the content of the packageExplorerView
3. Click the contextMenu "New"->"Project".

4. Confirm the popUpWindow “New Project” with OK.

The corresponding method chaining looks like:

```
superbot().views().packageExplorerView().bot().newC().project("Foo-bar");
```

With this concept writing tests is the same as recording your clicking path, so the test writer can very quickly construct readable and stable tests. The following figure shows us how to simulate the contextMenu click-path with method chaining:



SuperRemoteBot APIs introduction

SuperBot APIs consists of predefined methods that gather several RemoteBot operations which are commonly used SuperBot we can both do “alice add new Buddy bob”.

With RemoteBot:

```
ALICE.bot().view("Saros").toolbarButton("Add a New Buddy").click();
ALICE.bot().waitUntilShellIsOpen("Add Buddy");
ALICE.bot().shell("Add Buddy").activate();
ALICE.bot().shell("Add Buddy").bot()
ALICE.bot().shell("Add Buddy").bot().comboBoxWithLabel("XMPP/Jabber ID").setText(bob.getJID().getBase());
ALICE.bot().shell("Add Buddy").bot().button("Finish").waitUntilIsEnabled();
ALICE.bot().shell("Add Buddy").bot().button("Finish").click();
BOB.bot().waitUntilShellIsOpen("Request of Subskription Received");
BOB.bot().shell("Request of Subskription Received").activate();
BOB.bot().shell("Request of Subskription Received").bot().button("Ok").click();
```

With SuperBot:

```
ALICE.superBot().views().sarosView().addANewBuddy(bob.getJID());
BOB.superBot().confirmShellRequestOfSubscriptionReceived();
```

As you see, the test code written with SuperBot is very concise. So SuperBot is very suitable to quickly build a test environment for your test cases; and Bot is useful to test some details by performing a task, e.g. test add account with invalid server name.

9 Write robust tests

This chapter provides step-by-step instructions for writing JUnit tests with STF.

Well-designed test cases

It's time to begin with writing tests. The effort put into creating well-designed test suites is to satisfy the following fundamental objectives.

They must be

- › maintainable
- › modular
- › robust
- › well documented
- › and they should be built of reusable components

The ideal test should possess those attributes.⁴

A test case Is Independent

Why independent?

- › If a test case relied on the results of the previous test case, then if the first test case would failed, it would most likely cause a failure of the preceding test case. Such cascading errors would make it very difficult to find the root cause of these failures.
- › The maintainer should be able to choose a subset of test cases to run without having to concern the interdependencies between test cases. I.e. test cases should be executable in any sequence, unconscious reordering of the test case execution (e.g. by a tester or testing framework) could cause a chain of failures in a test suite which executed faultlessly the previous day.

⁴ Fewster, Graham 1994, 527; Myers 2004, 43-44.

Solution

Every test case has to take care of its own setup, verification, and clean-up.

- › In the setup phase, the application should be brought to a state where the actual test can be executed.
- › In the verification phase, the actual testing is performed, and the results are evaluated to a pass/fail status.
- › The clean-up phase should bring the application back to a state of before the setup - the so-called base state - to make it ready for the next test.

Compromise

Absolute independent is sometimes hard to apply in practice. For tests that modify a complex global state (e.g. creating or modifying a database), starting all tests from zero for each test case would be far too expensive. In such situations, test cases relying on specific states can be grouped together, but the interdependencies between them should be well documented to help future maintainers to analyze such a test suite.⁵

A test case has a single purpose

An ideal test case should have a single purpose. This should help keeping the code relatively short and simple to make it easy to understand, debug, and maintain. Moreover, it also means that the outcome of the test case should always be one of the two: pass or fail. This makes it much easier to interpret the results. In case of failure of a single purpose test case, it is trivial to locate the application function at fault. This implicates that a test suite should consist of many smaller test cases instead of a few large ones.⁶

⁵ Fewster, Graham 1994, 527.

⁶ Fewster, Graham 1994, 527-528.

Unsuccessful test case should not cause others to fail

A test case that fails due to an unexpected error leaves the application in an unknown state. The AUT is out of synch with what the test case is expecting. A well-behaved test should log the failure, abort and re-set the application to a known base state. It is the task of a test tool to isolate test case failures so that an unexpected error in one test case does not cause the whole script to abort. All of the most popular GUI test tools provide this functionality.⁷

A test case is well documented

As already mentioned, one of the advantages of writing a good test design is that you can take the test case description from this document and use it as header comments in the test code. Of course, also in-line comments should be used to describe the logic when necessary. Take the header comments for each test case from the test plan. Make the code easy to maintain. Comment and document well, especially any workarounds and interdependencies in the test code. All attributes discussed in chapter 2.6 make up requirements for well-designed test cases.⁸

⁷ Fewster, Graham 1994, 528.

⁸ Fewster, Graham 1994, 528.

Standardized error recovery

There are many things besides a bug in the AUT which can cause a test case to fail. It could be

- › a bug in the testing code,
- › an environmental error (e.g. network connection down, no disk space),
- › an intentional change in the application,
- › an excessive machine load causing timing errors, etc.

The problem is that when the test crashes, it leaves the application in an unknown state and unless some actions are taken to reset the AUT to a known state, subsequent tests are likely to fail. A base state is usually main window open, active, and not minimized (just as if the application was just started).

A good practice is to implement the capability of recovering to a state which would allow the continuation with next test cases. A recovery routine could be for instance:

- › Log the error
- › Abort the test case (because it is in an unknown state)
- › Attempt to come back to a known state (e.g. close all opened windows till the main window is active).
- › Resume execution with the next test case

Implementing those steps should allow execution of the consequent test cases.⁹

⁹ Fewster, Graham 1994, 528-533.

Describing STF test code

This chapter familiarizes the reader with the basic elements of the STF test.

The structure of JUnit tests

@BeforeClass

The annotation precedes a setUpBeforeClass() method. This method will be run once before any of the test methods in the class.

```
@BeforeClass
public static void runBeforeClass() throws RemoteException {
    .....
}
```

In @BeforeClass you first need to specify which testers should be initialized. Initialized testers can use the references remoteBot and superBot to drive the Eclipse UI.

```
@BeforeClass
public static void runBeforeClass() throws RemoteException,InterruptedException {
    initTesters(ALICE, BOB);
    .....
}
```

Then clean up the Eclipse workbench with setUpWorkbench(), which closes all opened editors, popUp windows and unnecessary views, delete all existing projects and switch to the Java perspective.

```
@BeforeClass
public static void runBeforeClass() throws RemoteException {
    ....
    setUpWorkbenchs();
    ....
}
```

Besides cleaning up the workbench we need to build the basic test environment like open all Saros views, check if all testers are in contact, connected, etc. Otherwise, automaticReminder sends surveys regularly that interrupt the testings, so it's strongly recommended to disable automaticReminder before testing. All of this can be done by using the method **setUpSaros()** defined in the superclass.

```
@BeforeClass
public static void runBeforeClass() throws RemoteException {
    ....
    setUpSaros();
    ....
}
```

If all test cases are based on a session, you can use the method `Util.setUpSessionWithProjectAndClass` to quickly building a session.

```
@BeforeClass
public static void runBeforeClass() throws RemoteException {
    ....
    setUpSessionWithJavaProjectAndClass(ALICE, BOB);
}
```

@AfterClass

The annotation precedes the afterClass() method. If expensive external resources were allocated in the BeforeClass method, they have to be released after all the tests in the class have run. All @AfterClass methods are guaranteed to run even if the BeforeClass method throws an exception.

Bring the AUT back to a state of before the setup - the so-called base state - to prepare it for the next test. The function resetSaros defined in the superClass ensures that the buddies name changed by rename-actions are reset, connections are disconnected and all existing projects are deleted.

```
@AfterClass
public static void afterClass() throws Exception {
    resetSaros();
}
```

If an additional after-class condition is needed, you can define a new method runAfterClass() in your test case, e.g. in this example, you want users to leave the sessions after every test method.

```
@AfterClass
public static void runAfterClass() throws RemoteException {
    leaveSessionHostFirst(alice);
}
```

@Before

The StfTestCase class have no default @Before Method.

@After

The StfTestCase class have no default @After Method.

You can define your own @Before and @After functions with different names, if you don't want to override the before() and after() of the superclass. E.g. for the test case "SarosViewTest" we've defined the additional conditions that before testing each test, all testers should be in a session, so using the method rebuildSession(Inviter, invitee...) guarantees the precondition. The @After function is responsible of resetting the session state, i.e. removes all existing follow modes.

```
@Before
public void runBeforeEveryTest() throws RemoteException {
    rebuildSession(ALICE, BOB);
}

@After
public void runAfterEveryTest() throws RemoteException {
    resetFollowModel(ALICE, BOB);
}
```

@Test

The annotation tells JUnit that the public void method to which it is attached can be run as a test case. To run the method, JUnit first constructs a fresh instance of the class and then invokes the annotated method. Any exceptions thrown by the test will be reported by JUnit as a failure. If no exceptions are thrown, the test is assumed to have succeeded.

```
public class BuddiesViewTest {  
  
    @Test  
    public void addition() {  
        assertEquals(12, calculator.add(7, 5));  
    }  
  
    @Test  
    public void subtraction() {  
        assertEquals(9, calculator.subtract(12, 3));  
    }  
}
```

Write tests with RemoteBot and SuperBot

Create a new Java project with the following click steps:

1. Open and activate the package explorer view
2. Focus on the content of the view
3. Click the contextMenu New->Java Project
4. Confirm the window “New Java Project”

With SuperBot:

```
ALICE.superBot().views().packageExplorerView() // 1  
    .bot() // 2  
    .newC().javaProject("Foo-Bar"); // 3, 4
```

With RemoteBot:

```
// 1
if (!ALICE.bot().isViewOpen("Package Explorer")) {
    ALICE.bot().openViewById("Package Explorer ID");
}
ALICE.bot().view("Package Explorer").show();
// 2
ALICE.bot().view("Package Explorer").bot().tree()
// 3
    .contextMenu("New", "Java Project").click();
// 4
if (!ALICE.bot().isShellOpen("New Java Project"))
    ALICE.bot().waitUntilShellsOpen("New Java Project");
ALICE.bot().shell("New Java Project").activate();
ALICE.bot().shell("New Java Project").bot()
    .textWithLabel("Project Name").setText("Foo-Bar");
ALICE.bot().shell("New Java Project").bot().button("Finish").click();
ALICE.bot().waitUntilShellsClosed("New Java Project");
```

Delete a buddy with the following click steps:

1. Open and activate the Saros buddies view.
2. Select the buddy whom you want to delete in the buddies list.
3. Click the contextMenu "Delete".
4. Confirm the window "Remove of Subscription".

With SuperBot:

```
ALICE.superBot().views().sarosView() // 1
    .selectBuddy(BOB.getJID()) // 2
    .delete(); // 3
BOB.superBot().confirmShellRemovelOfSubscription(); // 4
```

With RemoteBot:

```
if (!ALICE.bot().isViewOpen("Saros")) {
    alice.bot().openViewById("SarosID");
}
ALICE.bot().view("Saros").show(); // 1
ALICE.bot().view("Saros").bot().tree()
    .selectTreeItem(bob.getBaseJid()) // 2
    .contextMenu("Delete").click(); // 3
ALICE.bot().waitUntilShellIsOpen("Removal of Subscription");
ALICE.bot().shell("Removal of Subscription").activate();
ALICE.bot().shell("Removal of Subscription").confirm(OK); // 4
```

Guidelines

Internal implementation of RemoteWorkbenchBot

Normally you should not care about internal details, but from time to time this may be necessary. RemoteWorkbenchBot has two bots, one SarosWorkbenchBot which will never change and a SWTBot which will change all the time. Due to its implementation of RemoteWorkbenchBot this SWTBot instance is saved in a variable

```
IRemoteBotTree tree = ALICE.remoteBot().tree(); // tree is managed by a SWTBot call him a0
IRemoteBotShell shell = ALICE.remoteBot().shell().bot(); // the internal SWTBot a0 is override first by the call
//of ALICE.remoteBot() and then replaced with another bot from shell().bot()
```

To keep stuff simple. Only cache shells or views, and when you cache them, **never** cache the bots that are returned and only cache **one instance** of a shell or view. Superbot uses its own SWT(Workbench)bots and will not interfere with RemoteWorkbenchBot.

Concurrency where you won't expect it

Let us take this simple method call:

```
BOB.superBot().views().sarosView().selectParticipant(ALICE.getJID()).followParticipant();
```

At first glance this seems to be straightforward but it is not. During each method call we are synchronizing on the UI thread. Because our RMI connection is run on its own thread

and Saros is running in another thread, Saros is able to change UI data as well while we are executing those methods. That can result in some illegal states, where the widgets are now disposed or have no parent anyone. Before you call such methods, **always** make sure that Saros will not disturb you on this operations.

If you read data out from widgets such as trees or tables just wait a little while before you call the necessary methods or there is a chance that you do not fetch the whole data.

Do not expect that a contact is in your roster

If you forgot to call `initTester()` with all required participants, a former test case may have deleted that contact and so it will not be available on the roster.

Do expect that a contact in your roster change its name

If you work with RemoteBot make sure when you are selecting an item in a tree or table to use a regular expression or else the test case will randomly fail.

E.g. Before the session starts: roster entry is [bob@foo.bar](#). Then in the current session the roster entry might change to [bob@foo.bar \[Socks5\]](#)

Always wait until all files are shared

Never use `waitUntilInSession()`. You will get unexpected results if you are start any actions with the testers. Always use the method

```
XXX.superBot().views().packageExplorerView().waitUntilResourceIsShared(...)
```

Other stuff you should take care about

All Superbot methods that will return a boolean value will not throw any exception. If your test case fails, you have to look at log file if there was no internal error.

Be careful with boolean assert statements, see “Concurrency where you won't' except it”. These methods (at least in Superbot) will not wait and then return false, they do only a quick check. E.g. Saros thread starts to fill a tree. Saros put A to the tree. You query the tree for B and it return false. 100 milliseconds later Saros put B into the tree but your test case failed although all went well.

If you are accessing menus from the workbench, always activate the workbench first.

TimeoutExceptions are thrown if your current condition has failed to match the criteria or if you invoke an operation on a widget which can't be done (e.g clicking on a button in a shell which is not enabled).

WidgetNotFoundExceptions are thrown if the widget could not be found (e.g ALICE.remoteBot().shell("Foo"); and this shell is not available). Please keep in mind that the SWTBot will wait up to 5 seconds and constantly polling for that widget before this exception is thrown.

It is up to you to catch these exceptions and make the test case fail or pass them to the JUNIT framework which will report them as errors.

Use the @After annotation carefully. The Stf Client takes automatically screen-shots of failed test cases. If you are using @After annotation and that method will also throw an exceptions, no screen-shot will be taken.

Do not override the default @AfterClass method if you do not have a really good reason !

Example Test cases

Make sure that you can automate that test case. In general you cannot test the L&F that means you cannot check if a sound is played, or some images changed during certain actions.

Login into Test Link and check that the test case you want to write does not already exist or is already tested as part of another test case.

Write down the specification of that test case. This **should take some time !** (at least 10 – 20 minutes if necessary). If you have written down your specification reread it.

Ask yourself:

- Are there no ambiguities ?
- Is every step and the expected result well documented ?
- Can you write this test case from scratch without any problems if you read the specification a half year later ?

Write down what the test case is intended to test. (Summary)

Use the precondition field if you need one or to shorten the necessary steps. E.g. Alice and Bob are in a shared session.

Insert a unique identifier in the TestLinkID Label.

The screenshot shows a TestLink test case page. At the top, the title is "Saros-117:Sort online buddies over offline". Below the title are several action buttons: "Löschen", "Verschieben / Kopieren", "Version löschen", "Neue Version erstellen", "Version deaktivieren", "Exportieren", "Vergleiche Versionen", and "Druckansicht". A blue banner below the buttons states: "Sie können diese Version nicht verändern, da Sie schon ausgeführt wurde!". The main content area contains the following information:

- Version 2**
- Erstellt 28.06.2011 21:25:15 von rossbach
- Letzte Änderung 28.06.2011 21:41:48 von rossbach
- Zusammenfassung**
- Vorbedingungen**
- Bob and Carl are connected to the same XMPP server. Alice roster contains Bob and Carl as buddies.
- Bobs nickname or JID must be < Carls nickname or JID when compared as strings.

#	Schritt Aktionen	Erwartete Ergebnisse	Ausführung
1	Alice connects successfully to the XMPP server	Bob is listed before Carl in Alice roster view	Automatisch
2	Bob successfully disconnects from the XMPP server	Carl is listed before Bob in Alice roster view	Automatisch
3	Bob successfully connects to the XMPP server	Bob is listed before Carl in Alice roster view	Automatisch
4	Bob and Carl successfully disconnects from the XMPP server	Bob is listed before Carl in Alice roster view	Automatisch

Below the table, the execution type is "Ausführungstyp : Automatisch" and the test weight is "Test Gewichtung : Niedrig". At the bottom, there is a "TestLinkID" field containing the value "Saros-117_sort_online_buddies_over_offline" and a "Stichworte" field with the value "Keine".

Illustration 1: An example TestLink test

Please note that you are limited to the following characters in the ID:

[A-Z],[a-z],[0-9], -, _

Below follows the implementation of the test case:

```
package de.fu_berlin.inf.dpp.stf.test.rosterviewbehaviour;

import static de.fu_berlin.inf.dpp.stf.client.testers.SarosTester.ALICE;
import static de.fu_berlin.inf.dpp.stf.client.testers.SarosTester.BOB;
import static de.fu_berlin.inf.dpp.stf.client.testers.SarosTester.CARL;
import static org.junit.Assert.assertEquals;
import static org.junit.Assert.assertTrue;

import java.rmi.RemoteException;
import java.util.List;

import org.junit.BeforeClass;
import org.junit.Test;

import de.fu_berlin.inf.dpp.stf.annotation.TestLink;
import de.fu_berlin.inf.dpp.stf.client.StfTestCase;

@TestLink(id = "Saros-117_sort_online_buddies_over_offline")
public class SortBuddiesOnlineOverOfflineTest extends StfTestCase {

    @BeforeClass
    public static void selectTesters() throws Exception {
        select(ALICE, CARL, BOB);
    }
}
```

```
@Test
public void testSortBuddiesOnlineOverOffline() throws RemoteException
{

    // wait for roster update
    ALICE.remoteBot().sleep(1000);

    List<String> buddies = ALICE.superBot().views().sarosView()
        .getAllBuddies();

    assertTrue("corrupted size on roster", buddies.size() >= 2);
    assertEquals(BOB.getBaseJid(), buddies.get(0));
    assertEquals(CARL.getBaseJid(), buddies.get(1));

    checkBuddiesOrder(buddies, 2);

    BOB.superBot().views().sarosView().disconnect();
    BOB.superBot().views().sarosView().waitUntilIsDisconnected();

    // wait for roster update
    ALICE.remoteBot().sleep(1000);

    buddies = ALICE.superBot().views().sarosView().getAllBuddies();

    assertTrue("corrupted size on roster", buddies.size() >= 2);
```

```
assertEquals(CARL.getBaseJid(), buddies.get(0));

checkBuddiesOrder(buddies, 1);

BOB.superBot().views().sarosView()
    .connectWith(BOB.getJID(), BOB.getPassword());
BOB.superBot().views().sarosView().waitUntilIsConnected();

// wait for roster update
ALICE.remoteBot().sleep(1000);

buddies = ALICE.superBot().views().sarosView().getAllBuddies();

assertTrue("corrupted size on roster", buddies.size() >= 2);
assertEquals(BOB.getBaseJid(), buddies.get(0));
assertEquals(CARL.getBaseJid(), buddies.get(1));

checkBuddiesOrder(buddies, 2);

BOB.superBot().views().sarosView().disconnect();
CARL.superBot().views().sarosView().disconnect();

BOB.superBot().views().sarosView().waitUntilIsDisconnected();
CARL.superBot().views().sarosView().waitUntilIsDisconnected();

// wait for roster update
```

```
ALICE.remoteBot().sleep(1000);

buddies = ALICE.superBot().views().sarosView().getAllBuddies();

assertTrue("corrupted size on roster", buddies.size() >= 2);
checkBuddiesOrder(buddies, 0);

}

private void checkBuddiesOrder(List<String> buddies, int s) {
    for (int i = s; i < buddies.size() - 1; i++)
        assertTrue("roster is not sorted asc. : " + buddies.get(i) +
" > "
            + buddies.get(i + 1),
            buddies.get(i).compareTo(buddies.get(i + 1)) <= 0);
}
}
```

Another test case which could not be tested manual because you cannot click that fast:

```
package de.fu_berlin.inf.dpp.stf.test.session;

import static de.fu_berlin.inf.dpp.stf.client.testers.SarosTester.ALICE;
import static de.fu_berlin.inf.dpp.stf.client.testers.SarosTester.BOB;
import static de.fu_berlin.inf.dpp.stf.client.testers.SarosTester.CARL;
import static org.junit.Assert.assertEquals;
import static org.junit.Assert.fail;

import org.junit.BeforeClass;
import org.junit.Test;

import de.fu_berlin.inf.dpp.stf.client.StfTestCase;
import de.fu_berlin.inf.dpp.stf.client.testers.AbstractTester;
import de.fu_berlin.inf.dpp.stf.client.util.Util;
import de.fu_berlin.inf.dpp.stf.shared.Constants.TypeOfCreateProject;

public class CreateSameFileAtOnce extends StfTestCase {

    @BeforeClass
    public static void selectTesters() throws Exception {
        select(ALICE, BOB, CARL);
    }

    @Test
```

```
public void testCreateSameFileAtOnce() throws Exception {
    ALICE.superBot().internal().createProject("foo");
    Util.buildSessionSequentially("foo", TypeOfCreateProject.NEW_PRO-
JECT,
        ALICE, BOB, CARL);

    BOB.superBot().views().packageExplorerView()
        .waitUntilResourceIsShared("foo");
    CARL.superBot().views().packageExplorerView()
        .waitUntilResourceIsShared("foo");

    if ((System.currentTimeMillis() & 1L) != 0L) {
        BOB.superBot().internal()
            .createFile("foo", "readme.txt", BOB.toString());
        CARL.superBot().internal()
            .createFile("foo", "readme.txt", CARL.toString());
    } else {
        CARL.superBot().internal()
            .createFile("foo", "readme.txt", BOB.toString());
        BOB.superBot().internal()
            .createFile("foo", "readme.txt", CARL.toString());
    }

    ALICE.remoteBot().sleep(5000);
    ALICE.superBot().views().packageExplorerView()
        .selectFile("foo", "readme.txt").open();
}
```

```
ALICE.remoteBot().editor("readme.txt").waitUntilIsActive();

String aliceText = ALICE.remoteBot().editor("readme.txt").get-
Text();

BOB.superBot().views().packageExplorerView()
    .selectFile("foo", "readme.txt").open();
BOB.remoteBot().editor("readme.txt").waitUntilIsActive();

String bobText = BOB.remoteBot().editor("readme.txt").getText();

CARL.superBot().views().packageExplorerView()
    .selectFile("foo", "readme.txt").open();
CARL.remoteBot().editor("readme.txt").waitUntilIsActive();

String carlText = CARL.remoteBot().editor("readme.txt").getText();

if (bobText.equals(aliceText) && carlText.equals(aliceText))
    return; // already corrected

AbstractTester tester = null;

if (aliceText.equals(bobText))
    tester = CARL;
else if (aliceText.equals(carlText))
    tester = BOB;
```

```

else {
    fail("the content of Alice editor: '" + aliceText
        + "' is not expected, it must be '" + BOB.toString() + "'
or '"
        + CARL.toString() + "'");
    return; // just for get rid of the null pointer warning
}

tester.superBot().views().sarosView()
    .waitUntilIsInconsistencyDetected();
tester.superBot().views().sarosView().resolveInconsistency();

tester.superBot().views().packageExplorerView()
    .selectFile("foo", "readme.txt").open();
tester.remoteBot().editor("readme.txt").waitUntilIsActive();

String repairedText = tester.remoteBot().editor("readme.txt").get-
Text();
assertEquals(aliceText, repairedText);
}
}

```

source:
[F2]

References

[F1] QATestLab, *Beyond Regression Tests*, URL: <http://blog.gatestlab.com/2011/03/16/beyond-regression-tests/>

[F2] Alessandro Rei, Dark Glass, URL: <http://kde-look.org/content/show.php/Dark-Glass+reviewed?content=67902>