Maintaining Traceability Links with Cha-Q's MaTraca

Presenters: Angela Lozano, Tars Joris

Cha-Q inventivedesigners

Maintaining Traceability Links with Cha-Q's MaTraca

Angela Lozano
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twitter: @ang_loza

Dependencies across technologies

Presentation

HTML
CSS
Javascript
Flash
Java applets
ActiveX controls
Silverlight
App. server
Web server
Content management system

Business logic

C#, Java, VB, PHP, Perl, Python, Beans, Servlets, CGI, ASP.NET

Replication, security, concurrency, distribution, load balancing

Sockets, HTTP, EMail, SMS, SOAP, REST, Rails, AJAX

Storage

SQL, NoSQL, Files

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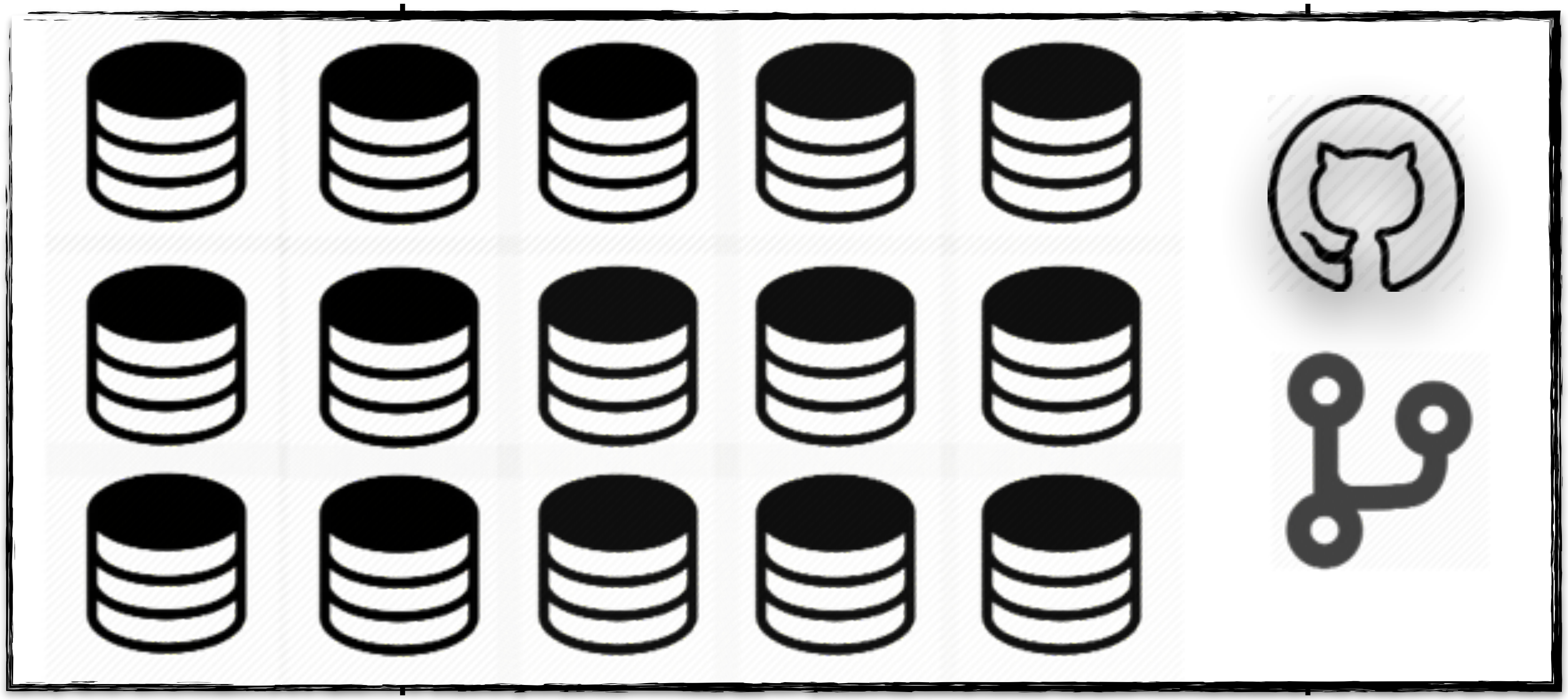

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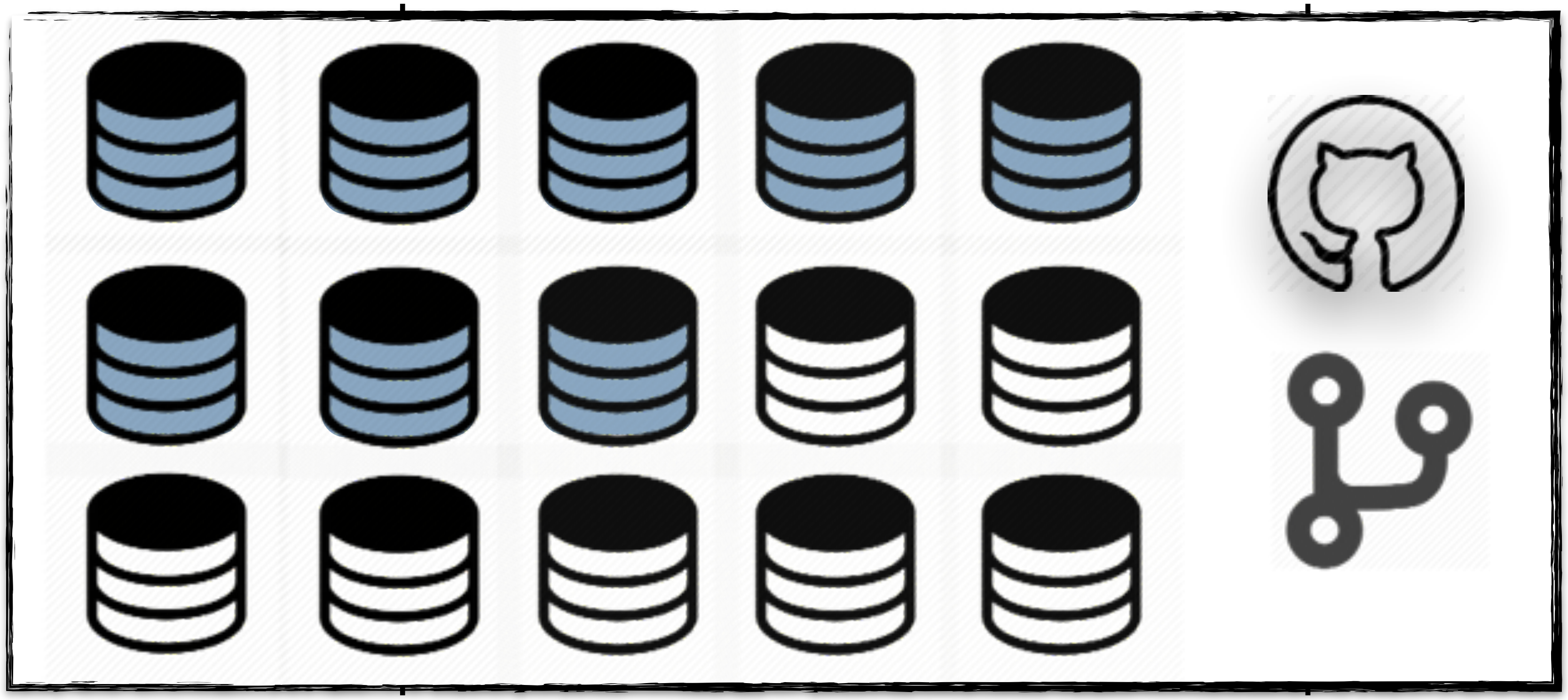

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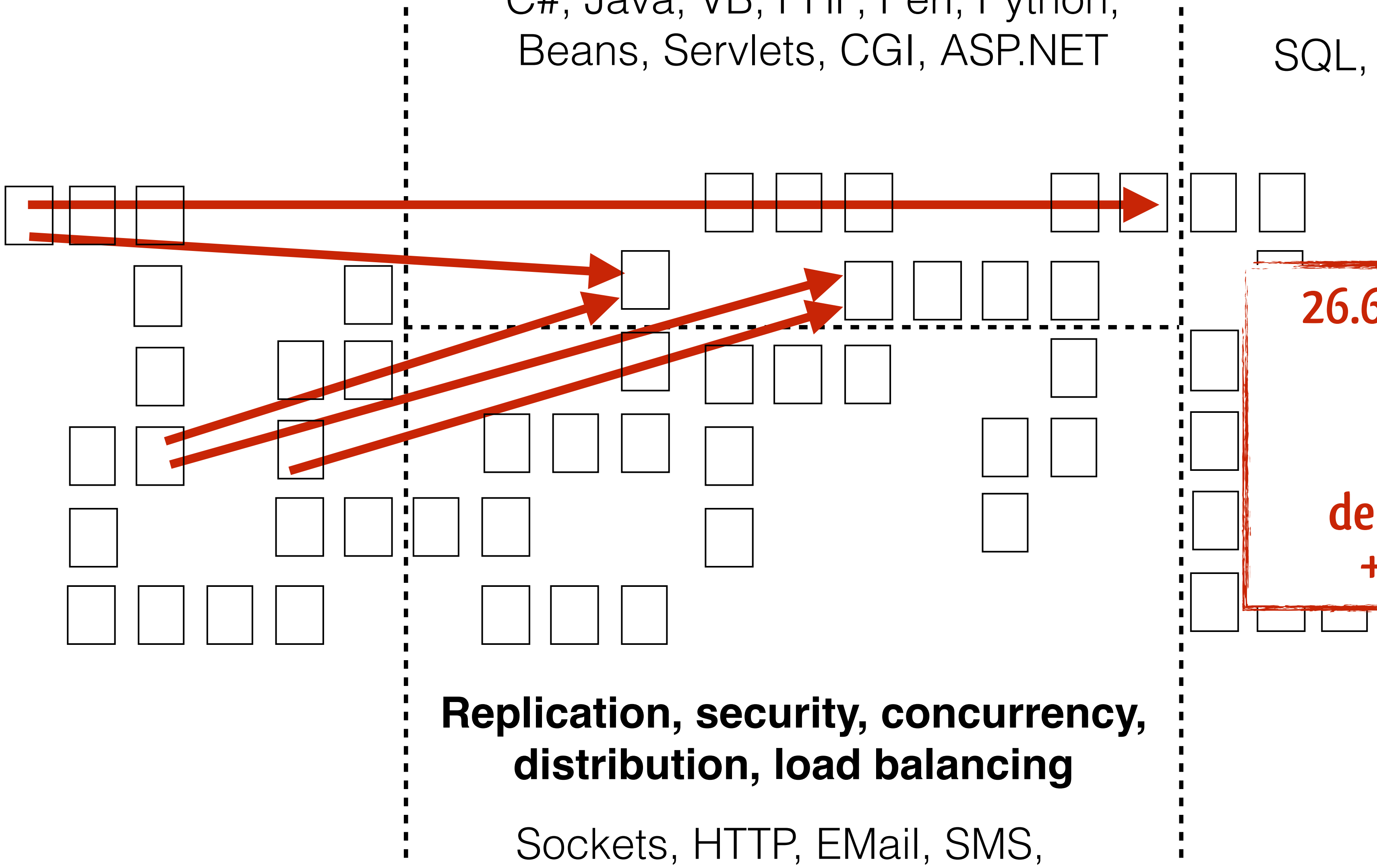

26.6 million builds
9 month
@ Google

dependencies =
+50% errors

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Dependencies across technologies

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e

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ecurity, concurrency,
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Can we help to reduce problems due to cross-technology dependencies?

Which technology first?

Maintaining Traceability Links with Cha-Q's MaTraca

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Tars Joris
Scrum Master & Development Team Manager
inventivedesigners

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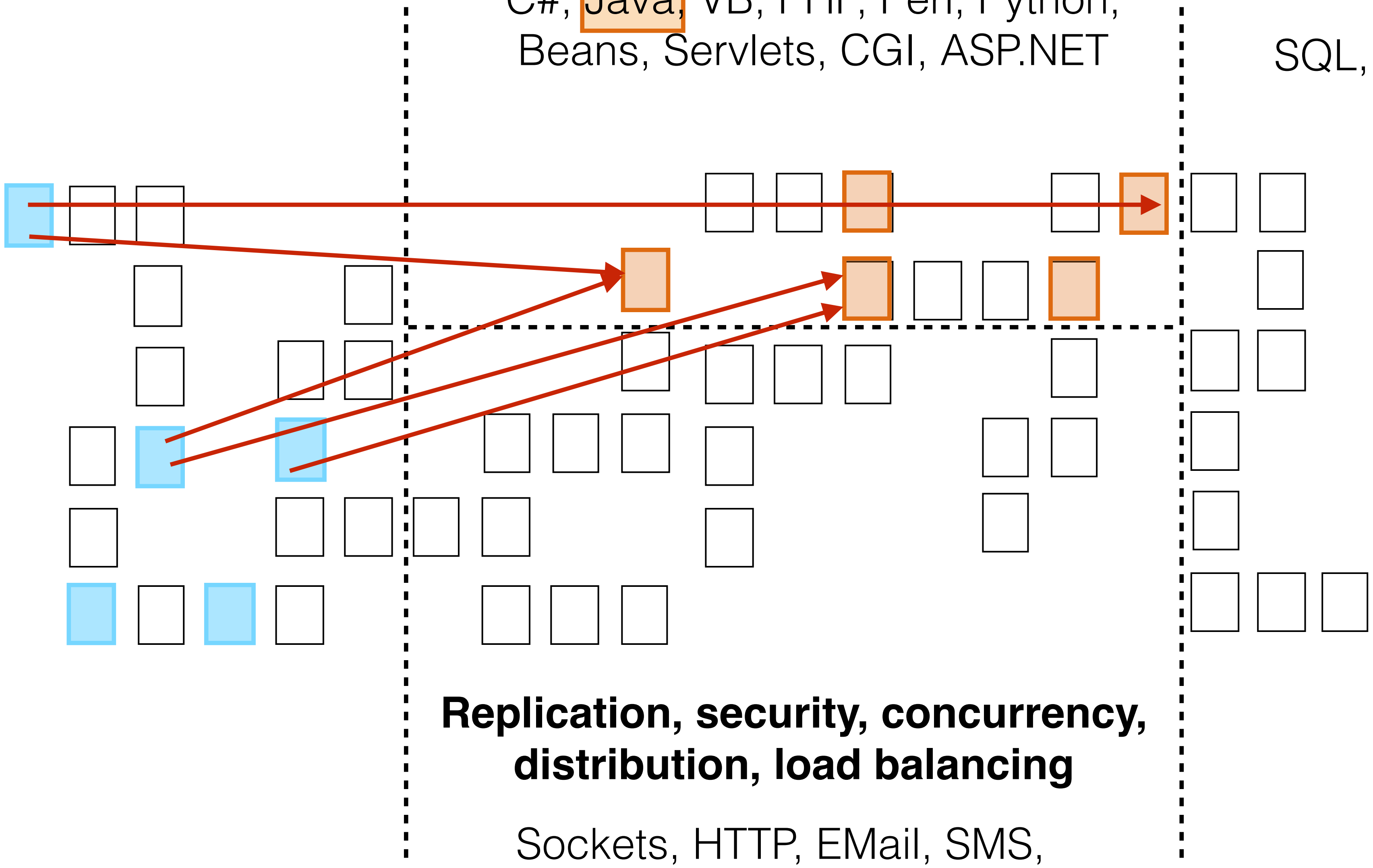

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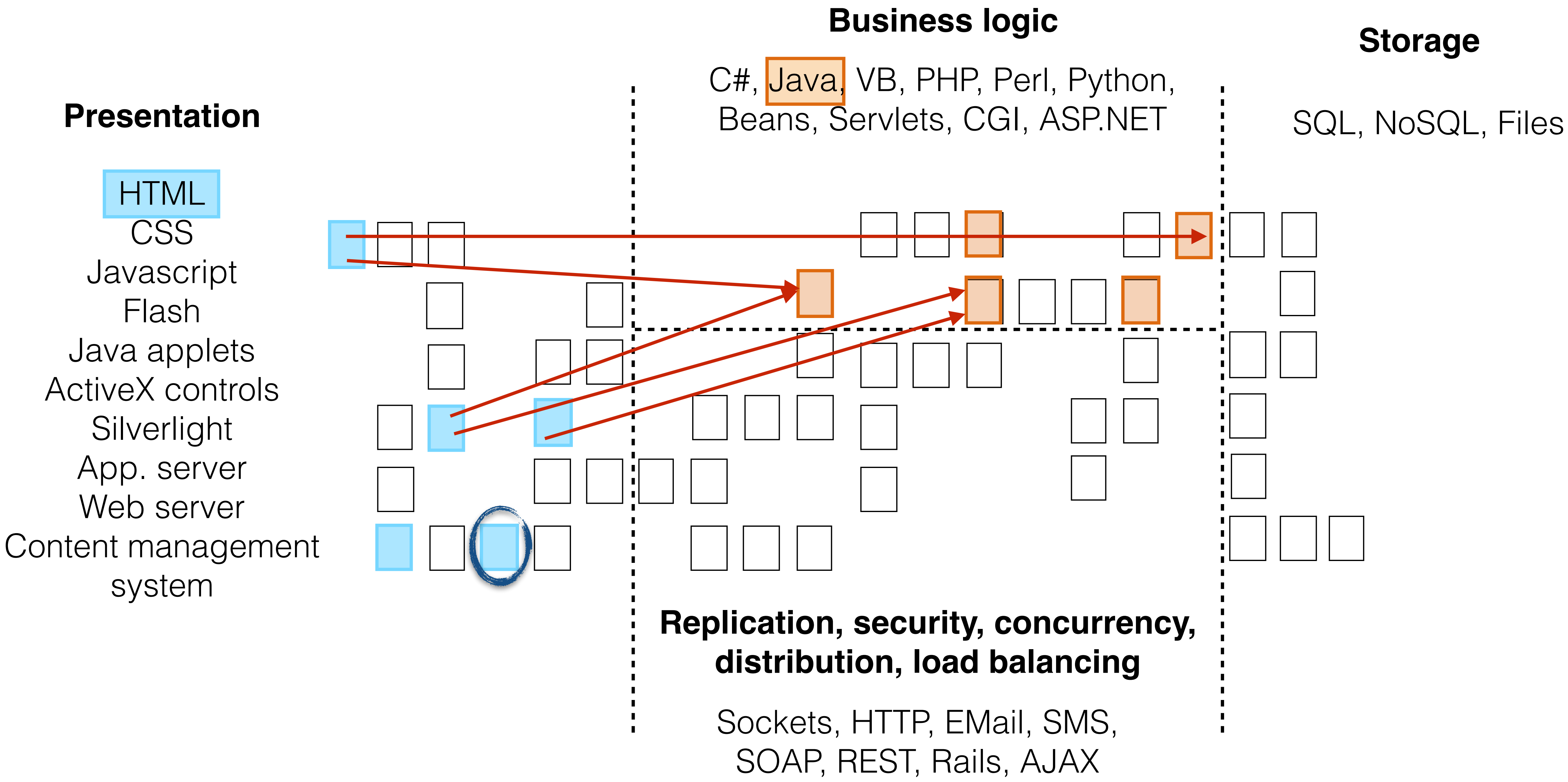

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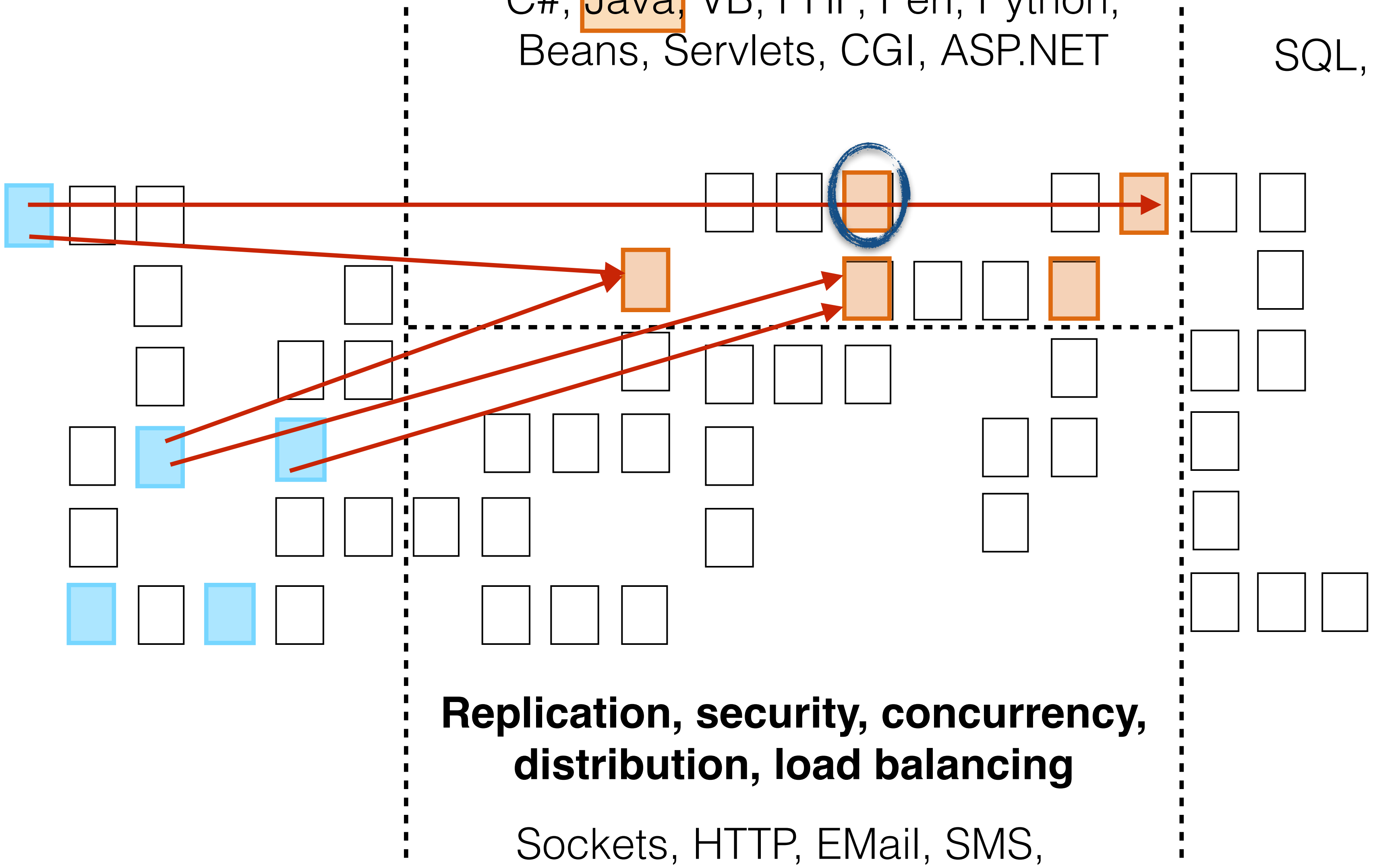

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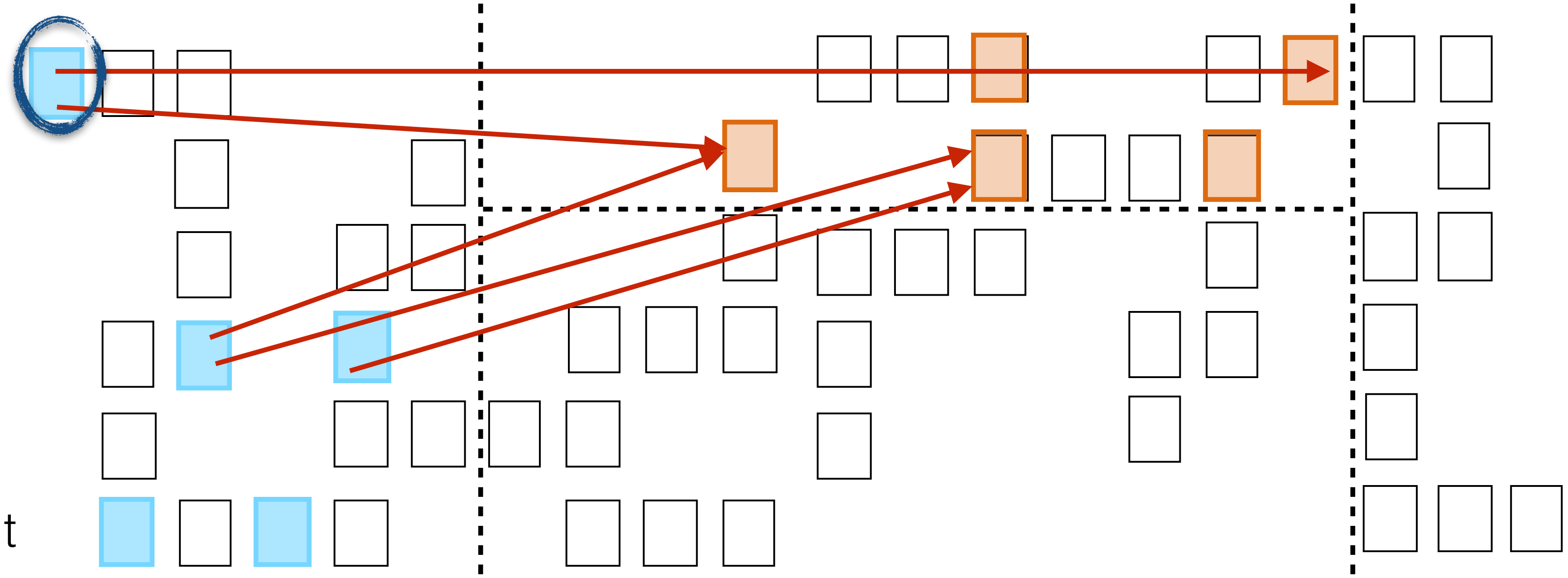

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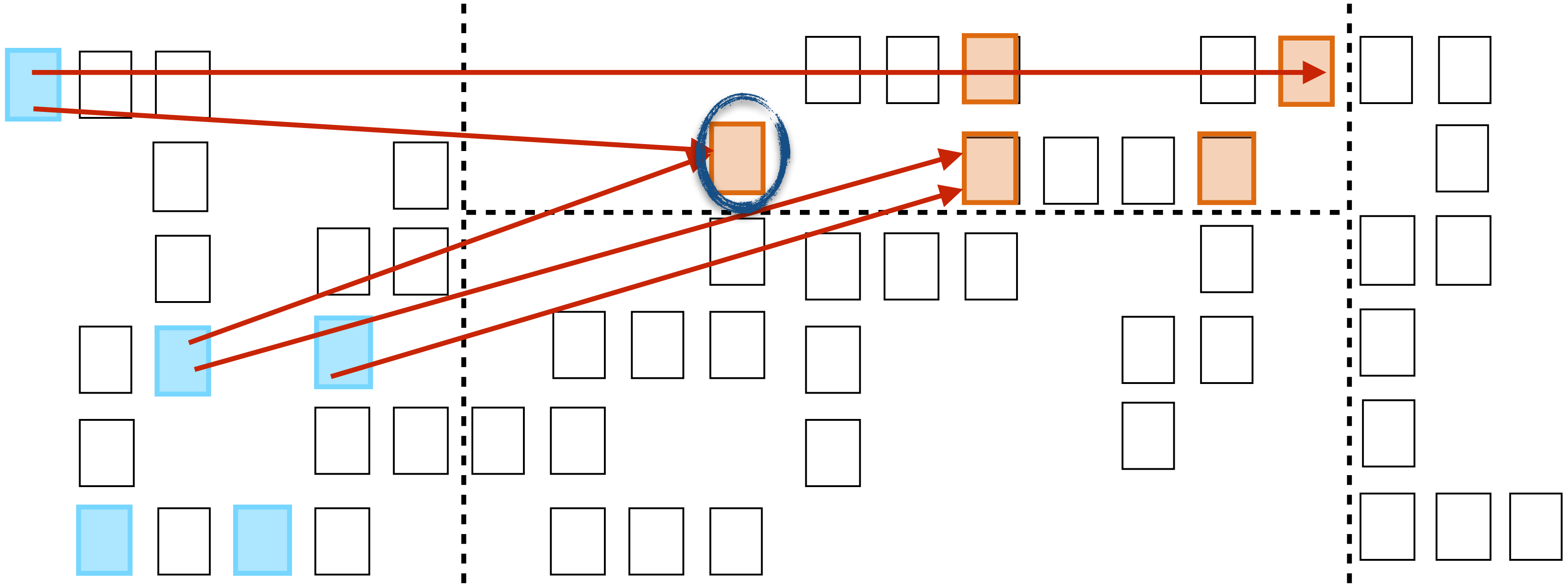

Replication, security, concurrency, distribution, load balancing

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How it works?

java

eclipse

xml

Goal: Adaptability

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eclipse

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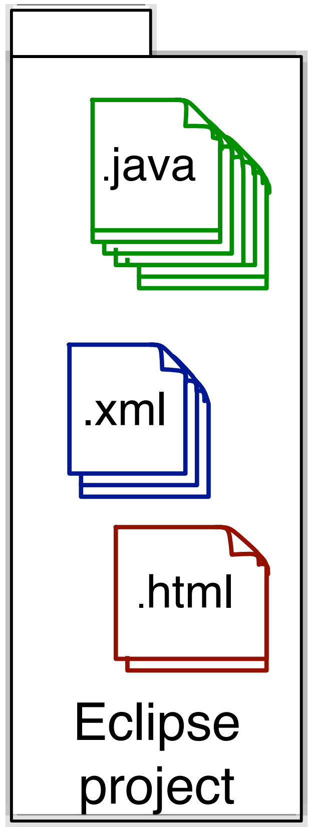


.java

.xml

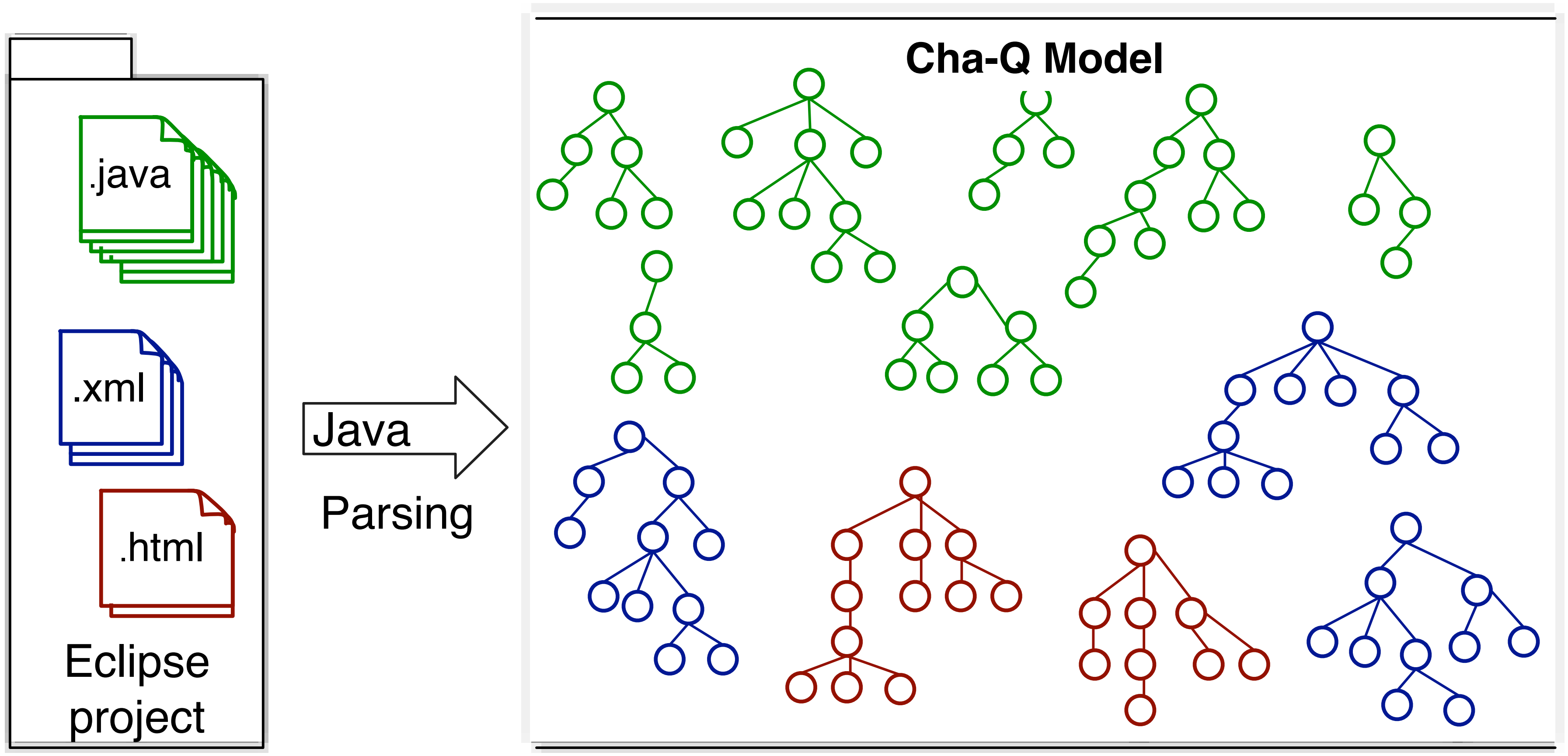
.html

Eclipse project

How it works?

eclipse

Goal: Adaptability



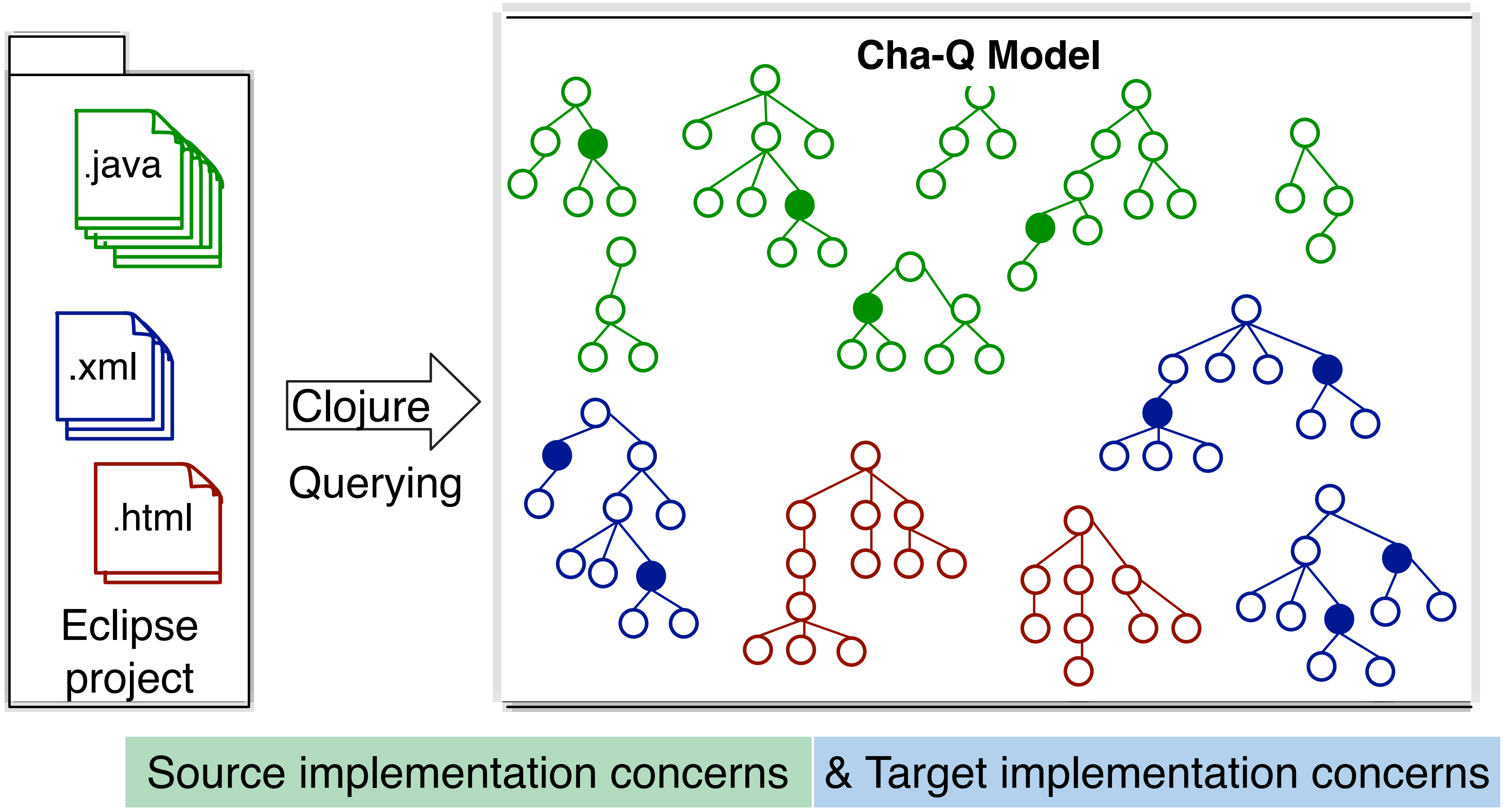
Cha-Q Model?:

Graph meta-model = querying of all source code entities.

How it works?

eclipse

Goal: Adaptability



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.xml

.html

Eclipse project

Clojure

Querying

Cha-Q Model

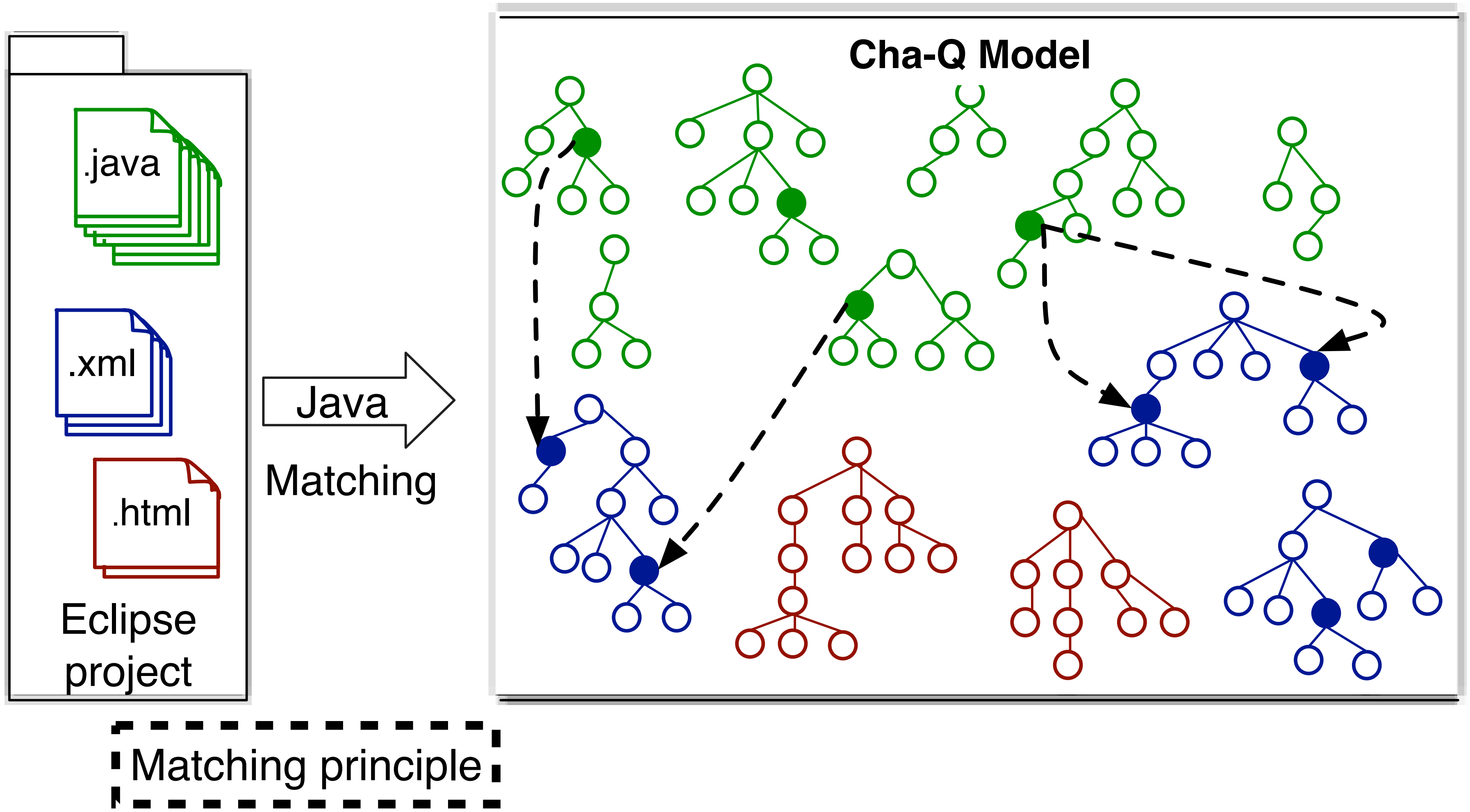
Source implementation concerns & Target implementation concerns

Cha-Q Model?:

Graph meta-model = querying of all source code entities.

How it works?

Goal: Adaptability



Cha-Q Model?:

Graph meta-model = querying of all source code entities.

How it works?

java

eclipse

xml

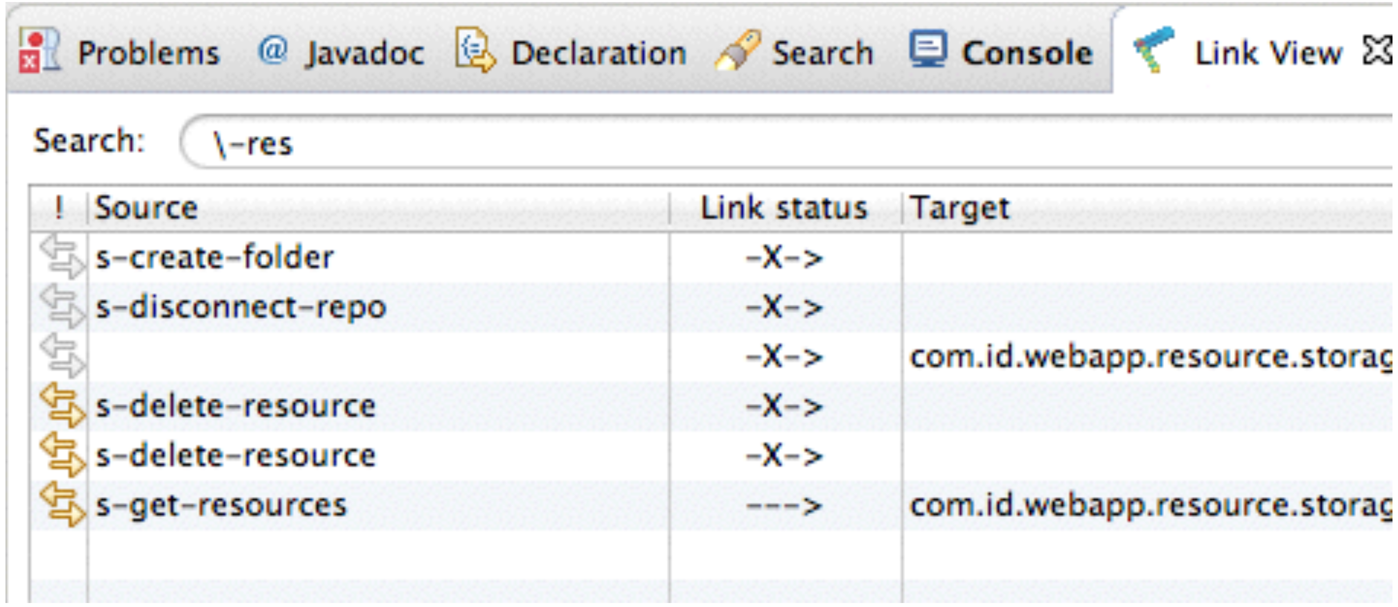
Goal: Adaptability

Why is it cool?

- Because it is adaptable***!
  - E.g., Inventive Designers' XML-Java error messages:
    - source of the traceability link (43 LOC in Clojure)
    - target of the traceability link (19 LOC in Clojure)
    - matching of source and target (7 LOC in Java)

*** once the entities to represent the other technology are part of the model

MaTraca's Features

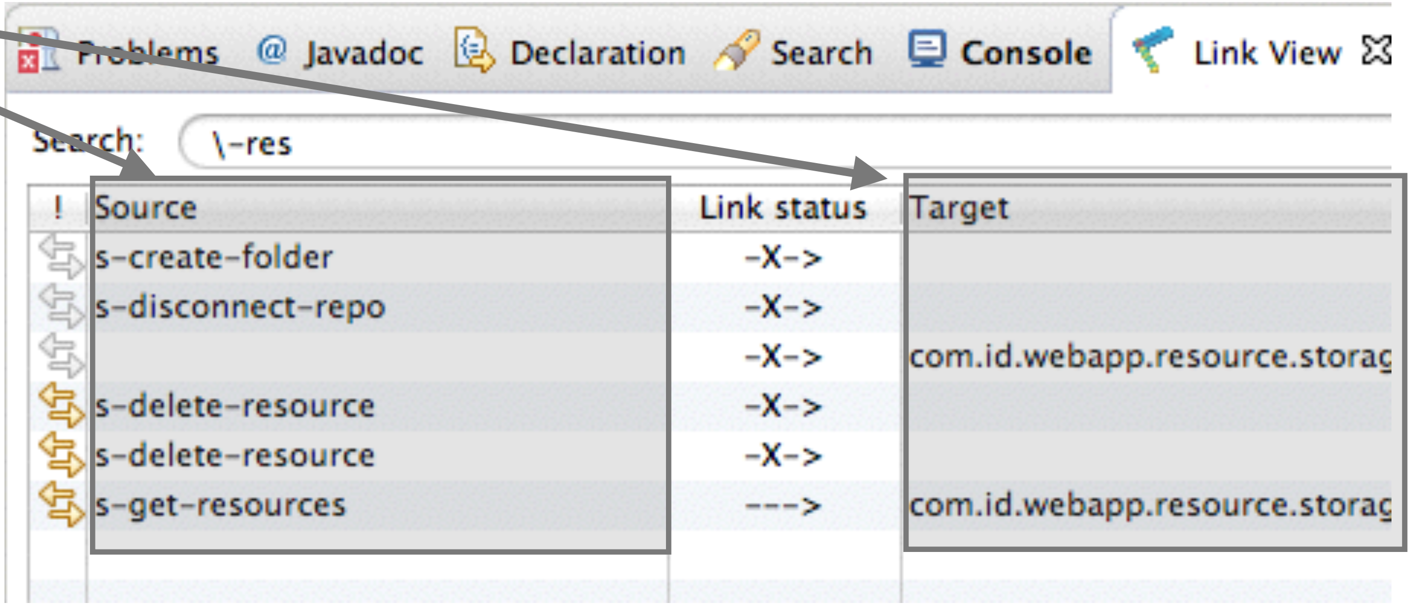


Search: \-res

!	Source	Link status	Target
	s-create-folder	-X->	
	s-disconnect-repo	-X->	
		-X->	com.id.webapp.resource.storag
	s-delete-resource	-X->	
	s-delete-resource	-X->	
	s-get-resources	--->	com.id.webapp.resource.storag

MaTraca's Features

find all the entities on the source or target concerns



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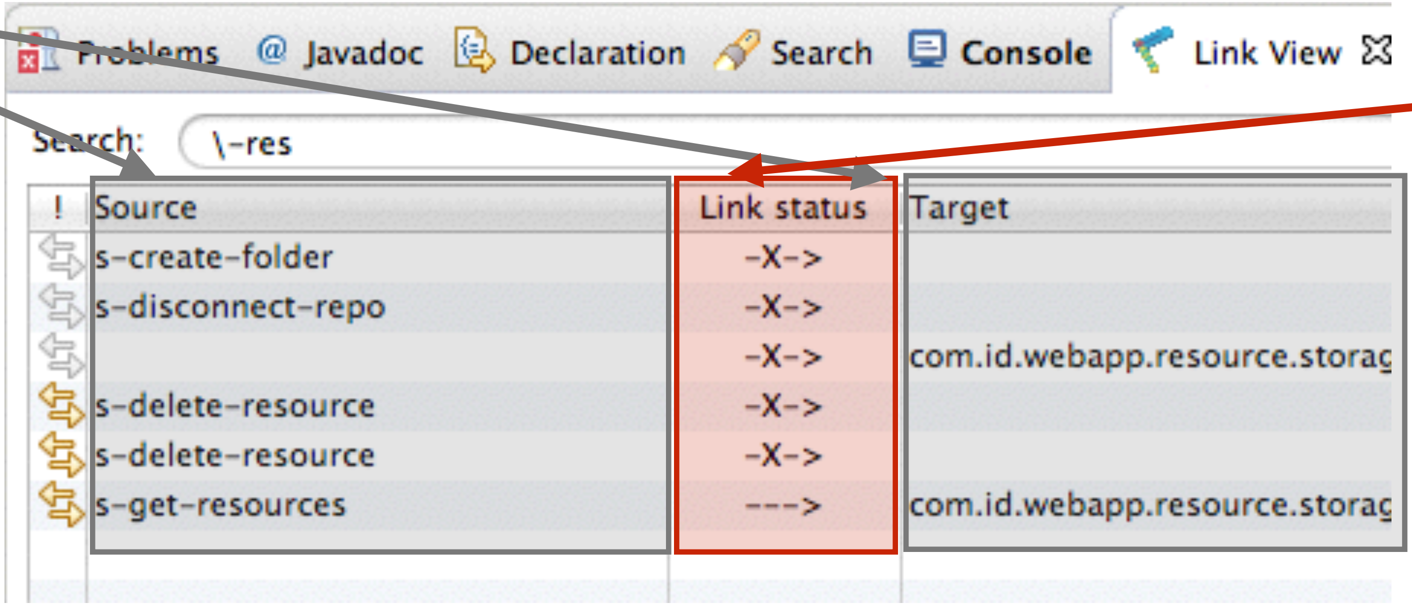

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evaluate compliance in marked links / entities

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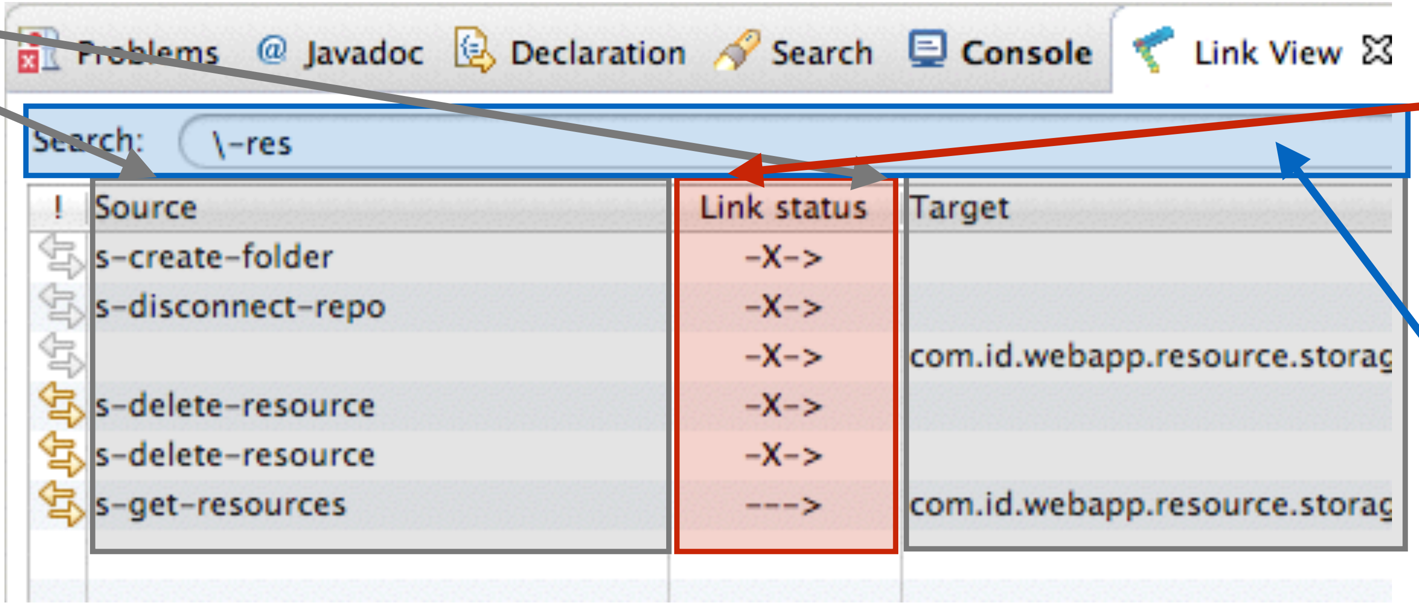

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filter results

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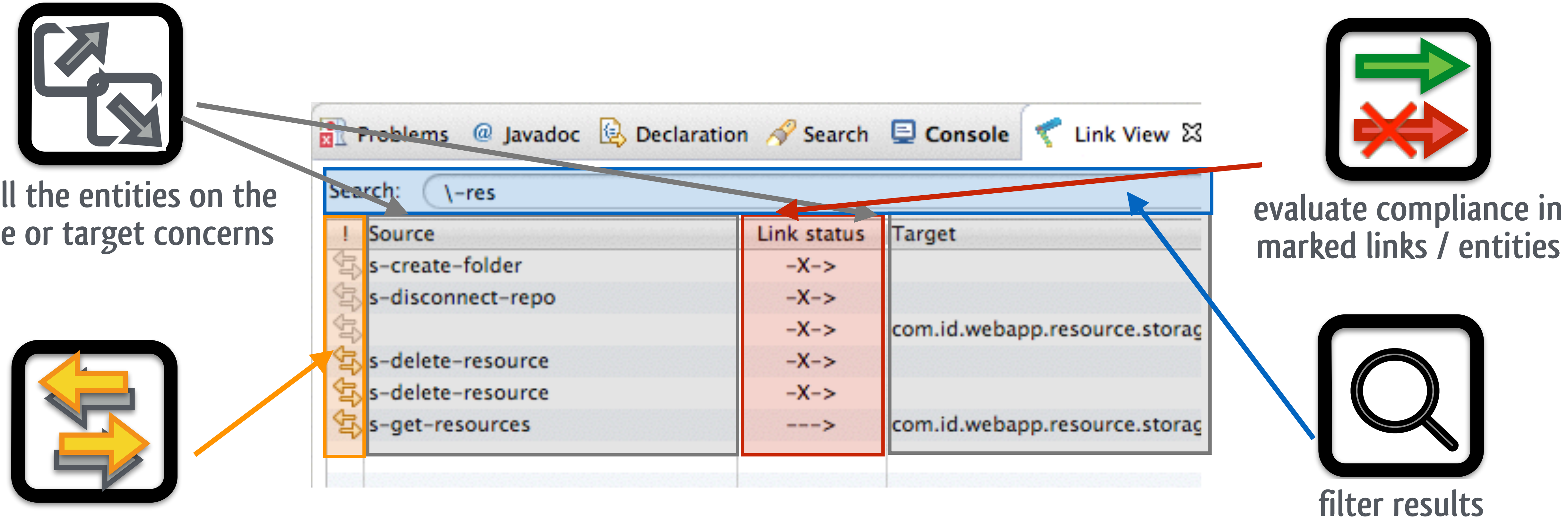

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evaluate compliance in marked links / entities

filter results

mark links / entities of interest

MaTraca’s Features

find all the entities on the source or target concerns

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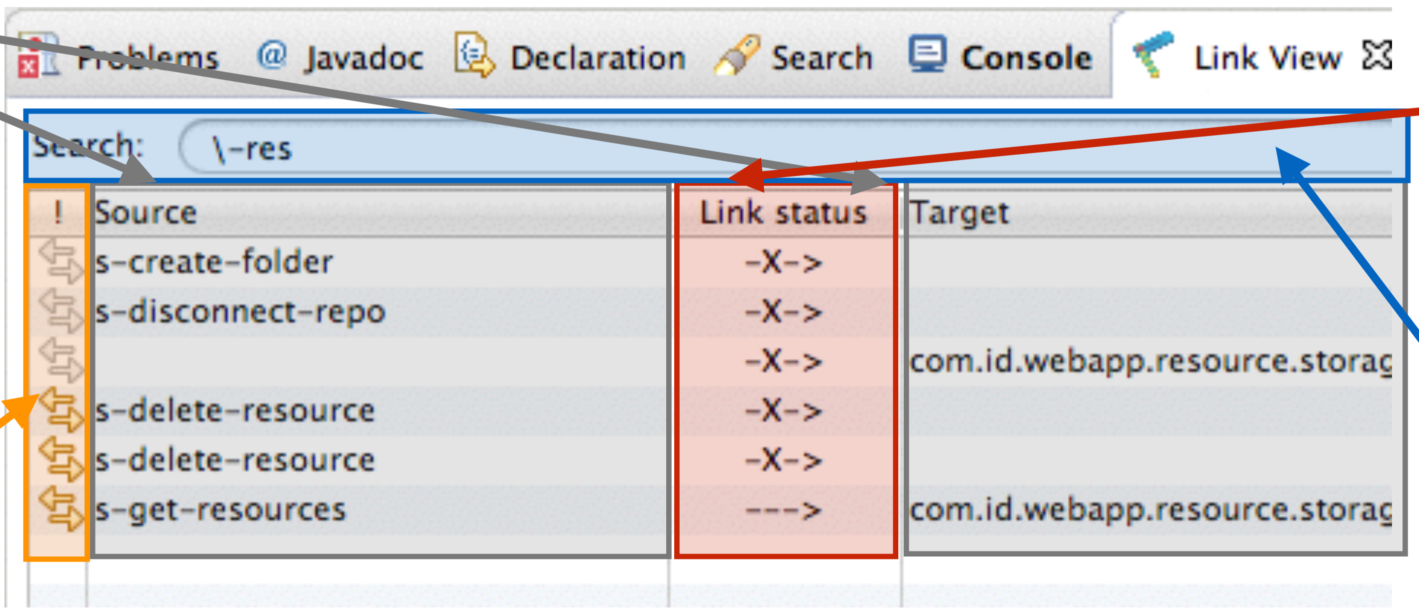

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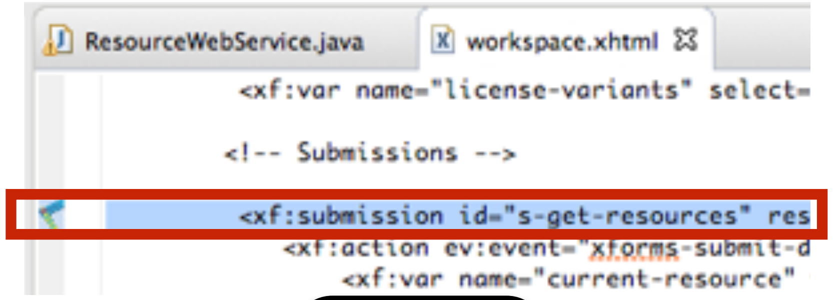

```
        <xf:var name="license-variants" select=
       <!-- Submissions -->
        <xf:submission id="s-get-resources" res
           <xf:action ev:event="xforms-submit-d
               <xf:var name="current-resource"
```

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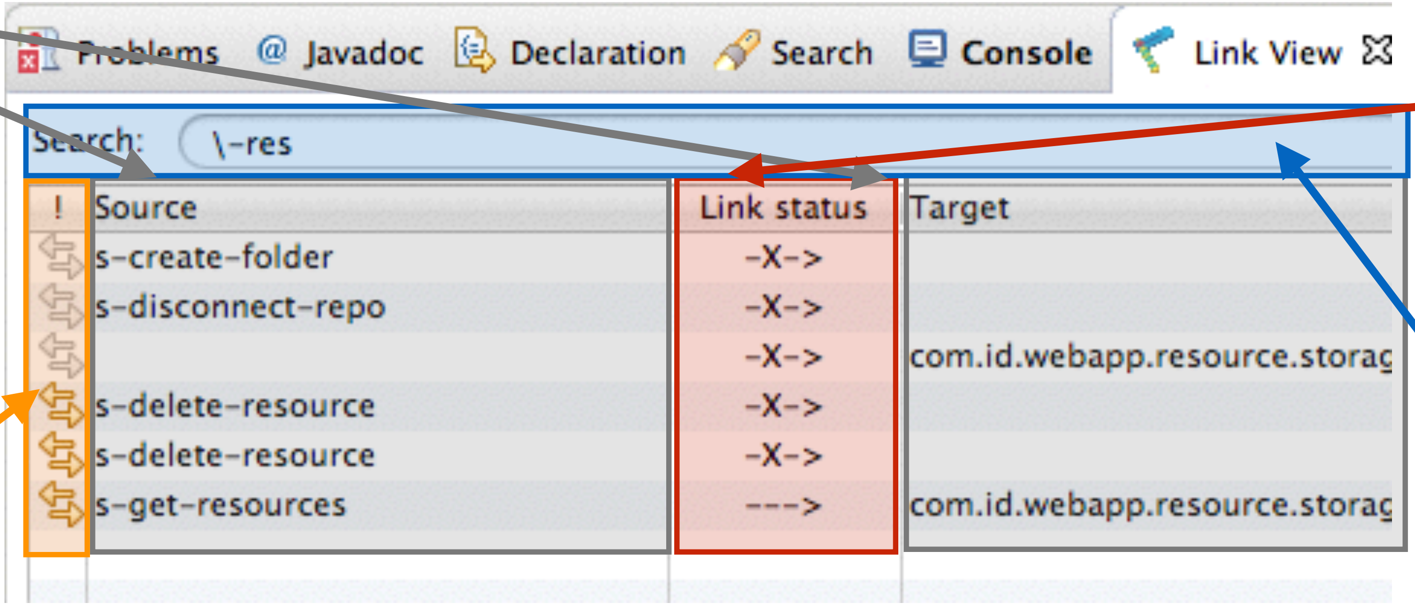
MaTraca's Features

find all the entities on the source or target concerns

mark links / entities of interest



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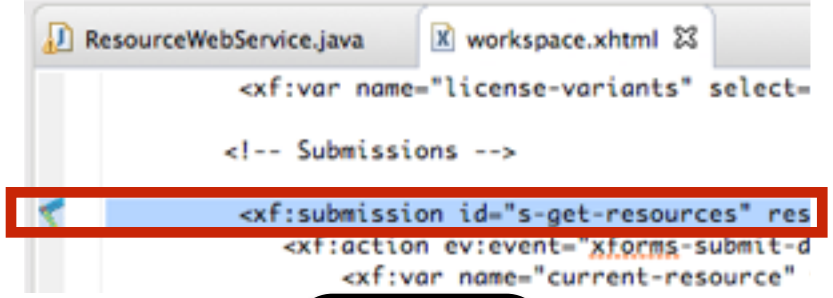

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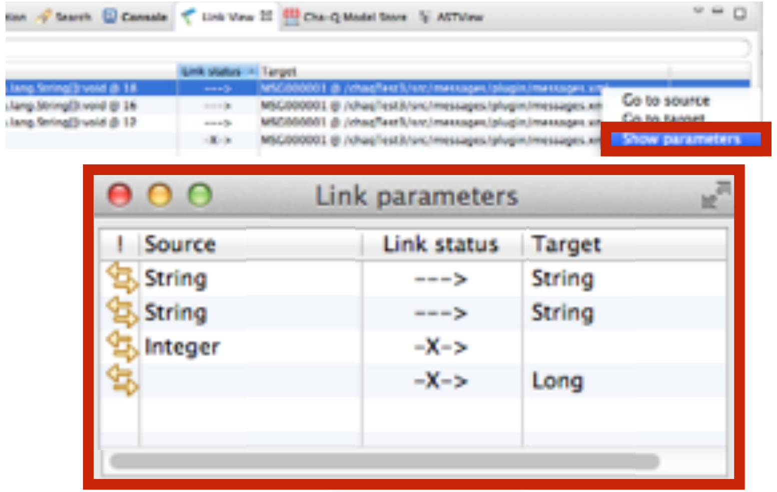

Link status	Target
--->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm
--->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm
--->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm
-X->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm

Link parameters

!	Source	Link status	Target
⇆	String	--->	String
⇆	String	--->	String
⇆	Integer	-X->	
⇆		-X->	Long

check matching of parameters

MaTraca’s Features

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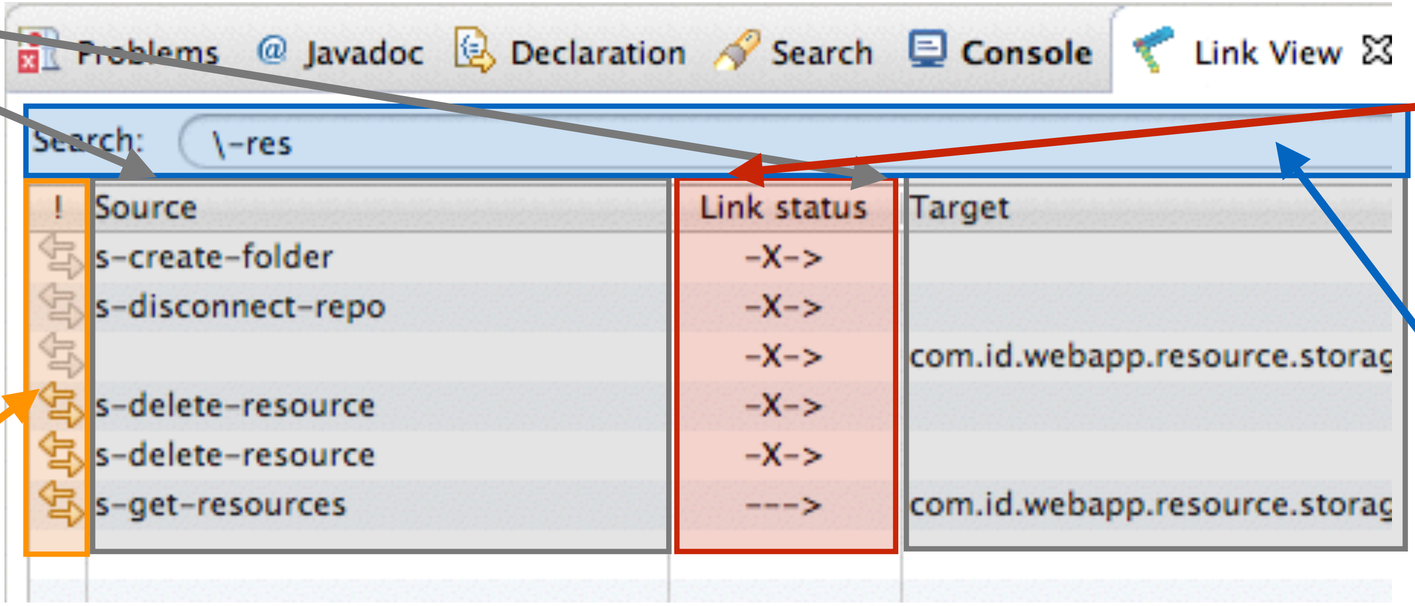

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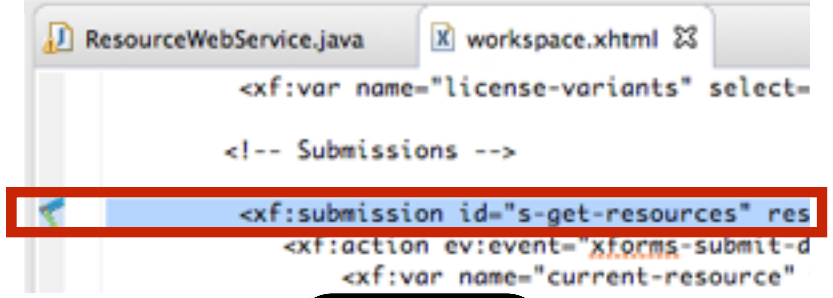

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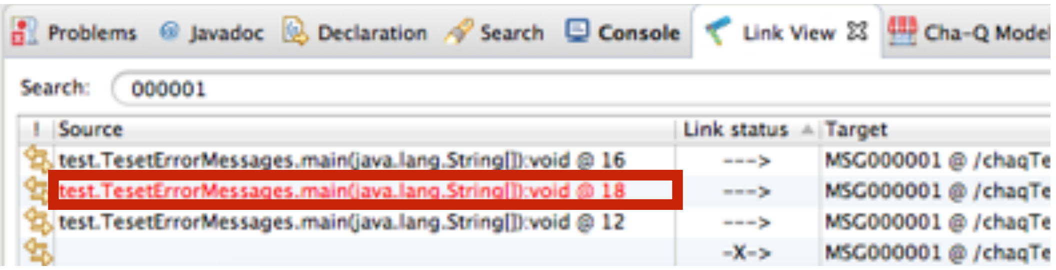
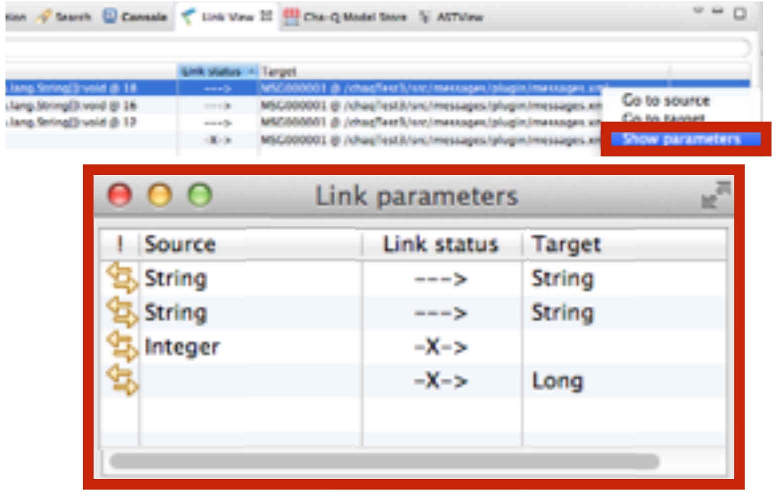
identify changes



Search: 000001

!	Source	Link status	Target
	test.TesetErrorMessages.main(java.lang.String[]):void @ 16	--->	MSG000001 @ /chaqTe
	test.TesetErrorMessages.main(java.lang.String[]):void @ 18	--->	MSG000001 @ /chaqTe
	test.TesetErrorMessages.main(java.lang.String[]):void @ 12	--->	MSG000001 @ /chaqTe
		-X->	MSG000001 @ /chaqTe



	Link status	Target
.lang.String[]):void @ 18	--->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm
.lang.String[]):void @ 16	--->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm
.lang.String[]):void @ 12	--->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm
	-X->	MSG000001 @ /chaqTest/src/messages/plugin/messages.xm

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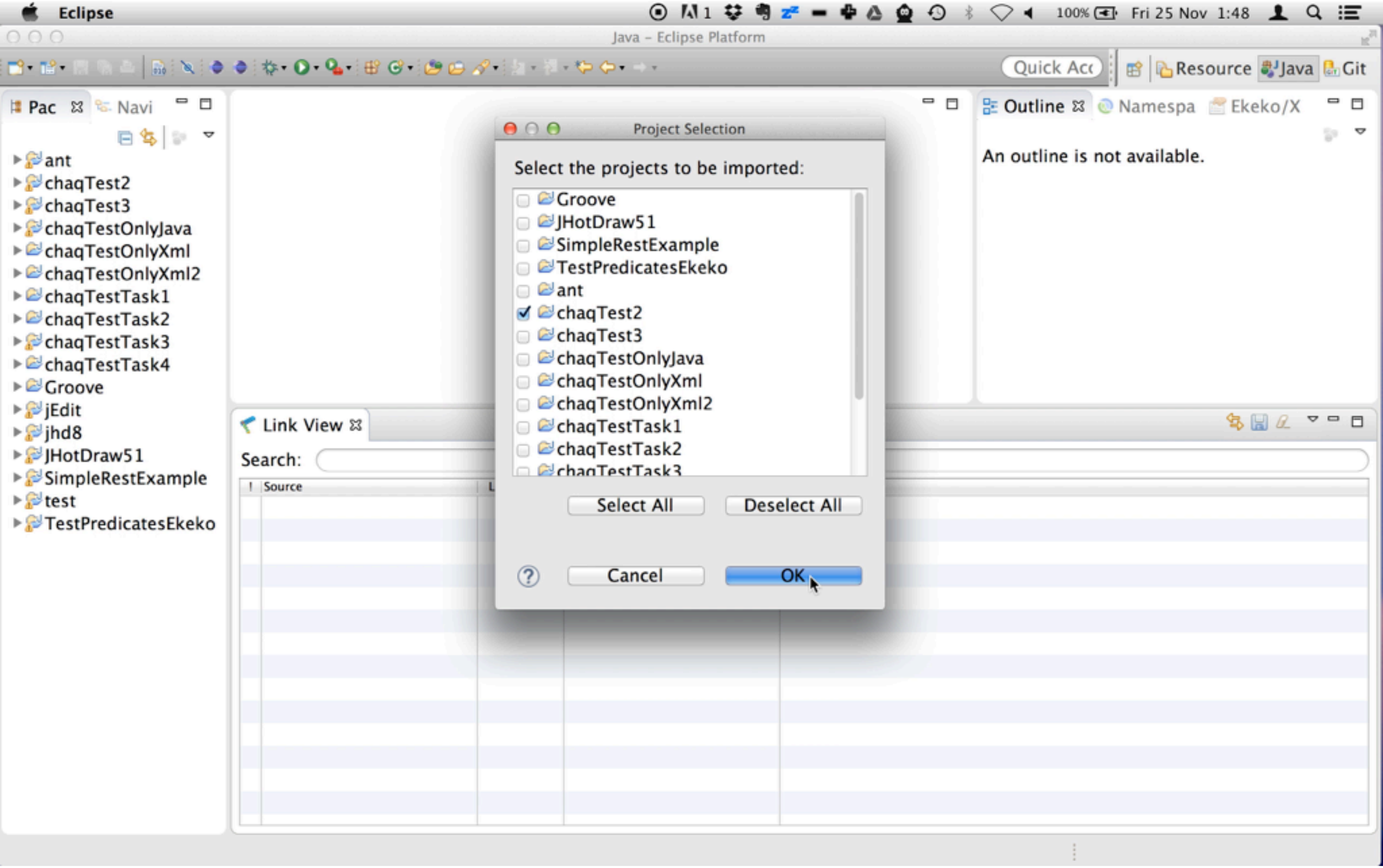
	Integer	-X->	
		-X->	Long

check matching of parameters

See satisfied and broken links



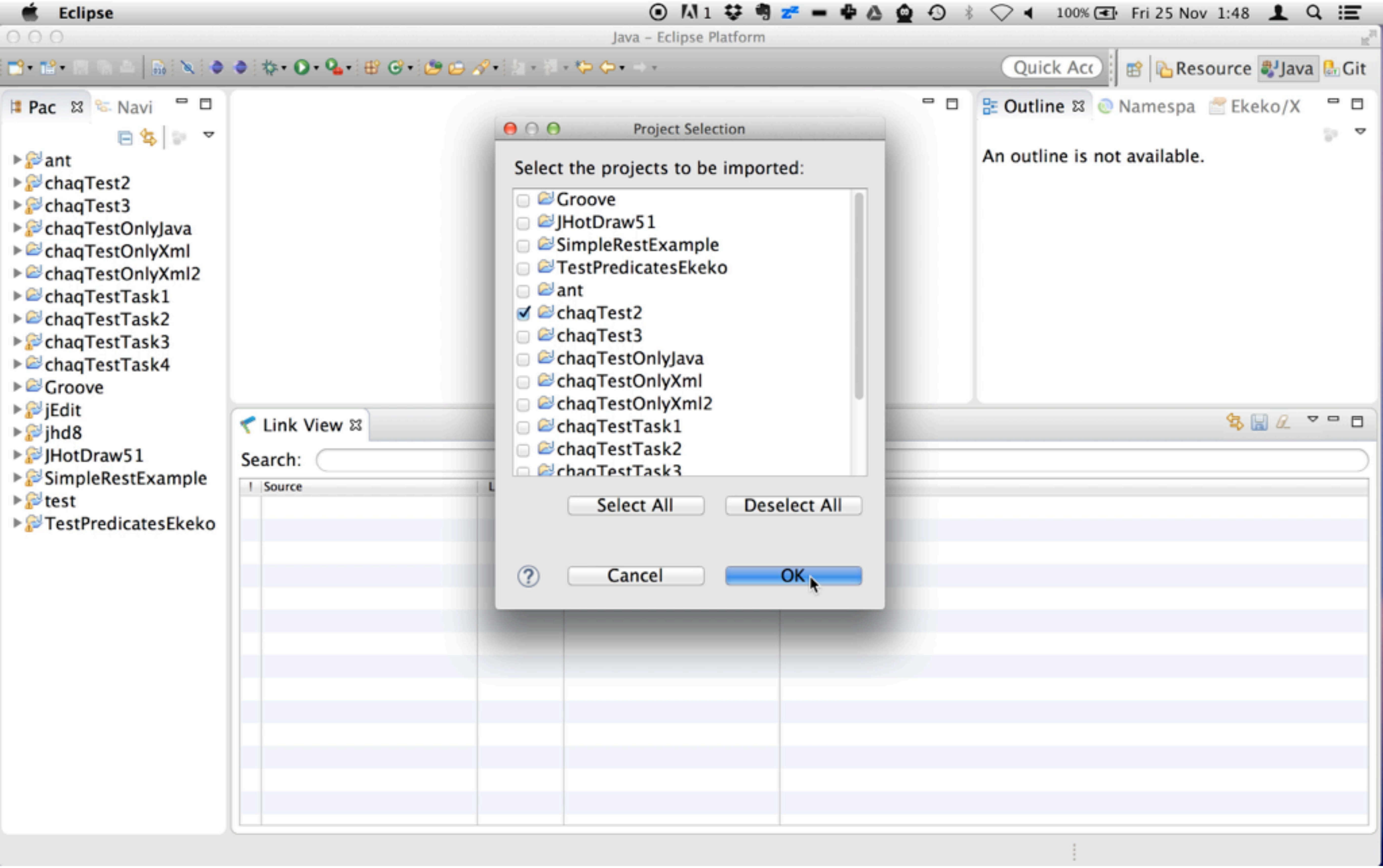
Project Selection

Select the projects to be imported:

- □ Groove
- □ JHotDraw51
- □ SimpleRestExample
- □ TestPredicatesEkeko
- □ ant
- ☑ chaqTest2
- □ chaqTest3
- □ chaqTestOnlyJava
- □ chaqTestOnlyXml
- □ chaqTestOnlyXml2
- □ chaqTestTask1
- □ chaqTestTask2
- □ chaqTestTask3

An outline is not available.

See satisfied and broken links



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- □ chaqTestTask3

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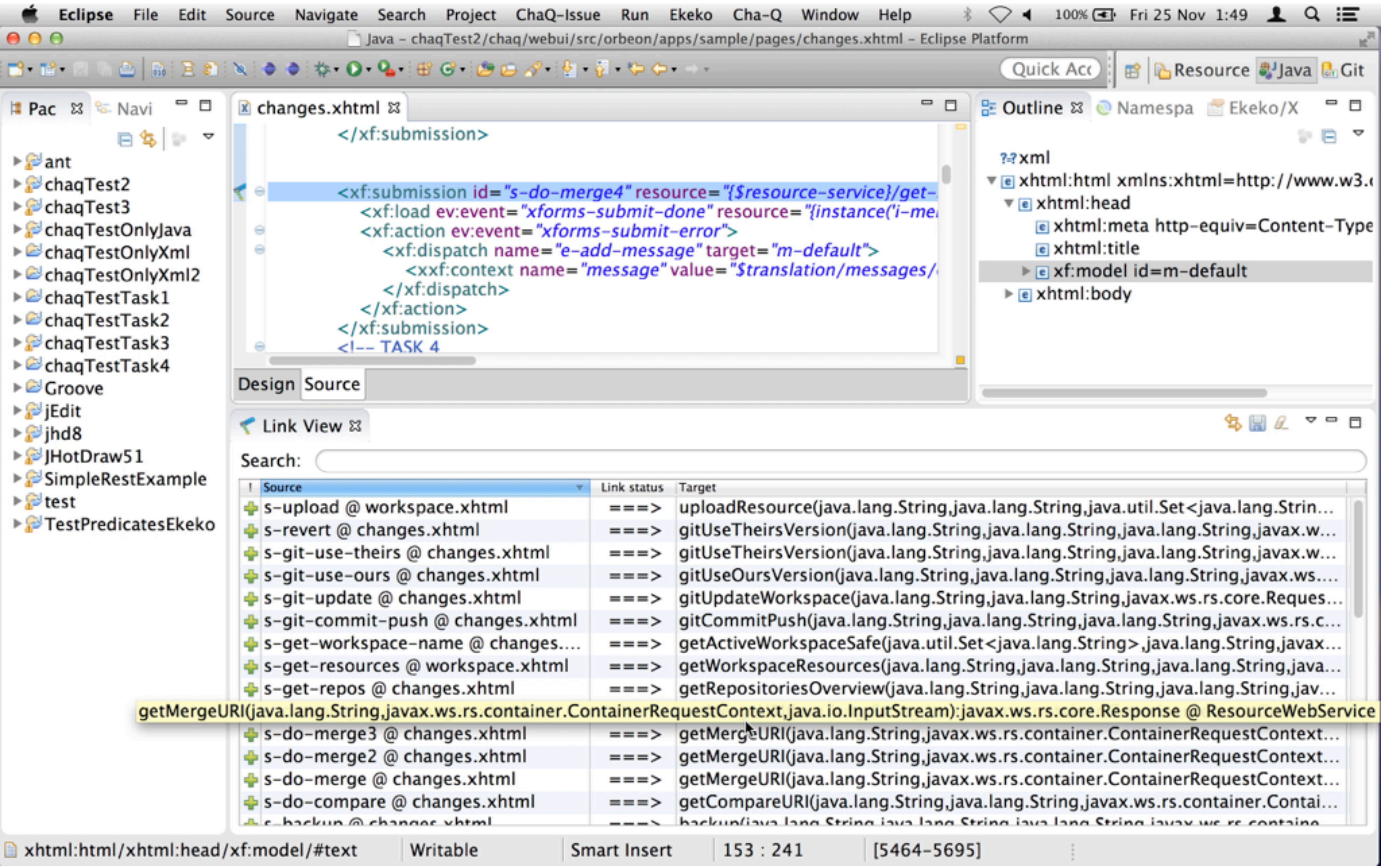
See effect of editions on a link



ant
chaqTest2
chaqTest3
chaqTestOnlyJava
chaqTestOnlyXml
chaqTestOnlyXml2
chaqTestTask1
chaqTestTask2
chaqTestTask3
chaqTestTask4
Groove
jEdit
jhd8
JHotDraw51
SimpleRestExample
test
TestPredicatesEkeko

```
</xf:submission>


<xf:submission id="s-do-merge4" resource="{$resource-service}/get-
   <xf:load ev:event="xforms-submit-done" resource="{instance('i-me
   <xf:action ev:event="xforms-submit-error">
      <xf:dispatch name="e-add-message" target="m-default">
         <xxf:context name="message" value="$translation/messages/
      </xf:dispatch>
   </xf:action>
</xf:submission>
<!-- TASK 4
```

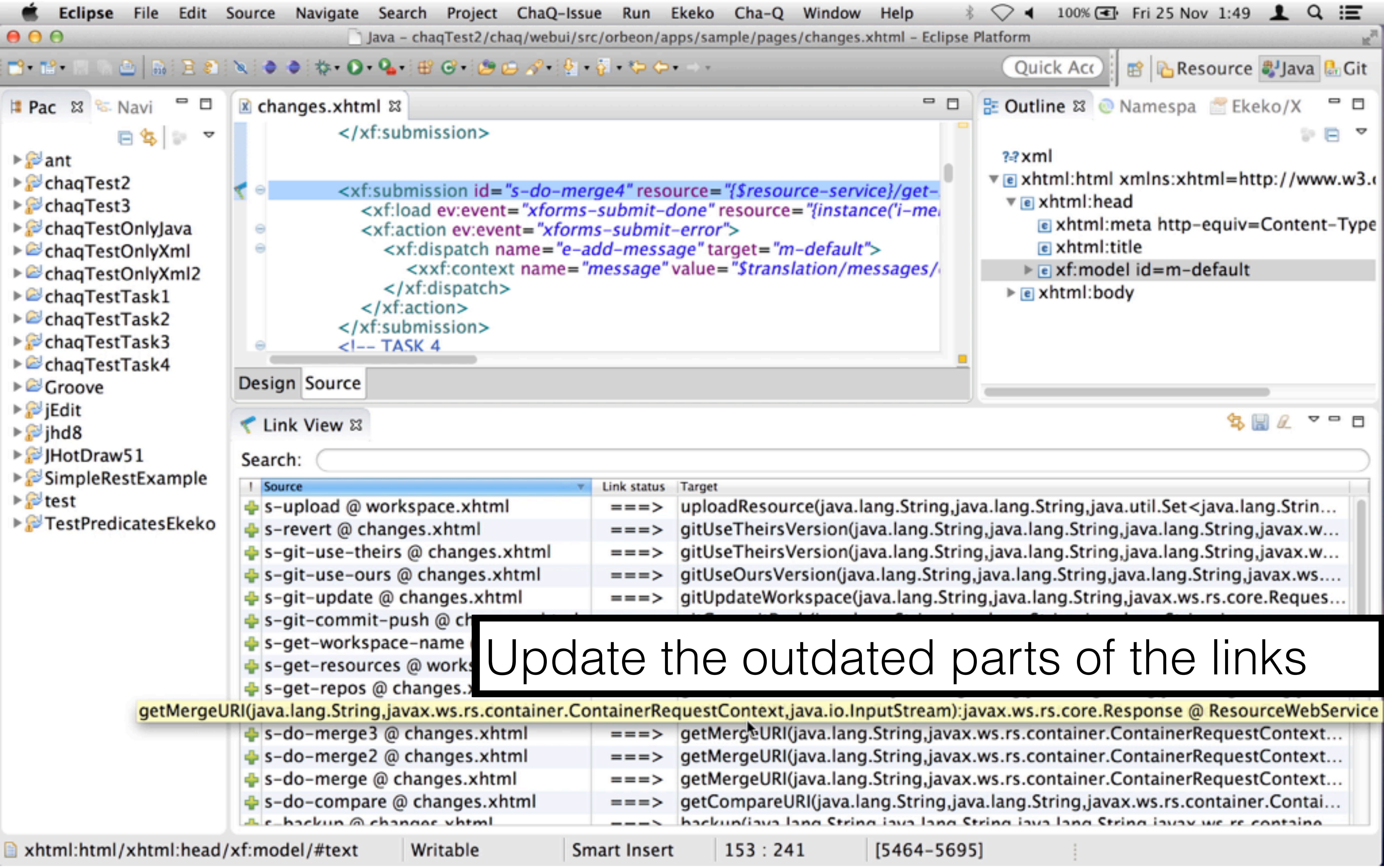
```
?-? xml
▼ xhtml:html xmlns:xhtml=http://www.w3.
   ▼ xhtml:head
        xhtml:meta http-equiv=Content-Type
        xhtml:title
      ▶ xf:model id=m-default
   ▶ xhtml:body
```

!	Source	Link status	Target
✚	s-upload @ workspace.xhtml	===>	uploadResource(java.lang.String,java.lang.String,java.util.Set<java.lang.Strin...
✚	s-revert @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
✚	s-git-use-theirs @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
✚	s-git-use-ours @ changes.xhtml	===>	gitUseOursVersion(java.lang.String,java.lang.String,java.lang.String,javax.ws....
✚	s-git-update @ changes.xhtml	===>	gitUpdateWorkspace(java.lang.String,java.lang.String,javax.ws.rs.core.Reques...
✚	s-git-commit-push @ changes.xhtml	===>	gitCommitPush(java.lang.String,java.lang.String,java.lang.String,javax.ws.rs.c...
✚	s-get-workspace-name @ changes....	===>	getActiveWorkspaceSafe(java.util.Set<java.lang.String>,java.lang.String,javax...
✚	s-get-resources @ workspace.xhtml	===>	getWorkspaceResources(java.lang.String,java.lang.String,java.lang.String,java...
✚	s-get-repos @ changes.xhtml	===>	getRepositoriesOverview(java.lang.String,java.lang.String,java.lang.String,jav...
✚	s-do-merge3 @ changes.xhtml	===>	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
✚	s-do-merge2 @ changes.xhtml	===>	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
✚	s-do-merge @ changes.xhtml	===>	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
✚	s-do-compare @ changes.xhtml	===>	getCompareURI(java.lang.String,java.lang.String,javax.ws.rs.container.Contai...
✚	s-backup @ changes.xhtml	===>	backup(java.lang.String,java.lang.String,java.lang.String,javax.ws.rs.containe

getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext,java.io.InputStream):javax.ws.rs.core.Response @ ResourceWebService

xhtml:html/xhtml:head/xf:model/#text | Writable | Smart Insert | 153 : 241 | [5464-5695]

See effect of editions on a link



```
        </xf:submission>


        <xf:submission id="s-do-merge4" resource="{$resource-service}/get-
            <xf:load ev:event="xforms-submit-done" resource="{instance('i-me
            <xf:action ev:event="xforms-submit-error">
                <xf:dispatch name="e-add-message" target="m-default">
                    <xxf:context name="message" value="$translation/messages/
                </xf:dispatch>
            </xf:action>
        </xf:submission>
        <!-- TASK 4
```

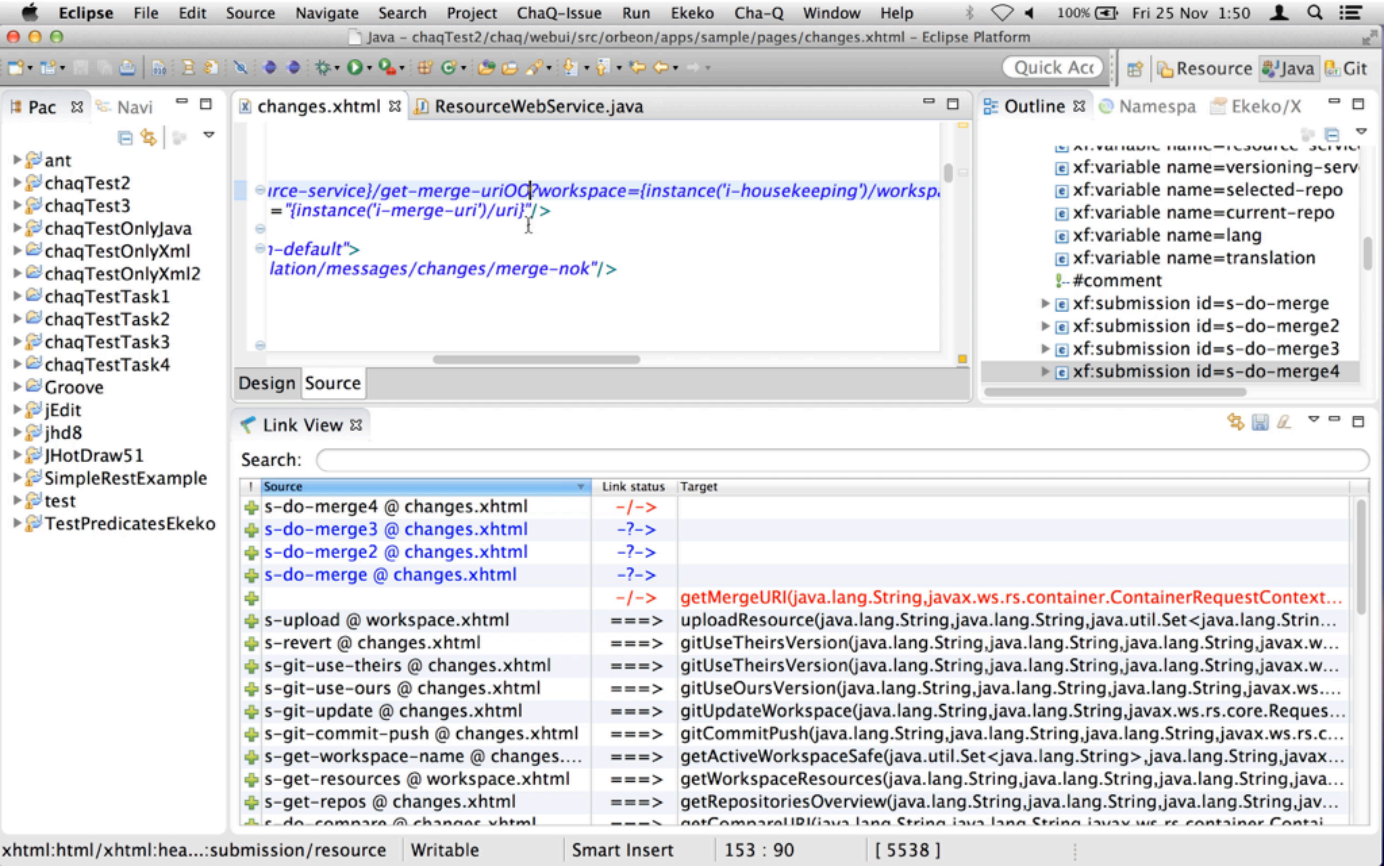
```
?-? xml
▼ xhtml:html xmlns:xhtml=http://www.w3.
  ▼ xhtml:head
      xhtml:meta http-equiv=Content-Type
      xhtml:title
    ▶ xf:model id=m-default
  ▶ xhtml:body
```

! Source	Link status	Target
s-upload @ workspace.xhtml	===>	uploadResource(java.lang.String,java.lang.String,java.util.Set<java.lang.Strin...
s-revert @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
s-git-use-theirs @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
s-git-use-ours @ changes.xhtml	===>	gitUseOursVersion(java.lang.String,java.lang.String,java.lang.String,javax.ws....
s-git-update @ changes.xhtml	===>	gitUpdateWorkspace(java.lang.String,java.lang.String,javax.ws.rs.core.Reques...
s-git-commit-push @ ch		
s-get-workspace-name		
s-get-resources @ works		
s-get-repos @ changes.x		
getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext,java.io.InputStream):javax.ws.rs.core.Response @ ResourceWebService		
s-do-merge3 @ changes.xhtml	===>	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
s-do-merge2 @ changes.xhtml	===>	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
s-do-merge @ changes.xhtml	===>	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
s-do-compare @ changes.xhtml	===>	getCompareURI(java.lang.String,java.lang.String,javax.ws.rs.container.Contai...
s-backup @ changes.xhtml	===>	backup(java.lang.String,java.lang.String,java.lang.String,javax.ws.rs.containe...

Update the outdated parts of the links

xhtml:html/xhtml:head/xf:model/#text | Writable | Smart Insert | 153 : 241 | [5464-5695]

See effect of editions on a link


Eclipse File Edit Source Navigate Search Project ChaQ-Issue Run Ekeko Cha-Q Window Help
100% Fri 25 Nov 1:50
Java – chaqTest2/chaq/webui/src/orbeon/apps/sample/pages/changes.xhtml – Eclipse Platform
Quick Acc
Resource
Java
Git
Pac
Navi
ant
chaqTest2
chaqTest3
chaqTestOnlyJava
chaqTestOnlyXml
chaqTestOnlyXml2
chaqTestTask1
chaqTestTask2
chaqTestTask3
chaqTestTask4
Groove
jEdit
jhd8
JHotDraw51
SimpleRestExample
test
TestPredicatesEkeko
changes.xhtml
ResourceWebService.java
Design
Source
Outline
Namespa
Ekeko/X
xf:variable name=resource-servic
xf:variable name=versioning-serv
xf:variable name=selected-repo
xf:variable name=current-repo
xf:variable name=lang
xf:variable name=translation
#comment
xf:submission id=s-do-merge
xf:submission id=s-do-merge2
xf:submission id=s-do-merge3
xf:submission id=s-do-merge4
Link View
Search:

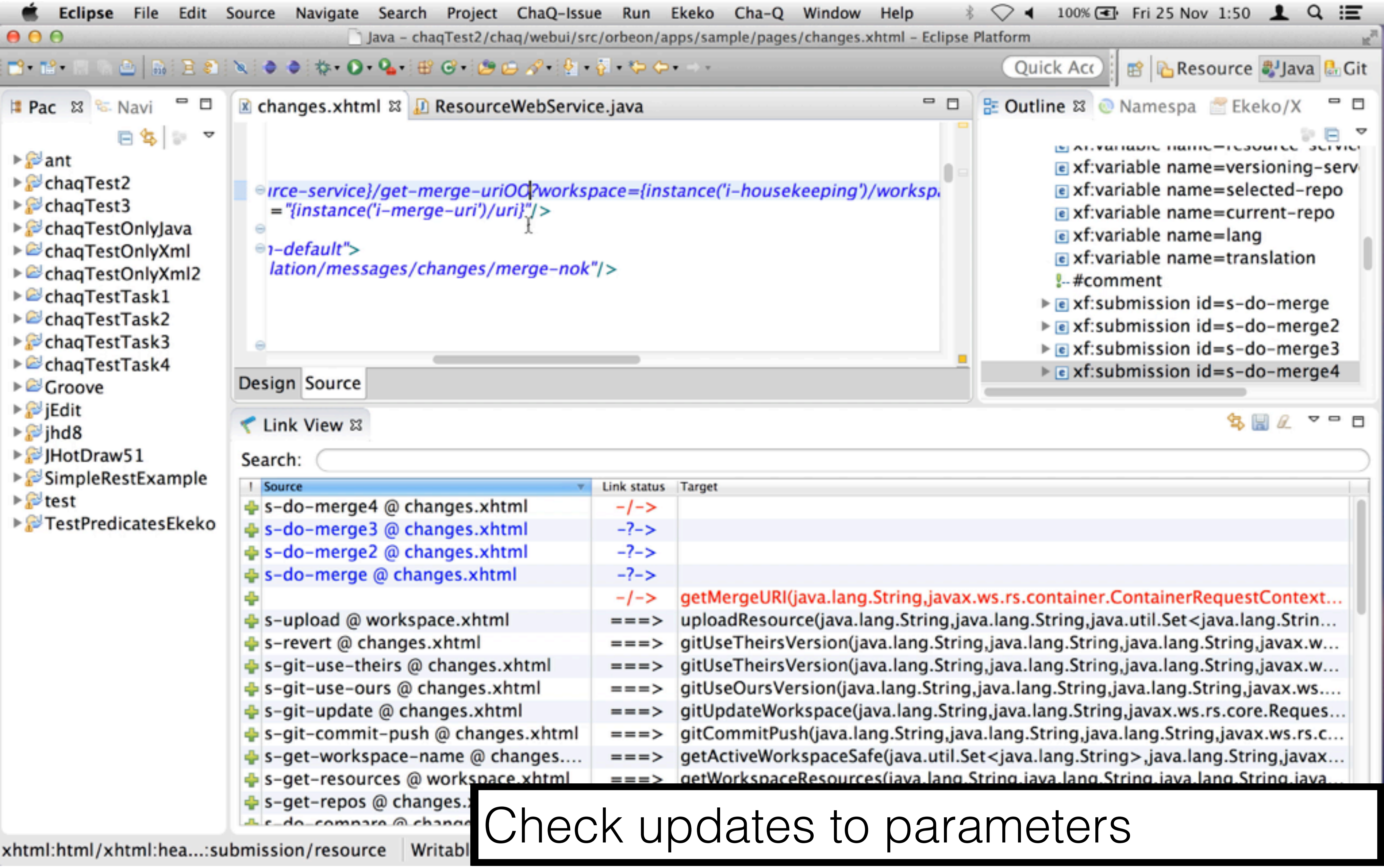
```
ırce-service}/get-merge-uriOO?workspace={instance('i-housekeeping')/worksp
 ="{instance('i-merge-uri')/uri}"/>

ı-default">
lation/messages/changes/merge-nok"/>
```

!	Source	Link status	Target
✚	s-do-merge4 @ changes.xhtml	-/->	
✚	s-do-merge3 @ changes.xhtml	-?->	
✚	s-do-merge2 @ changes.xhtml	-?->	
✚	s-do-merge @ changes.xhtml	-?->	
✚		-/->	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
✚	s-upload @ workspace.xhtml	===>	uploadResource(java.lang.String,java.lang.String,java.util.Set<java.lang.Strin...
✚	s-revert @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
✚	s-git-use-theirs @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
✚	s-git-use-ours @ changes.xhtml	===>	gitUseOursVersion(java.lang.String,java.lang.String,java.lang.String,javax.ws....
✚	s-git-update @ changes.xhtml	===>	gitUpdateWorkspace(java.lang.String,java.lang.String,javax.ws.rs.core.Reques...
✚	s-git-commit-push @ changes.xhtml	===>	gitCommitPush(java.lang.String,java.lang.String,java.lang.String,javax.ws.rs.c...
✚	s-get-workspace-name @ changes....	===>	getActiveWorkspaceSafe(java.util.Set<java.lang.String>,java.lang.String,javax...
✚	s-get-resources @ workspace.xhtml	===>	getWorkspaceResources(java.lang.String,java.lang.String,java.lang.String,java...
✚	s-get-repos @ changes.xhtml	===>	getRepositoriesOverview(java.lang.String,java.lang.String,java.lang.String,jav...
✚	s-do-compare @ changes.xhtml	===>	getCompareURI(java.lang.String,java.lang.String,javax.ws.rs.container.Contai...

xhtml:html/xhtml:hea...:submission/resource | Writable | Smart Insert | 153 : 90 | [5538]

See effect of editions on a link


Eclipse File Edit Source Navigate Search Project ChaQ-Issue Run Ekeko Cha-Q Window Help
100% Fri 25 Nov 1:50
Java – chaqTest2/chaq/webui/src/orbeon/apps/sample/pages/changes.xhtml – Eclipse Platform
Quick Acc
Resource
Java
Git
Pac
Navi
ant
chaqTest2
chaqTest3
chaqTestOnlyJava
chaqTestOnlyXml
chaqTestOnlyXml2
chaqTestTask1
chaqTestTask2
chaqTestTask3
chaqTestTask4
Groove
jEdit
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JHotDraw51
SimpleRestExample
test
TestPredicatesEkeko
changes.xhtml
ResourceWebService.java
Design
Source
Outline
Namespa
Ekeko/X
xf:variable name=versioning-serv
xf:variable name=selected-repo
xf:variable name=current-repo
xf:variable name=lang
xf:variable name=translation
#comment
xf:submission id=s-do-merge
xf:submission id=s-do-merge2
xf:submission id=s-do-merge3
xf:submission id=s-do-merge4
Link View
Search:
xhtml:html/xhtml:hea...:submission/resource
Writabl

```
ırce-service}/get-merge-uriOO?workspace={instance('i-housekeeping')/worksp
="{instance('i-merge-uri')/uri}"/>

ı-default">
lation/messages/changes/merge-nok"/>
```

!	Source	Link status	Target
+	s-do-merge4 @ changes.xhtml	-/->	
+	s-do-merge3 @ changes.xhtml	-?->	
+	s-do-merge2 @ changes.xhtml	-?->	
+	s-do-merge @ changes.xhtml	-?->	
+		-/->	getMergeURI(java.lang.String,javax.ws.rs.container.ContainerRequestContext...
+	s-upload @ workspace.xhtml	===>	uploadResource(java.lang.String,java.lang.String,java.util.Set<java.lang.Strin...
+	s-revert @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
+	s-git-use-theirs @ changes.xhtml	===>	gitUseTheirsVersion(java.lang.String,java.lang.String,java.lang.String,javax.w...
+	s-git-use-ours @ changes.xhtml	===>	gitUseOursVersion(java.lang.String,java.lang.String,java.lang.String,javax.ws....
+	s-git-update @ changes.xhtml	===>	gitUpdateWorkspace(java.lang.String,java.lang.String,javax.ws.rs.core.Reques...
+	s-git-commit-push @ changes.xhtml	===>	gitCommitPush(java.lang.String,java.lang.String,java.lang.String,javax.ws.rs.c...
+	s-get-workspace-name @ changes....	===>	getActiveWorkspaceSafe(java.util.Set<java.lang.String>,java.lang.String,javax...
+	s-get-resources @ workspace.xhtml	===>	getWorkspaceResources(java.lang.String,java.lang.String,java.lang.String,java...
+	s-get-repos @ changes.x		

Check updates to parameters

MaTraca to test

- 4 tasks: from the issue repository (total 4 hours)
- 4 developers: (equivalent expertise: d1-d2 & d3-d4)

	t1	**t2**	**t3**	**t4**
Baseline	dbd	dbd	dbd	dbd
without Matraca	d2+d4	d2+d4	d1+d3	d1+d3
with Matraca	d1+d3	d1+d3	d2+d4	d2+d4

Tasks

	Time recorded	Commits	LOCs simplif.	Files simplif.
T1: Added the path of the class to the url of the submissions	1 h 30 m	3	24	13
T2: Get resource type from resource server.	8 h	8	69	10
T3: Warn user when overwriting files during upload in workspace browser.	7 h	6	20	2
T4: Refactored method so that it retrieves workspace URI from current configuration.	30 m	7	4	5

Questions: Features used

	Never	Once	Twice	Several	Most of the time
	0	1	2	+	*
Calculate the links from scratch:					
Remember the projects that were previously chosen for a workspace:					
Search:					
Ignore irrelevant links:					
Calculate the links with respect to a baseline:					
See parameters of a link:					
Jump to the program element:					

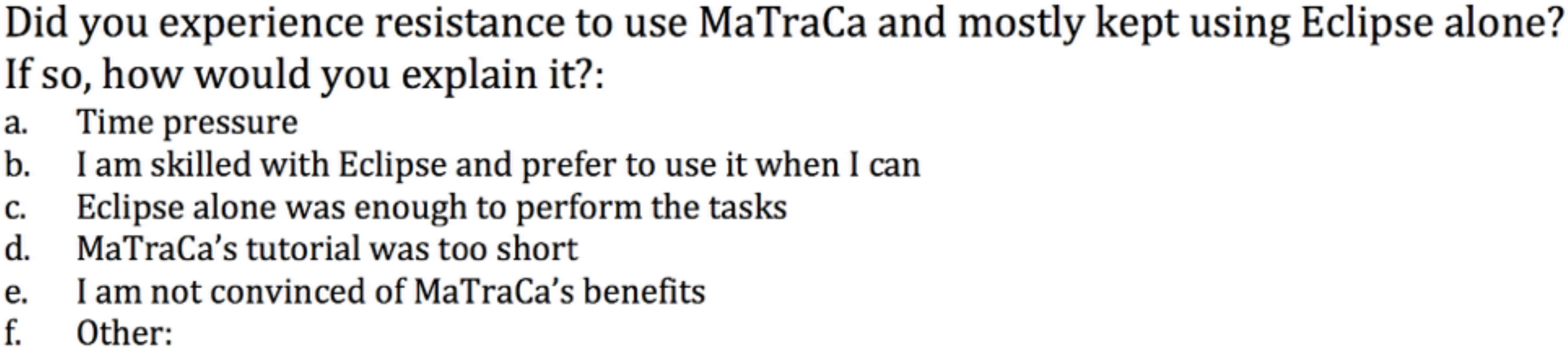
Results: Features used

Calculate links from scratch	Twice - Several
Remember projects chosen	Once
Search	Twice - Several
Ignore relevant links	Twice - Several
Calculate links w.r.t. baseline	Several
See parameters	Twice - Several
Jump to program element	Several

Questions: Matraca vs. Tasks

	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
	👎👎	👎	👉	👍	👍👍
MaTraCa was useful for the given tasks					
MaTraCa found information that I would not have found *as quickly* without it.					
MaTraCa found information that I would not have found *at all* without it.					
Without MaTraCa, it was difficult to perform the tasks.					
I would *not* use MaTraCa even if it were available.					
I felt more confident about the effect of my changes when using MaTraCa					
MaTraCa helped me to make informed judgments					

Questions: Matraca vs. Tasks



Did you experience resistance to use MaTraCa and mostly kept using Eclipse alone? If so, how would you explain it?:

a. Time pressure
b. I am skilled with Eclipse and prefer to use it when I can
c. Eclipse alone was enough to perform the tasks
d. MaTraCa's tutorial was too short
e. I am not convinced of MaTraCa's benefits
f. Other:

Results: Matraca vs. Tasks

Useful	Somewhat agree - Strongly agree
Saved time	Somewhat agree - Strongly agree
Increases confidence	Neutral - Somewhat agree
Gives hints for informed decisions	Neutral - Somewhat agree
I am willing to use it	Somewhat disagree - Neutral??
It facilitated the tasks	Strongly disagree - Somewhat disagree
Helped me to find insights	Strongly disagree - Somewhat disagree

Results: Matraca vs. Tasks

Useful

Saved time

Increases confidence

Gives hints for informed decisions

I am willing to use it

It facilitated the tasks

Helped me to find insights

- Time pressure: 2 / 4
- I prefer Eclipse: 2 / 4
- Eclipse was enough: 1 / 4

- "Time is short to find out how to use it best”
- "A tool needs to grow on the user. The benefits will become clear if you use it more."

Results: Matraca vs. Tasks

Useful	
Saved time	
Increases confidence	
Gives hints for informed decisions	
I am willing to use it	
It facilitated the tasks	"Tasks were not fully matched with the intended use-cases for Matraca”
Helped me to find insights	

Results: Matraca vs. Tasks

Useful

Saved time

Increases confidence

Gives hints for informed decisions

I am willing to use it

It facilitated the tasks

Helped me to find insights

- “Nice-to-have feature but too limited domain to really save time”
- “It was handy once you knew which web-services you are interested in. You do however first have to look for it in the code.”

Overall impression

- “It certainly helped me to find mistakes or omissions earlier”
- “I think matraca could be a very useful tool, it just needs more polishing”
- “Speed and responsiveness is OK”

Take Away Message

- MaTraca:
  - is an Eclipse plugin
  - helps developers keeping dependencies across technologies in sync
  - better than grep -> no false positives
  - better than tests -> the cause instead of the symptoms of the problem
- Currently covers XML and Java but it is extensible to:
  - other technologies
  - or even to your domain-specific / project-specific dependencies !

Thanks to

Inventive Designers
& Tars Joris