

SCXML 101

An Introduction to State Chart XML

Rahul Akolkar



Outline

- Introduction to State Chart XML (SCXML)
- Sample use cases for SCXML
- SCXML Extensibility
 - Data model
 - Custom actions
 - External communications module
- Specification Status
- Available implementations and tools



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State Chart XML (SCXML)

- **Generic and environment agnostic markup language for state machine definition**
 - **Based on**
 - UML 2.0
 - Harel state transition tables
 - Oriented towards reactive systems
 - **Powerful and generic controller with broad application**
 - Dialog flow in Voice applications
 - Interaction Manager for multimodal applications
 - Controller for multi-namespace documents (CDF type of documents)
 - Backend controller for business processes

SCXML features

- States and transitions
 - Composite, Orthogonal and Final
 - Events, guards and target(s)
- Data model
 - Pluggable data representation, expression language
- Executable content
 - On entry, exit or transition
 - Extensible
- External communications module
 - Send, cancel
 - Invoke, finalize
- History



Hello World and a transition

```
<scxml xmlns="http://www.w3.org/2005/07/scxml"  
       version="1.0" initial="hello">  
  
<state id="hello">  
  <onentry>  
    <log expr="Hello World" />  
  </onentry>  
  
  <transition target="done" />  
</state>  
  
<final id ="done" />  
</scxml>
```

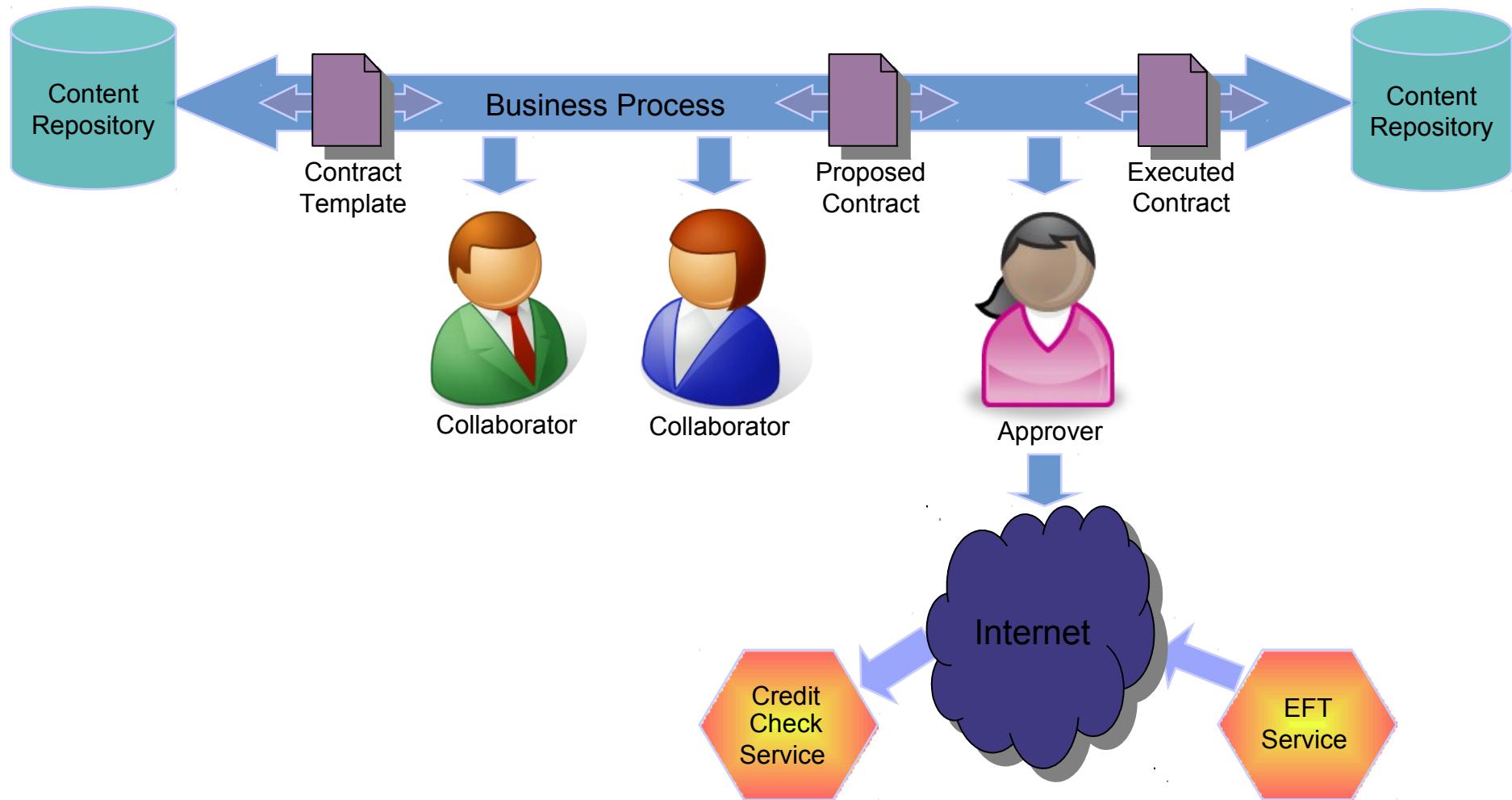


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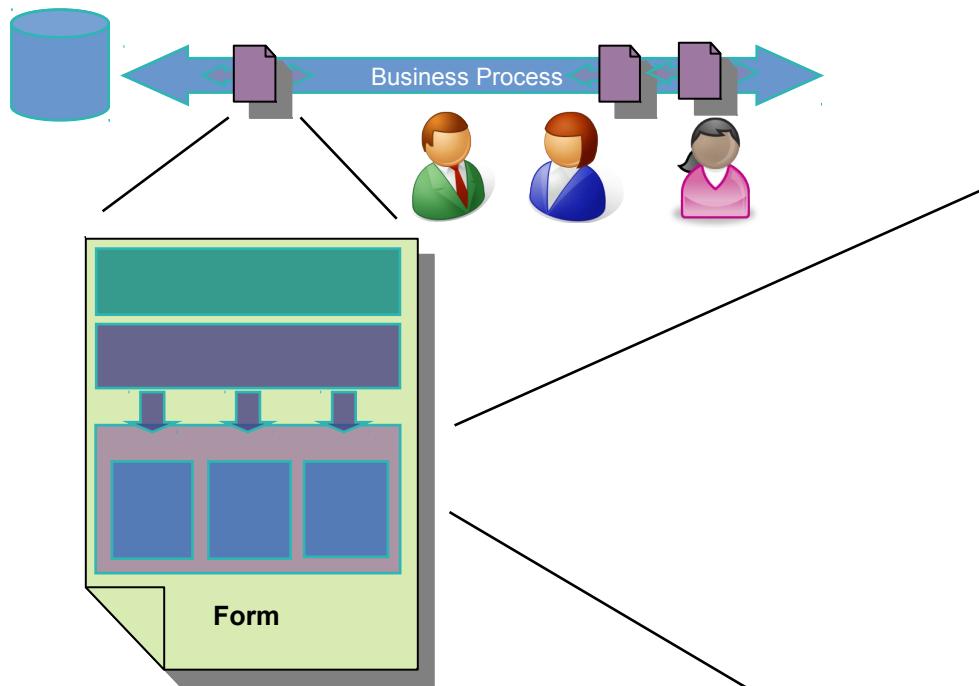


Workflow - Collaborative Business Process Systems



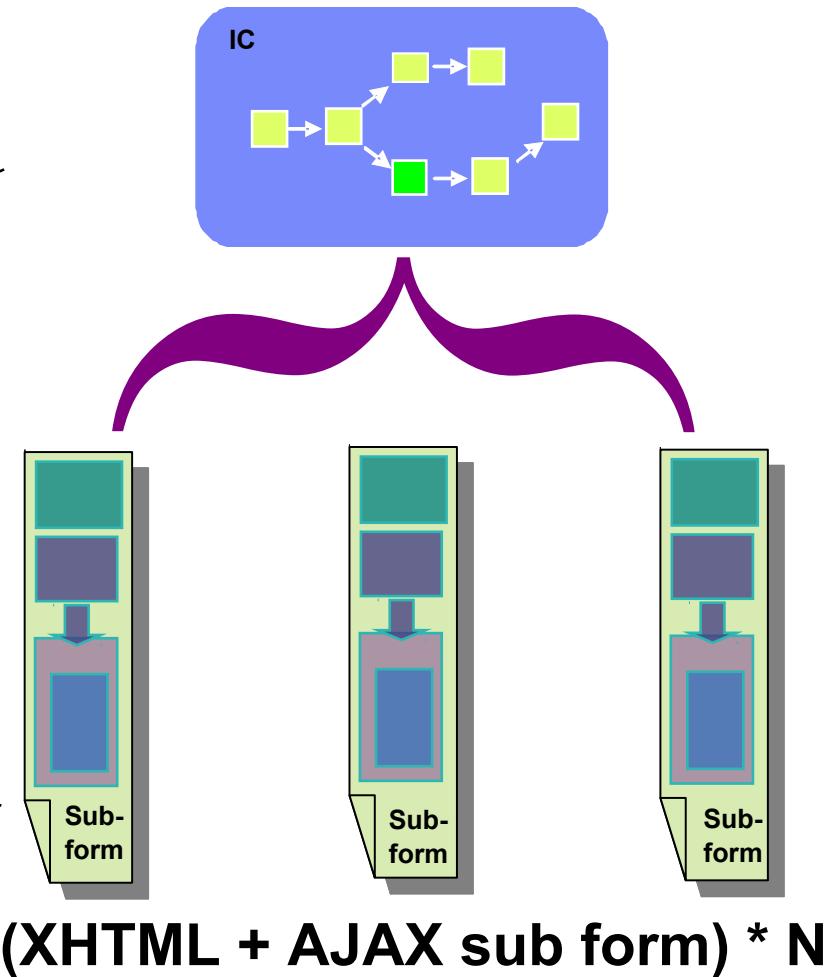
Interactive Web Documents

Interaction Controllers



**Multi-page XFDL
Form**

**Interaction Controller
(example: State Chart XML)**



Use Case: SCXML as SIP Controller

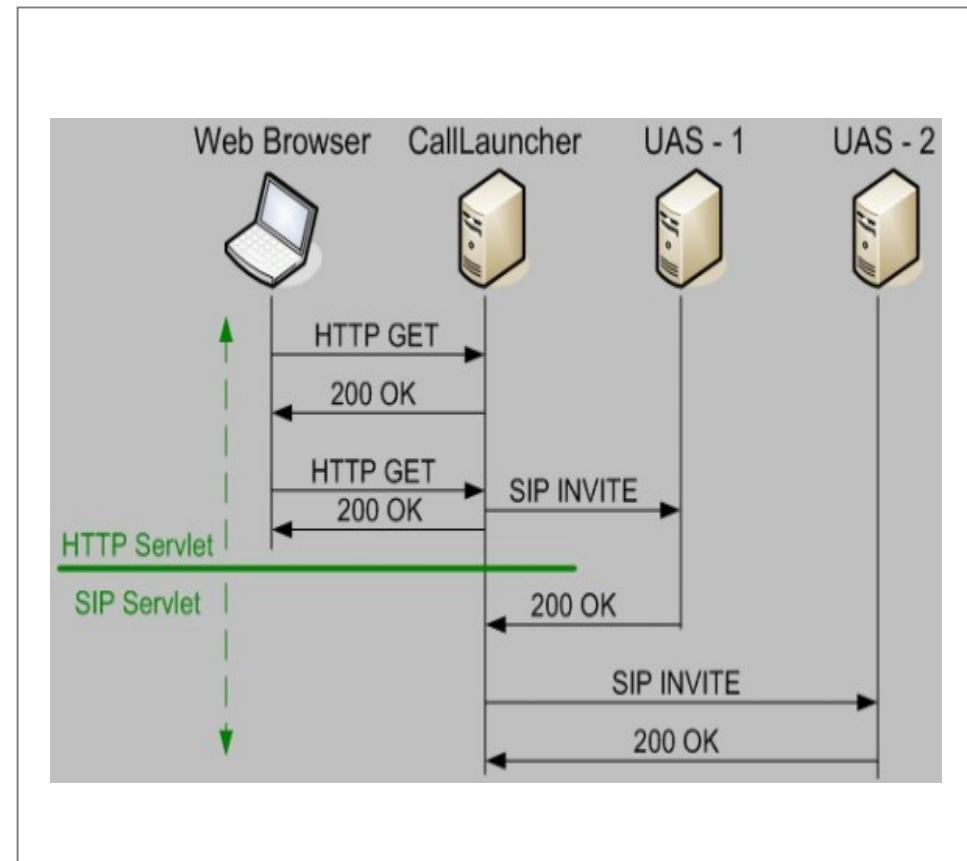
■ Problems with SIP Servlets

- Complex to author – low level Java
- Hard to express common patterns for event-driven, or parallel paths
- Difficult to scale, reuse, compose

■ Solution using SCXML

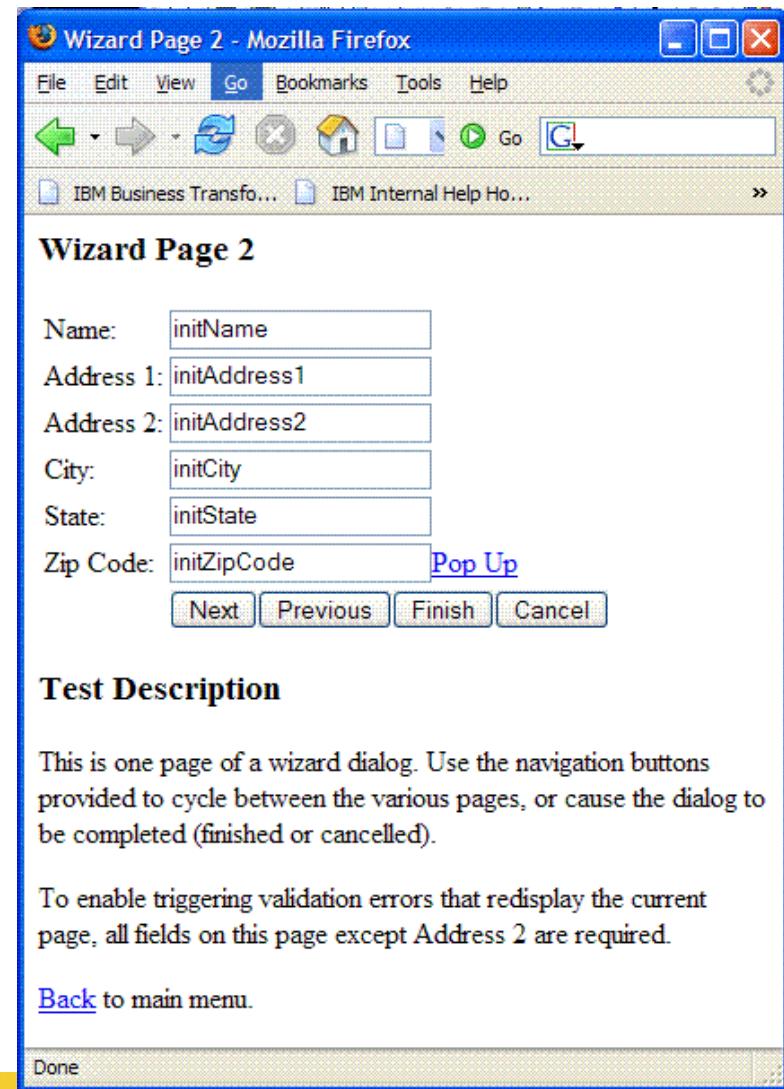
- Inherently event-driven semantics
- Direct support for parallelism, hierarchical composition
- Natural replacement for Java-based SIPlet implementations

Example Call/Invite SIP event flow



Use Case: SCXML in the J2EE Web Container as JSF Controller

- **Problems with current JSF controllers**
 - Ad-hoc state-machine like language
 - Difficult to scale, reuse, and compose
- **Solution using SCXML**
 - Shale “dialog manager” for cross-JSF page navigation in Apache
 - Apache Commons SCXML engine in Shale runtime environment
 - Invokes JSF pages or actions



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Data model extensibility – XML data, XPath

```
<datamodel>
  <data id="cities">
    <list xmlns="">
      <city id="nyc" count="0">New York</city>
      <city id="bos" count="0">Boston</city>
    </list>
  </data>
</datamodel>

<assign
  location="$cities/list/city[@id='nyc']/@count"
  expr="1"/>
```



Data model extensibility – JSON data, ECMAScript

```
<datamodel>
  <data id="cities">
    { "list" : [
      {id : "nyc", count : 0, city : "New York"} ,
      {id : "bos", count : 0, city : "Boston"} ]
    }
  </data>
</datamodel>
```

```
<assign
  location="cities.list[1].count"
  expr="1"/>
```



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Custom actions

- <onentry>, <onexit>, <transition>
 - open content model
 - Implementation or application specific namespaced actions

```
<scxml:onentry>
  <my:email  to="$employee/email"
            cc="$approver/email"
            subject="$message/title"
            content="$message/content"/>
</scxml:onentry>
```



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External communications module - send

- Send target types

```
<scxml:send type="scxml" target="..." />
```

```
<scxml:send type="x-foo" target="..." />
```

- I/O processors

- SCXML
- HTTP
- DOM



VoiceXML 3.0 Transition Controllers, e.g. SCXML

```
<v3:form>
  <scxml:scxml initial="...">
    <!--
      Controller
    -->
  </scxml:scxml>
<v3:form>
```

DOM events as glue:

- Initiate execution of a VoiceXML field

```
<scxml:send target="#vfield" type="DOM" event="DOMActivate"/>
```

- Notification on filling fields / slots

```
<scxml:transition event="filled.vfield" cond="vfield == 'foo'" 
  target="statefoo" />
```



External communications module - invoke

- Invoke source types

```
<invoke src="dialog.vxml#welcome" type="vxml3">
  <param name="skinpath" expr="res.paths.skin"/>
  <finalize>
    <script>finalizeAskHit();</script>
  </finalize>
</invoke>
```

- Data transformations

- param (outbound)
- finalize (inbound)



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State Chart XML (SCXML)

W3C Working Draft



State Chart XML (SCXML): State Machine Notation for Control Abstraction

W3C Working Draft 13 May 2010

This version:

<http://www.w3.org/TR/2010/WD-sxml-20100513/>

Latest version:

<http://www.w3.org/TR/scxml/>

Previous version:

<http://www.w3.org/TR/2009/WD-sxml-20091029/>

Editors:

Jim Barnett, Genesys (Editor-in-Chief)

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RJ Auburn, Voxeo

Michael Bodell, Microsoft

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Jerry Carter, (until 2008, when at Nuance)

Scott McGlashan, HP

Torbjörn Lager, Invited Expert



W3C Specification Status

- Currently Seventh Working Draft
- Last Call Working Draft expected soon
- Assertions and test suite being produced
- Multiple implementations exist



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Apache Commons SCXML (Java runtime)

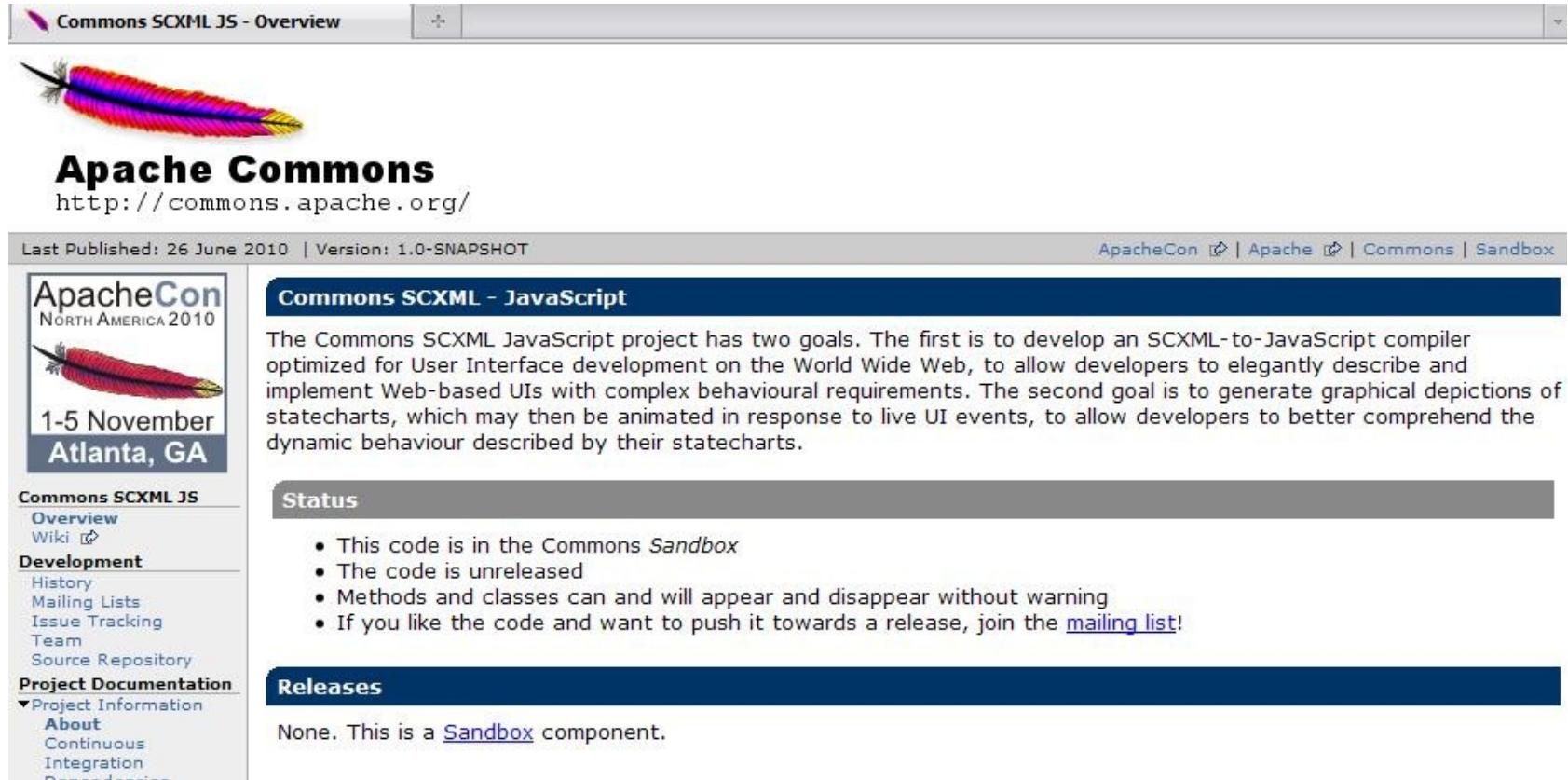
The screenshot shows the Apache Commons SCXML website. On the left, there's a sidebar with links for ApacheCon North America 2010, Commons SCXML Resources (Overview, User Guide, Javadoc, FAQ, Usecases, Building, Dependencies, Mailing lists, Issue Tracking, Team, SVN repository, Download), Releases (Version 0.9, 0.8, 0.7, 0.6, 0.5), Project Documentation (Project Information, Project Reports), Commons (Home, Components, Sandbox, Dormant, Volunteering, Contributing Patches, Building Components, Releasing Components, Wiki), and ASF (Sponsorship, Thank you). The main content area has a title 'Commons SCXML' and a sub-section 'State Chart XML (SCXML)'. It explains that SCXML is a Working Draft by W3C, providing a generic state-machine based execution environment. Below this is a diagram showing a UML statechart on the left, a 'Transform' menu in the center with options like 'UML to SCXML', and a 'Middleware' section on the right showing a Java code editor with SCXML code. At the bottom, there's a 'Runtime' section with icons for a computer monitor, smartphone, and telephone, and a heading 'Commons SCXML'.

State Chart XML (SCXML) is currently a Working Draft published by the World Wide Web Consortium (W3C). SCXML provides a generic state-machine based execution environment based on Harel State Tables. SCXML is a candidate for the control language within multiple markup languages coming out of the W3C (see Working Draft for details). *Commons SCXML* is an implementation aimed at creating and maintaining a Java SCXML engine capable of executing a state machine defined using a SCXML document, while abstracting out the environment interfaces.

The use cases for an SCXML engine are multiple and varied. Anything that can be represented as a UML state chart -- business process flows, view navigation bits, interaction or dialog management, and many more -- can leverage an SCXML engine library.

<http://commons.apache.org/scxml/>

Apache Commons SCXML-JS (JavaScript compiler)



The screenshot shows the Apache Commons SCXML-JS Overview page. At the top, there's a navigation bar with a feather icon and the text "Commons SCXML JS - Overview". Below the navigation bar is a large image of a colorful feather. The main content area has a dark blue header bar with the text "Apache Commons SCXML - JavaScript". The main text in this section describes the project's goals: developing an SCXML-to-JavaScript compiler for User Interface development and generating graphical depictions of statecharts. Below this, there are two sections: "Status" and "Releases". The "Status" section contains a bulleted list of notes about the code being in the Commons Sandbox and unreleased. The "Releases" section states that there are no releases yet, as it is a Sandbox component. On the left side of the page, there's a sidebar with links for ApacheCon North America 2010, the Commons SCXML JS Overview, a Wiki link, Development links (History, Mailing Lists, Issue Tracking, Team, Source Repository), and Project Documentation links (About, Continuous Integration, Dependencies).

Commons SCXML JS - Overview

Apache Commons

http://commons.apache.org/

Last Published: 26 June 2010 | Version: 1.0-SNAPSHOT

ApacheCon | Apache | Commons | Sandbox

ApacheCon NORTH AMERICA 2010

1-5 November Atlanta, GA

Commons SCXML - JavaScript

The Commons SCXML JavaScript project has two goals. The first is to develop an SCXML-to-JavaScript compiler optimized for User Interface development on the World Wide Web, to allow developers to elegantly describe and implement Web-based UIs with complex behavioural requirements. The second goal is to generate graphical depictions of statecharts, which may then be animated in response to live UI events, to allow developers to better comprehend the dynamic behaviour described by their statecharts.

Status

- This code is in the Commons *Sandbox*
- The code is unreleased
- Methods and classes can and will appear and disappear without warning
- If you like the code and want to push it towards a release, join the [mailing list](#)!

Releases

None. This is a [Sandbox](#) component.



<http://commons.apache.org/sandbox/gsoc/2010/scxml-js/>

Apache Commons SCXML-Eclipse (Visual Editor)

Visual SCXML - Visual SCXML - How to... +

Edit SCXML diagram content

You can edit SCXML diagram in this editor, use tools in palette tool bar, create states, execute content and data model and other elements in W3C's SCXML recommendation specification:

stopwatch.modeling_diagram X editor panel

Palettes

- Scxml State Element
 - InitialState
 - State
 - Parallel
 - FinalState
- Execute Content
 - Assign
 - Raise
 - If
 - ElseIf
- Data Model Element
 - DataModel
 - Data
 - Script
- Content

Problems @ Javadoc Declaration Properties

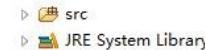
Transition watch.start property view

Core	Property	Value
Appearance	Anchor	
	Cond	
	Event	watch.start
	Source Status	
	Target	
	Target Status	State running

And as you see in the diagram above, you can edit elements' properties in Eclipse property view.

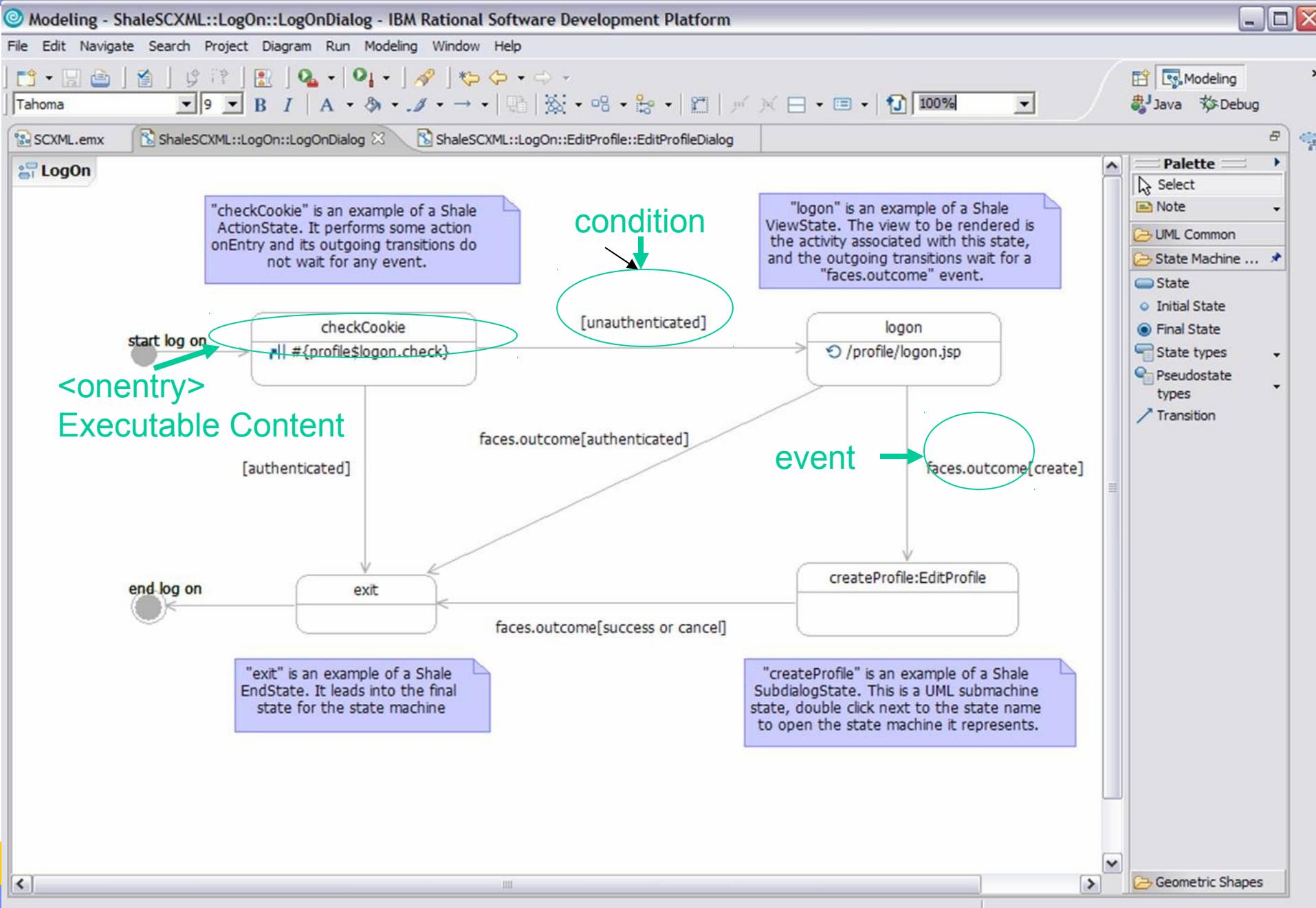
Export a SCXML document

Right click the SCXML "modeling" file which you would like to export, select "Export SCXML document", and fill a filename, click "Finish" to finish export operation.



New

<http://commons.apache.org/sandbox/gsoc/2010/scxml-eclipse/>



Synergy SCXML Web Laboratory

The screenshot shows a web-based application window titled "Synergy SCXML Web Laboratory". The left side of the window contains a code editor for SCXML source code. The current code is:

```
<?xml version="1.0"?>
<scxml initialstate="s0">

  <state id="s0">
    <onentry>
      <log expr="'Hello world!'" />
    </onentry>
    <transition target="s"/>
  </state>

  <final id="s"/>

</scxml>
```

Below the code editor are sections for "Tools" (with a "Run" button and a dropdown "Timelimit: 5 s."), "Report" (checkboxes for Trace, Log, Events), and "Input Events" (an empty text input field). The right side of the window is a large text area with a dark blue header bar containing the title "SCXML Web Laboratory". The main text in this area reads:

SCXML Web Laboratory is a web interface to a prototype implementation of State Chart XML (SCXML). For an immediate demonstration of what the program does, click the Run button in the frame to the left. Then perhaps try some of the other examples that appear in this frame when you click the More Examples button on the top. Note that you may actually edit the SCXML sources and/or the Input Events field before you click Run. This is the main purpose of SCXML Web Laboratory: To allow people to get a feeling for what SCXML is all about, and to elicit feedback in order that we can improve our implementation!

Never heard about SCXML? Unfortunately, this is not the place to introduce SCXML as such. Instead, we refer the interested visitor to the documents listed in [the bibliography](#).

Synergy SCXML v. 0.7.5

Synergy is the name of a dialogue system research platform that we are developing in a project of ours, and Synergy SCXML is an explorative implementation of SCXML in [the Oz programming language](#) - the language that we tend to use a lot in our projects.

We hope that our implementation of SCXML will provide us with flexible means to explore the [Data-Flow-Presentation \(DFP\) framework](#) recently proposed by the W3C. The choice of Oz as implementation language means that we can keep the codebase conveniently small (version 0.7.5 consists of less than 1,500 lines of code half of which is reusable library code). A small codebase together with what Oz has to offer in the form of dataflow concurrency, logic programming, constraint-programming, network transparent distribution, etc., means we will be able to explore advanced concepts very quickly.

Also, since we use Oz as our datamodel access/scripting language our SCXML developers will have at their disposal something far more powerful than Javascript or anything like it.

Thanks

