SALT

Speech Application Language Tags (SALT)
1.0 Specification

Document **SALT.1.0.doc**

15 July 2002

The information contained herein is not a license, either expressly or impliedly, to any intellectual property owned or controlled by any of the authors or developers of this specification. The information contained herein is provided on an "AS IS" basis and to the maximum extent permitted by applicable law, this information is provided *AS IS AND WITH ALL FAULTS*, and the authors and developers of this specification hereby disclaim all other warranties and conditions, either express, implied or statutory, including, but not limited to, any (if any) implied warranties, duties or conditions of merchantability, of fitness for a particular purpose, of accuracy or completeness of responses, of results, of workmanlike effort, of lack of viruses, and of lack of negligence, all with regard to the information and their contribution thereto. ALSO, THERE IS NO WARRANTY OR CONDITION OF TITLE, QUIET ENJOYMENT, QUIET POSSESSION, CORRESPONDENCE TO DESCRIPTION OR NON-INFRINGEMENT WITH REGARD TO THE INFORMATION.

IN NO EVENT WILL ANY AUTHOR OR DEVELOPER OF THIS SPECIFICATION BE LIABLE TO ANY OTHER PARTY FOR THE COST OF PROCURING SUBSTITUTE GOODS OR SERVICES, LOST PROFITS, LOSS OF USE, LOSS OF DATA, OR ANY INCIDENTAL, CONSEQUENTIAL, DIRECT, INDIRECT, PUNITIVE OR SPECIAL DAMAGES WHETHER UNDER CONTRACT, TORT, WARRANTY, OR OTHERWISE, ARISING IN ANY WAY OUT OF THIS OR ANY OTHER AGREEMENT RELATING TO THE SPECIFICATION INFORMATION, WHETHER OR NOT SUCH PARTY HAD ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

For more information, please contact the SALT Forum at mailto:info@saltforum.org or visit http://www.saltforum.org.

Table of Contents

1 Introduction

Speech Application Language Tags (SALT) 1.0 is an extension of HTML and other markup languages (cHTML, XHTML, WML, etc.) which adds a speech and telephony interface to web applications and services, for both voice only (e.g. telephone) and multimodal browsers.

This section introduces SALT and outlines the typical application scenarios in which it will be used, the principles which underlie its design, and resources related to the specification.

1.1 Overview

SALT is a small set of XML elements, with associated attributes and DOM object properties, events and methods, which may be used in conjunction with a source markup document to apply a speech interface to the source page. The SALT formalism and semantics are independent of the nature of the source document, so SALT can be used equally effectively within HTML and all its flavors, or with WML, or with any other SGML-derived markup.

The main top-level elements of SALT are:

<prompt …> for speech synthesis configuration and prompt playing
<listen …> for speech recognizer configuration, recognition execution and post-processing, and recording
<dtmf …> for configuration and control of DTMF collection
<smex …> for general purpose communication with platform components.

The input elements `listen` and `dtmf` also contain grammars and binding controls:

<grammar …> for specifying input grammar resources
<bind …> for processing recognition results.

`listen` also contains the facility to record audio input:

<record …> for recording audio input

`smex` also contains the binding mechanism `bind` to process messages.

All four top-level elements contain the platform configuration element **<param …>**.

A **PromptQueue** object and **LogMessage** function are also available. For control of telephony functionality, an optional **call control** object is defined (Part 3) and a set of predefined messages for linking SALT with other call control models is also possible (see section 2.4.4).

There are several advantages to using SALT with a mature display language such as HTML. Most notably (i) the event and scripting models supported by visual browsers can be used by SALT applications to implement dialog flow and other forms of interaction processing without the need for extra markup, and (ii) the addition of speech capabilities to the visual page provides a simple and intuitive means of creating multimodal applications. In this way, SALT is a lightweight specification which adds a powerful speech interface to web pages, while maintaining and leveraging all the advantages of the web application model.

1.2 Scenarios

Two major scenarios for the use of SALT are outlined below, with simple code samples. For a fuller description of the elements used in these examples, please see the detailed definitions later in the document.

Multimodal
For multimodal applications, SALT can be added to a visual page to support speech input and/or output. This is a way to speech-enable individual HTML controls for 'push-to-talk' form-filling scenarios, or to add more complex mixed initiative capabilities if necessary.

A SALT recognition may be started by a browser event such as clicking on a button, for example, which activates a grammar relevant to an adjacent input field, and binds the recognition result into that field:

```
<!-- HTML -->
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
      ...
      <input name="txtBoxCity" type="text" />
      <input name="buttonCityListen" type="button" onClick="listenCity.Start();" />
      ...

      <!-- SALT -->
      <salt:listen id="listenCity">
          <salt:grammar name="g_city" src="./city.grxml" />
          <salt:bind    targetelement="txtBoxCity"
                        value="//city" />
      </salt:listen>
</html>
```

Voice-only and telephony

For applications without a visual display, SALT manages the interactional flow of the dialog and the extent of user initiative by using the HTML eventing and scripting model. In this way, the full programmatic control of client-side (or server-side) code is available to application authors for the management of prompt playing and grammar activation. (Implementations of SALT are expected to provide scriptlets which will make easier many common dialog processing tasks, e.g. generic forms of the `RunAsk` script below or the `RunSpeech` script illustrated in section 2.6.1.2).

A simple system-initiative dialog might be authored in the following way, for example, where the `RunAsk()` function activates prompts and recognitions until the values of the input fields are filled:

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
 <body onload="RunAsk()">
  <form id="travelForm">
   <input name="txtBoxOriginCity" type="text" />
   <input name="txtBoxDestCity" type="text" />
  </form>

  <!-- Speech Application Language Tags -->
  <salt:prompt id="askOriginCity"> Where would you like to leave from? </salt:prompt>
  <salt:prompt id="askDestCity">   Where would you like to go to?      </salt:prompt>

  <salt:listen id="recoOriginCity" onreco="procOriginCity()">
            <salt:grammar src="city.xml" />
  </salt:listen>

  <salt:listen id="recoDestCity" onreco="procDestCity()">
            <salt:grammar src="city.xml" />
  </salt:listen>

  <!-- scripted dialog flow -->
  <script>
    function RunAsk() {
      if (travelForm.txtBoxOriginCity.value=="") {
        askOriginCity.Start();
        recoOriginCity.Start();
      } else if (travelForm.txtBoxDestCity.value=="") {
        askDestCity.Start();
        recoDestCity.Start();
      }
    }
    function procOriginCity() {
      travelForm.txtBoxOriginCity.value = recoOriginCity.text;
      RunAsk();
    }
    function procDestCity() {
      travelForm.txtBoxDestCity.value = recoDestCity.text;
      travelForm.submit();
    }
```

```
  </script>
 </body>
</html>
```

1.3 Design principles

SALT is designed to be a lightweight markup layer which adds the power of a speech interface to existing markup languages. As such it can remain independent (i) of the high-level page in which it is contained (e.g. HTML); (ii) of the low-level formats which it uses to refer to linguistic resources, e.g. the text-to-speech and grammar formats; and (iii) of the individual properties of the recognition and speech synthesis platforms used by a SALT interpreter. In order to promote interoperability of SALT applications, the use of standard formats for external resources is encouraged wherever possible.

SALT elements are not intended to have a default visual representation on the browser, since for multimodal applications it is assumed that SALT authors will signal the speech enablement of the various components of the page by using application-specific graphical mechanisms in the source page.

1.3.1.1 Modes of execution

Since SALT uses the browser environment of the page in which it is hosted to implement its execution model, the level of programmatic access afforded to the DOM interfaces of SALT elements will differ according to the capabilities of those environments. This notion comes most clearly into perspective when browsers with and without event and scripting capabilities are considered. These classes of browser are broadly labeled 'uplevel' and 'downlevel' respectively, and one can think of SALT as running in a different 'mode' in each class of browser: object mode and declarative mode.

Object mode, where the full interface of each SALT element is exposed in the host environment to programmatic access by application code, is available for uplevel browsers such as those supporting HTML events and scripting modules. Object mode offers SALT authors a finer control over element manipulation, since the capabilities of the browser are greater. (For the most part this specification provides illustrations of the SALT objects in object mode. These illustrations typically assume support of the XHTML Scripting and Intrinsic Event Modules, as defined in the W3C XHTML Recommendation at http://www.w3.org/TR/xhtml1.)

Declarative mode, where a more limited interface of each SALT element is directly exposed, but for which the key functionality is still accessible declaratively, is available in downlevel browsers, such as those not supporting event and scripting modules. Such browsers are likely to be smaller devices, without sufficient processing power to support a scripting host, or more powerful classes of device for which full scripting support is not required or desired. In declarative mode, manipulation of the DOM object of SALT elements is typically limited to attribute specification and simple method calling from other elements. As will be seen, such manipulation can be performed through `bind` statements in the SALT messaging or input modules, for example, or by other browser means if supported (e.g. the declarative multimedia synchronization and coordination mechanisms in SMIL 2.0, as described in 2.8.3).

1.3.2 Dynamic manipulation of SALT elements

In object mode, client-side scripts are able to access the elements of the SALT DOM. For this reason, it is important that SALT implementations address the dynamic manipulation of SALT elements. For example, client-side script may be used to change the value of an event handler:

```
<salt:listen id="listen1" onreco="regularListenFunction">
      ...
</salt:listen>

<script><![CDATA[
      listen1.onreco="specialListenFunction";
]]></script>
```

This is a well-known execution model with HTML and many other markup/script models. SALT implementations must address the probability that advanced dialog authors may dynamically reconfigure the objects of SALT just before a call to execute them.

1.3.3 Events and error handling

Each of the SALT elements and objects specified in this document defines a set of events associated with the functionality of the element. For example, the `onreco` event is fired on a `listen` element when the speech recognition

engine successfully completes the recognition process. The asynchronous nature of eventing in this environment means that applications will typically follow an event-driven programming model. A single textbox, for example, could be updated by values at any time from speech or GUI events. Dialog flow can be authored by triggering selection scripts for dialog turns on the basis of such events.

It should be noted that those properties of SALT objects which are updated by events (for example, the `status` property on many objects) are considered meaningful for evaluation only in the handler of the relevant event which sets them. For instance, an application should examine the `recoresult` property of a `listen` object in the `onreco` or `onnoreco` event handlers, and of the `bookmark` property of a `prompt` object in the `onbookmark` event handler.

Each SALT object specifies an `onerror` event, which when fired signifies a serious or fatal platform exception. The exception updates the element with an associated code in the `status` property that allows the application developer to decide what the best course of action is for the platform error that is thrown.

1.3.3.1 Event models and notation

Much work has been done and is ongoing in the web community on event models across web environments (e.g. HTML intrinsic events (http://www.w3.org/TR/html4/) and browser derivatives thereof; DOM Level 2 and 3 events (http://www.w3.org/DOM/); XML Events (http://www.w3.org/TR/xml-events/); etc.). Current web pages therefore reflect a diversity of event models. (For an illustration of the HTML event model implemented in Microsoft Internet Explorer and comparison with the W3C DOM Level 2 event model, see section 2.8.2.2.1.3.) Given that SALT does not define an event model itself and there is not yet a single event model which is standard across browsers and profiles, a number of syntaxes are possible for the events which SALT defines. Whichever is used will depend on the event model supported by the profile in which SALT is used.

In the sections that define SALT events, therefore, only the event name is provided. The syntax of using the event is exemplified for a number of common models in the table below, and this may be used as a reference for the use of any SALT event in that environment.

This table applies the syntax of these models to an example event, the `onbookmark` event of the prompt object, where *handler* is the name of the function called when the event is thrown, and *promptId* is the identifier of the `prompt` object which holds the event:

Syntax:

Inline HTML	<prompt onbookmark="*handler*" …>
XML Events	<ev:listener ev:name="*promptId*" ev:event="onbookmark" ev:handler="*handler*" … />
Programmatic assignment	ECMAScript: Object.onbookmark = *handler;* VBScript: Object.onbookmark = GetRef("*handler*");

1.3.4 Management of external resources

SALT applications may require resources held in external documents such as audio files, grammars, script libraries, etc. These resources can be large and/or time-consuming to access and load, and applications often need fine level control over downloading and caching policies. Mechanisms for such management are typically available within the host environments in which SALT is expected to be used, for example the HTTP 1.1 mechanisms in HTML. Hence SALT does not itself include any resource management capabilities (with the exception of the `prefetch` attribute on the `prompt` element).

1.4 Document structure

The rest of this specification is structured as follows.

Part 2 describes the SALT speech interface. Sections 2.1 to 2.4 describe the core elements of the SALT markup: `prompt`, `listen`, `dtmf` and `smex`. Each section details the syntax and semantics of the SALT element, including default behavior, and outlines the element and its associated attributes, properties, methods and events. Chapter 2.5 describes the logging function for the recording of platform events and data. Chapter 2.6 contains a number of examples illustrating

the use of SALT to accomplish a variety of tasks. Chapter 2.7 holds the SALT DTD. Chapter 2.8 introduces modularization and profiling issues and outlines SALT/HTML profiles for multimodal and voice-only scenarios.

Part 3 describes the optional `CallControl` object that may be available in telephony profiles for the control of telephony functionality, and shows some illustrative examples of how it may be used.

Part 4 specifies conformance criteria for different classes of SALT browser.

1.5 Terms and definitions

Throughout this document, the uses of the words 'must', 'should' and 'may' with respect to requirements on SALT browser behavior are to be interpreted as "MUST" (REQUIRED), "SHOULD" (RECOMMENDED) and "MAY" (OPTIONAL), respectively, as defined in IETF RFC 2119 (http://www.ietf.org/rfc/rfc2119.txt). The conformance section in part 4 defines overall conformance requirements for SALT browsers.

Here are the definitions of some terms used within the specification.

Term	Definition
CCXML	Call Control eXtensible Markup Language. A markup language for specifying telephony call control applications. Developed by the Voice Browser Working Group at W3C, the initial Working Draft is at http://www.w3.org/TR/ccxml/.
CFG	Context-free grammar, such as W3C SRGS (see below).
cHTML	Compact HTML for Small Information Appliances, a W3C Note at http://www.w3.org/TR/1998/NOTE-compactHTML-19980209/.
DOM	Document Object Model, a standard interface to the contents of a web page, as described at http://www.w3.org/DOM/.
DTMF	Dual Tone Multi-Frequency. Telephone touch-tone or push-button dialing.
Downlevel browser	A browser which does not support full eventing and scripting capabilities. This kind of SALT browser will support the declarative aspects of a given element (i.e. rendering of the core element and attributes), but will not expose all the DOM object properties, methods and events for direct manipulation by the application. Downlevel browsers will typically be found on clients with limited processing capabilities.
ECMA-323	XML Protocol for Computer Supported Telecommunications Applications (CSTA) Phase III, as specified at http://www.ecma.ch/ecma1/STAND/ecma-323.htm by ECMA, the European Computer Manufacturers Association. This specifies an XML protocol for the CSTA services described in ECMA 269.
Event bubbling / Event propagation	This is the idea that an event can affect one object and a set of related objects. Any of the potentially affected objects can block the event or substitute a different one (upward event propagation). The event is broadcast from the node at which it originates to every parent node.
JCP	Java Call Processing API. See http://java.sun.com
JTAPI	Java Telephony API. See http://java.sun.com
Mixed Initiative	A form of dialog interaction model, whereby the user is permitted to share the dialog initiative with the system, e.g. by providing more answers than requested by a prompt, or by switching task when not prompted to do so (see also System Initiative.)
Multimodal	Describing applications or interactions where more than a single mode of input or output is available to the end-user. For SALT this is used in the case where a speech interface is available in addition to a visual interface.
N-Gram	A stochastic language model, such as W3C Stochastic Language Models (N-Gram) Specification (http://www.w3.org/TR/ngram-spec/).
NLSML	Natural Language Semantic Markup Language. W3C specification for representing the meaning of a natural language utterance and associated information. At the time of writing, this specification is at early Working Draft status. The latest version may be found at http://www.w3.org/TR/nl-spec/.
SGML	Standard Generalized Markup Language, a formalism for languages which structure document content. SGML resources may be found at http://www.w3.org/MarkUp/SGML/.
SRGS	Speech Recognition Grammar Specification. W3C specification for representing speech recognition grammars. The latest version may be found at http://www.w3.org/TR/speech-grammar/
SMIL	Synchronized Multimedia Integration Language. A W3C Recommendation, SMIL 2.0

Term	Definition
	(pronounced "smile") enables simple authoring of interactive audiovisual applications. See http://www.w3.org/TR/smil20.
SSML	Speech Synthesis Markup Language. W3C specification for controlling the output of a prompt engine. The latest version may be found at http://www.w3.org/TR/speech-synthesis.
System Initiative	A form of dialog interaction model, whereby the system holds the initiative, and typically drives the dialog with simple questions to which only a single answer is possible. (see also Mixed Initiative.)
TTS	Text-To-Speech: the synthesis of speech output on the basis of textual input.
Uplevel browser	A browser which supports full event and scripting capabilities. This kind of SALT browser will support programmatic manipulation of the attributes, properties, methods and events of every given SALT element. Uplevel browsers will typically be found on 'rich' clients with full processing capabilities.
Voice-only	Describing applications or interactions where the speech modality is the only interface available to the end-user, such as typical telephony scenarios.
WML	Wireless Markup Language, a language developed by the Wireless Application Protocol Forum (http://www.wapforum.org) for applications on wireless devices. Some WML browsers also support WMLScript, a compact scripting language. Specifications may be found at: http://www.wapforum.org/what/technical.htm
XHTML	eXtensible HyperText Markup Language. W3C Recommendation which reformulates HTML as an XML application, defined at http://www.w3.org/TR/xhtml1
XML Name	Syntactic construct for tokens in XML documents, essentially "a token beginning with a letter or one of a few punctuation characters, and continuing with letters, digits, hyphens, underscores, colons, or full stops" (from http://www.w3.org/TR/REC-xml#NT-Name).
XPath	XML Path language, a W3C Recommendation for addressing parts of an XML document. See http://www.w3.org/TR/xpath.
XSLT	Extensible Stylesheet Language Transformations, a W3C Recommendation for transforming XML documents. See http://www.w3.org/TR/xslt.

2 SALT speech interface

2.1 Speech output: <prompt>

The `prompt` element is used to specify the content of audio output. The content of prompts may be one or more of the following:

- inline or referenced text, which may be marked up with prosodic or other speech output information;
- variable values retrieved at render time from the containing document;
- links to audio files.

Prompts can be specified and played individually, and, in more complex applications, they may be managed through a model of prompt queuing. In this model, prompts are queued and played in conceptual *subqueues* and, in those browsers which support the PromptQueue module, subqueue manipulation is available through the `PromptQueue` object (see section 2.1.5). This model is outlined below.

Prompt queuing model
Before defining `prompt`s and the `PromptQueue` in detail, it may be useful to explain the conceptual model behind prompt queuing and playback. There are effectively three units of prompt management:

- `prompt` object (or element)
- prompt subqueue
- `PromptQueue` object

The `prompt` object is the smallest unit of manipulation. As defined in 2.1.1, it holds content for playback.

The prompt subqueue is a conceptual sequence of one or more `prompt` objects. A prompt is added to a subqueue when the prompt is queued. The subqueue is "closed" (that is, it becomes a fixed unit to which no more prompts may be added) by a call to start audio playback. In downlevel browsers, queuing and starting playback typically happen sequentially (activation is mapped to prompt `Start` behavior, as in 2.1.3.2), so the prompt subqueue in a downlevel browser will consist of only a single prompt. In uplevel browsers, individual `Queue` and `Start` methods are available to a prompt, so a prompt subqueue may consist of multiple prompts. For example, an application can call the following sequence of methods:

```
prompt1.Queue();
prompt2.Queue();
prompt3.Start();
prompt4.Queue();
prompt5.Start();
```

which builds two subqueues. The first subqueue holds `prompt1`, `prompt2` and `prompt3`; the second subqueue holds `prompt4` and `prompt5`. Similarly, the following example:

```
prompt1.Start();
prompt2.Start();
prompt3.Start();
```

builds 3 subqueues, holding `prompt`1, `prompt2`, and `prompt3`, respectively. The 3 subqueues will be played sequentially, each subqueue starting immediately after the previous one completes (without the need for subsequent calls to begin playback).

The `PromptQueue` object is supported in uplevel browsers which implement the PromptQueue module. As defined in section 2.1.5, the `PromptQueue` object may be thought of as the container of the prompt subqueues. The `PromptQueue` object provides a means of controlling the subqueue of prompts currently under playback. In relevant HTML profiles the `PromptQueue` is a child of the `window` object.

The behavior of `prompt`s, subqueues and the `PromptQueue` object is explained in greater detail below.

2.1.1 prompt content

The `prompt` element contains the resources for system output. The content of prompts may be one or more of the following:

- inline or referenced text, which may be marked up with prosodic or other speech output information;
- variable values retrieved at render time from the containing document;
- links to audio files.

It also permits platform-specific configuration using the `param` element.

2.1.1.1 Text and inline TTS markup

Simple prompts need specify only the text required for output, e.g.:

```
<prompt id="Welcome">
   Thank you for calling the weather report.
</prompt>
```

SALT also allows any format of speech synthesis markup language to be used inside the prompt element.

To enable interoperability of SALT applications, SALT browsers must support the W3C Recommendation for Speech Synthesis Markup Language (SSML), http://www.w3.org/TR/speech-synthesis. A SALT browser may support any other speech synthesis formats. (Note: at the time of writing, the W3C SSML specification is currently a Working Draft and not yet a W3C Recommendation.)

The following example shows text with an instruction to emphasize certain key phrases:

```
<prompt id="giveBalance" xmlns:ssml="http://www.w3.org/2001/10/synthesis">
      You have <ssml:emphasis> five dollars </ssml:emphasis> left in your account.
</prompt>
```

2.1.1.2 value

The `value` element can be used to refer to text or markup held in elements of the document.

value element
value: Optional. Retrieves the values of an element in the document.

Attributes:

- **targetelement:** Required. The `id` of the element containing the value to be retrieved.
- **targetattribute:** Optional. The attribute of the element from which the value will be retrieved. If unspecified, no attribute is used, and the value defaults to the content (text or XML) of the element.

The `targetelement` attribute is used to reference an element within the containing document. The content of the element whose `id` is specified by `targetelement` is inserted into the text to be synthesized. If the desired content is held in an attribute of the element, the `targetattribute` attribute may be used to specify the necessary attribute on the `targetelement`. This is useful for referencing the values in HTML form controls, for example. In the following illustration, the `value` attributes of the `txtBoxOrigin` and `txtBoxDest` elements are inserted into the text before the prompt is output:

```
<prompt id="Confirm">
      Do you want to travel from
      <value targetelement="txtBoxOrigin" targetattribute="value" />
      to
      <value targetelement="txtBoxDest" targetattribute="value" />
      ?
</prompt>
```

2.1.1.3 content

The `content` element can be used to reference external content such as dynamically generated speech markup or remote audio files. It also holds optional inline content which will be rendered in the event of a problem with the externally referenced material. This can take the form of any of the inline content possible for `prompt`.

content element
content: Optional. The `content` element specifies a link to an external output resource and identifies its type. SALT platforms should attempt to render if possible the content of the resource, but if this is impossible, any content specified inline will instead be output.

Attributes:

- **href:** Required. A URI referencing prompt output markup or audio.
- **type:** Optional. The media-type corresponding to the speech output format used. For XML content, typical types may be the W3C Speech Synthesis Markup Language format, specified as `application/ssml+xml`, or proprietary formats such as `application/x-sapitts+xml`. This attribute permits the SALT author to signal the format of a prompt resource and determine compatibility before a potentially lengthy download. Note, however, that it does not guarantee the format of the target (or inline resource), and platforms are free to treat the attribute (or its absence) in their own way. Formats required by SALT clients which support the basic media playback module (see section 2.8.1.5) are G.711 wav (audio/wav: 8kHz 8-bit mono [PCM] single channel) and headerless (audio/basic: 8kHz 8-bit mono [PCM] single channel)[1]. (Compression type is expected according to the telephony standard in the country of deployment, e.g. Mu-law in North American deployments, A-law in European deployments, etc.)

The following example holds one content element to reference XML content in SSML, and another to point to an audio file.

```
<prompt>
      <content href="/VoiceMailWelcome.ssml" type="application/ssml+xml" />
      After the beep, please record your message:
      <content href="/wav/beep.wav" />.
</prompt>
```

2.1.1.4 Speech output configuration: <param>

Additional, non-standard configuration of the prompt engine is accomplished with the use of the `param` element, which passes parameters and their values to the platform. `param` is a child element of `prompt`.

The exact nature of the configurative parameters will differ according to the proprietary platform used. Values of parameters may be specified in an XML namespace, in order to allow complex or structured values.

param element
param: Optional. Used to pass parameter settings to the speech platform.

param content

Attributes:

- **name:** required. The name of the parameter to be configured.
- **xmlns:** optional. Specifies a namespace and potentially a schema for XML content of the parameter.

So, for example, the following syntax:

```
<salt:param name="promptServer">//myplatform/promptServer</salt:param>
```

could be used to specify the location of a remote prompt engine for distributed architectures.

Note that page-level parameter settings in HTML profiles may also be defined using the `meta` element (see 2.8.2.2.1.5).

[1] audio/wav is widely used as a media type, although it is not formally registered as an rfc. The audio/basic media type is described in http://www.ietf.org/rfc/rfc1521.txt.

2.1.2 prompt attributes and properties

The `prompt` element holds the following attributes and properties. Attributes are supported by all browsers. Properties by uplevel browsers.

2.1.2.1 Attributes

- **id:** optional. The identifier of the `prompt` element. Must be a valid XML Name and unique within the document (i.e. of XML type `ID`).
- **bargein:** Optional. This Boolean flag indicates whether the platform is responsible for stopping prompt playback when speech or DTMF input is detected (this is sometimes also known as delegated bargein or cut-through)[2]. If true, the platform will stop prompt playback in response to input and flush the current subqueue. If false, the platform will take no default action in response to input. If unspecified, it defaults to true. In both cases the `onbargein` handler is called when input is detected (see section 2.1.4.2)[3].
- **prefetch:** Optional. A Boolean flag which, if true, indicates to the platform that the external content of a prompt is likely to require a lengthy download, and may be prefetched sooner than playback time if possible. Defaults to false.
- **xmlns** Optional. This is the standard XML namespacing mechanism and is used with inline XML prompts to declare a namespace and identify the schema of the format. See http://www.w3.org/TR/REC-xml-names/ for usage.
- **xml:lang:** Optional. String indicating the language of the prompt content. The value of this attribute follows the `xml:lang` definition in XML 1.0 (http://www.w3.org/TR/REC-xml#sec-lang-tag). For example, xml:lang="en-US" denotes US English. The attribute is scoped, so if unspecified, a higher level element in the page may propagate the xml:lang value down to `prompt` (see equivalent in `grammar` element, section 2.2.1.1). If `xml:lang` is not specified at any level, the platform is free to determine the language of choice.

2.1.2.2 Properties

Uplevel browsers support the following properties in the prompt's DOM object.

- **bookmark:** Read-only. A string object recording the text of the last synthesis bookmark encountered (see 2.1.4.1). For each playback, the property is set to null string until an `onbookmark` event is encountered.
- **status:** Read-only. Integer holding the status code returned by the speech platform on an event. The `status` property is only meaningful after status-setting events are thrown by the `prompt` object, and applications should examine it in the handler of the relevant event. A status code of zero is set by the `oncomplete` event (see 2.1.4.3). Other status values are set when the `onerror` event is thrown (see 2.1.4.4).

2.1.3 prompt methods

The queuing and playback of prompts may be controlled using the following methods on the `prompt` object. These methods will be supported by uplevel browsers. (Further manipulation of prompt subqueues is exposed through the `PromptQueue` object in uplevel browsers which support the PromptQueue module (see section 2.1.5)).

2.1.3.1 Queue

Queue the prompt onto the prompt subqueue. Takes an optional argument of type string (which may be markup, as for inline content). If no argument is provided, the method queues the inline content of the object. If an argument is provided, the value of the argument is treated as the string to be output instead of inline content, and is subject to any relevant features specified in the prompt's attributes in section 2.1.2.1 (i.e. `bargein`, `xmlns` and `xml:lang`). After an individual prompt has finished normal playback, the `oncomplete` event is thrown, and its `status` code is set to zero.

Syntax:

[2] This applies to whichever kind of input detection (or 'bargein type') is supported by platform. The type of detection could be set by using a platform-specific setting using the `param` element. It is not fired by keypress input on a visual display.

[3] It is important to notice that even if bargein is false, the starting of a `listen` or `dtmf` object before the end of a prompt will still collect input immediately. If it is desired to begin collecting input only on completion of prompt playback, this sequence should be explicitly programmed (for example, in an uplevel HTML profile by wiring the prompt's `oncomplete` event to the starting of `listen/dtmf`, or in a SMIL profile by declarative sequencing, and so on).

Object.Queue([strText]);

Parameters:

- **strText:** optional. String holding the text or markup to be sent to the speech output engine. If present, this value is used instead of the contents of the object. The content specified in the argument is treated exactly as if it were inline content in terms of resolving external references, etc.

Return value:

None.

Exception:

In the event of a problem with queuing the prompt, e.g. that external content cannot be retrieved and no alternate inline text is provided (see 2.1.1.3), the `onerror` event is thrown, and the `prompt`'s status code is set to one of the relevant values described in 2.1.4.4.

Browsers should check prompts for freshness of content and validity of reference on the `Queue()` call. In general, error events should be raised as soon as possible after this call is made.

As noted in section 2.1.1.3, inline text can be specified as an alternative to external content, and this text is queued if external content is invalid or unretrievable. If no inline text is specified, and content is unable to be resolved, the `onerror` event is thrown as described above.

If `Queue()` is called in succession on multiple `prompt` objects, playbacks are queued in sequence onto a subqueue. Playback of the resulting subqueue does not begin until `Start()` is called (on a `prompt` or the `PromptQueue` object). If `Queue()` is called during playback (i.e. after `PromptQueue.Start()` but before the `onempty` event is thrown), the prompt is added to a new subqueue, which will only be played back after another explicit `Start()` call.

2.1.3.2 Start

Queue the prompt onto the prompt subqueue and schedule that subqueue for playback (i.e. begin playback immediately if no other prompts are currently in play, or begin playback of the subqueue directly after the last subqueue has ceased playback). Takes an optional argument of type string. If no argument is provided, the method queues the inline content of the object. If an argument is provided, the value of the argument is treated as the string to be output. This argument overrides any inline content, and is subject to any relevant features specified in the prompt's attributes in section 2.1.2.1 (i.e. `bargein`, `xmlns` and `xml:lang`). This method can be thought of a shorthand for `prompt.Queue([arg])` followed by a call to begin audio playback (`PromptQueue.Start()` in relevant profiles) and its content, arguments and the possible resulting events are just as if these two functions had been called sequentially.

Syntax:

Object.Start([strText]);

Parameters:

- **strText**: optional. String holding the text or markup to be sent to the speech output engine. If present, this value is used instead of the contents of the object.

Return value:

None.

Exception:

In the event of a problem with queuing or playing back the prompt, e.g. that external content cannot be retrieved and no alternate inline text is provided (see 2.1.1.3), the `onerror` event is thrown, and the `prompt`'s status code is set to one of the relevant values described in 2.1.4.4.

2.1.4 prompt events

The `prompt` object supports the following events, whose handlers may be specified as attributes of the `prompt` element.

2.1.4.1 onbookmark

Fires when a synthesis bookmark is encountered. Bookmarks are specified by application authors in the input to the speech output engine, and are used to notify an application that a particular point has been reached during playback. When the engine encounters a bookmark, the event is thrown to the platform. The example in section 2.6.2.2 shows how bookmarks in a prompt can be used to help determine the meaning of a user utterance.

On reception of this event, the `bookmark` property of the prompt object is set to the name of the bookmark thrown. The event does not pause or stop the playback.

Event Object Information:

Bubbles	No
To invoke	A bookmark in the rendered string is encountered
Default action	Returns the bookmark string

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.1.4.2 onbargein

optional. Fires when an input event is detected from the user. This event corresponds to the detection of input from either speech or DTMF, and will be triggered by the `onspeechdetected` event on a started `listen` object (see section 2.2.4.3), or by the `onkeypress` event or `onnoreco` event on a started `dtmf` object for in-grammar and out-of-grammar keypresses respectively (sections 2.3.4.1, 2.3.4.3)[4].

This handler is used to specify processing either (i) instead of, or (ii) in addition to the cessation of prompt playback on reception of an input event. (See section 3.2.1 for use of the `bargein` attribute to automatically stop prompt playback on detection of such an event.)

(i) If the `bargein` attribute is false and user input is detected, the prompt will keep playing when the `onbargein` event fires and while its associated processing is executed (unless of course it is explicitly stopped elsewhere in the application). This may be used in an email reader application, for example, where commands are enabled which do not require the prompt to stop (e.g. 'speak louder' or 'read faster') or for bookmarking (such as the example in 2.6.2.2).

(ii) If the `bargein` attribute is true, and user input is detected, the `onbargein` handler will fire after prompt playback has been halted by the platform and the prompt subqueue flushed. This may be used to specify any additional processing of a bargein event (e.g. to log the timing of the bargein).

It should not need restating that whether or not this event is specified, prompt playback is stopped and the subqueue flushed automatically by user input when the `bargein` attribute is set to true (section 3.2.1). (The automatic method generally results in less latency than using the `onbargein` handler to script an explicit `PromptQueue.Stop()`)[5].

Event Object Information:

Bubbles	No
To invoke	A speech/dtmf input event is encountered
Default action	None

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.1.4.3 oncomplete

This event fires when the prompt playback completes normally. It has no effect on the rest of the prompt subqueue. (In relevant profiles, after the `oncomplete` event of the last prompt in the subqueue, the `onempty` event is thrown by the `PromptQueue` object (section 2.1.5.3.1)).

Event Object Information:

Bubbles	No
To invoke	prompt playback completes
Default action	Set status = 0.

[4] Note that in multimodal profiles where a visual display is used, the keypress event from a GUI element will not trigger the `onbargein` event.

[5] As noted previously, it is important to remember that the starting of a `listen` or `dtmf` object before the end of a prompt will still collect input immediately. If it is desired to begin collecting input only on completion of prompt playback (i.e. that the `onbargein` event never fires on the prompt), this sequence should be explicitly programmed (for example, in an uplevel HTML profile by wiring the prompt's `oncomplete` event to the starting of `listen/dtmf`, or in a SMIL profile by declarative sequencing, and so on).

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.1.4.4 onerror

The `onerror` event is fired if a serious or fatal error occurs with a prompt such that it is unable to be queued or played. The `onerror` event will typically be thrown after the `Queue()` command, and before playback of the current subqueue begins. Different types of errors are distinguished by status code and are shown in the event object information table below. The throwing of this event by a single prompt will flush the subqueue in which it is contained.

Event Object Information:

Bubbles	No
To invoke	The synthesis process experiences a serious or fatal problem.
Default action	On encountering an error, status codes are set as follows: **status -1:** Generic failure to queue the prompt onto the `PromptQueue` object. **status -2:** Failure to find a speech output resource (for distributed architectures) **status -3:** An illegal property/attribute setting that causes a problem with the synthesis request. **status -4:** Failure to resolve content – this is likely to be an unreachable URI, or malformed markup content.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.1.4.5 Telephony hang-up

In telephony profiles where the `PromptQueue` object is not supported, a disconnect event will have the effect of stopping playback of all prompts and flushing all subqueues.

2.1.5 PromptQueue object

The `PromptQueue` object is a browser object used to control prompt playback. It is accessible from script and has no markup element on the SALT page. Not all browsers need to support the PromptQueue module. In an HTML profile where the PromptQueue module is supported, the `PromptQueue` object will be a child of the `window` object.

The `PromptQueue` is maintained as a browser object rather than a markup element for two reasons:

1. It maintains a central object for playback control. The asynchronous nature of the call to `prompt.Queue()` means that with multiple queued prompts, the application cannot know (without explicit maintenance scripts) which prompt is currently being played back, and therefore which to pause/stop/resume, etc. when necessary. The `PromptQueue` object provides a single object for doing this.

2. This permits prompt playback to be uninterrupted across page transitions, since the `PromptQueue` object persists across the loading and unloading of individual pages. That is, unlike the markup elements in the DOM, it is not destroyed when its containing page is unloaded (although events which would otherwise be thrown to the `prompt` elements, are lost if the containing page has been unloaded). An example of this is shown in section 2.6.2.3.

The `PromptQueue` object operates in the following manner:

The `PromptQueue` is a singleton object which conceptually holds one or more prompt subqueues. As outlined in 2.1, these subqueues are delimited by `Start()` calls (either on individual prompts or on the `PromptQueue` itself). A new subqueue is initiated by calling `Queue()` on a prompt either when the `PromptQueue` is empty, or after a `Start()` call when it is playing back. That is, each set of prompts queued and followed by `Start()` is considered a single subqueue. A subqueue will not be played back until a `Start()` call is made.

It will be seen below that actions of the `PromptQueue` are local to a subqueue rather than the entire `PromptQueue` object, with the exception of the `Flush()` and `Change()` methods. The events supported by `PromptQueue` have scope at the level of subqueue. For example, the completion of playback of each subqueue is signaled by the `onempty` event (see 2.1.5.3.1). An `onerror` event on a single `prompt` will flush the subqueue in which that prompt was held, but will not affect any other subqueues in the `PromptQueue` (and therefore does not necessarily halt playback, see 2.1.5.3.2). Bargein behavior is also local to a subqueue: recall from section 2.1.2.1 that where `bargein` is set true, an `onbargein` event on a single prompt will stop playback and flush the current subqueue. Similarly, all `PromptQueue` methods take effect in the scope of the subqueue rather than that of the `PromptQueue` object, except `PromptQueue.Flush()`, which is a global action to flush all the subqueues from the `PromptQueue` object, and `PromptQueue.Change()`, which applies adjustments of speed and volume to all subqueues on the PromptQueue.

For a detailed illustration of queuing and the PromptQueue, see 2.1.5.4.

The properties and methods of the `PromptQueue` object are described in detail below.

2.1.5.1 PromptQueue properties

Uplevel browsers support the following properties in the `PromptQueue` object.

- **status:** Read-only. Status code returned by the speech platform. The status code of zero indicates a successful completed subqueue operation by the speech platform, a negative status code indicates an error on the speech output platform.

2.1.5.2 PromptQueue methods

2.1.5.2.1 Start

Schedule an open subqueue of prompts for playback, that is, begin playback of the subqueue immediately if no other prompts are currently in play, or begin playback of the subqueue directly after the last subqueue on the PromptQueue has ceased playback. When the final prompt in a subqueue finishes playback (and after the throwing of that prompt's `oncomplete` event), an `onempty` event is thrown to the `PromptQueue` object (see 2.1.5.3.1) and its `status` property is set to zero. If no prompts are in the subqueue (including the case where all subqueues are already scheduled for playback), or a problem arises with the speech output resource, this call throws an `onerror` event with the error codes listed in 2.1.5.3.2.

Syntax:
PromptQueue.Start();
Parameters:
None.
Return value:
None.
Exception:
In the event of a problem the `onerror` event is fired, and the status code is set to a negative value, as listed in 2.1.5.3.2.

2.1.5.2.2 Pause

This method pauses playback of the current subqueue without flushing the audio buffer or otherwise affecting the subqueue. This method has no effect if playback is paused or stopped. Notice that `Pause()` is a synchronous method with a return value. While playback is paused, `Start` calls to playback (on a `prompt` or the `PromptQueue`) have the usual effects of subqueue delimitation and scheduling, but playback remains in a paused state (until `Resume` is called).

Syntax:
PromptQueue.Pause();
Parameters:
None.
Return value:
0 for successful pause, -1 for failure.
Exception:
None.

2.1.5.2.3 Resume

This method resumes playback after a pause. This method has no effect if playback has not been paused. Notice that `Resume()` is a synchronous method with a return value.

Syntax:
PromptQueue.Resume();
Parameters:
None.
Return value:
0 for successful resumption, -1 for failure.
Exception:
None.

2.1.5.2.4 Change

Change speed and/or volume of playback of prompts in all subqueues. `Change()` may be called before playback begins, or during playback. It takes effect beginning with the first or current prompt (as appropriate), and applies to prompts in all subqueues on the `PromptQueue` object. The adjustment factors to speed and volume are relative to current speed and volume, e.g. the consecutive commands:

```
PromptQueue.Change(2.0, 2.0);
PromptQueue.Change(2.0, 2.0);
```

will twice double the rates of speed and volume relative to those which were in effect before the first command was made.

Syntax:
PromptQueue.Change(speed, volume);
Parameters:
- **speed:** Required. The factor to change. `speed=2.0` means double the current rate; `speed=0.5` means halve the current rate; `speed=1.0` means keep the current rate; `speed=0` means to restore the default value.
- **volume:** Required. The factor to change. `volume=2.0` means double the current volume, `volume=0.5` means halve the current volume, `volume=1.0` means keep the current volume; `volume=0` means to restore the default value.

Return value:
None.
Exception:
If the `Change()` method is not supported, the `onerror` event is fired, and the status code is set to -3.

2.1.5.2.5 Stop

Stop playback and flush the subqueue. If playback has been paused, the method simply flushes the current subqueue. If playback is not underway at all, the method has no effect.

Syntax:
PromptQueue.Stop();
Parameters:
None.
Return value:
None.
Exception:
There are no explicit exceptions associated with this method.

2.1.5.2.6 Flush

Stop playback and flush the audio buffer. All subqueues are removed from the `PromptQueue`. If playback is not underway (i.e. it has not been started or has already been stopped or paused) the method flushes all prompt subqueues. In telephony profiles, the `Flush()` method is executed automatically by the detection of a disconnect (the order of firing is as follows: `listen`, `dtmf`, `PromptQueue`), and the `onerror` event is thrown, with status code -30.

Syntax:

```
PromptQueue.Flush();
```

Parameters:

None.

Return value:

None.

Exception:

There are no explicit exceptions associated with this method. However, `onerror` is thrown and status code -30 set in telephony profiles when a disconnect event automatically invokes `Flush()`.

2.1.5.3 PromptQueue event handlers

2.1.5.3.1 onempty

This event fires when the last of the prompts in a subqueue have finished playback. It fires after the `oncomplete` is fired on the last prompt of the subqueue (and therefore only fires when the playback of the prompt subqueue completes naturally without explicit stop calls). For prompt queues which are not stopped by other means, there will be one `onempty` event for every subqueue, i.e. for every `Start()` call made.

Event Object Information:

Bubbles	No
To invoke	Final prompt in prompt subqueue has completed playback.
Default action	Set status = 0 if playback completes normally.

Event Properties:

Although the event handler does not receive properties directly, the handler can query the event object for data.

2.1.5.3.2 onerror

The `onerror` event is fired if a serious or fatal error occurs with the synthesis (voice output) process. Since `onerror` on the `PromptQueue` object will fire on generic platform errors, playback is stopped on reception of this event and the subqueue is flushed. (Other queues held in the `PromptQueue` object are not affected.) For platform errors, a status code of -1 is set; for errors fired due to `Start()` being called on an empty subqueue, a status code of -2 is set, and for `Change()` when unsupported, a status code of -3 is set. `onerror` is also fired in telephony profiles as a result of the automatic call to `Flush()` on detection of a disconnect (status -30), or if playback is attempted after a disconnect event.

Event Object Information:

Bubbles	No
To invoke	The synthesis process experiences a serious or fatal problem.
Default action	On encountering an error, status codes are set as follows: **status -1:** A generic speech output resource error occurred during playback. **status -2:** the `Start()` call was made on an empty prompt subqueue. **status -3:** the `Change()` call was made, but the platform does not support it. **status -30:** (telephony profiles only) a disconnect invoked the `Flush()` method, or prompt playback was attempted after disconnect.

Event Properties:

Although the event handler does not receive properties directly, the handler can query the event object for data.

2.1.5.4 PromptQueue illustrations

This section contains diagrams illustrating the mechanisms of the `PromptQueue` in action.

2.1.5.4.1 Initializing a subqueue

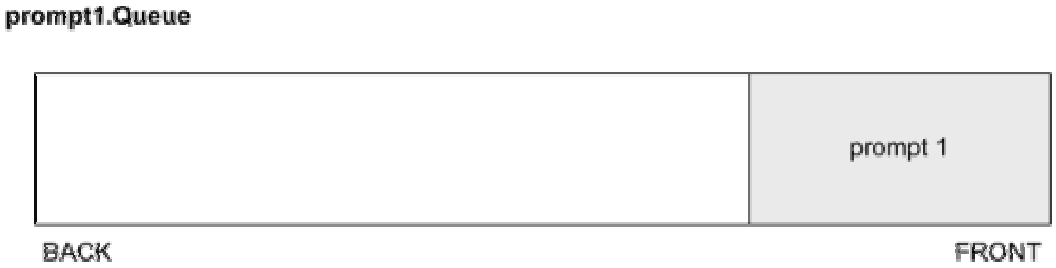


Figure 1: single prompt queued

Figure 1 shows the results of queuing a single prompt, `prompt1`, using its `Queue` method. This initializes a new subqueue, and places `prompt1` at its head.

2.1.5.4.2 Adding a second prompt to the subqueue

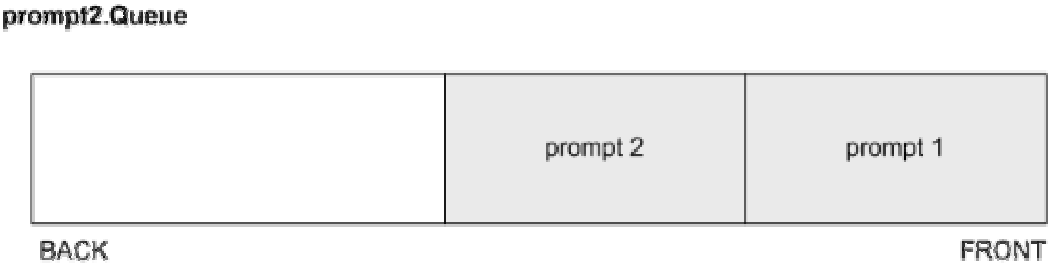


Figure 2: two prompts queued

Figure 2 shows the queuing of a second prompt, `prompt2`, again with the `Queue` method. It is added to the tail of the same subqueue, after `prompt1`.

2.1.5.4.3 Adding a third prompt to the subqueue

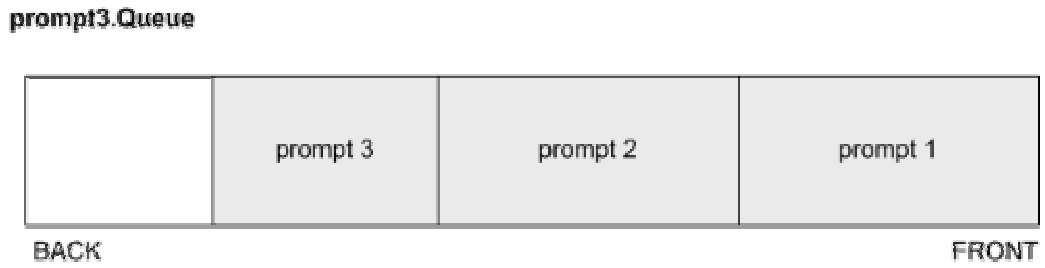


Figure 3: three prompts queued

Figure 3 shows the queuing of a third prompt, `prompt3`, using its Queue method. As with `prompt2`, it is added to the tail of the same subqueue.

2.1.5.4.4 Call to begin playback

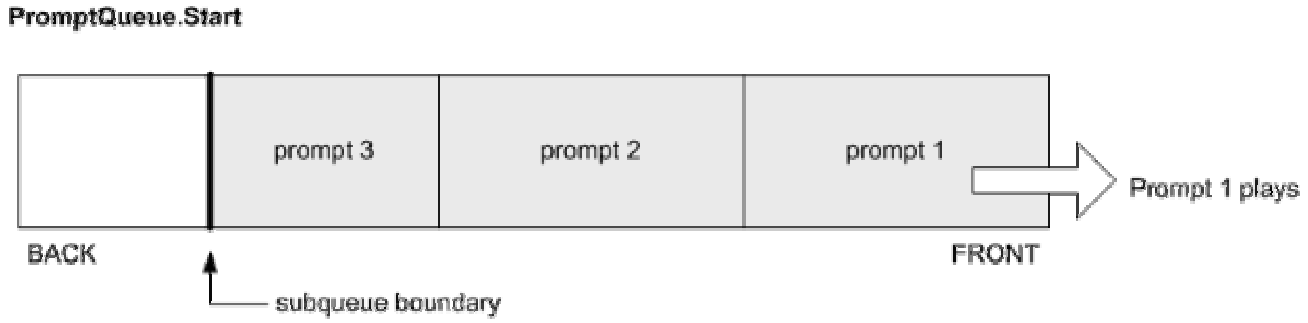


Figure 4: Starting playback

Figure 4 shows the call to start playback, `PromptQueue.Start()`, on the prompts currently queued. The call has the effect of (i) closing the subqueue after `prompt3`, and (ii) scheduling the subqueue for playback, beginning with the first prompt, `prompt1`. Since no other subqueues are being output, playback begins immediately. When `prompt1` has finished, its `oncomplete` event will be fired, and the next prompt in the subqueue will begin (`prompt2`).

2.1.5.4.5 Prompt queuing during playback

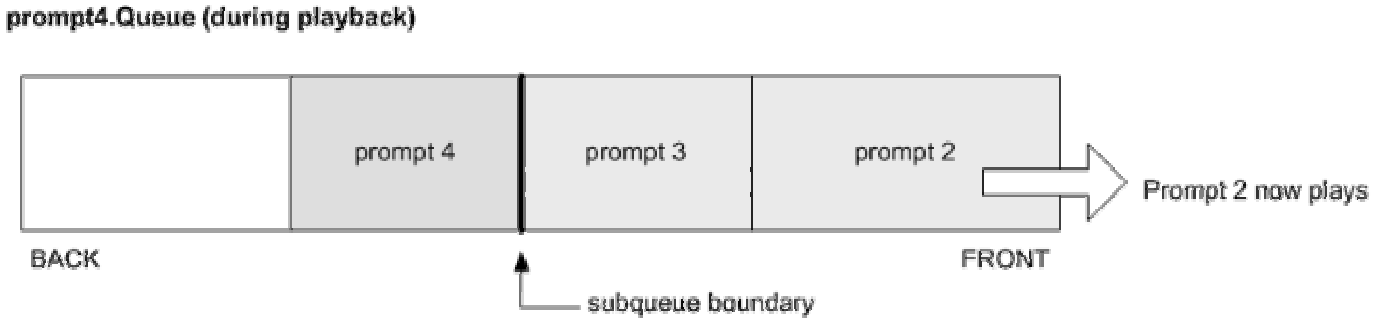


Figure 5: prompt queuing during playback

Figure 5 shows a prompt being queued while playback is underway. Since the last subqueue was closed, the new prompt, `prompt4` initializes a new subqueue and places itself at the head. This happens while the current subqueue is being played back. (As above, when `prompt2` has finished, its `oncomplete` event will be fired, and the next prompt in the subqueue will begin (`prompt3`).

2.1.5.4.6 Playback using Start on the prompt

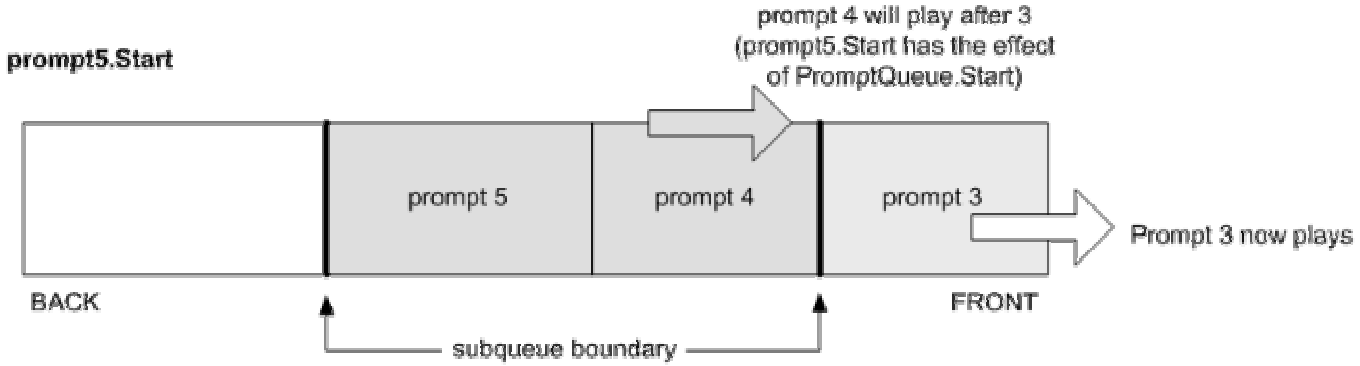


Figure 6: new subqueue playback

Figure 6 shows the queuing of another prompt and a call to playback on the new subqueue. Two things are important to note here.

Firstly, the `Start` method on the `prompt` is used, rather than the `Start` method on the `PromptQueue` object. The calling of `Start` on the new prompt, `prompt5`, is equivalent in this profile to the two consecutive commands `prompt5.Queue` followed by `PromptQueue.Start` (as described in section 2.1.3.2). The effect of the call is as follows:

(i) `prompt5` is queued onto the tail of the new subqueue; (ii) the new subqueue is closed after `prompt5`; and (iii) the new subqueue is scheduled for playback on completion of the current subqueue.

Secondly, the call to playback happens before the first subqueue has finished playback. So the second subqueue is scheduled for output as soon as the first is finished, that is, `prompt4` will begin playback immediately after `prompt3` has completed.

2.1.5.4.7 A third subqueue

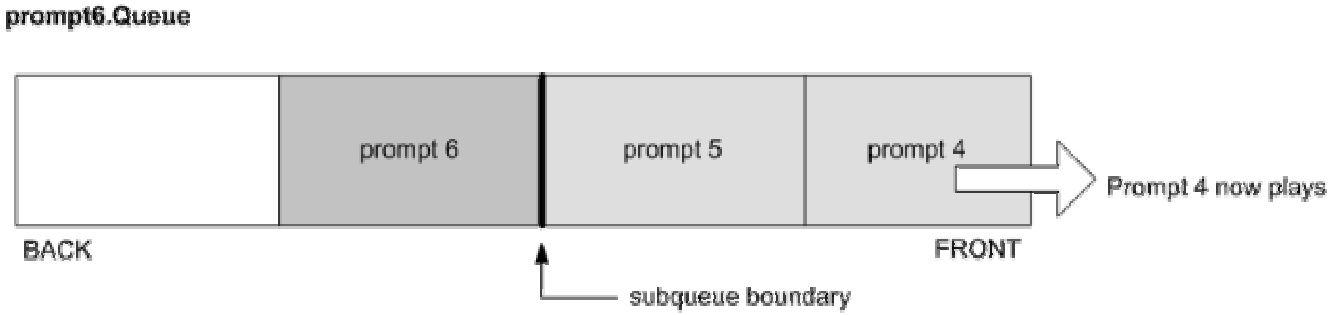


Figure 7: another new subqueue

Figure 7 shows the creation of another new subqueue. The very first subqueue (consisting of `prompt1`, `prompt2` and `prompt3`) has now been played out and has disappeared from the `PromptQueue`. The current subqueue is now the second subqueue, of which `prompt4` is currently in playback. The queuing of another prompt, `prompt6`, initializes the third subqueue and places `prompt6` at its head.

2.1.5.4.8 End of the second subqueue

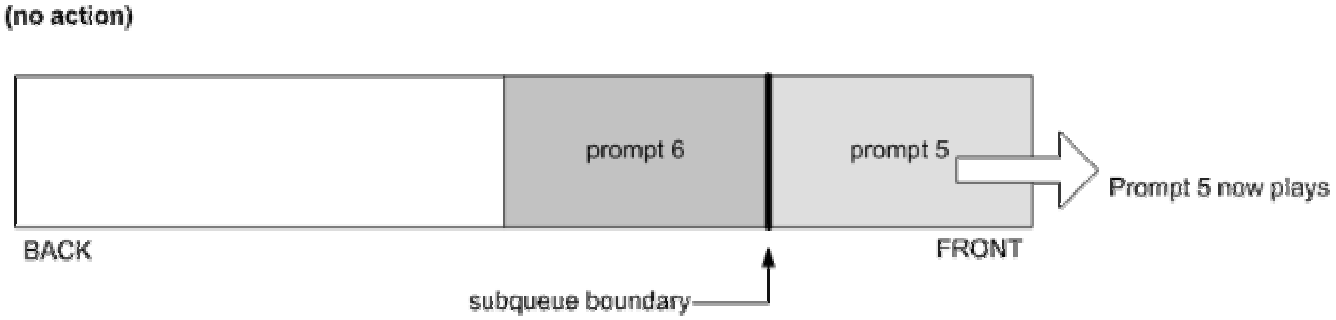


Figure 8: completion of current subqueue

Figure 8 shows the final prompt of the current subqueue, `prompt5`, being played out. When it has finished, its `oncomplete` event will be fired, and since it ends a subqueue, the `onempty` event will then be fired on the `PromptQueue` object. `prompt6` awaits in the next subqueue.

2.1.5.4.9 Subqueue awaiting call to playback

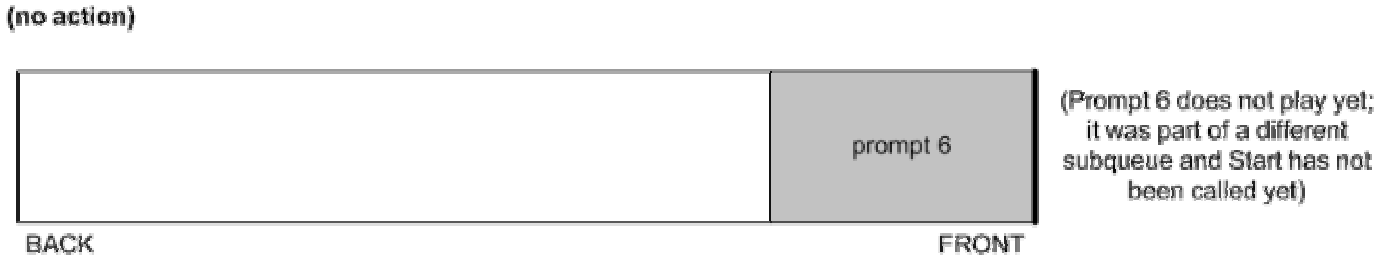


Figure 9: subqueue awaiting Start call

Figure 9 shows the `PromptQueue` after the completion of `prompt5`. The second subqueue, made up of `prompt4` and `prompt5`, has played out and is no longer on the `PromptQueue`. The current subqueue is now made up of `prompt6`, which is still open and has not begun playback (since no `Start` call, either on a `prompt` or on the `PromptQueue`, has yet been made).

2.1.5.4.10 Two subqueues before a Stop call

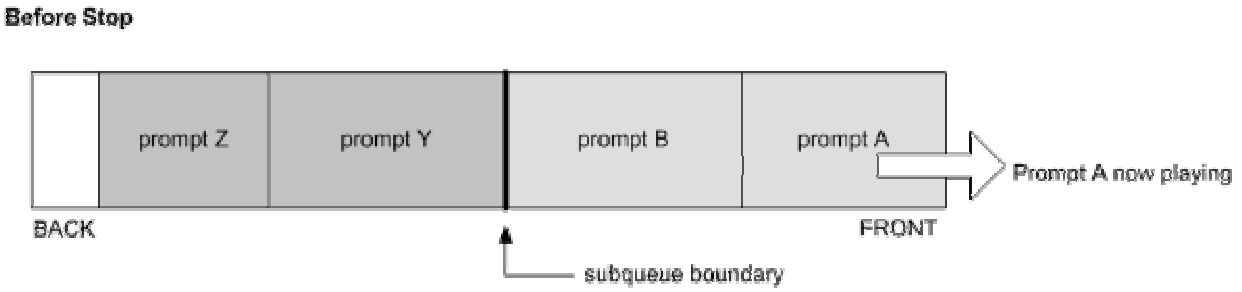


Figure 10: two subqueues before Stop()

Figure 10 shows a different scenario: two subqueues on the `PromptQueue`, right before a `Stop()` call. `promptA` and `promptB` are in the current subqueue, and `promptA` is in playback. `promptY` and `promptZ` are in the second subqueue, which has not yet been scheduled for playback.

2.1.5.4.11 Result of Stop, next subqueue not yet scheduled

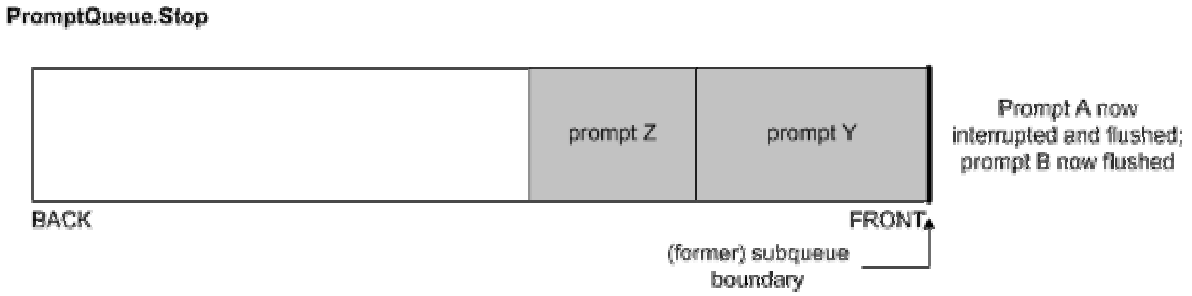


Figure 11: result of Stop, next subqueue not yet scheduled

Figure 11 shows the results of a `Stop()` call on the situation in Figure 10. The prompt that was in playback, `promptA`, was stopped and its subqueue flushed (including `promptB`). (Recall that a user input event during a prompt whose bargein attribute is true will trigger the same behavior.) The next subqueue, consisting of `promptY` and `promptZ`, remains on the `PromptQueue`, awaiting a call to begin playback.

This situation is effectively a return to the situation in Figure 2, where two prompts are on a subqueue that has not yet been scheduled for playback. Should `PromptQueue.Start()` be called, playback will begin on the existing `promptY` and `promptZ` subqueue. Should `PromptQueue.Stop()` be called again, it will have no effect, since the subqueue is not in playback. Should another prompt be queued, it will be added to the tail of the existing `promptY` and `promptZ` subqueue.

2.1.5.4.12 Two subqueues before a Stop call, both scheduled

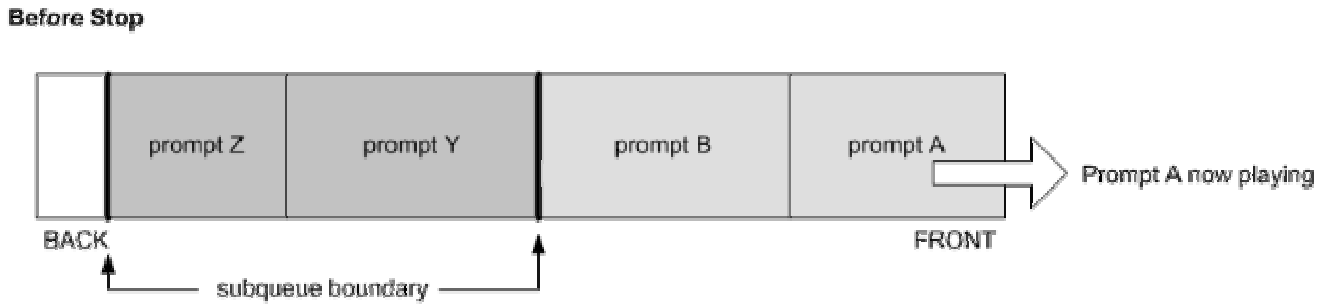


Figure 12: Two subqueues before Stop, both scheduled

Figure 12 shows a different scenario: two subqueues on the `PromptQueue`, right before a `Stop()` call. `promptA` and `promptB` are in the current subqueue, and `promptA` is in playback. `promptY` and `promptZ` are in the second subqueue, and have been scheduled for playback (e.g. `PromptQueue.Start` was called after they were queued).

2.1.5.4.13 Result of Stop, next subqueue already scheduled

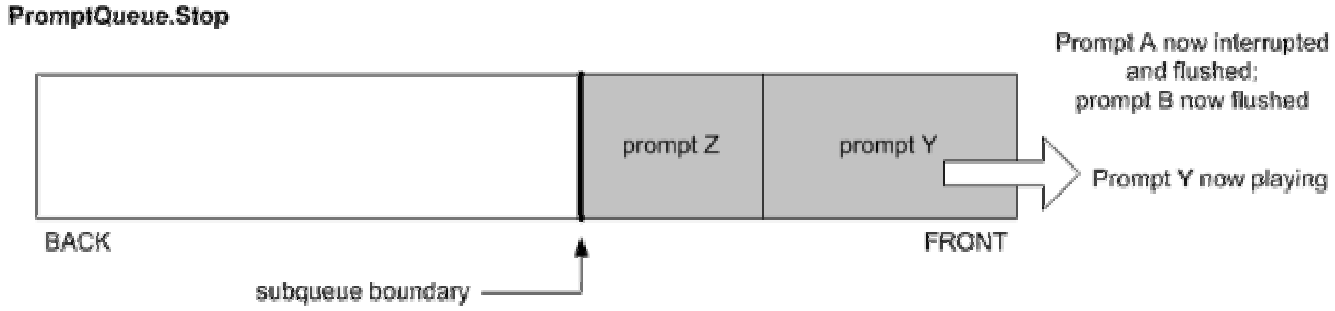


Figure 13: Result of Stop, next subqueue already scheduled

Figure 13 shows the results of a `Stop()` call on the situation in Figure 12. Again, the prompt that was in playback, `promptA`, was stopped and its subqueue flushed (including `promptB`). The next subqueue, consisting of `promptY` and `promptZ`, this time begins playback immediately, since it was already scheduled for playback.

2.1.5.4.14 Result of Flush

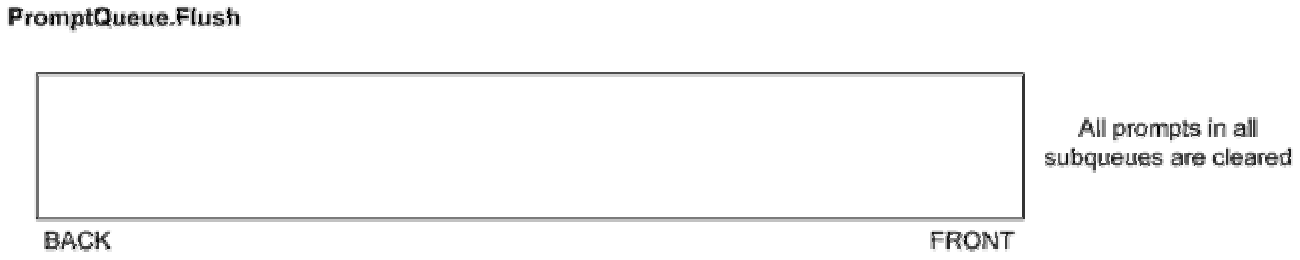


Figure 14: result of Flush()

Figure 14 shows the results of the Flush() method on the situation in Figure 10, and, in fact, on any situation. The Flush() method stops playback and flushes all prompts in all subqueues out of the PromptQueue, leaving it empty. (Recall also that in telephony profiles this method is called automatically when a disconnect event occurs.)

2.1.5.4.15 Pause() and the queuing model

As described in 2.1.5.2.2, the `PromptQueue.Pause()` command can be used to stop playback without flushing the audio buffer, ready to resume playback at the point at which it was halted. Since the semantics of this command is to temporarily cease playback without otherwise affecting the subqueues on the `PromptQueue`, this allows multiple queuing operations to be performed while playback is paused. So a `Start` call, either on a `prompt` or the `PromptQueue`, made while playback is paused will still have the usual semantics of delimiting a subqueue, and scheduling a subqueue for

playback, even though playback is not underway. (This permits the scheduling of multiple subqueues 'under the covers', i.e. without corresponding immediate execution of playback, if this is desired.)

2.2 Speech input: <listen>

The `listen` element is used for speech recognition, for audio recording, or for both.

A `listen` element which is used for speech recognition contains one or more `grammar` elements, which are used to specify possible user inputs. A `listen` element which is used for audio recording contains a `record` element which is used to configure the recording process. A `listen` element used for simultaneous recognition and recording holds one or more `grammar` elements and a `record` element. In all cases, `bind` can be used to process the results obtained from recognition and/or recording.

Many of the features of the `listen` object are used in both the recognition and the recording scenarios, and the attributes, properties, methods and event handlers of listen have similar behavior whether it is used for speech recognition or for recording. In those browsers which support the Concurrent Recognition and Recording module (see 2.8.1.4), simultaneous speech recognition and audio recording is enabled with the specification of both `grammar` and `record` in a single `listen` object, and the behavior of the object is driven by speech recognition events.

`listen` elements used for speech recognition may also take a particular mode - 'automatic', 'single' or 'multiple' – to distinguish the kind of recognition scenarios which they enable and the behavior of the recognition platform, as described in 2.2.6.

The use of the `listen` element for speech recognition is defined in sections 2.2.1 to 2.2.7. The use of the `listen` element for recording is described in detail in section 2.2.8.

2.2.1 listen content

As noted above, the `listen` element contains one or more grammars (and/or a `record` element), and (optionally) a set of `bind` elements which inspect the results of the speech input and copy the relevant portions to values in the containing page. It also permits further configuration using the `param` mechanism.

In uplevel browsers, `listen` also supports the programmatic activation and deactivation of individual grammar rules.

2.2.1.1 <grammar> element

The `grammar` element is used to specify grammars, either inline or referenced using the `src` attribute. `grammar` is a child element of `listen`. At least one grammar (either inline or referenced) must be specified for speech recognition. Inline grammars must be text-based grammar formats, while referenced grammars can be text-based or binary type. Multiple `grammar` elements may be specified, in which case each `grammar` element is considered in a separate namespace for the purpose of grammar compilation. All the grammars of a `listen` element are treated as active unless (i) explicitly deactivated, or (ii) inactive by virtue of internal content.

To enable interoperability of SALT applications, SALT browsers must support the XML form of the W3C Recommendation for Speech Recognition Grammar Specification (SRGS), http://www.w3.org/TR/speech-grammar/. A SALT browser may support any other grammar formats. (Note: at the time of writing, the W3C SRGS specification is not yet a W3C Recommendation.) In order to guarantee complete interoperability of grammars, it is expected that W3C will eventually require the use of the W3C Semantic Interpretation (SI) specification with W3C grammars (http://www.w3.org/TR/semantic-interpretation/). Until this is the case, SALT platforms which implement semantic interpretation using W3C grammar formats should also support W3C SI.

Attributes:

- **name** Optional. This value identifies the grammar for the purposes of activation and deactivation (see 2.2.3.4 and 2.2.3.5). Grammars within the same `listen` element must not be identically named. Note that the use of name does not enable the referencing of the rules of one inline grammar from another.
- **src** Optional. URI of the grammar to be included. The reference of the URI must be a valid grammar reference or grammar rule reference according to the semantics of the grammar format used. Specification of the `src` attribute in addition to an inline grammar is illegal and will result in an invalid document.
- **type** Optional. For externally referenced grammars, the media-type corresponding to the grammar format used. This may refer to text or binary formats. Typical types may be the W3C XML grammar format, specified as

`application/srgs+xml`, or proprietary formats such as `application/x-sapibinary`. The type attribute permits the SALT author to signal the format of a grammar resource and determine compatibility before a potentially lengthy download. However, note that it does not guarantee the format of the target (or inline resource), and platforms are free to treat the attribute (or its absence) in their own way. If unspecified, the type will default to the common format required for interoperability.

- **xmlns** Optional. This is the standard XML namespacing mechanism and is used with inline XML grammars to declare a namespace and identify the schema of the format. See http://www.w3.org/TR/REC-xml-names/ for usage.
- **xml:lang** Optional. String indicating which language the grammar refers to. The value of this attribute follows the `xml:lang` definition in XML 1.0 (http://www.w3.org/TR/REC-xml#sec-lang-tag). For example, xml:lang="en-US" denotes US English. The attribute is scoped, so if unspecified, a higher level element in the page may propagate the xml:lang value down to `grammar` (e.g. `listen`)[6]. If `xml:lang` is specified in multiple places then `xml:lang` follows a precedence order from the lowest scope – remote grammar file (i.e `xml:lang` may be specified within the grammar file) followed by `grammar` element followed by `listen` element, so for external grammars, it may even be overridden by `xml:lang` specified within the target grammar. If `xml:lang` is completely unspecified, the platform is free to determine the language of choice.

Whether inline or referenced, SALT grammars are expected to respect the declaration and referencing semantics of the format used.

Notes for use of W3C SRGS grammars
For applications using W3C SRGS grammars the following should be noted.

A W3C grammar used inline should declare a root. For a W3C grammar used by reference, the `src` attribute may include the rulename fragment. If the `src` does not reference a public rule of the grammar then the reference is in error. If the rulename fragment is omitted then the reference is an implied reference to the root rule of the referenced grammar. If the referenced grammar has no root then the `src` reference is in error. It is legal to have more than one reference to the same external grammar where each `grammar` element references a different public rulename of that grammar (by the rulename fragment).

Example referenced and inline grammars

```
<salt:grammar src="cities.grxml" type="application/srgs+xml" />
```

or

```
<salt:grammar xmlns="http://www.w3.org/2001/06/grammar">
      <grammar root="root">
          <rule id="root">
              <item repeat="0-1">from </item>
              <ruleref name="#cities" />
          </rule>
          <rule id="cities">
              <one-of>
                   <item> Cambridge </item>
                   <item> Seattle   </item>
                   <item> London    </item>
              </one-of>
          </rule>
      </grammar>
</salt:grammar>
```

The specification of both the `src` attribute and inline content in the same grammar element will result in an invalid document.

Grammar types

[6] `xml:lang` is a 'global' XML attribute which when placed on an element, says that any human language used in that element and all elements beneath it, is in the language referred to by `xml:lang`.

SALT grammars are expected to be either context-free grammars (CFGs), as illustrated above and commonly used today in command driven telephony voice applications, or N-Gram grammars, as used in larger vocabulary dictation and "How can I help you?"-style applications. Whereas listens of automatic and single mode can be used with CFG or N-Gram grammars (or both), listens of 'multiple' mode will typically use N-Grams to accomplish dictation. (For the `mode` attribute on `listen`, see section 2.2.6).

To enable interoperability of SALT applications, SALT browsers which support N-Gram recognition must support the W3C Recommendation for Stochastic Language Models (N-Gram) (http://www.w3.org/TR/ngram-spec). A SALT browser may support any other stochastic grammar formats. (Note: at the time of writing, the W3C N-Gram specification is currently a Working Draft and not yet a W3C Recommendation.)

In terms of the recognition result, a `listen` using N-Grams will hold the recognized text or the N-Best variants in its XML result structure, which may take the form of a word graph.

2.2.1.2 <bind> element

The `bind` element is used to bind values from spoken input into the page, and/or to call methods on page elements. `bind` is a child element of `listen`.

The input result processed by the `bind` element is an XML document containing a semantic markup language (e.g. W3C Natural Language Semantic Markup Language) for specifying recognition results. Its contents typically include semantic values, actual words spoken, and confidence scores. The return format could also include alternate recognition choices (as in an N-best recognition result).

To enable interoperability of SALT applications, SALT browsers must support the W3C Recommendation for Natural Language Semantic Markup Language (NLSML) format (http://www.w3.org/TR/nl-spec/). A SALT browser may support any other semantic markup language. (Note: at the time of writing, the W3C NLSML specification is currently a Working Draft and not yet a W3C Recommendation.)

A sample W3C NLSML return for the utterance "I'd like to travel from Seattle to Boston" is illustrated below:

```
<result grammar="http://flight" xmlns:xf="http://www.w3.org/2000/xforms">
  <interpretation confidence="0.4">
    <input mode="speech">
      I'd like to travel from Seattle to Boston
    </input>
    <xf:instance>
      <airline>
        <origin_city confidence="0.45">Seattle</origin_city>
        <dest_city   confidence="0.35">Boston</dest_city>
      </airline>
    </xf:instance>
  </interpretation>
</result>
```

Since a recognition result produces an XML document, the values to be bound from that document are referenced using an XPath query. And since the elements in the page into which the values will be bound should be uniquely identified (they are likely to be form controls), these target elements are referenced directly with the `targetelement` attribute.

The binding operation is executed whenever a recognition result is returned and before the relevant recognition event is thrown. When `bind` is used for assignment, the result of the XPATH query is copied from the result DOM into the page DOM. If the target of assignment `targetattribute` is of type string, the result will be converted into a well-formed XML string without loss of information. This feature can be used with a complete recognition result, for instance, to submit the entire result to a web server. Otherwise, if the `targetattribute` is of type XML DOM Node, the assignment follows the copy-of semantics of XSLT 1.0 (defined at http://www.w3.org/TR/xslt#copy-of), namely, the DOM node tree returned by the XPATH will be copied to the `targetattribute` as a DOM node tree. It raises no events itself. If it fails to execute or contains errors in content, no operation is performed.

Attributes:

- **targetelement:** Required. The name of the element to which the `value` content from the recognition XML will be assigned (as in W3C SMIL 2.0).

- **targetattribute:** Optional. The attribute of the target element to which the `value` content from the recognition XML will be assigned (as with the `attributeName` attribute in SMIL 2.0). If unspecified, defaults to "value".
- **targetmethod:** Optional. The method of the target element which will be called if the bind is executed. Such methods are presently limited to functions that assume "void" for both the argument list and the return type. Examples include the `submit` method of the HTML form object, the `click` method of the button and the hyperlink objects, and the `Start` and `Stop` methods of a listen object.
- **test:** Optional. String holding an XML pattern (as for the `test` attribute of conditional expressions in XSLT, http://www.w3.org/TR/xslt#section-Conditional-Processing), indicating the condition under which the `bind` will be executed. If unspecified, no condition is applied and the `bind` element will always be executed on the return of recognition results.
- **value:** Optional. An ***XPath*** (as in http://www.w3.org/TR/xpath) string that specifies the value from the recognition result document[7] to be assigned to the target element. Ignored when used with method execution (`targetmethod`). If unspecified and used with assignment, defaults to the entire recognition result document.

Each bind directive can have at most one `targetmethod` or `targetattribute` attribute. Specification of more than one, or of both `targetattribute` and `targetmethod` will result in an invalid document.

When multiple bind directives return a Boolean value "true" on their respective test conditions, they are executed in document order.

Example:
So given the recognition result of the examples above, the following `listen` element uses `bind` to transfer the values in `origin_city` and `dest_city` into the target page elements `txtBoxOrigin` and `txtBoxDest`:

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
    ...
    <form id="formTravel">
        <input name="txtBoxOrigin" type="text"/>
        <input name="txtBoxDest" type="text" />
    </form>
    ...
    <salt:listen id="listenTravel">
        <salt:grammar src="./city.grxml" />

        <salt:bind      targetelement="txtBoxOrigin"
                        value="//origin_city" />
        <salt:bind      targetelement="txtBoxDest"
                        value="//dest_city" />
    </salt:listen>
    ...
</html>
```

This binding may be conditional, as in the following example, where a test is made on the `confidence` attribute of the `dest_city` result as a pre-condition to the `bind` operation:

```
<salt:bind  targetelement="txtBoxDest"
            value="//dest_city"
            test="//dest_city[@confidence &gt; 0.4]" />
```

The `bind` element is also able to call methods on the specified element, so the following example would submit the HTML travel form without needing any script code:

```
<salt:bind  test="//dest_city[@confidence &gt; 0.4]"
            targetelement="formTravel"
            targetmethod="submit" />
```

[7] It is important to remember that many speech recognizers return results as a set of N-Best alternatives within the recognition XML. In these cases, since a typical XPath query may return more than one node, the extraction of a single result may require an array index to identify the most likely node (e.g. "`(//dest_city)[1]`" for the query in the example on this page). For the purpose of illustrative simplicity, the examples in the rest of this document assume a single relevant node in the recognition result.

The bind element is a simple declarative means of processing recognition results on downlevel or uplevel browsers. For more complex processing, the listen DOM object supported by uplevel browsers implements the onreco (or onnoreco) event handler to permit programmatic script analysis and post-processing of the recognition return (see 2.2.4.1) or recording results (see 2.2.8.4.2).

Further illustrations of the use of bind may be found in the sample markup examples in 2.6.

2.2.1.3 Recording: <record>

The recording of audio is described in section 2.2.8.

2.2.1.4 Speech recognition configuration: <param>

Additional, non-standard configuration of the speech recognition engine is accomplished with the use of the param element which passes parameters and their values to the platform. param is a child element of listen.

The exact nature of the configurative parameters will differ according to the proprietary platform used. Values of parameters may be specified in an XML namespace, in order to allow complex or structured values.

param element
param: Optional. Used to pass parameter settings to the speech platform.

param content

Attributes:

- **name:** required. The name of the parameter to be configured.
- **xmlns:** optional. Specifies a namespace and potentially a schema for XML content of the parameter.

So, for example, the following syntax:

```
<salt:param name="recoServer">//myplatform/recoServer</salt:param>
```

could be used to specify the location of a remote speech recognition server for distributed architectures.

Note that in HTML profiles, page-level parameter settings may also be defined using the meta element (see 2.8.2.2.1.5).

2.2.2 listen attributes and properties

The following attributes are supported by all browsers and the following properties are supported by uplevel browsers.

2.2.2.1 Attributes

The following attributes of listen are used to configure the speech recognizer for a dialog turn.

- **id:** optional. The identifier of the listen element. Must be a valid XML Name and unique within the document (i.e. of XML type ID).
- **initialtimeout**: Optional. The time in milliseconds between the start of recognition (if no prompt is in playback) or the end of prompt (if a prompt is in playback) and the detection of speech. This value is passed to the recognition platform, and if exceeded, an onsilence event will be thrown from the recognition platform (see 2.2.4.2). A value of 0 effectively disables the timeout. If the attribute is not specified, the speech platform will use a default value.
- **babbletimeout**: Optional. The maximum period of time in milliseconds for an utterance. For listens in automatic and single mode (see 2.2.6), this applies to the period between speech detection and the speech endpoint or Stop() call. For listens in 'multiple' mode, this timeout applies to the period between each speech detection and subsequent phrase recognition– i.e. the period is restarted after each return of results or other event. If exceeded, the onnoreco event is thrown with status code -15. This can be used to control when the recognizer should stop processing excessive audio. For automatic mode listens, this will happen for exceptionally long utterances, for example, or when background noise is mistakenly interpreted as continuous speech. For single mode listens, this may happen if the user keeps the audio stream open for an excessive amount of time (e.g. by holding down the stylus in tap-and-talk). For a summary of onnoreco

status codes, see section 2.2.4.4. A value of 0 effectively disables the timeout[8]. If the attribute is not specified, the speech platform will use a default value.

- **maxtimeout**: Optional. The period of time in milliseconds between the call to start recognition if no prompt is in playback) or the end of prompt (if a prompt is in playback) and the returning of results to the browser. If exceeded, an `onerror` event is thrown – this caters for network or recognizer failure in distributed environments. For `listen`s in 'multiple' mode, as with `babbletimeout`, the period is restarted after the return of each recognition or other event. Note that the `maxtimeout` attribute should be greater than or equal to the sum of `initialtimeout` and `babbletimeout` (and `endsilence` for automatic mode). A value of 0 effectively disables the timeout. If the attribute is not specified, the speech platform will use a default value.
- **endsilence**: Optional. For `listen`s in automatic mode (see 2.2.6), the period of silence in milliseconds after the end of an utterance which must be free of speech after which the recognition results are returned. The speech recognizer may ignore this attribute for `listen`s of modes other than automatic. If unspecified, defaults to platform internal value.
- **reject**: Optional. The confidence threshold for recognition rejection, below which the platform will throw the `onnoreco` event. If not specified, the speech platform will use a default value. Confidence scores are floating point values between 0 and 1. `reject` values lie in between.
- **xml:lang:** Optional. String indicating which language the speech recognizer should attempt to recognize. The string format follows the `xml:lang` definition in XML 1.0 (http://www.w3.org/TR/REC-xml#sec-lang-tag). For example, xml:lang="en-US" denotes US English. This attribute is only meaningful when `xml:lang` is not specified in the grammar element (see 2.2.1.1), or in its content.
- **mode:** Optional. String specifying the recognition mode to be followed (see 2.2.6 below). If unspecified, defaults to "automatic" mode.

Many of these attributes are used in the same way to configure the audio recording process, as detailed in section 2.2.8.2.1.

In certain HTML profiles, the HTML attributes `accesskey` and `style` may also be used as attributes of `listen`, as described in 2.8.2.1.1.

2.2.2.2 Properties

The following properties contain the results returned by the recognition process (these are supported by uplevel browsers).

- **recoresult** Read-only. The results of recognition, held in an XML DOM node object containing the recognition return, as described in 2.2.1.2, In case of no recognition, the return may be empty.
- **text** Read-only. A string holding the text of the words recognized. A SALT browser must attempt to extract such a string from the return result. Where the result format is known to the browser, this is found in a standard query related to that format, e.g. for NLSML, `/result/interpretation[1]/input`. For N-Best results, the string holds the text of the first (typically the most likely) utterance in the N-Best list. If the browser is unable to determine the text of the utterance (even after applying the standard query for the default format) the value will be null string.
- **status:** Read-only. Integer holding a status code returned by the recognition platform. The `status` property is only meaningful after status-setting events are thrown by the listen object, and applications should examine it in the handler of the relevant event. Possible values are 0 for successful recognition, or the failure values -1 to -9 (as defined in the exceptions possible on the Start method (section 2.2.3.1) and Activate method (section 2.2.3.4)) and statuses -11 to -15 set on the reception of recognizer error events (see 2.2.4.5), statuses -20 to -24 in the case of recording (see 2.2.8.4.5), and status -30 for telephony hang-ups (see 2.2.4.5).

2.2.3 listen methods

The execution of `listen` elements may be controlled using the following methods in the `listen`'s DOM object. With these methods, browsers can start and stop listen objects, cancel recognitions in progress, and uplevel browsers can also activate and deactivate individual grammar top-level rules.

[8] This may be interpreted by the platform as an instruction to allow maximum rather than infinite length input.

2.2.3.1 Start

The `Start` method starts the recognition process, using as active grammars all those which have not been explicitly deactivated (or are inactive by declaration). As a result of the `Start` method, a speech recognition event such as `onreco`, `onnoreco`, or `onsilence` will typically be fired, or an `onerror` event will be thrown in the case of an application or platform error. See section 2.2.4 for a description of these events. (Note that for telephony profiles, associated `dtmf` recognition events can also end the execution of `listen`, as described in 2.3.6.)

Syntax:
Object.Start()
Parameters:
None.
Return value:
None.
Exception:
The method sets a non-zero status code and fires an `onerror` event if it fails. The `onerror` event description in section 2.2.4.5 lists possible non-zero status codes.

On the calling of the `Start()` method the speech recognition platform must ensure that the active grammars of a `listen` are complete and up-to-date. Only one `listen` object may be started at a given time. If `Start()` is called on a `listen` object which is already in execution, the call has no effect. If `Start()` is called on a `listen` object while another is in execution, the `onerror` event is thrown on the object on which the second `Start()` was attempted. `onerror` events resulting from the `Start()` method are thrown according to the status codes in section 2.2.4.5.

2.2.3.2 Stop

The `Stop` method is a call to end the recognition process. The listen object stops processing audio, and the recognizer returns recognition results on the audio received up to the point where recording was stopped. Once the recognition process completes, all the recognition resources used by listen are released. The result of calling `Stop()` will be an `onreco` or `onnoreco` event and the return of a recognition result, or an `onerror` event. (Note that this method need not be used explicitly for typical recognitions in automatic mode (see 2.2.6), since the recognizer itself will stop the `listen` object on endpoint detection after recognizing a complete grammar match.) If the `listen` has not been started, the call has no effect. In telephony profiles, the `Stop()` method is executed automatically by the detection of a disconnect (the order of firing is as follows: `listen`, `dtmf`, `PromptQueue`), and as a result `onreco` or `onnoreco` is thrown.

Syntax:
Object.Stop()
Parameters:
None.
Return value:
None.
Exception:
There are no explicit exceptions associated with this method. However, if `Stop()` is called before speech is detected, the `onnoreco` event is fired and status code is set to -11 (as in 2.2.4.4), and if there is any problem an `onerror` event is fired with and the status codes as outlined in section 2.2.3.1 are set.

2.2.3.3 Cancel

The `Cancel` method stops the audio feed to the recognizer and releases recognizer resources. The platform may return a recognition result for a cancelled recognition (although this may be empty). If the recognizer has not been started, the call has no effect. No event is thrown when the `Cancel` method is called.

Syntax:
Object.Cancel()
Parameters:
None.
Return value:
None.
Exception:
None.

2.2.3.4 Activate

The `Activate` method activates the grammars of a `listen`. The first argument identifies the grammar for activation, the optional second argument identifies a top-level rulename within that grammar. If called during a 'started' `listen`, the change will not take effect until the listen is restarted. (Recall also that `Activate()` is not necessary in the default case: the grammars of a `listen` object are treated as active unless explicitly deactivated.)

Syntax:

Object.Activate(grammarName, [ruleName]);

Parameters:

- **grammarName:** Required. Name of the grammar (i.e. the `name` attribute of the relevant grammar).
- **ruleName:** Optional. Rule name within the grammar.

Return value:

None.

Exception:

There are no explicit exceptions associated with this method. However, if the grammar identified with the `grammarName` argument does not exist, an `onerror` event is fired and a value of -6 set in the `status` property of the `listen` object. (Note also that `onerror` would be fired as a result of the `listen.Start()` method if the rule identified by the `ruleName` argument does not exist.)

Note that for W3C SRGS grammars the rule name is not necessary (since only a single rule can be root).

2.2.3.5 Deactivate

The Deactivate method deactivates the grammars of a `listen`. The first argument identifies the grammar for deactivation, the optional second argument identifies a top-level rulename within that grammar. If called during a 'started' `listen`, the change will not take effect until the `listen` is restarted. If the grammar or rule is already deactivated, the call has no effect.

Syntax:

Object.Deactivate(grammarName, [ruleName]);

Parameters:

- **grammarName:** Name of the grammar (i.e. the `name` attribute of the relevant grammar).
- **ruleName:** Optional. Rule name within the grammar.

Return value:

None.

Exception

There are no explicit exceptions associated with this method. However, if the grammar identified with the `grammarName` argument does not exist, an `onerror` event is fired and a value of -6 is set in the `status` property of the `listen` object. (Note also that `onerror` would be fired as a result of the `listen.Start()` method if the rule identified by the `ruleName` argument does not exist.)

Note that for W3C SRGS grammars the rule name is not necessary (since only a single rule can be root).

2.2.4 listen events

The `listen` object supports the following events, whose handlers may be specified as attributes of the `listen` element. For a graphical summary of events along the timeline in different modes of recognition see section 2.2.6.

It is important to notice that the `recoresult` property is updated for both successful and unsuccessful events from the speech recognizer. So applications should assume that the property holds a valid result from the user only in the case of successful recognitions. In the case of unsuccessful or aborted recognitions, the result may be an empty document, or it may hold extra information which applications are free to use or ignore. In either case, applications examining the `recoresult` property should do so in the relevant speech event handler, i.e. `onreco` or `onnoreco`, since the property may not be valid for examination at other times.

2.2.4.1 onreco

This event is fired when the recognizer has a successful recognition result available for the browser. This corresponds to a valid match in the grammar and a confidence value above the `reject` threshold. For listens in automatic mode, this event stops the recognition process automatically and clears resources. The `onreco`

handler is typically used for programmatic analysis of the recognition result and processing of the result into the page.

Event Object Information:

Bubbles	No
To invoke	User says something
Default action	Return recognition result object. In telephony profiles, status codes are set as follows: **status -30**: (telephony profiles only): `Stop()` invoked by disconnect.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data (see the use of the event object in the example below).

Example
The following XHTML fragment uses onreco to call a script to parse the recognition outcome and assign the values to the proper fields.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
      ...
      <input type="button" value="Talk to me" onClick="listenCity.Start()" />
      <input name="txtBoxOrigin" type="text" />
      <input name="txtBoxDest" type="text" />
      ...
      <salt:listen id="listenCity" onreco="processCityRecognition()">
            <salt:grammar src="/grammars/cities.grxml" />
      </salt:listen>

      <script><![CDATA[
            function processCityRecognition () {
                  smlResult = event.srcElement.recoresult;

                  origNode = smlResult.selectSingleNode("//origin_city/text()");
                  if (origNode != null) txtBoxOrigin.value = origNode.value;

                  destNode = smlResult.selectSingleNode("//dest_city/text()");
                  if (destNode != null) txtBoxDest.value = destNode.value;
            }
      ]]></script>
</html>
```

2.2.4.2 onsilence

`onsilence` handles the event of no speech detected by the recognition platform before the duration of time specified in the `initialtimeout` attribute on the listen (see 2.2.2.1). This event cancels the recognition process automatically for the automatic recognition mode – see Figure 15.

Event Object Information:

Bubbles	No
To invoke	Recognizer did not detect speech within the period specified in the `initialtimeout` attribute.
Default action	Set status = -11

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.4.3 onspeechdetected

`onspeechdetected` is fired by the speech recognition platform on the detection of speech. Determining the actual time of firing is left to the platform (which may be configured on certain platforms using the `param` element, as in 2.2.1.4), so this may be anywhere between simple energy detection (early) or complete phrase or semantic value recognition (late).

This event also triggers `onbargein` on a `prompt` which is in play (see 2.1.4.2), and may disable the `initialtimeout` of a started `dtmf` object, as described in 2.3.6. This handler can be used in multimodal scenarios, for example, to generate a graphical indication that recognition is occurring, or in voice-only scenarios to enable fine control over other processes underway during recognition.

Event Object Information:

Bubbles	No
To invoke	Recognizer detects speech.
Default action	Trigger `onbargein` if prompt is in playback, disable `dtmf initialtimeout` if started.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.4.4 onnoreco

`onnoreco` is a handler for the event thrown by the speech recognition platform when it is unable to return a complete recognition result. The different cases in which this may happen are distinguished by status code. For `listen`s in automatic mode, this event stops the recognition process automatically.

Event Object Information:

Bubbles	No
To invoke	Recognizer detects speech but is unable to fully interpret the utterance.
Default action	Update recoresult and status properties. recoresult may be an empty document or it may hold information provided by the speech recognizer. Status codes are set as follows: **status -11**: execution was stopped before speech was detected. **status -13**: sound was detected but no speech was able to be interpreted; **status -14**: some speech was detected and interpreted but rejected with insufficient confidence (for threshold setting, see the `reject` attribute in 2.2.2.1); **status -15**: speech was detected and interpreted, but a complete recognition was unable to be returned between the detection of speech and the duration specified in the babbletimeout attribute (see 2.2.2.1). **status -30**: (telephony profiles only): `Stop()` invoked by disconnect, input not recognized.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.4.5 onerror

The `onerror` event is fired if a serious or fatal error occurs with the recognition process (i.e. once the recognition process has been started with a call to the `Start` method). Different types of error are distinguished by status code and are shown in the event object table below.

Event Object Information:

Bubbles	No
To invoke	The grammar activation or recognition process experiences a serious or fatal problem.
Default action	Set `status` property and return null recognition result. The `listen`'s `recoresult` and `text` properties are set to empty. Status codes are set as follows: **status -1:** A generic (speech) platform error occurred during

	recognition. **status -2:** Failure to find a speech platform (for distributed architectures) **status -3:** An illegal property/attribute setting that causes a problem with the recognition request. **status -4:** Failure to find resource – in the case of recognition this is a grammar resource. **status -5:** Failure to load or compile a grammar resource **status -6:** Failure to activate or deactivate rules/grammars (this is thrown as a result of the `Activate/Deactivate` methods as in 2.2.3.4, 2.2.3.5). **status -7:** The period specified in the `maxtimeout` attribute (see 2.2.2.1) expired before recognition was completed **status -8:** recognition was attempted without active grammars **status -9:** recognition was attempted while another listen object was in execution. **status -30**: (Telephony profiles only) recognition was attempted after a disconnect.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.5 Interaction with DTMF

In telephony profiles which support DTMF input, platforms will implement certain links between `listen` objects and `dtmf` objects which simplify the authoring of joint behavior on a single dialog turn. This relationship is discussed in section 2.3.6 of the DTMF input chapter.

2.2.6 Recognition mode

Different scenarios of speech recognition can require subtle differences in behavior from a speech recognizer. Although the starting of the recognition process is standard in all cases – an explicit `Start()` call from uplevel browsers, or a declarative `listen` element in downlevel browsers – the means of stopping the process and the return of results may differ.

For example, an end-user using tap-and-talk in a multimodal application may control the period of spoken input to the device by tapping and holding a form field, so the application uses a GUI event (e.g. pen up) to control when recognition will stop and return results. However, in voice-only scenarios such as telephony or hands-free, the user has no direct control over the browser, and the recognition platform must take the responsibility of deciding when to stop recognition and return results (typically once a complete path through the grammar has been recognized). Further, dictation and other scenarios where intermediate results may need to be returned before recognition is stopped not only require an explicit stop but also need to return multiple recognition results to the application before the recognition process is stopped.

Hence the `mode` attribute on the listen element is used to distinguish the following three modes of recognition: automatic, single and multiple. These are distinguished by how and when the speech recognizer returns results. The return of results is accompanied by the throwing of the `onreco` event.

SALT defines profiles for the support expected of different modes according to the class of client device in 2.8.1. Generally, automatic mode will be more useful in telephony profiles, single mode in multimodal profiles, and multiple mode in all kinds of dictation scenarios. (It is expected that applications will reflect such profiles in server-side page generation, that is, individual pages will be tailored on a web server to specific classes of client device according to the modality capabilities of that client.)

As noted above, if `mode` is unspecified, the default recognition mode is ‘automatic’.

Note
Applications may make the assumption that communications between the browser and the recognition platform are ordered correctly in time. This assumption may not always hold true in distributed architectures where heavy loads on the recognition platform cannot guarantee the chronological sequencing of communications across components. For example

a `Stop()` call may transmitted from browser to platform after the user has stopped speaking, but while the platform is still processing the input. Browser implementations with distributed architectures will clearly need to take this into account.

2.2.6.1 Automatic mode

<listen **mode="automatic"** … >

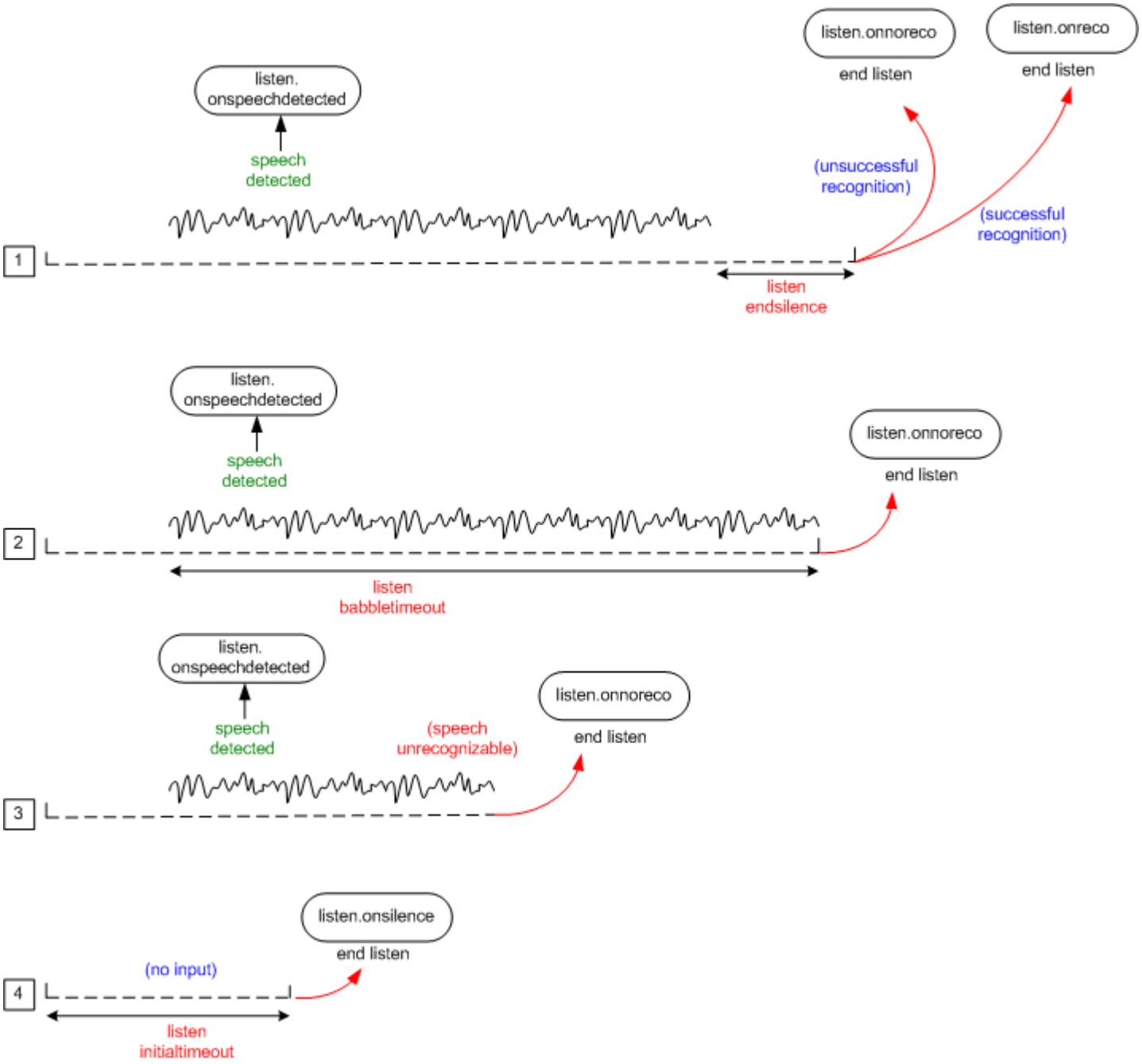


Figure 15: Automatic mode listen timeline

Automatic mode is used for recognitions in telephony or hands-free scenarios. The general principle with automatic listens is that the speech platform itself (rather than the application) is in control of when to stop the recognition process. So no explicit `Stop()` call is necessary from the application, because the utterance end will be automatically determined, typically using the `endsilence` value.

Speech detection is signaled by the `onspeechdetected` event. As described in 2.2.4.3, the timing of this event is determined completely by the platform. (If a prompt is in playback when `onspeechdetected` is thrown, the `onbargein`

event will be thrown on the prompt (see 2.1.4.2), and if the prompt's `bargein` attribute is true, playback will first be stopped.)

As soon as a recognition result is available (the `endsilence` time period is used to determine the phrase-end silence which implies recognition is complete), the speech platform automatically stops the recognizer and returns its results. The `onreco` event is thrown for a successful recognition (i.e. confidence higher than the threshold specified in the `reject` attribute), and `onnoreco` for an unsuccessful recognition (i.e. confidence lower than the threshold specified in the `reject` attribute). This is shown in diagrammatic form in case (1) of Figure 15. Case (2) shows the firing of `onnoreco` after the `babbletimeout` period is exceeded, which ends execution of the `listen`. Case (3) displays an unsuccessful recognition attempt where the recognizer throws `onnoreco` before the utterance `endsilence`. Case (4) shows no input from the user, and the resulting throwing of the `onsilence` event. As noted above, all events except `onspeechdetected` end the execution of a `listen` in automatic mode.

2.2.6.2 Single mode

<listen **mode="single"** … >

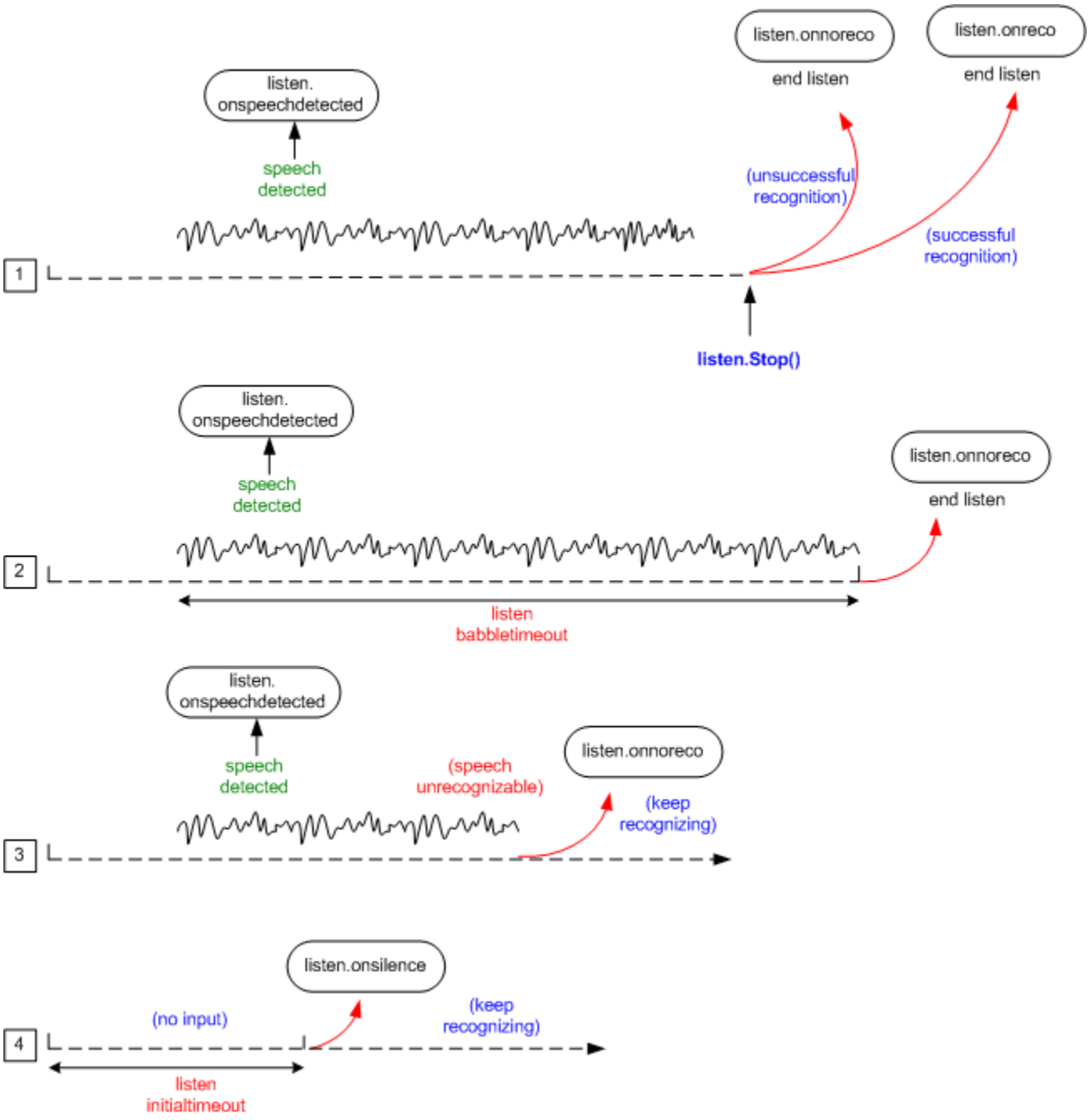


Figure 16: Single mode listen timeline

Single mode recognitions are typically used for push-to-talk scenarios. In this mode, the return of a recognition result is under the control of an explicit `Stop` call from the application.

Figure 16 shows the common speech recognition events and their behavior for a single mode `listen`.

Speech detection is signaled by the `onspeechdetected` event. As described in 2.2.4.3, the timing of this event is determined completely by the platform. (If a prompt is in playback when `onspeechdetected` is thrown, the `onbargein` event will be thrown on the prompt (see 2.1.4.2), and if the prompt's `bargein` attribute is true, playback will first be stopped.)

Case (1) shows the `Stop()` call in action and the possible resulting events of `onreco` or `onnoreco`, according to whether recognition was successful or not. Case (2) illustrates the firing of `onnoreco` in response to the `babbletimeout`, and this event automatically ends the execution of the `listen`. Case (3) shows how `onnoreco` may

be fired in the case of an unrecognizable utterance, but this does not automatically cease execution of the `listen`. And case (4) shows how, as with all modes, the `onsilence` event is thrown if speech is not detected within the timeout period (but for a single mode `listen` this does not stop recognition). So for single mode listens, the only speech event which automatically halts execution before a stop call is `onnoreco` as a result of `babbletimeout` (along with the non-speech event `onerror`).

2.2.6.3 Multiple mode

<listen **mode="multiple"** … >

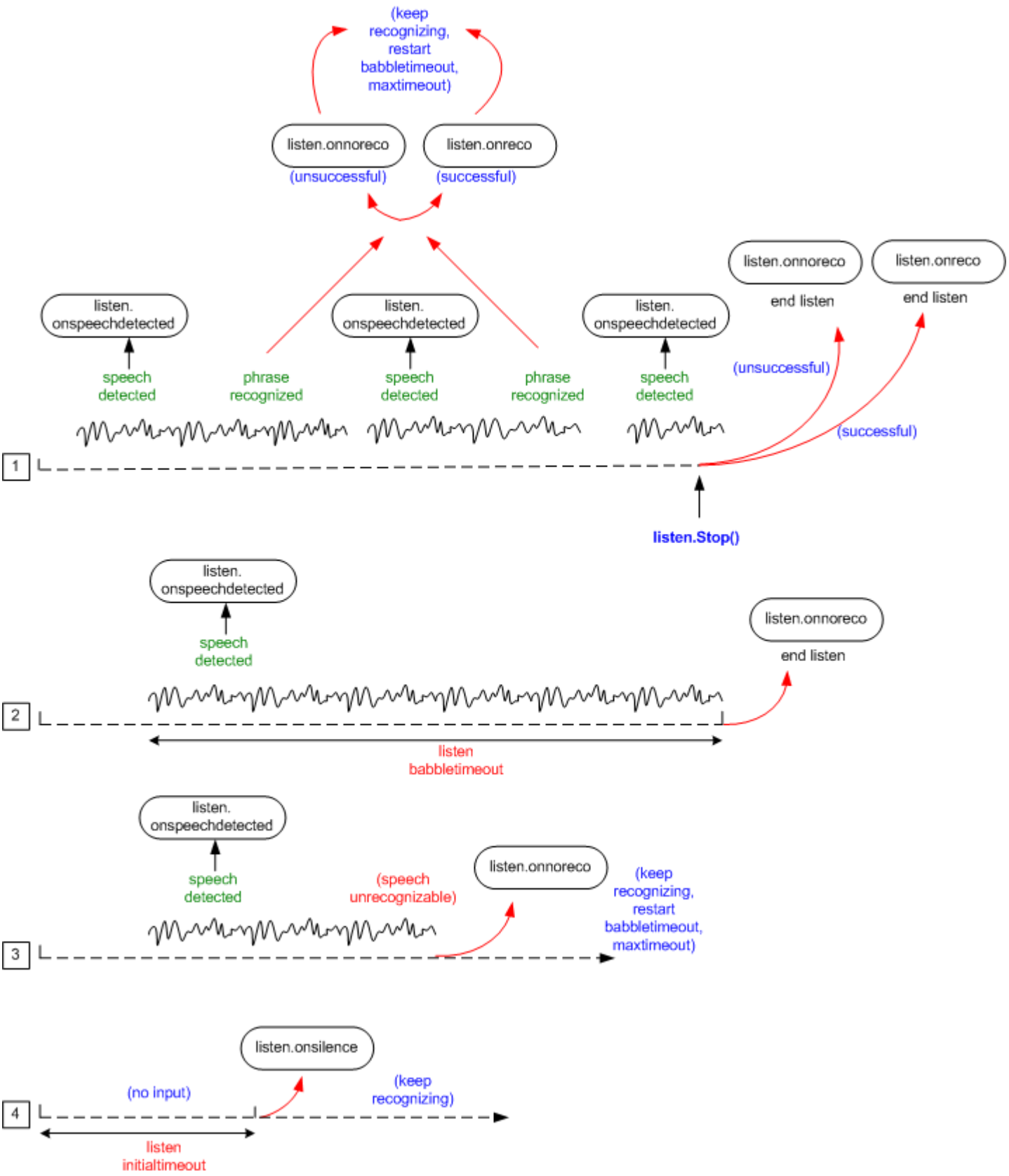


Figure 17: Multiple mode listen timeline

Multiple mode recognition is useful for "open-microphone" or dictation scenarios. In this mode, recognition results are returned at intervals until the application makes an explicit `Stop()` call (or the `babbletimeout` or `maxtimeout` periods are exceeded). It is important to note that after any `onsilence`, `onreco`, or `onnoreco` event which does not stop

recognition, the maxtimeout and babbletimeout periods are restarted. recoresult is updated by these events as for the other modes of recognition.

For each phrase recognized, an onspeechdetected event is thrown, followed by an onreco event and the return of the phrase result. As with the other modes, onspeechdetected has the effects on prompt playback described in section 2.1.4.2. The decision of what constitutes a valid recognized phrase for the return result is left entirely to the platform. Phrase recognition is shown in case (1) of Figure 17. On the return of the result, the babbletimeout and maxtimeout periods are restarted. Case (2) shows how the exceeding of the babbletimeout results in the onnoreco and the halting of listen. Case (3) displays the throwing of onnoreco in response to unrecognizable input, with the listen object continuing execution and the restarting of the babbletimeout and maxtimeout periods. Case (4) shows the throwing of onsilence in response to no input during the initialtimeout period, and again the execution of the listen object continues.

2.2.7 Events which stop listen execution

The following is a summary of the commands and events that will stop a listen while in execution:

methods

- listen.Stop()
- listen.Cancel()

listen events

- listen.onreco (automatic mode only)
- listen.onnoreco (babbletimeout: all modes)
- listen.onnoreco (unsuccessful recognition: automatic mode only)
- listen.onsilence (automatic mode only)
- listen.onerror

DTMF events (telephony profiles only)

- dtmf.onreco
- dtmf.onnoreco
- dtmf.onsilence
- dtmf.onerror

Recall also that in telephony profiles a hang-up event automatically calls Stop() on an active listen.

2.2.8 Recording with listen

The listen element is also used for recording audio input from the user. Recording may be used in addition to recognition or in place of it, according to the abilities of the platform and its profile. The attributes, properties and methods of listen are used in the recording case with equivalent or appropriate semantics. This section explains these features for recording scenarios, and a full example can be found in section 2.6.8.

For concurrent recognition and recording in a single listen (e.g. using 'hotword' recognition to end a recording), both grammar and record may be used. The attributes of record configure the recording process, and the attributes, properties, methods and event handlers of listen should be considered to apply to the speech recognition process. The mode of recognition used will typically determine the overall behavior of such a listen object. The results of both recognition and recording will be contained in the recoresult returned to the browser (whether recognition is a success or a failure) and all the relevant properties of the listen object will be updated.

2.2.8.1 <listen> content for recording

2.2.8.1.1 <record> element

Recording is enabled on a listen element by the use of the record element. Only one record element is permitted in a single listen. The following optional attributes of record are used to configure the recording process:

- **type**: Optional. If unspecified, defaults to G.711 wav file. Formats required by SALT clients which support the basic recording module (see section 2.8.1.3) are G.711 wav (audio/wav: 8kHz 8-bit mono [PCM] single

channel) and headerless (audio/basic: 8kHz 8-bit mono [PCM] single channel)[9]. (Compression type is expected according to the telephony standard in the country of deployment, e.g. Mu-law in North American deployments, A-law in European deployments, etc.).

- **beep** optional. Boolean value, if true, the platform will play a beep before recording begins. Defaults to false.

2.2.8.1.2 <grammar> element

If specified in addition to a `record` element, the grammar element enables speech recognition during the recording process as described in 2.2.1.1. (not all platforms will support this profile). This is useful in certain scenarios, including 'hotword' detection to end recording, or where the audio of recognized input needs to be made available to the application.

2.2.8.1.3 <bind> element

The semantic markup document returned after a recording holds in its root element the following extra attributes relevant to the recording result:

recordlocation: uri of the location of the recorded audio;
recordtype: media-type of the recorded audio.
recordduration: value (in ms) corresponding to the approximate length of the recording;
recordsize: value (in bytes) holding the size of the recorded audio file;

The values of these attributes are copied to the relevant properties of a recording `listen` object (see 2.2.8.2.2). In the case of a totally unsuccessful recording, `recordlocation` and `recordtype` will hold empty strings, and `recordduration` and `recordsize` will hold values of zero.

2.2.8.1.4 <param> element

As with typical listens, the `param` element can be used to specify the platform-specific features of recording, e.g. sampling rate, mu-law/A-law compression, etc.

2.2.8.2 Attributes and properties

2.2.8.2.1 Attributes

The following attributes of `listen` are used to configure the speech recognizer for recording. For all attributes, where concurrent recognition and recording are performed, the attributes are used as for the speech recognition case in 2.2.2.1.

- **initialtimeout**: Optional. For recording only, the time in milliseconds between start of recording (if no prompt is in playback) or the end of prompt (if a prompt is in playback) and the detection of speech. This value is passed to the recording platform, and if exceeded, an `onsilence` event will be thrown from the recognition platform (see 2.2.4.2)[10]. If not specified, the speech platform will use a default value.
- **babbletimeout**: Optional. For recording only, this sets the time limit on the amount of audio that can be recorded once speech has been detected[11]. If `babbletimeout` is exceeded, the `onnoreco` event is thrown with status code -15 (see section 2.2.4.4). If `babbletimeout` is not specified, the speech platform will default to an internal value. A value of 0 effectively disables the timeout[12].
- **maxtimeout**: Optional. For recording only, this sets the maximum timeout period in which a recording must be returned, and is used as defined for a typical `listen` (see 2.2.2.1).
- **endsilence**: Optional. For recording only, the period of silence in milliseconds after the end of an utterance which must be free of speech after which audio recording is automatically stopped. If unspecified, defaults to a platform internal value.
- **reject**: Optional. For `listen`s used only for recording, this is ignored.
- **xml:lang:** Optional. For `listen`s used only for recording, this is ignored.

[9] audio/wav is widely used as a media type, although it is not formally registered as an rfc. The audio/basic media type is described in http://www.ietf.org/rfc/rfc1521.txt.
[10] For recording on a telephony platform this functionality could also be accomplished by most telephony cards. Hence, for recording, the implementation of this feature is left in the hands of platform implementation.
[11] Recording platforms may begin writing to file at any time during the `initialtimeout` period, so the entire length of a recorded file may be anywhere up to the sum of `initialtimeout` and `babbletimeout`.
[12] This may be interpreted by the platform as an instruction to allow maximum rather than infinite length input.

- **mode:** Optional. For `listen`s used only for recording, this is ignored.

2.2.8.2.2 Properties

The following properties contain the results returned by the recording process. Those properties which hold values specific to recording obtain the corresponding values from the return document described in 2.2.8.1.3.

- **recoresult** Read-only. As for recognition, the results of recording in an XML DOM node holding the return document described in 2.2.8.1.3. For listens used for simultaneous recording and recognition, the return document will hold information for both results.
- **text** Read-only string. (Only used when recognition is enabled along with recording).
- **status** Read-only. Integer holding status code returned by the recognition platform. Status codes from -20 to -24 are relevant for errors specific to the audio recording process (see 2.2.8.4.5). Status code -30 indicates a disconnect in telephony profiles.
- **recordlocation** Read-only. String holding the location of the recorded audio in a URI.
- **recordtype** Read-only. String holding the media type of the recorded audio.
- **recordduration**: Read-only. Integer holding the approximate length of the recording in milliseconds.
- **recordsize**: Read-only. Integer holding the size of the recorded audio file in bytes.

2.2.8.3 Object methods

Recording activation can be controlled using the following methods of listen. With these methods, uplevel browsers can start and stop recording, and cancel recordings in progress.

2.2.8.3.1 Start

This method is used to start audio recording.

Syntax:
Object.Start()
Parameters:
None.
Return value:
None.
Exception:
The method sets a non-zero status code and fires an `onerror` event if it fails. See the `onerror` event description in section 2.2.4.5 for the non-zero status codes.

2.2.8.3.2 Stop

This method is used to stop audio recording. For recording-only listens, unless there is a recording error, the `onreco` event will fire as a result, once the platform completes the audio recording. In telephony profiles, the `Stop()` method is executed automatically by the detection of a disconnect (the order of firing is as follows: `listen`, `dtmf`, `PromptQueue`), which results in `onreco` and a status code of -30.

Syntax:
Object.Stop()
Parameters:
None.
Return value:
None.
Exception:
There are no explicit exceptions associated with this method. However, an `onerror` event may be fired in the case of failure and the status codes as outlined in section 2.2.8.4.5 are set.

2.2.8.3.3 Cancel

This method is used to cancel audio recording in a recording only `listen`. Any written audio data may be removed by the platform. No events are fired when this method is called.

Syntax:
Object.Cancel()

Parameters:
None.
Return value:
None.
Exception:
None.

2.2.8.3.4 Activate

This method is used only when recognition is enabled, and is as described in section 2.2.3.4.

2.2.8.3.5 Deactivate

This method is used only when recognition is enabled, and is as described in section 2.2.3.5.

2.2.8.4 Recording events

A recording listen supports the following events, whose handlers may be specified as attributes of the `listen` element.

For `listen`s which execute recording only (without recognition), the event behavior is as for a `listen` of automatic mode (see section 2.2.6.1.). For `listen`s which accomplish recognition along with recording, the mode of recognition used will determine which events are thrown and their behavior (see section 2.2.6 for different modes of recognition).

2.2.8.4.1 onspeechdetected

`onspeechdetected` is fired by the speech recognition platform on the detection of speech. Determining the actual time of firing is left to the platform (which may be configured on certain platforms using the `param` element, as in 2.2.1.4), so this may be anywhere between simple energy detection (early) or more sophisticated speech detection (late). This event also triggers `onbargein` on a prompt which is in play (see 2.1.4.2), and may disable the `initialtimeout` of a started `dtmf` object, as described in 2.3.6.

Event Object Information:

Bubbles	No
To invoke	Speech is detected.
Default action	Trigger `onbargein` if prompt is in playback, disable `dtmf` `initialtimeout` if started.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.8.4.2 onreco

For recording-only listens, this event is fired when audio recording has completed. The `recoresult` property is returned with the recording result and properties are updated according to the previous sections.

Event Object Information:

Bubbles	No
To invoke	Recording is accomplished
Default action	Return recording result object. In telephony profiles only, the following status codes are set: **status -30**: `Stop()` was invoked by a disconnect.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data (see the use of the event object in the example below).

2.2.8.4.3 onsilence

For recording-only listens, this event is fired when no speech is detected by the platform before the duration of time specified in the `initialtimeout` attribute on the `listen` (see 2.2.8.2.1). This event cancels the audio recording process automatically.

Event Object Information:

Bubbles	No
To invoke	Recognizer did not detect speech within the period specified in the initialtimeout attribute.
Default action	Set status = -11

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.8.4.4 onnoreco

For recording-only `listen`s, this event is thrown when the `babbletimeout` period on the recording has been exceeded. This is a common occurrence in voice mail scenarios when the time allotted for leaving a message is exceeded by the user. The platform also returns the recording results via the `recoresult` property, and applications will typically apply the same handler as for `onreco`.

Event Object Information:

Bubbles	No
To invoke	`babbletimeout` expires during audio recording.
Default action	Set `status` property and return recording result in `recoresult`. Status codes are set as follows: **status -15**: speech was detected and recording made but `babbletimeout` was exceeded (see 2.2.2.1).

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.8.4.5 onerror

The `onerror` event is fired if a serious or fatal error occurs with the recording process. Different types of error are distinguished by status code and are shown in the event object information table below.

Event Object Information:

Bubbles	No
To invoke	The recording process (once the `Start` method has been invoked) experiences a serious or fatal problem.
Default action	Set `status` property and return empty recording result. Recording status codes are set as follows: **status -20**: Failure to record file locally on the platform **status -21**: Unsupported codec **status -22**: Unsupported format (if neither format nor codec are unsupported, only one of the values need be set) **status -23**: Error occurred during streaming to a remote server. **status -24**: An illegal property/attribute setting that causes a problem with the recording request. **status -30**: Recording was attempted after a disconnect (telephony profiles).

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.2.8.5 Timeline for recording listen

The following figure, Figure 18, shows the typical events of a `listen` which is executing audio recording (without concurrent recognition).

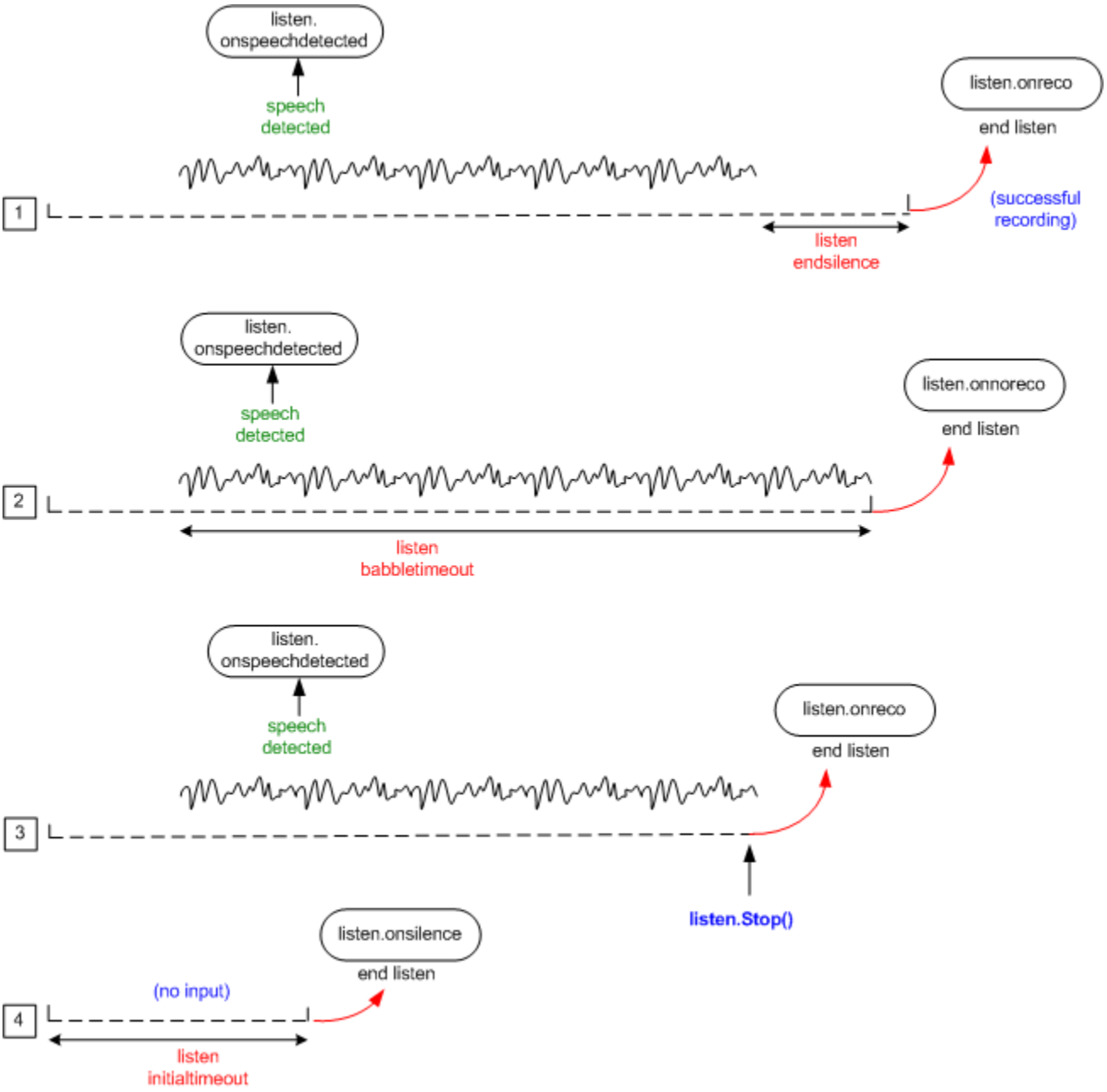


Figure 18: Recording listen timeline

Speech detection is signaled by the `onspeechdetected` event. As described in 2.2.4.3, the timing of this event is determined by the platform. (If a prompt is in playback when `onspeechdetected` is thrown, the `onbargein` event will be thrown on the `prompt` (see 2.1.4.2), and if the `prompt`'s `bargein` attribute is true, playback will first be stopped.)

As soon as a recording is available (the `endsilence` time period can be used to determine the silence which implies that the recording is over), the speech platform automatically stops the recording and returns results. The `onreco` event is thrown, as shown in diagrammatic form in case (1). Case (2) shows the firing of `onnoreco` after the `babbletimeout` period is exceeded, which ends execution of the `listen` and returns the recording. Case (3) shows an explicit `Stop()` call which returns the recording result and throws the `onreco` event (recall that a disconnect in telephony profiles automatically calls the `Stop()` method). Case (4) shows no input from the user, and the consequent throwing of the `onsilence` event.

2.2.8.6 Stopping audio recording

Audio recording is stopped by any of the means of stopping a `listen` object in automatic mode (see section 2.2.7). Since a result is always returned to the `listen` object, a recording `listen` which is stopped by DTMF input or a hang-up (as in many voice mail applications, for instance) will always contain a recording result if available.

The following is a summary of the commands and events that will stop a record-only `listen` while in execution:

methods

- `listen.Stop()`
- `listen.Cancel()`

listen events

- `listen.onreco`
- `listen.onnoreco`
- `listen.onsilence`
- `listen.onerror`

DTMF events (telephony profiles only)

- `dtmf.onreco`
- `dtmf.onnoreco`
- `dtmf.onsilence`
- `dtmf.onerror`

Recall also that in telephony profiles a hang-up event automatically calls `Stop()` on an active `listen`.

2.2.9 Advanced speech recognition technology

It should be clear that advanced speech recognition technologies such as speaker verification or enrollment are enabled by the listen element as it is currently defined in SALT, although optimal methods for accomplishing such mechanisms may not be portable across platforms.

2.3 DTMF input : <dtmf>

The `dtmf` element is used in telephony applications to specify possible DTMF inputs and a means of dealing with the collected results and other DTMF events. Like `listen`, its main elements are `grammar` and `bind`, and it holds resources for configuring the DTMF collection process and handling DTMF platform and collection events.

2.3.1 dtmf content

Mirroring the `listen` recognition element, the `dtmf` element holds as content the `grammar` and `bind` elements, and may also be configured in extensible ways with the `param` element.

2.3.1.1 <grammar>

This is a grammar, as defined in section 2.2.1.1. The only difference between a speech grammar and a DTMF grammar is that the DTMF grammar will hold DTMF keys as tokens, rather than words of a particular language. So for a DTMF grammar, the `xml:lang` attribute is not meaningful, and within the grammar itself, terminal rules will contain as possible tokens only the digits 0-9, *, # and A, B, C and D. In all other respects, the `grammar` element is identical to the speech recognition `grammar` element in section 2.2.1.1.

2.3.1.2 <bind>

The `bind` element is a declarative way to assign the DTMF result to a field in the host page, and is defined in section 2.2.1.2. `bind` acts on the XML in the result returned by DTMF collection in exactly the same way as it does for `listen`.

The following example demonstrates how to allow consecutive DTMF input into multiple fields, using DTMF grammars and `bind` to update the fields.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
   ...
   <input type="text" name="iptAreaCode" onFocus="dtmfAreaCode.start()"   />
```

```
      <input type="text" name="iptPhoneNumber" />
      ...

      <salt:dtmf id="dtmfAreaCode" onreco="dtmfPhoneNumber.Start()">
         <!-- grammar result will contain "smlAreaCode" node -->
         <salt:grammar src="3digits.grxml" />
         <salt:bind value="//smlAreaCode" targetelement="iptAreaCode" />
      </salt:dtmf>

      <salt:dtmf id="dtmfPhoneNumber">
         <!-- grammar result will contain "smlPhoneNumber" node -->
         <salt:grammar src="7digits.grxml" />
         <salt:bind value="//smlPhoneNumber" targetelement="iptPhoneNumber" />
      </salt:dtmf>
   </html>
```

2.3.1.3 DTMF configuration: <param>

Additional, non-standard configuration of the DTMF engine is accomplished with the use of the `param` element which passes parameters and their values to the platform. `param` is a child element of `dtmf`.

The exact nature of the configurative parameters will differ according to the proprietary platform used. Values of parameters may be specified in an XML namespace, in order to allow complex or structured values.

param element
param: Optional. Used to pass parameter settings to the speech platform.

param content

Attributes:

- **name:** required. The name of the parameter to be configured.
- **xmlns:** optional. Specifies a namespace and potentially a schema for XML content of the parameter.

So, for example, the following syntax:

```
<salt:param name="myDTMFParam"> myDTMFValue </salt:param>
```

could be used to specify a parameterization on particular DTMF platform.

Note that in HTML profiles, page-level parameter settings may also be defined using the `meta` element (see 2.8.2.2.1.5).

2.3.2 dtmf attributes and properties

2.3.2.1 Attributes

- **id:** optional. The identifier of the `dtmf` element. Must be a valid XML Name and unique within the document (i.e. of XML type `ID`).
- **initialtimeout:** Optional. The time in milliseconds between start of collection and the first key pressed. If exceeded, the `onsilence` event is thrown and `status` property set to -11. A value of 0 effectively disables the timeout. If the attribute is not specified, the speech platform will use a default value.
- **interdigittimeout:** Optional. Timeout period for adjacent DTMF keystrokes, in milliseconds. A value of 0 effectively disables the timeout. If unspecified, defaults to the telephony platform's internal setting. When exceeded, the platform throws an `onnoreco` event and sets the `status` property to -16.
- **endsilence:** optional. The timeout period when input matches a complete path through the grammar but further input is still possible. This timeout specifies the period of time in which further input is permitted after the complete match. Once exceeded, `onreco` is thrown. (For a complete grammar match where further input is not possible, the `endsilence` period is not required, and `onreco` is thrown immediately.) If this attribute is not supported directly by a platform, or unspecified in the application, the value of `endsilence` defaults to that used for `interdigittimeout`.

- **preflush:** Optional. Boolean flag indicating whether to automatically flush the DTMF buffer on the underlying telephony interface card before activation. If unspecified, defaults to false (in order to facilitate type-ahead applications).

2.3.2.2 Properties

- **dtmfresult:** Read only. XML node holding the DTMF result. This is updated at the end of DTMF collection, and holds an XML document containing semantic markup language. Semantic markup language is discussed in section 2.2.1.2.
- **text:** Read-only string containing tokens of the actual keys pressed during recognition. This string is appended with every key press event (in-grammar or out-of-grammar) received by the dtmf object, so it is updated on every `onkeypress`, `onreco` and `onnoreco` event. The string does not hold white space between tokens.
- **status:** Read-only. Integer holding the status code returned by DTMF collection. The `status` property is only meaningful after status-setting events are thrown by the `dtmf` object, and applications should examine it in the handler of the relevant event. Possible values are 0 for successful collection, the failure values -1 to -9 (as defined in the exceptions possible on the `Start` method (section 2.3.3.1)), status -11 on the reception of `onsilence` (see 2.3.4.4), and status -13 or -16 on an `onnoreco` (see 2.3.4.3). (These values reflect corresponding status codes in the `listen` object of section 2.2.2.2.) Status -30 indicates a telephony disconnect event.

2.3.3 dtmf methods

DTMF collection may be controlled using the following methods on the `dtmf` object. With these methods, browsers can start, stop and flush `dtmf` objects.

2.3.3.1 Start

The `Start` method starts the DTMF collection process, using the grammars defined within the object.

Syntax:
Object.Start();
Parameters:
None.
Return value:
None
Exception:
The method sets a non-zero status code and fires an `onerror` event if it fails. See the `onerror` event description in section 2.3.4.5 for the non-zero status codes.

Only one `dtmf` object may be started at a given time. If `Start()` is called on a `dtmf` object which is already in execution, the call has no effect. If `Start()` is called on a `dtmf` object while another is in execution, the `onerror` event is thrown on the object on which the second `Start()` was attempted.

2.3.3.2 Stop

Stop dtmf collection and return results received up to the point when collection was stopped. (Any subsequent keystrokes entered by the user, however, will remain in the platform buffer unless explicitly flushed.) The result of calling `Stop()` will be an `onreco` or `onnoreco` event and the return of a result, or an `onerror` event. If the `dtmf` object has not been started, this call has no effect. In telephony profiles, the `Stop()` method is executed automatically by the detection of a disconnect (the order of firing is as follows: `listen`, `dtmf`, `PromptQueue`), and the relevant event thrown with status code -30.

Syntax:
Object.Stop();
Parameters:
None.
Return value:
None
Exception:
There are no explicit exceptions associated with this method. However, if there is any problem an `onerror` event is fired and the status codes as outlined in section 2.3.4.5 are set.

2.3.3.3 Flush

Flush the DTMF buffer. `Flush` has no effect if called while the `dtmf` object is started.

Syntax:
Object.Flush();
Parameters:
None.
Return value:
None
Exception:
There are no explicit exceptions associated with this method. However, if there is any problem an `onerror` event is fired and the status codes as outlined in section 2.3.4.5 are set.

2.3.4 dtmf events

When returning a result from DTMF collection, browsers will update the `recoresult` property for both successful and unsuccessful DTMF recognitions. However, applications should assume this property holds a valid result only in the case of successful recognitions. In the case of unsuccessful or aborted recognitions, the result may be an empty document (or it may hold extra information which applications are free to use or ignore).

2.3.4.1 onkeypress[13]

Fires on every pressing of a DTMF key which is legal according to the input grammar (a key which is out-of-grammar triggers an `onnoreco` event). Immediately prior to the event firing, the token corresponding to the key pressed is appended to the value of the `text` property of the `dtmf` element. If a prompt is in playback, the `onkeypress` event will trigger the `onbargein` event on the prompt (and cease its playback if the prompt's `bargein` attribute is set to true). If a `listen` element is active, the first `onkeypress` event has the effect described in section 2.3.6.

Event Object Information:

Bubbles	No
To invoke	Key press on the DTMF key pad.
Default action	Appends `text` property with key pressed

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.3.4.2 onreco

Fires when a DTMF recognition is complete. This event stops the current `dtmf` object automatically and updates `dtmfresult` with the results of recognition. If a `listen` is also active, this event stops the `listen` object, as described in section 2.3.6. The `onreco` handler is typically used for programmatic analysis of the recognition result and processing of the result into fields on the page.

DTMF recognition is considered complete and `onreco` fired in the following circumstances:

1. Immediately after the input sequence matches a complete path through the grammar and further input is not possible according to that grammar.
2. After the period specified in the `endsilence` attribute in the case where the input sequence matches a complete path through the grammar but further input is still possible according to that grammar. (So setting an `endsilence` period of zero would fire `onreco` immediately a complete path through the grammar is matched, and have the same behavior as 1.)

Event Object Information:

Bubbles	No
To invoke	DTMF recognition is complete.
Default action	Returns result in `dtmfresult`. Set status codes as follows:

[13] For HTML and XHTML, this overrides the default `onkeypress` event inherited from the HTML control. Only DTMF keypresses fire this event.

	status -30: a disconnect invoked the `Stop()` method[14].

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.3.4.3 onnoreco

Fires when a key is pressed which is not legal according to the DTMF grammar, or when `interdigittimeout` is exceeded (or on the `Stop()` call when input is not a complete grammar match). This event stops the DTMF object automatically, appends the `text` property with key pressed (if an illegal key was pressed) and updates `dtmfresult` with a result (this may be an empty document or it may hold the out-of-grammar input). If a listen is also active, this event stops the `listen` object, as described in section 2.3.6.

Event Object Information:

Bubbles	No
To invoke	Illegal key press, or exceeding of `interdigittimeout` period when input is incomplete.
Default action	Stops `dtmf` collection. Appends `text` property with key pressed (if applicable), updates `dtmfresult` and sets `status` property. Status codes are set as follows: **status -13**: out-of-grammar DTMF keypress. **status -16**: `interdigittimeout` was exceeded. **status -30**: a disconnect invoked the `Stop()` method.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.3.4.4 onsilence

`onsilence` handles the event of no DTMF collected by the platform before the duration of time specified in the `initialtimeout` attribute (see 2.3.2.1). This event stops the dtmf object automatically.

Event Object Information:

Bubbles	No
To invoke	No DTMF input detected within the period specified in the `initialtimeout` attribute.
Default action	Set status = -11

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.3.4.5 onerror

The `onerror` event is fired if a serious or fatal error occurs with the DTMF collection process. Different types of error are distinguished by status code and are shown in the event object information table below.

Event Object Information:

Bubbles	No
To invoke	The DTMF collection process experiences a serious or fatal problem.
Default action	On encountering an error, the `dtmf` object is stopped and status codes are set as follows: **status -1:** A generic platform error occurred during DTMF collection. **status -3:** An illegal property/attribute setting that causes a

[14] A status code of -30 for the `dtmf` object's `onreco` event is only possible if the disconnect event occurred after the input sequence matched a valid path through the grammar, but before the endsilence period expires.

	problem with the DTMF collection request. **status -4:** Failure to find resource – in the case of DTMF this is likely to be a the URI of a DTMF grammar. **status -5:** Failure to load or compile a grammar resource **status -8:** collection was attempted without active grammars **status -9:** collection was attempted while another `dtmf` object was in execution. **status -30**: DTMF collection attempted after a disconnect.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.3.5 DTMF event timeline

The following diagram illustrates typical event possibilities for the `dtmf` element.

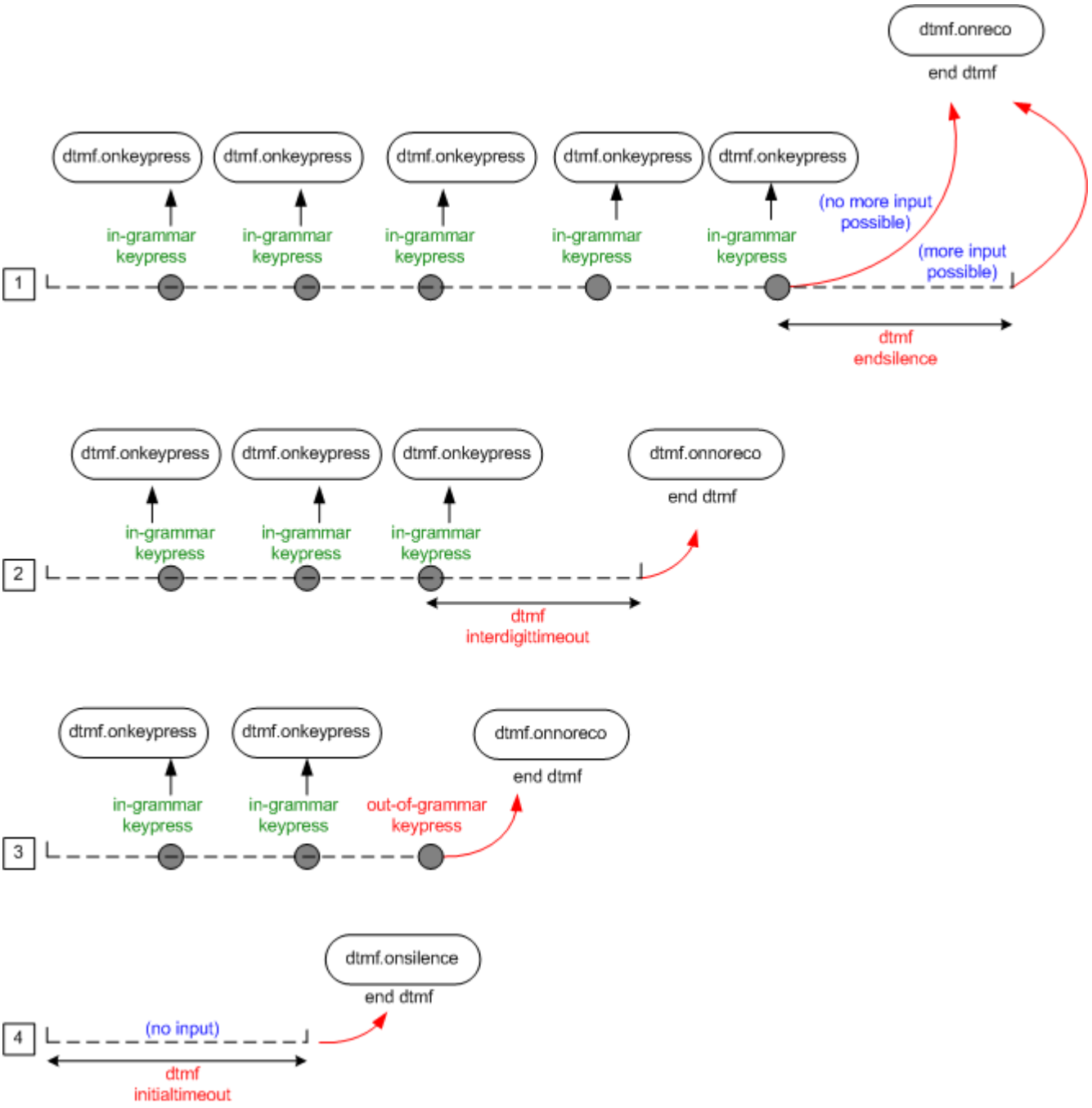


Figure 19: DTMF event timeline

Case (1) shows a successful DTMF recognition. `onkeypress` events are fired for every in-grammar keypress, and `onreco` is thrown either when a complete grammar match has been made or after the `endsilence` period if further input was permitted in the grammar. Case (2) shows the `onnoreco` event being thrown by the exceeding of the `interdigittimeout` period. Case (3) shows that an out-of-grammar keypress fires `onnoreco`. Case (4) shows `onsilence` being thrown if no input is entered before the `initialtimeout` period elapses. As noted, all events except `onkeypress` end DTMF collection.

2.3.6 Using listen and dtmf simultaneously

Many telephony applications typically permit speech and/or DTMF to be used at the same time. To simplify the authoring of such scenarios, SALT platforms implement a model of default behavior whereby detection and successful recognition of one mode of input need not interfere with the other. In general, this means that the application only has to worry about receiving a single recognition result, or other event, even when both objects are started. For finer level behavior, `listen` or `dtmf` events can be handled individually without affecting the other mode.

SALT enables this in two ways: (i) the disabling of initial timeouts on the other mode on detection of input, and (ii) the automatic cancellation of one mode when the other mode comes to an end. This behavior is discussed in the following two subsections, and the section completes with a diagram illustrating the interplay of the objects.

2.3.6.1 Disabling timeouts

Once the platform has detected input in one mode, it disables the `initialtimeout` of the other mode. That is, when the `initialtimeout` period is exceeded, the object is stopped automatically but its event is not thrown to the handler. This is effectively an acknowledgement that user input is occurring, and therefore the calling of an `onsilence` handler on the other, unused mode is irrelevant. This prevents, for example, a listen's `onsilence` from calling its handler while the user is entering DTMF. The manifestation of detection is a keypress (`onkeypress` event) for `dtmf`, and the `onspeechdetected` event for `listen`[15].

```
dtmf.onkeypress         --> disable listen timeouts
listen.onspeechdetected --> disable dtmf timeouts
```

With `initialtimeout` disabled, such 'unused' objects do not throw an `onsilence` event. If the timeout of the unused mode does not expire, both objects remain active until otherwise stopped. This may be useful, for example, in scenarios such as where DTMF keypresses are used to control playback of the prompt, while voice commands effect dialog navigation (e.g. in an e-mail reader application). If the application author wishes to stop the unused object on detection of the other input mode, this is possible by adding such a `Stop` command to the relevant event handler of the 'used' mode.

Once disabled, the `initialtimeout` is not re-enabled or re-started. That is, once the platform detects one mode of input, `onsilence` will never be thrown on either mode. This should never be a problem, since other timeouts are still active on any 'used' modes (`endsilence`, `babbletimeout` and `interdigittimeout`), so they will always eventually stop.

2.3.6.2 Automatic stop

When one mode stops and throws an event of `onsilence`, `onnoreco`, `onreco` or `onerror`, the other mode is automatically stopped[16]. (Stopping actually occurs before the object receives the event, in order for the event handler functions to operate under a predictable situation.) A result will be returned in the relevant property of the automatically stopped object (`recoresult` for `listen`, `dtmfresult` for `dtmf`) and the `status` property may be given a particular code.

```
dtmf.onsilence    --> stop listen
dtmf.onnoreco     --> stop listen
dtmf.onreco       --> stop listen
dtmf.onerror      --> stop listen

listen.onsilence  --> stop dtmf
listen.onnoreco   --> stop dtmf
listen.onreco     --> stop dtmf
listen.onerror    --> stop dtmf
```

This means that such events from either mode which signal the end of a dialog turn do not need to be caught twice. So the firing of `onsilence` will be thrown only to the started listen or to the started `dtmf` object, but not to both. Similarly, the other mode is stopped automatically on (i) a misrecognition or out-of-grammar DTMF sequence (`listen.onnoreco` or `dtmf.onnoreco`); or (ii) a successful recognition (`listen.onreco`, `dtmf.onreco`).

This allows the application author to write modular code for these handlers which does not need to take explicit account of which objects have been started. And since a result is returned for the automatically stopped object, it allows scenarios where one mode is actually used to force a result return of the other, for example using dtmf to stop audio recording.

[15] Recall from section 2.2.4.3 that the decision when to throw `onspeechdetected` is left to the platform - this permits platforms to operate robust mechanisms whereby throwing the event later - i.e. at a safer time - will not unnecessarily disable the `dtmf` timeout.

[16] Of course this does not apply to a mode which is stopped explicitly by the stopping of the other mode (as described in this paragraph).

2.3.6.3 listen and dtmf interaction event timeline

The model described above is illustrated in the following event diagram, which shows possible interactions between the two started modes of input.

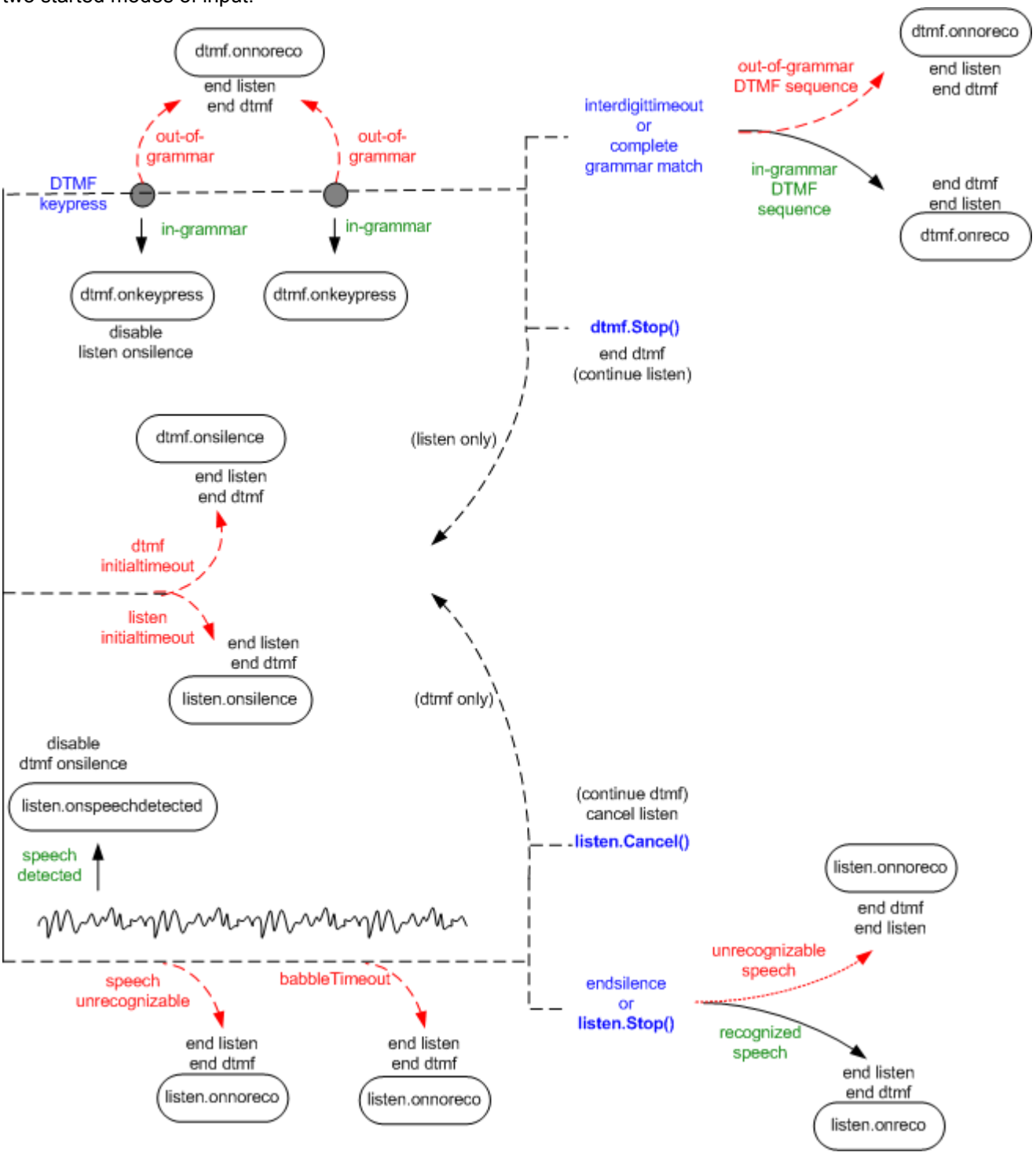


Figure 20: listen and dtmf event interaction

2.3.7 Events which stop dtmf execution

The following is a summary of the commands and events that will stop dtmf while in execution:

methods

- `dtmf.Stop()`

dtmf events

- dtmf.onreco
- dtmf.onnoreco
- dtmf.onsilence
- dtmf.onerror

listen events

- listen.onreco
- listen.onnoreco
- listen.onsilence

Recall also that a telephony hang-up event automatically calls Stop() on an active dtmf object.

2.4 Platform messaging: <smex>

smex, short for Simple Messaging EXtension, is a SALT element that communicates with the external component of the SALT platform. It can be used to implement any application control of platform functionality such as logging and telephony control. As such, smex represents a useful mechanism for extensibility in SALT, since it allows any new functionality to be added through this messaging layer.

On its instantiation, the object is directed to establish an asynchronous message exchange channel with a platform component through its configuration parameters (specified in param elements) or attributes. The smex object can send or receive messages through this channel. The content of a message to be sent is defined in the sent property. Whenever the value of this property is updated (either on page load or by dynamic assignment through script or binding), the message is sent to the platform. The smex element can also receive XML messages from the platform component in its received property. The onreceive event is fired whenever a platform message is received. Since the smex object's basic operations are asynchronous, it also maintains a built-in timer for the manipulation of timeout settings. ontimeout and onerror events may also be thrown.

The smex object makes no requirement on the means of communication with platform components. It should also be noted that the smex object has the same life span as other XML elements, that is, it will be destroyed when its hosting document is unloaded. While in many cases, the smex object can perform automatic clean-up and release communication resources when it is unloaded, there might be use cases (e.g. call control) in which a persistent communication link is desirable across pages. For those cases, SALT places the responsibility of relinquishing the allocated resources (e.g. closing the socket) on the application.

The smex object also is neutral on the format (schema) of messages. In order to encourage interoperability, however, the conformance criteria in Part 4 recommend that implementations support a known schema for common functionality, with a strong preference for existing standard message formats. Such a schema for telephony call control is suggested in section 2.4.4, and 4.3. In essence, SALT allows both platform and application developers to take the full advantage of the standardized extensibility of XML to introduce innovative and perhaps proprietary features without necessarily losing interoperability.

2.4.1 smex content

smex may have the following child elements:

2.4.1.1 bind

This is the same element as described in section 2.2.1.2. It operates on the XML document contained in the message received by the browser, so the XPath query held in the value attribute will match an XML pattern in this document.

2.4.1.2 param

param is used to provide platform-specific parameters for the smex object. Each param element may be named using a name attribute, with the contents of the param element being the value of the parameter.

The exact nature of the configurative parameters will differ according to the proprietary platform used. Values of parameters may be specified in an XML namespace, in order to allow complex or structured values.

param element
param: Optional. Used to pass parameter settings to the speech platform.

param content

Attributes:
- **name:** required. The name of the parameter to be configured.
- **xmlns:** optional. Specifies a namespace and potentially a schema for XML content of the parameter.

So, for example, the following syntax:

```
<param name="myPlatformParam">myParamValue</param>
```

could be used to specify a parameterization of the message interface to the platform.

Note that in HTML profiles, page-level parameter settings may also be defined using the `meta` element (see 2.8.2.2.1.5).

2.4.2 smex attributes and properties

2.4.2.1 smex attributes

The `smex` object has the following attributes:

- **id:** optional. The identifier of the `smex` element. Must be a valid XML Name and unique within the document (i.e. of XML type `ID`).
- **sent**: Optional. String corresponding to the message to be sent to the platform component. Whenever a non-null value is assigned to this attribute, its contents are dispatched.
- **timer**: Optional. Number in milliseconds indicating the time span before a timeout event will be triggered. The clock starts ticking when the property is assigned a positive value (this may be on document load, if the attribute is specified declaratively). The value can be changed when a countdown is in progress. A zero or negative value stops the clock without triggering the timeout event. The default is 0, meaning no timeout.

2.4.2.2 smex properties

In addition to the attributes, the `smex` element holds the following properties:

- **received**: Read-only. XML DOM Node data indicating the received message. The message is held as the value of this property until the next `onreceive` event is ready to fire.
- **status**: Read-only. Integer indicating the recent status of the object. The possible values are 0, -1, and -2, which indicate, respectively, normal, timeout expired, and communication with the platform cannot be established or has been interrupted. Platform-specific error messages are conveyed through the `received` property. For the cases that the error message is successfully delivered, the status code is 0.

2.4.3 smex events

The `smex` object has the following events:

2.4.3.1 onreceive

The `onreceive` event is fired when the browser receives a platform message. If there are any directives declared by the `bind` elements, those directives will first be evaluated before the event is fired. Prior to the firing, the `received` property is updated with the message content.

Event Object Information:

Bubbles	No
To invoke	Platform message received by the browser.
Default action	`bind` directives are evaluated, the `received` property is updated, and `status` code set to zero.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.4.3.2 ontimeout

The `ontimeout` event is fired when the timeout expires.

Event Object Information:

Bubbles	No
To invoke	Time out.
Default action	Set `status` code set to -1: timeout.

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.4.3.3 onerror

The `onerror` event is fired when a communication error is encountered. When the event fires, the `status` property is updated with a corresponding error code as described above.

Event Object Information:

Bubbles	No
To invoke	Communication error
Default action	Set `status` code to -2: communication error

Event Properties:
Although the event handler does not receive properties directly, the handler can query the event object for data.

2.4.4 Using smex for telephony call control

Browsers which support the use of `smex` messages for implementing call control functionality on a telephony platform are recommended to support the ECMA 323 standard XML Protocol for Computer Supported Telecommunications Applications (CSTA) Phase III, as specified at http://www.ecma.ch/ecma1/STAND/ecma-323.htm, which specifies an XML protocol for the CSTA services described in ECMA 269. (Note also the alternative CallControl object specified in Part 3).

2.5 Logging

This chapter specifies the basic requirements for diagnostic logging, and how uplevel SALT browsers implement these requirements.

2.5.1 Overview

Uplevel browsers which support logging provide basic diagnostic logging functionality through a global script method called `LogMessage()`. This is used to write output to a location of the platform's choosing.

This function allows the application to log to the same location as other component objects. For example, the `listen`, `dtmf`, and `prompt` elements, and `CallControl` and other objects may all send log messages to an Operation, Administration and Maintenance (OA & M) server – in concurrence or separately. In order to enable operations administrators to monitor a system through a single, centralized point, applications should be able to send messages to the same location at any time.

2.5.2 Format

The format of the script function is:

LogMessage(*id*, *message*); where `id` and `message` are both strings.

- `id` will typically be used to specify the "class" of the message for filtration purposes; for example, an application may define `SYSTEM_CRITICAL` and use this string to filter all fatal errors to a specific location. This is also useful in off-line analysis and reporting.
- `message` is the content of the diagnostic message itself.

2.5.3 Requirements

- The platform is responsible for providing the global script method. To ensure portability among all SALT platforms, no additional (mandatory) parameters must be added to the logging function. The platform must be

able to handle the `LogMessage()` function under any circumstance. With respect to observing the semantics of the function, platforms are free to treat the function in the manner of their own choosing. Possible actions may be:

- write it to a timestamped log file
- write it to standard out (a console, for example)
- ignore it (for example, send it to `/dev/null` or equivalent).

Section 9.5.1 illustrates how a platform implementing `smex` can use the `smex` element to implement the requirements specified above for the logging function.

2.6 SALT illustrative examples

2.6.1 Controlling dialog flow

2.6.1.1 Click to talk

This simple example shows how, in a multimodal application, GUI events can be wired to SALT commands such as beginning a recognition turn. In this example, pressing the button named `buttonCityListen` starts the listen named `listenCity`, which holds a grammar of city names, and a `bind` command to transfer the value into the input control named `txtBoxCity`.

```
<!-- HTML -->
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
   <form id="travelForm">
      <input name="txtBoxCity" type="text" />
      <input name="buttonCityListen" type="button" onClick="listenCity.Start();" />
   </form>

   <!-- SALT -->
   <salt:listen id="listenCity">
      <salt:grammar name="g_city" src="./city.grxml" />
      <salt:bind  targetelement="txtBoxCity"
                  value="//city[1]" />
   </salt:listen>
</html>
```

2.6.1.2 Dialog flow with HTML and scripting

The following examples show how scripting may be used in HTML environments to control dialog flow. The two examples show how the developer can precisely script this flow, since full control of activation of the speech interface is available through algorithms in the script (the `RunAsk` and `RunSpeech` functions respectively).

2.6.1.2.1 Form-filling

This example is a fuller version of the dialog shown in the Scenarios section of the Introduction (1.2), which introduces handlers for the case of misrecognitions.

```
<!-- HTML -->
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
 <body onload="RunAsk()">
  <form id="travelForm">
   <input name="txtBoxOriginCity" type="text" />
   <input name="txtBoxDestCity" type="text" />
  </form>

  <!-- Speech Application Language Tags -->
  <salt:prompt id="askOriginCity"> Where would you like to leave from? </salt:prompt>
  <salt:prompt id="askDestCity">   Where would you like to go to?      </salt:prompt>
  <salt:prompt id="sayDidntUnderstand" oncomplete="runAsk()">
      Sorry, I didn't understand.
  </salt:prompt>

  <salt:listen id="recoOriginCity"
            onreco="procOriginCity()" onnoreco="sayDidntUnderstand.Start()">
```

```
          <salt:grammar src="city.xml" />
  </salt:listen>

  <salt:listen id="recoDestCity"
           onreco="procDestCity()" onnoreco="sayDidntUnderstand.Start()">
          <salt:grammar src="city.xml" />
  </salt:listen>

  <!-- scripted dialog flow -->
  <script>
    function RunAsk() {
      if (travelForm.txtBoxOriginCity.value=="") {
        askOriginCity.Start();
        recoOriginCity.Start();
      } else if (travelForm.txtBoxDestCity.value=="") {
        askDestCity.Start();
        recoDestCity.Start();
      }
    }
    function procOriginCity() {
      travelForm.txtBoxOriginCity.value = recoOriginCity.text;
      RunAsk();
    }
    function procDestCity() {
      travelForm.txtBoxDestCity.value = recoDestCity.text;
      travelForm.submit();
    }
  </script>

 </body>
</html>
```

2.6.1.2.2 Form-filling and giving help

This example shows how to implement a simple dialog flow which seeks values for input boxes and offers context-sensitive help for the input. It uses the `title` attribute on the HTML input mechanisms (used in a visual browser as a "tooltip" mechanism) to help form the content of the help prompt.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
      <title>Context Sensitive Help</title>
            <head>
                  <script>
                  <![CDATA[
                  var focus;
                  function RunSpeech() {
                        if (trade.stock.value == "") {
                              focus="trade.stock";
                              p_stock.Start();
                              return;
                        }
                        if (trade.op.value == "") {
                              focus="trade.op";
                              p_op.Start();
                              return;
                        }
                        //.. repeat above for all fields
                        trade.submit();
                  }
                  function handle() {
                        res = event.srcElement.recoresult;
                        if (res.value == "help") {
                              text = "Please just say ";
                              text += document.all[focus].title;
                              p_help.Start(text);
```

```
                        } else {
                              // proceed with value assignments
                        }
                  }
                  ]]>
                  </script>
            </head>
      <body onload="RunSpeech()">
            <salt:prompt id="p_help" oncomplete=" RunSpeech()" />
            <salt:prompt id="p_stock" oncomplete="g_stock.Start()">
                  Please say the stock name
            </salt:prompt>
            <salt:prompt id="p_op" oncomplete="g_op.Start()">
                  Do you want to buy or sell
            </salt:prompt>
            <salt:prompt id="p_quantity" oncomplete="g_quantity.Start()">
                  How many shares?
            </salt:prompt>
            <salt:prompt id="p_price" oncomplete="g_price.Start()">
                  What's the price
            </salt:prompt>

            <salt:listen id="g_stock" onreco="handle(); RunSpeech()">
                  <salt:grammar src="./g_stock.grxml" />
            </salt:listen >

            <salt:listen id="g_op" onreco="handle(); RunSpeech()">
                  <salt:grammar src="./g_op.grxml" />
            </salt:listen >

            <salt:listen id="g_quantity" onreco="handle(); RunSpeech()">
                  <salt:grammar src="./g_quant.grxml" />
            </salt:listen >

            <salt:listen id="g_price" onreco="handle();RunSpeech()">
                  <salt:grammar src="./g_quant.grxml" />
            </salt:listen >

            <form id="trade">
                  <input name="stock" title="stock name" />
                  <select name="op" title="buy or sell">
                        <option value="buy" />
                        <option value="sell" />
                  </select>
                  <input name="quantity" title="number of shares" />
                  <input name="price" title="price" />
            </form>
      </body>
</html>
```

2.6.1.3 Downlevel dialog flow

This example asks and confirms with the caller for a London football team without using script. It demonstrates a system initiative dialog. However, since the data and the user interface markup are separate, application developers only need to change the speech section when changing interaction style to mixed initiative. The data section remains the same.

The example works in the following way: when an incoming call comes in, the `bind` in `smex` starts the welcoming prompt and the corresponding `listen` object. Depending on the recognition results, the `bind` directives in the listen object guide the execution using declarative logic. Finally, when the value is confirmed, the form is submitted. All of this is achieved without a single line of script.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
      <body>
```

```
<!--  the data section -->
  <form id="get_team">
    <input name="team" />
    <input name="uid" type="hidden"/>
  </form>
<!-- The speech section -->
  <salt:prompt id="welcome">
      Welcome, caller!
  </salt:prompt>
  <salt:prompt id="ask">
      Which team would you like the latest results for: Arsenal, Chelsea,
Spurs or West Ham?
  </salt:prompt>
  <salt:prompt id="confirm">
      I heard <value targetelement="team" />. Is this correct?
  </salt:prompt>
  <salt:prompt id="thanks">
      Thank you. Please wait while I get the latest results.
  </salt:prompt>
  <salt:prompt id="retry">
      Okay, let's do this again
  </salt:prompt>
  <salt:prompt id="reprompt">
      Sorry, I missed that.
  </salt:prompt>

  <salt:listen id ="listen_team">
      <salt:grammar src="./teamtypes.grxml" />

      <salt:bind  test="/[@confidence $gt$ 10]"
                  targetelement="team" value="//team" />
      <salt:bind  test="/[@confidence $gt$ 10]"
                  targetelement="confirm" targetmethod="start" />
      <salt:bind  test="/[@confidence $gt$ 10]"
                  targetelement="listen_yesno" targetmethod="start" />

      <salt:bind  test="/[@confidence $le$ 10]"
                  targetelement="reprompt" targetmethod="start" />
      <salt:bind  test="/[@confidence $le$ 10]"
                  targetelement="ask" targetmethod="start" />
      <salt:bind  test="/[@confidence $le$ 10]"
                  targetelement="listen_team" targetmethod="start" />
  </salt:listen>

  <salt:listen id="listen_yesno">
      <salt:grammar src="./yesno.grxml" />

      <salt:bind test="/yes[@confidence $gt$ 10]"
                 targetelement="thanks" targetmethod="start" />
      <salt:bind test="/yes[@confidence $gt$ 10]"
                 targetelement="get_team" targetmethod="submit" />

      <salt:bind test="/no or ./[@confidence $le$ 10]" />
                 targetelement="retry" targetmethod="start"
      <salt:bind test="/no or ./[@confidence $le$ 10]"
                 targetelement="ask" targetmethod="start" />
      <salt:bind test="/no or ./[@confidence $le$ 10]"
                 targetelement="listen_team" targetmethod="start" />
   </salt:listen>

<!-- call control section -->
<salt:smex id="telephone" sent="start_listening">
      <salt:param name="server" value="ccxmlproc" />
      <salt:bind targetelement="uid" value="/@uid" />
```

```
                    <salt:bind test="/Call_connected"
                               targetelement="welcome" targetmethod="queue" />
                    <salt:bind test="/Call_connected"
                               targetelement="ask" targetmethod="start" />
                    <salt:bind test="/Call_connected"
                               targetelement="listen_team" targetmethod="start" />
               </salt:smex>
        </body>
</html>
```

2.6.2 Prompt examples

2.6.2.1 Prompt control example

The following example shows how control of the prompt using the methods above might be authored for a platform which does not support a keyword bargein mechanism. On detection of a speech input event, the application reduces the volume of the prompt being played while the input speech is being recognized. The prompt is stopped if recognition succeeds, or is restored to full value if it fails.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
  <title>Prompt control</title>
  <head>
  <script>
        function checkKWBargein() {
          if (keyword.value == "") { // result is below threshold
                news.change(1.0, 2.0); // restore the volume
                keyword.Start(); // restart the recognition
          } else {
                PromptQueue.Stop(); // keyword detected! Stop the prompt
                // Do whatever that is necessary
          }
        }
   </script>
    <script for="window" event="onload">
       news.Start(); keyword.Start();
     </script>
  </head>
<body>
      <salt:prompt id="news" bargein="false" onbargein=" news.change(1.0, 0.5);" >
        <!-- onbargein... turns down the volume while verifying -->
        Stocks turned in another lackluster performance Wednesday as investors received
        little incentive to make any big moves ahead of next week's Federal Reserve
        meeting. The tech-heavy Nasdaq Composite Index dropped 42.51 points to close at
        2156.26. The Dow Jones Industrial Average fell 17.05 points to 10866.46 after an
        early-afternoon rally failed.
       <!--
       More to follow
        -->
     </salt:prompt>
     <salt:listen       id="keyword"
                 reject="70"
                 onreco="checkKWBargein()"
                 onnoreco="checkKWBargein()"  >
          <salt:grammar src="grams/news_bargein_grammar.grxml" />
     </salt:listen>
    </body>
  </html>
```

2.6.2.2 Using bookmarks and events

The following example shows how bookmark events can be used to determine the semantics of a user response – either a correction to a departure city or the provision of a destination city – in terms of the timing of the bargein during the prompt output. The `onbargein` handler calls a script which sets a global `mark` variable to the last bookmark encountered

in the prompt, and the value of this `mark` is used in the `listen`'s postprocessing function (`ProcessCityConfirm`) to set the correct value.

```
<script><![CDATA[
      var mark;
      function interrupt() {
            mark = event.srcElement.bookmark;
      }
      function ProcessCityConfirm() {
            PromptQueue.stop(); // flush the audio buffer
            if (mark == "mark_origin_city")
                  txtBoxOrigin.value = event.srcElement.value;
            else
                  txtBoxDest.value = event.srcElement.value;
      }
]]></script>


<body xmlns:salt="http://www.saltforum.org/2002/SALT"
      onload="pConfirm.Start();lConfirm.Start();">
...
<input name="txtBoxOrigin" value="Seattle" type="text" />
<input name="txtBoxDest" type="text" />
...
<salt:prompt id="pConfirm" onbargein="interrupt()" bargein="true">
      From <bookmark mark="mark_origin_city" />
      <value targetelement="txtBoxOrigin" targetattribute="value" />,
      please say <bookmark mark="mark_dest_city" /> the
      destination city you want to travel to.
</salt:prompt>
<salt:listen id="lConfirm" onreco="ProcessCityConfirm()" >
      <salt:grammar src="/grm/1033/cities.grxml" />
</salt:listen>
...
</body>
```

2.6.2.3 Prompt playback during page transitions

This example shows how the `PromptQueue` is used to ensure seamless prompt playback across page transitions in an HTML profile:

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
      <body>

            <form id="form1" action="nextpage.html">
                  <input type="button" onclick="transition();" value="go to next page" />
            </form>

            <salt:prompt id="transitionPrompt">
                Let's go to the next page!
            </salt:prompt>

            <script>
                  function transition() {
                        transitionPrompt.Queue();
                        PromptQueue.Start();
                        form1.submit();
                  }
            </script>
      </body>
</html>
```

The prompt will play back during the transition to the next page, because although the `transitionPrompt` element itself is destroyed when the DOM is torn down for the next page, it has been queued onto the `PromptQueue` object which

is persistent across pages. Subsequent prompts from the next page will be played once the `transitionPrompt` prompt has been played out.

Notice that the `transition()` function could be replaced by the simple shorthand `transitionPrompt.Start()` in the `onclick` event handler.

2.6.2.4 Queuing prompt subqueues in advance

Certain applications may require not only the content of prompts to be prefetched, but also the earliest possible queuing of prompts in advance of playback, in the interests of efficient operation. The following example shows how individual prompts (or subqueues) which are known to follow the current prompt can be queued while the current prompt is being played back.

This example shows two `prompt`s which are marked with the `prefetch` attribute (to indicate to the browser that their content should be retrieved at an early opportunity). The first is queued for playback on page load. The second is queued as soon as the first is scheduled for playback by a click on the `play` button, and is itself played back by a click on the `next` button.

```
  <prompt id="p1" prefetch="true">
    <content href="http://mybank/getStockName.asp?id=1" />
    <content href="http://mybank/getStockValue.asp?id=1" />
  </prompt>
  <prompt id="p2" prefetch="true">
    <content href="http://mybank/getStockName.asp?id=2" />
    <content href="http://mybank/getStockValue.asp?id=2" />
  </prompt>

<body onload="p1.Queue();">
 ...
 <input type="button" value="play" onclick="PromptQueue.Start(); p2.Queue();"  />
 <input type="button" value="next" onclick="PromptQueue.Stop(); PromptQueue.Start;"/>
 ...
</body>
```

This model can be scaled up to N prompts by ensuring that the `next` button always queues the following prompt, by calling the relevant function after the `PromptQueue.Start()` call, e.g.:

```
      <input type="button" value="next"
             onclick="PromptQueue.Stop(); PromptQueue.Start; QueueNextPrompt();" />
```

where `QueueNextPrompt()` is a function that decides which prompt needs to be queued next.

A simpler solution for the case where the ordering of the prompts is known in advance would be to call `Start` on each subqueue in sequential order. That is, not only queue each subqueue but also schedule it for playback in advance[17]. This permits the queuing of multiple subqueues in advance, and, in this case, the 'next' functionality would be a simple call to `PromptQueue.Stop()`, which has the effect of ceasing playback, flushing the current subqueue, and allowing the next to begin playback. (This also allows each subqueue to begin playback immediately after the previous subqueue has finished, without needing to wire the next `Start` call to the `onempty` event handler.)

2.6.3 Using SMIL

The following example is taken from section 2.8.3.1.3:

Multimedia prompting followed by recognition:

```
   <t:seq>
      <t:par t:endsync="all">
```

[17] If periods of silence are required either before or during playback, the `PromptQueue` can be paused while the `Start` calls are made.

```
            <t:img id="xxx" src="talkinghead.gif"/>
            <salt:prompt t:begin="xxx.begin-1s">
                     Please say the name
               </salt:prompt>
      </t:par>
      <salt:listen> ... </salt:listen>
   </t:seq>
```

The multimedia prompting is provided by an animated GIF and a SALT `prompt` object. The synthesis is estimated to take one second, therefore the SMIL `begin` attribute is set to start the synthesis 1 second before the animation. The prompting is contained in a SMIL `<par>` block, with the `endsync` attribute set to `all`. As a result, the following recognition object will not be activated until both the animation and prompt finish playing.

Multimodal activation of recognition or recording:

```
<input id="clickToTalk" type="button" />
<salt:listen t:begin="clickToTalk.onclick" >
   ...
</salt>
```

In this example, an HTML button is used to start the `listen` object.

2.6.4 Wireless Phone (WML) example

The following example demonstrates how SALT speech capabilities might be integrated with WML 1.1 markup for wireless telephones. The example shows the use of voice and/or the keypad to lookup a telephone number (via a server-side script `/cgi-bin/lookup.cgi`) from a dialing directory by a name (names are assumed to be stored in `namelist.grxml`).

Notice that this example uses SALT in "declarative mode" because browsers prior to WML 3.0 (the bulk of today's deployed telephones) do not include WMLScript. The assumption is that SALT elements would be activated by the browser on loading of the relevant card.

```
<?xml version="1.0"?>
<!DOCTYPE wml PUBLIC "-//WAPFORUM//DTD WML 1.1//EN"
   "http://www.wapforum.org/DTD/wml_1.1.xml">
<wml xmlns:salt="http://www.saltforum.org/2002/SALT">
   <head>
      <meta http-equiv="Cache-Control" content="max-age=0"/>
   </head>
   <card id="Splash">
      <do type="accept" label="Lookup">
         <go href="/cgi-bin/lookup.cgi" method="post">
            <postfield name="name" value="$friend"/>
         </go>
      </do>
      <p>
         This is the SALT WAP Phone Book. <br/>
         <salt:prompt>
            Please speak the name of the person
            whose number you'd like to find,
         </salt:prompt>
         or enter from the keypad here:
         <input name="friend" title="Name"/>
         <salt:listen>
            <salt:grammar src="namelist.grxml"/>
            <salt:bind targetelement="friend" value="//name[1]"/>
            <salt:bind targetelement="Lookup" targetmethod="Click"/>
         </salt:listen>
      </p>
   </card>
</wml>
```

Such an application would be even more useful if the results of submitting this document would allow a telephone call to be placed using the retrieved number and SALT Call Control. Most of today's wireless telephones lack the ability to run WML scripts and perform telephony functions concurrently, although this is planned for future generations of equipment.

2.6.5 A 'safe' voice-only dialog

This example shows prompt and listen elements used with script in a simple voice-only dialog. Its point is to show that all possible user input and error events are caught and safely handled, so that the dialog is never left in a 'hanging' state.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">

<head>
      <title>origin and destination</title>
</head>

<body>
      <form id="travelForm" action="http://mysite.com/travel/inquire.php"
                  method="post">
            <input name="txtBoxOriginCity" type="text" />
            <input name="txtBoxDestCity" type="text" />
      </form>

      <!-- SALT -->
      <salt:prompt id="askOriginCity" onerror="procError()">
            Where from?
      </salt:prompt>
      <salt:prompt id="askDestCity" onerror="procError()">
            Where to?
      </salt:prompt>
      <salt:prompt id="notUnderstood" onerror="procError()">
            Sorry, I could not understand your input.
      </salt:prompt>
      <salt:prompt id="operator"
                  oncomplete="transferToOperator()"
                  onerror="transferToOperator()">
                        <!-- external function -->
            I am transferring you to an operator.
      </salt:prompt>

      <salt:listen id="recoOriginCity"
                  onreco="procOriginCity()"
                  onnoreco="procNothingUnderstood()"
                  onsilence="procNothingUnderstood()"
                  onerror="procError()">
            <salt:grammar src="./city.grxml" />
      </salt:listen>

      <salt:listen id="recoDestCity"
                  onreco="procDestCity()"
                  onnoreco="procNothingUnderstood()"
                  onsilence="procNothingUnderstood()"
                  onerror="procError()">
            <salt:grammar src="./city.grxml" />
      </salt:listen>

      <!-- scripts -->
      <script>
            function RunAsk() {
                  if (txtboxOriginCity.value=="") {
                        askOriginCity.Start();
                        recoOriginCity.Start();
                  } else if (txtboxDestCity.value=="") {
                        askDestCity.Start();
                        recoDestCity.Start();
                  } else {
                        <!-- all slots filled -->
                        travelForm.submit();
```

```
                  }
            }
            function procOriginCity () {
                  txtBoxOriginCity.value = recoOriginCity.value;
                  RunAsk();
            }
            function procDestCity () {
                  txtBoxDestCity.value = recoDestCity.value;
                  RunAsk();
            }
            function procNothingUnderstood(){
                  notUnderstood.Start();
                  RunAsk();
            }
            function procError() {
                  operator.Start();
            }
            function terminate() {
                  <!-- caller hung up -->
                  window.close();
            }

      </script>

      <!-- on page load -->
      <script>
            <!-- detect disconnect at a central place instead of
                placing disconnect detect handlers in the listen objects -->
            callControl.attachEvent("call.disconnected",terminate());
            <!-- start dialog execution -->
            RunAsk();
      </script>

</body>
</html>
```

2.6.6 smex examples

2.6.6.1 Logging

```
<salt:smex id="logServer">
      <salt:param name="d:server" xmlns:d="urn:Microsoft.com/COM">
            <d:protocol>DCOM</d:protocol>
            <d:clsid>209309302930202932094209843209 8</d:clsid>
            <d:iid>09038593049034985309853090948 03</d:iid>
      </salt:param>
</salt:smex>

<salt:listen>
      // other directives binding listen results to input fields
      <salt:bind  targetelement="logServer" targetattribute="sent"
                  value="*[@log $ge$ 3]"/>
</salt:listen>
```

This example demonstrates how a logging mechanism can be written using a COM object with its class id and interface id. The speech developers attach an attribute `log` indicating the level of interests for logging to the relevant SML nodes. In the example above, the developer chooses to log all nodes with `log` value greater or equal to 3 by using a single `bind` directive. The example works in both downlevel and uplevel browsers.

The example also intends to demonstrate it is possible for a page to contain multiple `smex` objects which communicate with the same platform component as long as there will not be confusion on which `smex` object is responsible for delivering the platform messages back to the SALT document. The above example implies a component can implement multiple interfaces, each of which has its own `smex` conduit. The same argument could apply to TCP servers listening to multiple ports.

2.6.6.2 Call control with ECMA 323

The following example demonstrates the use of ECMA 323 in SALT. The main purpose of the example is simply to ask the caller to say a phone number and transfer the call. (References inline to parts of the ECMA-323 specification refer to sections in the documents to be found at http://www.ecma.ch/ecma1/STAND/ecma-323.htm).

The SALT application can be logically composed of the following sections.

Data for the application:

```
<input name="transferTarget" />
<input name="callerID" />
<input name="callID" />
<input name="deviceID" />
<input name="monitorObject" type="hidden" value="2234" />
<input name ="monitorCrossRefID" />
```

Speech objects in English (only section affected by natural language):

```
<listen id="recNumber" onreco ="procRecNumber()" onnoreco="procNoReco()
        onsilence="procNoReco()">
      <grammar src="..."/>
</listen>

<listen id="recYesNo" onreco="procYesNo()" onnoreco="procNoReco()"
        onsilence="procNoReco()">
      <grammar src="..."/>
</listen>

<prompt id="sayWelcome">Hello! Please say the phone number to transfer to. </prompt>
<prompt id="askAgain"> Sorry, I missed that. Please say the number again. </prompt>
<prompt id="confirm"> Did you say <value href="transferTarget"/>? </prompt>
<prompt id="sayBye"> Thank you. Your call is being transferred. </prompt>
<prompt id="tryAgain">
      The number, <value href="transferTarget"/>, cannot be
      reached for transfer. Please try again later.
</prompt>
```

Speech event handlers (dialog logic) in ECMAScript:

```
<script><!--
function procRecNumber() {
      var msg = event.srcElement.recoresult;
      transferTarget.value = msg.SelectSingleNode("*/phoneNumber").value;
            // read recognized phone number
      var confidence = msg.selectSingleNode("/@confidence").value;
      if (confidence < 0.5) {
            confirm.Start(); recYesNo.Start();
      } else {
            sayBye.Start(); ccTransfer();
      }
}

function procYesNo() {
      var answer = event.srcElement.recoresult.SelectSingleNode(
            "*/yes[@confidence>0.5]");
                  // accept only yes with confidence
      if (answer == null) {
            procNoReco();
      } else {
            sayBye.Start(); ccTransfer();
      }
}
```

```
function procNoReco() {
      transferTarget.value = "";
      askAgain.Start(); recNumber.Start();
}
--></script>
```

The call control section (unaffected by locale, dialog logic):

```
<smex id="callControl" onreceive="ccHandler()">...</smex>
<script><!--
      // The cchandler handles the ECMA-323 events.
      //
      // Once the connection is answered, a welcome prompt
      // is played and the transfer target telephone number is solicited.
      //
      // When the speech event handler detects and confirms the correct
      // speech input, an ECMA-323 SingleStepTransfer service is used to
      // transfer the caller to the new transfer target.
      //
function ccHandler() {
      var msg = event.srcElement.received;
      if (msg.nodeName == "DeliveredEvent") { // incoming call notification
      //
      // If the connection is alerting (DeliveredEvent, ECMA-323, 15.2.5) the
      // connection information from the Delivered event is saved
      // called.value and deviceID.value) and the call is answered by using the
      // ECMA-323 AnswerCall service with the saved connection information.
      // If the application needed the ANI and DNIS, it could also obtain
      // this information from this event.
      //
            callID.value = msg.selectSingleNode("./connection/callID").value;
            deviceID.value = msg.selectSingleNode(
                  "./connection/deviceID").value;
            ccAnswer();
      } else if (msg.nodeName == "EstablishedEvent") { // call answered
      //
      // Once the connection is answered (EstablishedEvent, ECMA-323, 15.2.8)
      // a welcome prompt is played and the transfer target telephone number
      // is solicited.
      //
            callerID.value = msg.selectSingleNode(
                  "./callingDevice/DeviceIdentifier").value;
            sayWelcome.Start(); recNumber.Start();
      } else if (msg.nodeName == "TransferredEvent") { // call transferred
      //
      // The TransferredEvent (ECMA-323, 15.2.18) is received when
      // the transfer has been completed. ccCleanup is called to clean up
      // the application data.
      //
            ccCleanUp();
      } else if (msg.nodeName == "ConnectionClearedEvent") { // user hang up
      //
      // A user hang up is indicated by a ConnectionClearedEvent (ECMA-323,
      // 15.2.4) which flushes the prompt queue and cleans the application
      // data. This could happen at any time during the call.
      //
            promptQueue.Flush();
            ccCleanUp();
      } else if (msg.nodeName == "CSTAErrorCode") { // service failure event
      //
      // The ccError function handles any failure responses from any of the
      // ECMA-323 services that may have failed.
```

```
      //
            ccError();
      } // feel free to handle other events here
}

function ccTransfer() { // transferring a call
      //
      // The SingleStepTransferCall service (ECMA-323, 15.1.24) is used to
      // invoke the transfer. There are two elements provided. The first
      // element is the connection information that was obtained from
      // the DeliveredEvent. The second element is the transfer target that
      // was solicited from the caller.
      //
      callControl.sent = "<SingleStepTransferCall" +
            " xmlns='http://www.ecma.ch/standards/ecma-323/csta'>" +
            "<activeCall><callID>" +
            callID.value + "</callID><deviceID>" +
            deviceID.value + "</deviceID></activeCall><transferredTo>" +
            transferTarget.value+"</transferredTo></SingleStepTransferCall>";
}

function ccStartListening() { // listening for call events
      //
      // The MonitorStart service (ECMA-323, 13.1.2) is used to place a
      // monitor on a device so that events can be generated when activity
      // happens at that device. The single element provided indicates the
      // identifier of the device that is to be monitored. In this example
      // it was part of the application data.
      //
      callControl.sent = "<MonitorStart" +
            " xmlns='http://www.ecma.ch/standards/ecma-323/csta'>" +
            "<monitorObject><deviceObject>" +
            monitorObject.value + "</deviceObject></monitorObject></MonitorStart>";
}

function ccAnswer() { // answering a call
      //
      // The AnswerCall service (ECMA-323, 15.1.3) is used to answer the
      // alerting connection. The single element provided is the connection
      // information that was obtained in the Delivered event.
      //
      callControl.sent = "<AnswerCall" +
            " xmlns='http://www.ecma.ch/standards/ecma-323/csta'>" +
            "<callToBeAnswered><callID>" +
            callID.value + "</callID><deviceID>"
            deviceID.value + "</deviceID></callToBeAnswered></AnswerCall>";
}

function ccCleanUp() {
      callerID.value = ""; transferTarget.value = ""; callID.value = "";
      recNumber.Stop(); recYesNo.Stop(); ...
}

function ccHangup() { // clearing a connection
      //
      // The ClearConnection service (ECMA-323, 15.1.8) is used to clear
      // a connection. In this example, this is used when the transfer is
      // unable to be completed.
      //
      callControl.sent = "<ClearConnection " +
            "xmlns='http://www.ecma.ch/standards/ecma-323/csta'>" +
            "<connectionToBeCleared> <callID>" +
            callID.value + "</callID><deviceID>" +
            deviceID.value + "</deviceID></connectionToBeCleared>" +
```

```
            "</ClearConnection>";
}

function ccError() {
      //
      // The ccError function is called to handle any failure responses to
      // ECMA-323 service requests. If there was an error starting a
      // monitor, the application logs an error. If there was an error
      // response to the SingleStepTransfer service, a message is played
      // for the caller and the connection is cleared.
      //
      var request = callControl.sent.substr(1, 7);
                  // read the first 7 characters of service requested
      if (request == "Monitor") { // error starting a monitor
            logMessage("ccError", callControl.sent);
      } else if (request == "SingleS") { // error in transfer
            tryAgain.Start();
            ccHangup();
      } // feel free to handle other errors here
}
--> </script>
```

Putting it all together:

```
<html>
...
<body>
// data section here
<div xmlns="http://www.saltforum.org/2002/SALT" style="visibility:hidden">
      // put the speech objects here
</div>
// speech event handlers here
// call control section here
// finally, when the page is loaded...
<script>
      ccStartListening();
</script>
</body>
</html>
```

2.6.7 Compatibility with visual browsers

SALT documents can be designed to be compatible with both multimodal browsers and legacy (visual-only) browsers. Because SALT extends and enhances markup languages, rather than altering the behavior of the base markup language, SALT documents can be used by legacy browsers by simply omitting or ignoring the SALT tags.

Dynamically generated web pages can examine the browser's `HTTP_USER_AGENT` to determine whether to include or omit the SALT tags and any associated scripts. This is discussed in section 2.8.1.12.

It is also possible to create static web pages that work equally well with both legacy browsers and multimodal browsers. Because legacy browsers may not recognize the SALT tags, legacy browsers will ignore them. However, SALT-specific text that is not within a tag (not within angle-brackets), will be displayed by legacy browsers. This includes text that is part of an inline `grammar`, or part of a `prompt`, for example. The recommended way to exclude the display of such text in legacy browsers is by encompassing it with the `span` tag as follows:

```
<span style="display:none">
   <salt:prompt id="giveBalance" xmlns:ssml="http://www.w3.org/2001/10/synthesis">
            Which city do you want to <emphasis> depart </emphasis> from?
   </salt:prompt>

      <salt:grammar xmlns="urn:microsoft.com/speech/schemas/STGF">
            <grammar>
```

```
                    <rule toplevel="active">
                        <p>from </p>
                        <ruleref name="cities" />
                    </rule>
                    <rule name="cities">
                        <list>
                              <p> Chicago </p>
                              <p> Milwaukee </p>
                              <p> Kalamazoo </p>
                        </list>
                    </rule>
                </grammar>
            </salt:grammar>
      </span>
```

To prevent SALT scripts in static web pages from interfering with legacy browsers, the scripts should be designed such that they do not fail because the legacy browser does not find an object. Therefore, for static pages, it is recommended that scripts test for the existence of SALT objects before referencing them. For example:

```
      function procOriginCity () {
            if (txtBoxOriginCity && recoOriginCity) {
                  txtBoxOriginCity.value = recoOriginCity.value;
                  RunAsk();
            }
      }
```

2.6.8 Audio recording example

The following example demonstrates recording audio for a voice mail system.

```
<!-- HTML -->
<!-- on page load -->
<body xmlns:salt="http://www.saltforum.org/2002/SALT" onload="RunAsk()">

      <form id="f1" action="http://www.example.com/savewaveform.aspx" method="get">
            <input name="vmail" type="hidden" />
      </form>

      <!-- Prompts -->
      <salt:prompt id="p_record" oncomplete="l_recordvm.Start()">
            Please speak after the tone. You may press any key to end your recording.
      </salt:prompt>
      <salt:prompt id="p_save">
            Do you want to save this voicemail?
      </salt:prompt>

      <!-- listens -->
      <!-- Recording session - max 60 seconds recording -->
      <salt:listen id="l_recordvm"
            initialtimeout="3000" endsilence="1500" babbletimeout="60000"
            onreco="saveAudio()" onnoreco="saveAudio()" onsilence="RunAsk()" >
            <salt:record />
      </salt:listen>

      <!-- listen for capturing whether user wants to save voice mail -->
      <salt:listen id="l_save" onreco="processSave()">
          <salt:grammar src="./yesno.grxml" />
      </salt:listen>

      <salt:dtmf id="d_stop_rec" onreco="saveAudio()">
            <grammar src="alldigits.grxml" />
      </salt:dtmf>

      <!-- HTML + script controlling dialog flow -->
```

```
      <script>
      function RunAsk() {
            if (voicemail.value=="") {
                  p_record.Start();
            }
      }

      // Ask user if they are satisfied with their recording
      function saveAudio () {
            p_save.Start();
            l_save.Start();
      }

      // If user is satisfied post file name back to web server
      // otherwise start again
      function processSave () {
            smlResult = event.srcElement.recoresult;

            origNode = smlResult.selectSingleNode("//answer/text()");
            if (origNode.value == "Yes") {
                  vmail.value = l_recordvm.recordlocation;
                  f1.submit();
            } else {
                  RunAsk();
            }
      }
      </script>
</body>
```

2.6.9 Using XPath for DOM queries

The following example demonstrates XPath queries used on the DOM of the example page itself.

```
<html>
      <head>
            <title>
                  SALT XPath example
            </title>
      </head>
      <script language="JavaScript">
            <!-- hide from browsers
            var xmlDoc;
            function doOnLoad() {
                  // load MS XML parser
                  xmlDoc = new ActiveXObject("MSXML2.DOMDocument");
                  xmlDoc.async = false;
                  // load my own HTML document as an XML DOM tree
                  if (!xmlDoc.load(location.href)) {
                        alert("Error loading myself from: " + location.href);
                        return false;
                  }
                  // fill in "first" query ("*" == entire document)
                  queryFromTextBox();
                  return true;
            }
            function queryFromTextBox() {
                  document.entry_form.txtResults.value
                        = doXPathQuery(document.entry_form.queryBox.value);
                  return true;
            }
            function doXPathQuery(szQuery) {
                  // find nodes that match the query
                  xmlDoc.setProperty("SelectionLanguage", "XPath");
                  var arrayMatches = xmlDoc.selectNodes(szQuery);
                  // display results
                  var szResults = "[" + arrayMatches.length + " matches]"
```

```
                  for (i = 0; i < arrayMatches.length; i++) {
                        szResults += "\n\n[match " + (i + 1) + "]\n" +
arrayMatches[i].xml;
                  }
                  return szResults;
            }
            // -->
      </script>
      <body bgcolor="white" onLoad="javascript:doOnLoad();">
            <form name="entry_form">
                  Enter XPath query:
                  <input type="text" name="queryBox" value="*" />
                  <input type="button" name="queryButton" value="Query Now"
onClick="javascript:queryFromTextBox();" />
                  <br />
                  XPath query results (XML format):
                  <br />
                  <textarea name="txtResults" cols="100" rows="20"></textarea>
                  <br />
            </form>
      </body>
</html>
```

The following queries are instructive:

```
    //form
    //input
    //input[@type="text"]
```

The way in which an XPath query would be made on the callControl object's `capabilities` property to determine whether the implementation supported the `transfer` method would be something like this:

```
    var xmlDoc = new ActiveXObject("MSXML2.DOMDocument");
    xmlDoc.async = false;
    if (!xmlDoc.loadXML(callControl.capabilities)) {
        // capabilities don't parse as valid XML: abort
    }
    xmlDoc.setProperty("SelectionLanguage", "XPath");
    var arrayMatches = xmlDoc.selectNodes("//transfer");
    if (arrayMatches.length > 0) // transfer is supported
```

This would typically be written as a JavaScript function and reused as needed.

2.7 Appendix A: SALT DTD

```
<!--            DTD for SALT 1.0 (2002)           -->

<!ENTITY % boolean "(true | false)">
<!ENTITY % confidence.value "CDATA">  <!-- should be a float between 0.0 and 1.0 -->
<!ENTITY % content.type "CDATA">
<!ENTITY % expression "CDATA">
<!ENTITY % milliseconds "CDATA">
<!ENTITY % object.method "CDATA">
<!ENTITY % listen.mode "(automatic | multiple | single)">
<!ENTITY % script.statement "CDATA">
<!ENTITY % script.variable "CDATA">
<!ENTITY % uri "CDATA">
<!ENTITY % xpath.query "CDATA">
<!ENTITY % xpattern.string "CDATA">

<!ELEMENT bind EMPTY>
<!ATTLIST bind
      targetattribute         %script.variable;       "value"
      targetelement           %script.variable;       #REQUIRED
```

```
      targetmethod            %object.method;         #IMPLIED
      test                    %xpattern.string;       #IMPLIED
      value                   %xpath.query;           #IMPLIED
>

<!ELEMENT content (#PCDATA)>
<!ATTLIST content
      href                    %uri;                   #REQUIRED
      type                    %content.type;          #IMPLIED
>

<!ELEMENT dtmf (grammar | bind | param)* >
<!ATTLIST dtmf
      id                      ID                      #IMPLIED
      endsilence              %milliseconds;          #IMPLIED
      preflush                %boolean;               "false"
      initialtimeout          %milliseconds;          #IMPLIED
      interdigittimeout       %milliseconds;          #IMPLIED
      onerror                 %script.statement;      #IMPLIED
      onkeypress              %script.statement;      #IMPLIED
      onnoreco                %script.statement;      #IMPLIED
      onreco                  %script.statement;      #IMPLIED
      onsilence               %script.statement;      #IMPLIED
>

<!ELEMENT grammar ANY>
<!ATTLIST grammar
      name                    NMTOKEN                 #IMPLIED
      src                     %uri;                   #IMPLIED
      type                    %content.type;          "application/srgs+xml"
      xmlns                   %uri;                   #IMPLIED
      xml:lang                CDATA                   #IMPLIED
>

<!ELEMENT listen (record | grammar | bind | param)* >
<!ATTLIST listen
      id                      ID                      #IMPLIED
      initialtimeout          %milliseconds;          #IMPLIED
      babbletimeout           %milliseconds;          #IMPLIED
      maxtimeout              %milliseconds;          #IMPLIED
      endsilence              %milliseconds;          #IMPLIED
      reject                  %confidence.value;      #IMPLIED
      xml:lang                CDATA                   #IMPLIED
      mode                    %listen.mode;           "automatic"
      accesskey               CDATA                   #IMPLIED
      style                   CDATA                   "visibility: hidden"
      onerror                 %script.statement;      #IMPLIED
      onnoreco                %script.statement;      #IMPLIED
      onreco                  %script.statement;      #IMPLIED
      onsilence               %script.statement;      #IMPLIED
      onspeechdetected        %script.statement;      #IMPLIED
>
<!-- NOTE: accesskey and style attributes are used only in HTML profiles -->

<!ELEMENT param ANY>
<!ATTLIST param
      xmlns                   %uri;                   #IMPLIED
      name                    CDATA                   #REQUIRED
>

<!ELEMENT prompt (#PCDATA | content | value | param)* >
<!ATTLIST prompt
      id                      ID                      #IMPLIED
      bargein                 %boolean;               "true"
```

```
      prefetch                %boolean;               "false"
      xmlns                   %uri;                   #IMPLIED
      xml:lang                CDATA                   #IMPLIED
      accesskey               CDATA                   #IMPLIED
      style                   CDATA                   "visibility: hidden"
      onbargein               %script.statement;      #IMPLIED
      onbookmark              %script.statement;      #IMPLIED
      oncomplete              %script.statement;      #IMPLIED
      onerror                 %script.statement;      #IMPLIED
>
<!-- NOTE: accesskey and style attributes are used only in HTML profiles -->

<!-- default audio MEDIA type conforms to RFC 2361 -->
<!ELEMENT record EMPTY>
<!ATTLIST record
      type                    %content.type;          "audio/wav;codec=g711"
      beep                    %boolean;               "false"
>

<!ELEMENT smex (bind | param)* >
<!ATTLIST smex
      id                      ID                      #IMPLIED
      sent                    CDATA                   #IMPLIED
      timer                   %milliseconds;          #IMPLIED
      onerror                 %script.statement;      #IMPLIED
      onreceive               %script.statement;      #IMPLIED
      ontimeout               %script.statement;      #IMPLIED
>

<!ELEMENT value EMPTY>
<!ATTLIST value
      targetattribute         %script.variable; #IMPLIED
      targetelement           %script.variable; #IMPLIED
>
```

2.8 Appendix B: SALT modularization and profiles

2.8.1 Modularization of SALT

This section defines a number of SALT modules for use in different profiles according to device capability and application functionality.

SALT browsers fall into the following main classes of device:

- **Smart Clients**: simple or mobile devices with modest computation power and resources. In this case, the speech capabilities may be achieved using a distributed computing architecture, the devices may have only rudimentary displays, and the browsers may not support scripting. A possible scenario for such devices is an eyes-free/hands-free application where only speech input and output modes are available. Examples include PDA, smart phones, set top boxes, and some automobile navigation systems, etc.
- **Rich Clients**: computing devices of similar capabilities to PCs. Usually, the devices have suitable displays, and UI may be more biased towards a visual design (other than for hands-free, eyes-free applications). Speech-related processing may still be distributed, but a network connection is not mandatory. Examples include desktop, wall, and pocket PCs and some automobile PCs. Rich Clients should have no problem supporting scripting.
- **Telephony Servers**: SALT browsers are running on server-grade computers that process multiple phone calls. The user interface includes speech and/or DTMF. Scripting support is considered a reasonable requirement for this class.

Many functional features in SALT do not make sense in all environments. The purpose of SALT modularization is to classify them into proper categories so that browser implementers have the greatest flexibility and the application developer can enjoy maximum interoperability.

2.8.1.1 Declarative Programming Module

The module contains the `bind` subelement and all its attributes, as defined in 2.2.1.2.

Note that application developers can still enjoy the full SALT functionality on a browser that does not implement this module but supports scripting or SMIL. It is reasonable to allow browsers to claim certain level of compliance without declarative module.

2.8.1.2 Basic Recognition Module

The module contains the `listen` object, all the recognition related properties (e.g., `text`, `recoresult`), the `grammar` and `param` subelements and all their attributes, and all the events and methods, as defined in section 2.2.

Support of this module requires implementing 'automatic' mode recognition. Additional support of 'single' and 'multiple' mode is optional. As noted in 2.2.1, support of this module also requires support for the W3C SRGS, W3C NLSML and, if applicable, W3C SLM (N-Gram) Recommendations.

The module is particularly sensible for smart clients, where basic recognition but not recording is needed.

2.8.1.3 Basic Recording Module

The module contains the `listen` object, all the recording related properties (e.g., `recordlocation`, `recordtype`, `recordduration`, `recordsize`), the `record` and `param` subelements and all their attributes, and all the events and methods defined in section 2.2.8.

This module makes sense for browsers that use only input methods that do not generate uncertainties (e.g. DTMF, keyboards, pointing devices). For this case, the browsers should be able to claim certain level of conformance without implementing any speech recognition features.

2.8.1.4 Concurrent Recording and Recognition Module

When a browser claims to support both the Basic Recognition and the Basic Recording modules independently, this does not guarantee that recording and recognition can be performed simultaneously. Note that for distributed recognition, the browser can perform front-end signal processing locally and only send the acoustic features to the recognition servers. Doing so usually lowers the bandwidth requirements considerably. Therefore, there might be cases where recording and recognition are performed by two different remote servers, and the browser only implements single channel streaming but not two-channel multicasting.

Applications can only enjoy simultaneous recording and recognition on a browser supporting this module. This module contains the union of the basic recognition and recording modules. Supporting this module implies the support of both the basic recognition and recording modules.

2.8.1.5 Basic Media Playback Module

The module contains the `prompt` element and all its properties, methods, events, but the `prompt` element can only contain `content` nodes for referring to pre-recorded media files, and not text nodes in speech synthesis markup languages.

2.8.1.6 Speech Synthesis Module

The module contains the `prompt` element and all its properties, methods, events, and subelements[18], including text nodes for speech synthesis content.

As noted in 2.1.1.1, support of this module also requires support for the W3C SSML Recommendation.

2.8.1.7 Messaging Module

This module contains the `smex` element and all its properties, methods, events, and the `param` subelement, as defined in 2.4.

[18] The `PromptQueue` object is not included here. It is a separate module because a multimedia enabled browser (e.g. a SMIL implementation) often has sophisticated mechanisms in place already to synchronize different media types. For that case, synthesized speech should behave more like other media streams that do not define their own media buffer.

2.8.1.8 Call Control Module

This module enables telephony call control. This may be accomplished through the use of `smex` with ECMA-323 messages (section 2.4.4), or by support of the `CallControl` object (section 3).

2.8.1.9 DTMF Module

This module contains the `dtmf` element and all its properties, methods, and events, as defined in 2.3. When this module is supported in addition to the `listen` element (i.e. the Basic Recognition, Basic Recording and/or Concurrent Recognition and Recording modules), the behavior described in section 2.3.6 is required to be supported.

2.8.1.10 PromptQueue Module

The module supports the `PromptQueue` object and all its properties, events, and methods, as defined in 2.1.5 (with the exception of the `Change()` method in 2.1.5.2.4, which is optional).

2.8.1.11 Logging Module

The module contains the global logging function, as defined in 2.5.

2.8.1.12 Run-time determination of supported modules

Given that clients will support differing collections of SALT modules, it is useful for server-side scripts to have a mechanism to determine client capabilities and dynamically generate the appropriate markup.

Traditionally, web servers have been able to examine an environment variable `HTTP_USER_AGENT` to obtain client capability information. Here are some representative examples of `HTTP_USER_AGENT` strings from a cross-section of clients[19]:

Microsoft Internet Explorer 6.0 on a Windows 2000 desktop PC manufactured by IBM: `Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; T312461; Q312461; .NET CLR 1.0.3328)`
Netscape Navigator 4.72 on a Windows 95 laptop PC manufactured by Sony: `Mozilla/4.7 [en]C-CCK-MCD {Sony} (Win95; U)`
Planetweb browser on a Sega Dreamcast game console: `Mozilla/3.0 (compatible; Planetweb/1.123 JS SSL US Gold; Dreamcast US)`
Openwave WML browser on a Mitsubishi T-250 wireless telephone: `UP.Browser/3.1.03-T250 UP.Link/4.3.3.4`
Palm Web Clipping Application browser on a Palm Pilot VIIx: `Mozilla/2.0 (compatible; Elaine/3.0)`

Following this model, a SALT browser will include an identifying substring of the form `SALT X.Y.Z NNNNN` where:

- `X.Y.Z` is the version number `X.Y` of the SALT specification implemented by the browser and the `.Z` portion is a "build number" of that implementation. Example: `1.0.1023` is the 1023rd build of a SALT browser that implements version 1.0 of the SALT specification.
- `NNNNN` is a "bitmap" of the SALT modules supported. This bitmap is the sum (logical OR) of the "bitmap values" for each of the modules as listed in the table below.

SALT Module Name	***Bitmap Value***
Scripting (e.g., ECMAScript or WMLScript)	1
Declarative Programming	2
Basic Recognition	4
Basic Recording	8
Concurrent Recognition & Recording	16
Basic Media Playback	32
Speech Synthesis	64
Messaging	128
Call Control	256
DTMF	512
Prompt Queue	1024

[19] Trade names and brands are the property of their respective holders.

Logging	2048

If the first example `HTTP_USER_AGENT` string were re-written to include the SALT substring, it would look something like:

```
Mozilla/4.0 (compatible; MSIE 6.0; Windows NT 5.0; T312461; Q312461; .NET CLR
1.0.3328; SALT 1.0.1023 3583)
```

This client supports all the SALT Modules except "DTMF" (3583 = 1 + 2 + 4 + 8 + 16 + 32 + 64 + 128 + 256 + 1024 + 2048).

2.8.2 SALT/HTML profiles

This section defines the support of HTML and associated environmental features in terms of multimodal and voice-only profiles.

2.8.2.1 HTML multimodal

SALT can be used in HTML multimodal profiles which support a display. In these cases the extent to which HTML is supported depends on the capabilities of the device. The extent of SALT module support is also dependent on the device capability, and this will be reflected in individual profiles. For example, if a scripting module is not supported, then full object mode of SALT is unlikely to be incorporated in the profile.

All the HTML examples in this document can also be used in compact HTML (cHTML) browsers, as described at http://www.w3.org/TR/1998/NOTE-compactHTML-19980209/, since the subset of HTML used in the examples falls under the cHTML definition.

2.8.2.1.1 accesskey and style

When SALT is used in HTML profiles which support the two general HTML attributes `accesskey` and `style`, SALT adopts these attributes and their capabilities into the `listen` and `prompt` elements. As described below, this enables simple declarative authoring of the typical functionality required in multimodal applications.

accesskey
When the hosting environment supports accesskey, the attribute has the following semantics:

- `listen`: for 'automatic' mode, the `onkeypress` event for the accesskey invokes the `Start()` method.
- `listen`: for 'single' mode, the `onkeydown` and `onkeyup` events invoke the `Start()` and `Stop()` methods, respectively. In other words, the accesskey enables "push-hold-and-talk".
- `listen`: for 'multiple' mode and recording, the `onkeypress` event toggles the `Start()` and `Stop()` methods. In other words, the `accesskey` enables "click to talk".
- `prompt`: the `onkeypress` event invokes the `Start()` method.

This permits simple declarative statements such as:

```
<listen accesskey="*" ... />
<prompt accesskey="*" ... />
```

where the `onkeypress` event from the "`*`" will have the behavior described above without the need for programmatic script activation.

style
When the hosting HTML environment supports the style module, the listen object shall at minimum implement that portion of the object model conforming to W3C CSS level 1 specification. The `onclick`, `onmousedown`, `onmouseup` events assume the same behaviors as the `onkeypress`, `onkeydown` and `onkeyup` events as those defined for the `accesskey` above. In addition, when the hosting environment supports `tabindex`, a `listen` object shall have the same behavior as other visual HTML objects.

2.8.2.2 HTML voice-only

2.8.2.2.1 HTML module support

This section describes the subset of HTML elements to be supported by a SALT voice-only browser. The subset is defined on the basis of useful functionality in structuring and executing a web application with a SALT speech interface but without a visual display[20].

2.8.2.2.1.1 XHTML Modules

The following XHTML modules as defined at http://www.w3.org/TR/xhtml-modularization/abstract_modules.html should be supported by voice-only XHTML browsers according to the table below. Required elements are in bold typeface, with hyperlinks to the relevant W3C module definition recommendation. (see the following subsection 2.8.2.2.1.1.1 for finer detail on the required level of support for each element).

Required	Module Name	Supported elements
Part	**Attribute Collections***	This defines the following common attributes: **class, id**, title, **xmlns**, **xml:lang**, style, and common events collection (i.e. onclick, onkeypress, etc)
All	**Structure Module***	**body, head, html, title**
Part	**Text Module***	abbr, acronym, address, blockquote, br, cite, code, dfn, **div**, em, h1, h2, h3, h4, h5, h6, kbd, p, pre, q, samp, span, strong, var
All	**Hypertext Module***	**a**
No	List Module	dl, dt, dd, ol, ul, li
No	Applet	
No	Text Extension	
No	Presentation	
No	Edit	
No	Bi-directional	
No (see below)	Basic forms	
Part	**Forms Module**	button, fieldset, **form, input**, label, legend, **select**, optgroup, **option, textarea**
No	Basic Tables	
No	Table Module	caption, col, colgroup, table, tbody, td, tfoot, th, thead, tr
No	Image	
No	Client-side Image Map	
No	Server-side Image Map	
No	Object	
No	Frames	
No	Target	
No	Iframe	
Part	Intrinsic Events Module	Events attributes (**onreset, onsubmit** for **form,** and **onload, onunload** for **body**).
All	**Metainformation Module**	**meta**
Part	**Scripting Module**	noscript, **script**
No	Style Sheet	
No	Style Attribute	
All	**Link Module**	**link**
All	**Base Module**	**base**
No	Name Identification	

[20] The subset of elements listed here does not correspond strictly to W3C's existing XHTML Abstract Modules as defined at http://www.w3.org/TR/xhtml-modularization/, since many modules contain elements and functionality superfluous to speech functionality.

No	Legacy	

2.8.2.2.1.1.1 Elements

The following elements and events must be supported by HTML voice browsers:

- <!DOCTYPE>
- <html>
- <head>
- <body>
- <title>
-
- <a>
- <form>
- <input>
- <select>
- <option>
- <textarea>
- <meta>
- <script>
- <link>
- <base>
- Common Events.

The level of support required for the interface of each of the above elements in the supported modules is outlined below. Interfaces which are required are shown in bold. DOM methods and properties (i.e. not attributes) are italicized.

ID	Element	Subcategory	Detail	Comments
General				
1	**<!DOCTYPE>**	**-**	**-**	
Structure				
2	**body**	**Attribute set**	**Common**	
3	**head**	**Attribute set**	**I18N**	
	head	**Attribute**	**profile**	
4	**html**	**Attribute set**	**I18N**	
5		Attribute	version	
6		**Attribute**	**xmlns**	For XHTML, this attribute defaults to "http://www.w3.org/ 1999/xhtml".
7	**title**	**Attribute**	**I18N**	
Text				
8	abbr	Attribute	Common	
9	acronym	Attribute	Common	
10	address	Attribute	Common	
11	blockquote	Attribute	Common	
12	blockquote	Attribute	Common	
13	br	Attribute	Common	
14	cite	Attribute	Common	
15	code	Attribute	Common	

16	dfn	Attribute	Common	
17	**div**	**Attribute**	**Common**	
18	em	Attribute	Common	
19	h1	Attribute	Common	
20	h2	Attribute	Common	
21	h3	Attribute	Common	
22	h4	Attribute	Common	
23	h5	Attribute	Common	
24	h6	Attribute	Common	
25	kbd	Attribute	Common	
26	p	Attribute	Common	
27	pre	Attribute	Common	
28	samp	Attribute	Common	
39	span	Attribute	Common	
30	strong	Attribute	Common	
31	var	Attribute	common	
Hypertext				
32	**a**	**Attribute**	**Common**	
33		Attribute	accesskey	
34		**Attribute**	**charset**	
35		**Attribute**	**href**	
36		**Attribute**	**hreflang**	
37		**Attribute**	**rel**	
38		**Attribute**	**rev**	
39		Attribute	tabindex	
40		**Attribute**	**type**	
41		***DOM method***	***click()***	*This allows the simulation of mouse clicks and simpler navigation. Not strictly part of the HTML DOM spec (but is supported in many visual browsers).*
Forms				
42	**form**	**Attribute**	**Common**	
43		**Attribute**	**accept**	
44		**Attribute**	**accept-charset**	
45		**Attribute**	**action**	
46		**Attribute**	**method**	
47		**Attribute**	**enctype**	
48		***DOM Property***	***elements***	
49		***DOM Property***	***length***	
50		***DOM method***	***reset()***	
51		***DOM method***	***submit()***	
52	**input**	**Attribute**	**Common**	
53		**Attribute**	**accept**	

54		Attribute	accesskey	
55		Attribute	alt	
56		Attribute	checked	
57		Attribute	disabled	
58		Attribute	maxlength	
59		**Attribute**	**name**	
60		Attribute	readonly	
61		Attribute	size	
62		Attribute	src	
63		Attribute	tabindex	
64		**Attribute**	**type**	Only ("text" | "submit" | "reset" | "file" | "hidden") values need be supported (and not "password", "checkbox", "button", "radio", "image".)
65		**Attribute**	**value**	
66		***DOM Property***	***defaultValue***	
67		***DOM Property***	***form***	
68		***DOM method***	***click()***	
69	**select**	**Attribute**	**Common**	
70		Attribute	disabled	
71		**Attribute**	**multiple**	
72		**Attribute**	**name**	
73		Attribute	size	
74		Attribute	tabindex	
75		***DOM Property***	***form***	
76		***DOM Property***	***length***	
77		***DOM Property***	***options***	
78	**option**	**Attribute**	**Common**	
79		Attribute	disabled	
80		Attribute	label	
81		**Attribute**	**selected**	
82		**Attribute**	**value**	
83		***DOM Property***	***form***	
84		***DOM Property***	***index***	
85	**textarea**	**Attribute**	**Common**	
86		Attribute	accesskey	
87		Attribute	cols	
88		Attribute	disabled	
89		**Attribute**	**name**	
90		Attribute	readonly	
91		Attribute	rows	
92		Attribute	tabindex	
93		***DOM Property***	***form***	
94		***DOM Property***	***type***	
95	button	Attribute	Common	
96		Attribute	accesskey	

97		Attribute	disabled	
98		Attribute	name	
99		Attribute	tabindex	
100		Attribute	type	("button"|"submit"|"reset")
101		Attribute	value	
102	fieldset	Attribute	Common	
103	label	Attribute	Common	
104		Attribute	accesskey	
105		Attribute	for	
106	legend	Attribute	Common	
107		Attribute	accesskey	
108	optgroup	Attribute	Common	
109		Attribute	disabled	
110		Attribute	label	
Intrinsic events				
111	a&	Attribute		
112	area&	Attribute		
113	frameset&	Attribute		
114	form&	Attribute	onreset	
115		Attribute	onsubmit	
116	body&	Attribute	onload	
117		Attribute	onunload	
118	label&	Attribute		
119	input&	Attribute		
120	select&	Attribute		
121	textarea&	Attribute		
122	button&	Attribute		
Metainformation				
123	**meta**	**Attribute**	**I18N**	
124		Attribute	content	
125		**Attribute**	**http-equiv**	
126		Attribute	name	
127		Attribute	scheme	
Scripting				
128	noscript	Attribute		
129	**script**	**Attribute**	**charset**	
130		Attribute	defer	
131		**Attribute**	**src**	
132		**Attribute**	**type**	
133		**Attribute**	**xml:space**	
134		**Attribute**	**-**	
Link				
135	**link**	**Attribute**	**Common**	

136		Attribute	charset	
137		Attribute	href	
138		Attribute	hreflang	
139		Attribute	media	
140		Attribute	rel	
141		Attribute	rev	
142		Attribute	type	
Base				
143	**base**	**Attribute**	**href**	
Common				
144	**-**	**Attribute**	**-**	Core + Events + I18N + Style
145	**Core attribute collection**	**Attribute**	**class**	
146		**Attribute**	**id**	
147		Attribute	title	
		Attribute	**xmlns**	
148	**I18N attribute collection**	**Attribute**	**xml:lang (and lang)**	lang is HTML
149	Events attribute collection	Attribute	-	
150	Style attribute collection	Attribute	style	

2.8.2.2.1.2 HTML DOM

SALT platforms supporting HTML are expected to support the DOM specified in the HTML DOM Level 1 Core spec (http://www.w3.org/TR/2000/WD-DOM-Level-1-20000929/idl-definitions.html).

The following methods however need not be implemented, since they permit application scripts to change the DOM significantly, possibly invalidating internal browser or script host data structures.

- `INode` `insertBefore, replaceChild, appendChild, removeChild`
- `INamedNodeMap` `setNamedItem, removeNamedItem`
- `IElement` `setAttribute, setAttributeNode, removeAttributeNode, normalize`
- `IText` `SplitText`

2.8.2.2.1.3 Event model

This section contains examples of the event model implemented by (1) the Microsoft Internet Explorer browser (versions 5+), and by (2) the emerging DOM level 2 specification.

2.8.2.2.1.3.1 IE 5,6 event model

Event listener registration:

In HTML, one may use event name like an attribute:

```
<listen id="Listen1" onreco="myhandl()"…>
```

Script method 1: use generic `attachEvent` method as

```
Listen1.attachEvent("onreco", myhandle);
```

Script method 2: use the event delegate on the object model

```
Listen1.onreco = myhandle;
```

All above 3 mechanisms share the same event handler:

```
function myhandle() {
  var obj = event.srcElement;
  // obj is listen object that dispatches the event.
}
```

Script method 3: use HTML `script` tag that registers event listener and implements event handler in one step:

```
<script for="Listen1" event="onreco" language="Jscript">
      var obj = event.srcElement;
      // obj is the listen object that sends the event.
</script>
```

By definition, an event handler has no argument, returns nothing, and throws no exception.

2.8.2.2.1.3.2 DOM Level 2 model

The DOM Level 2 event model is currently specified at http://www.w3.org/TR/2000/REC-DOM-Level-2-Events-20001113/. This may be used in profiles outside of HTML.

Event listener registration:

Since DOM Level 2 HTML module is not finalized yet, currently the standard way to register an event listener is through scripting. A standard `addListener` method, similar to the `attachEvent` above, is defined in the standard for all nodes and can be used as follows:

```
Listen1.addListener("onreco", myhandle, false);
```

The third argument is a Boolean flag indicating whether user wants to initiate capture. See DOM Level 2 for precise definition for event capturing.

As before, an event handler returns nothing and throws no exception, but now has an argument of the `event` type:

```
function myhandle(event e) {
   var obj = e.target;
   // obj is the object that sends the event.
}
```

Again, refer to the DOM Level 2 documentation for a definition of event type.

2.8.2.2.1.4 HTML window object

The following is the proposed subset of features of the `window` object which is required for implementation by a SALT voice-only browser.

Methods:

- `attachEvent`
- `clearInterval`
- `clearTimeout`
- `close`
- `detachEvent`
- `navigate`
- `setInterval`
- `setTimeout`

Attributes/Properties:

- `length`

- name
- self

Events:

- onbeforeunload (note: this applies to the page)
- onerror
- onload
- onunload (note: this is inherited from HTML object)

Objects:

- clientInformation/navigator
- document
- event
- location

Relevant profiles may also support the PromptQueue object (see section 2.1.5) and/or the CallControl object (Part 3) within the window object.

2.8.2.2.1.5 Using <meta >

Following the principles established for expressing meta data in HTML (see http://www.w3.org/TR/html4/struct/global.html#meta-data), the meta element can be used in SALT to express meta data about the spoken aspects of the page. (This can be used in conjunction with a profile definitions referenced in the HTML head elements).

The content of such data will be meaningful to SALT platforms in proprietary contexts, so it may be considered a page-level equivalent of the param element (which expresses configuration data particular to an individual element). param is defined on the prompt, listen, dtmf and smex elements. Browsers may then treat such data as applicable to the entire page.

The following are sample uses of the meta element in SALT:

```
<meta name="recoServer" content="myRecoServer.url" />
<meta name="recoSpeechDetectionThreshold" content="0.15" />

<meta name="promptServer" content="myPromptServer.url" />
<meta name="audioEncoding" content="a-law" />
```

etc.

2.8.2.3 HTML telephony profile

This profile will be defined in terms of the HTML voice-only profile, and the SALT modules specific to conducting telephony dialogs. Relevant profiles may also support the PromptQueue object (see section 2.1.5) and/or the CallControl object (Part 3) within the window object for these profiles.

2.8.3 SALT and SMIL 2.0

This section defines the normative behavior of SALT elements when hosted in a SMIL 2.0 compliant environment. SMIL 2.0 is defined at http://www.w3.org/TR/smil20. SALT modules that are not explicitly described in this section are either unaffected by SMIL 2.0, or a normative behavior is not defined, (e.g., the non-XML SALT modules).

SALT elements may contain no visual presentation. When this is the case, all the presentation-related SMIL attributes attached to SALT elements are ignored.

2.8.3.1 SMIL Timing and Synchronization Module

Below are the desired behaviors when the host language claims support of SMIL 2.0 Timing modules. The basic timing for an element in SMIL consists of specifications on the onset and the duration of the element. This section defines only the onset and duration for the SALT elements. Advanced timing and synchronization semantics of SALT elements will follow SMIL 2.0 specification based on the onset and duration specification in the following sections.

2.8.3.1.1 The listen object

The onset of a `listen` element is the time when its `Start` method is called. As a result, the SMIL `begin` attribute is used to describe when the `Start` method of the `listen` object will be called.

The duration of a `listen` object is the length of audio consumed. The SMIL `min` and `max` attributes are aliased to the `initialtimeout` and `maxtimeout` of the `listen` object, respectively. Effectively, a SMIL `dur` attribute will invoke the `Stop` method of the `listen` object. Note that the end of the audio stream does not mean the recognition or recording results are ready for processing. As a result, it is most often that the SMIL synchronization will be cued off to related `listen` events.

A "freezing" (in SMIL sense) `listen` object simply means the object no longer consumes audio inputs. The recognition or recording process may continue as described above.

(Note: As the `listen` object provides programmatic means for changing grammars, using SMIL to repeat a `listen` object does not always guarantee the same grammar will be used each time. The same applied to SMIL restart. In other words, resetting the state of a `listen` object means to recompile the grammar if the grammar has been modified.)

As of SALT 1.0, a `listen` object cannot be paused and resumed. Since pausing an active element is most frequent inside the SMIL `excl` block, the listen object may treat SMIL pause as an alias for invoking the `Cancel` method and the consequent resume as a fresh `Start`.

The SMIL `beginEvent` corresponds to the `listen` object `onspeechdetected` event. The SMIL `endEvent` is raised when the `bind` subelements are processed, or the `listen` object is about to raise `onreco`, `onnoreco`, or `onerror` event.

2.8.3.1.2 The prompt object

Like the `listen` object, the onset is the time when its `Start` method is called.

The duration of a `prompt` object is the length of the audio played plus the time needed to synthesize its textual contents, if any. The `prompt` object shall follow SMIL Content Control Module in resolving streamed audio. Once the text to speech synthesis is finished and streaming audio is resolved per SMIL definitions, the `prompt` object assumes all the behaviors of a SMIL audio object.

The SMIL Prefetch Content Control Module may be used to direct the SALT `prompt` object to synthesize static text prior to its invocation. When used, SALT prompt object follows the timing, freshness, and other semantics in SMIL.

2.8.3.1.3 Examples

1) Multimedia prompting followed by recognition:

```
<t:seq>
      <t:par t:endsync="all">
            <t:img id="xxx" src="talkinghead.gif"/>
            <salt:prompt t:begin="xxx.begin-1s">
                  Please say the name
            </salt:prompt>
      </t:par>
      <salt:listen> ...</salt:listen>
</t:seq>
```

   The multimedia prompting is provided by an animated GIF and a SALT `prompt` object. The synthesis is estimated to take one second, therefore the SMIL `begin` attribute is set to start the synthesis 1 second before the animation. The prompting is contained in a SMIL `<par>` block, with the `endsync` attribute set to `all`. As a result, the following recognition object will not be activated until both the animation and prompt finish playing.

2) Multimodal activation of recognition or recording:

```
<input id="clickToTalk" type="button" />
<salt:listen t:begin="clickToTalk.onclick">
```

```
        ...
    </salt:listen>
```

In this example, an HTML button is used to start the `listen` object.

3 SALT CallControl object

This part specifies the SALT telephony call control object, which can be used in SALT profiles for the control of telephony functionality. (An alternative is to use the smex element with ECMA-323 messages, as described in 2.4.4.)

3.1 CallControl object definition

3.1.1 Requirements

1. An HTML document containing SALT markup must have the ability to provide access to telephony call control related functions, such as answering a call, transferring a call (bridged or unbridged), managing a call or disconnecting a call.
2. The specification must define a means to associate a telephony media stream with SALT media tags, such as tags for Speech Recognition, Recording, Speech Synthesis, and Audio Playback.
3. The call control related objects defined in the specification must provide a programming abstraction that is independent of the underlying call control signaling protocol.
4. The call control related tags and objects defined in the specification must be extensible. Different applications will have varying degrees of need for access to call control functionality from the simple (e.g., interactive voice dialog with a single caller) to the complex (e.g., full call center capability, or enhanced services by service providers). It should be possible for SALT documents to perform run-time query of extension availability to handle variances in the environment.
5. The call control object model specified here should follow an accepted industry standard, and be easy for programmers to use. This approach leverages a trained telephony developer community. This also provides a vision and guidelines for the upgrade path.
6. The call control object model specified here supports first party call control (third party call control is outside the scope of a Speech Recognition endpoint system).[21] The specified model should support both client and server call control requirements.

3.1.2 Solution Overview

The call control object will be specified as an intrinsic entity of the SALT-enhanced browser. Various call control interface implementations conformant with this specification may be "plugged in" by browser-specific configuration procedures and in that way be made accessible to SALT documents. SALT documents can query for the presence of these "plug-ins" at run-time.

The object shall appear in the DOM of the HTML document. The object will have various properties and methods that can be manipulated via ECMAScript code. Some of these methods will create derivative "child" objects, thereby instantiating an entire call control object hierarchy. The objects should also generate events. Event handlers may be written as ECMAScript functions.

The call control object model specification shall be derived from and modeled after the Java Call Processing API (JCP),[22] which is an open industry specification. The SALT call control specification will not necessarily follow those specifications to the letter, as much of those specifications deal with issues specific to the Java language, whereas the SALT call control specification will be adapted to the ECMAScript programming environment in HTML documents.

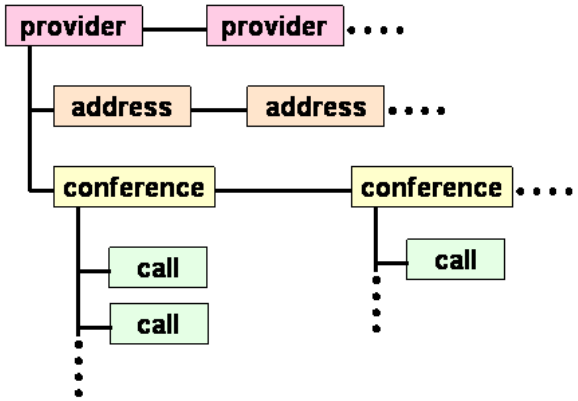
For call control use examples see section 3.2.

3.1.2.1 Call Control Object Hierarchy

The SALT call control objects comprise a hierarchy.

[21] A first-party call control system is one where the activating entity (the system executing the call control function) is also one of the parties of the conversation. This is the case with SALT documents, which participate in a dialog with a human. A third-party call control system is one where the activating entity is *not* one of the parties of the conversation, but is instead a "moderator" of the conversation. This is the typical case with a telephony switching element such as a softswitch, SIP proxy, etc. This specification addresses the former scenario and not the latter.

[22] To be explicit, this specification is an ECMAScript binding derived from the documents for JCP/JCC 1.0 (JSR 021) and selected portions of JTAPI 1.4 (JSR 034), which may be located on the World Wide Web at http://java.sun.com.



Although each of these objects is present, implementation of many of the features is optional. The **capabilities** property in 3.1.3.2.1 enumerates which of the features is implemented on the current platform. For example, even on a platform that does not support the conferencing feature, the **conference** object is still present, but it has at most one child **call** object.

At the very top of the hierarchy are one or more **window** objects within the browser. Each **window** object has a **document** object representing the loaded HTML page. The **document** object will have all the traditional subordinate objects as defined elsewhere (q.v., W3C HTML DOM at http://www.w3.org).

Each **window** contains a single **callControl** object giving a single point of abstraction for interface to the platform's call control functionality.

The **callControl** object contains one or more **provider** objects. Each **provider** allows access to a single telephony implementation.

Different telecommunication vendors can market **provider**s for different styles of telecommunication platforms, so long as they are conformant with this specification. For example, vendor "A" may market a SIP telephony **provider** for Voice over IP, while vendor "B" may market an ISDN telephony **provider** for a specific T1/E1 adaptor card.

The SALT call control interface is platform and protocol independent. It provides a common abstraction above many possible telephony platform implementations.
Which **provider**s are present on any given system is a platform browser configuration issue.

Each **provider** object provides telecommunications connectivity through one or more **address**es. In traditional telephone networks, an **address** is commonly known as a telephone number.

Providers also allow creation and management of **conference**s, which are logical groupings of **call**s.[23] **Conference**s may be created and terminated. **Call**s may be created and terminated, and also moved into or out of **conference**s. A **call** is commonly thought of as a "call leg".

Each **call** has media streams associated with it, known as channels. These media streams will typically be audio, but could also be video streams (for support of video conferencing) or text (for support of teletext or chat).

3.1.2.2 Browser Configuration of Call Control Providers

The method of instantiation of call control **provider**s inside the browser is a platform specific configuration issue.

All other call control objects are derived from the **provider** object programmatically using methods of call control objects. For example, you can use the `createConference()` method of a **provider** object resulting in a **conference** object. Likewise, you can use the `createCall()` method of a **conference** object resulting in a **call** object, and so on.

[23] Those of you intimately familiar with Java call control will notice that this specification is using the terms **conference** and **call** in place of **call** and **connection** objects, respectively. This is for alignment with the terminology used by the current draft of the Call Control XML (CCXML) document of the W3C Voice Browser Working Group.

The major exception is that incoming calls can result in **conference** and **call** objects being spontaneously created by the platform. Appropriate events will be generated informing the script of the creation of those objects, and the names of the newly created objects.

3.1.2.3 Call Control Event Handling

When the **browser** starts up and each **provider** object is "plugged in", the first event each **provider** throws is the "`provider.inService`" event.

An ECMAScript event handler to catch this event can be written as shown below.

```
<script language="JavaScript">
      callControl.provider[0].attachEvent("provider.inService", myProviderEventHandler);

      function myProviderEventHandler(event, object) {
            if (event == "provider.inService") {
                  // handle In-Service event here.
            }
      }
</script>
```

Any call control object can have a programmer-written ECMAScript event handler attached to it using the `attachEvent` method as illustrated above. The event handler may be dedicated to handling a single event, or multiple events may be attached to a single handler. The handler can discriminate between different arriving events by examining the `event` parameter passed to the handler. The handler can also tell what call control object threw the event by examining the `object` parameter.

If any call control object throws an event and it is not caught by a handler attached to the object throwing the event, then the event will "bubble" up to its parent object. The event will continue to "bubble" up the object hierarchy until it is either caught by an attached event handler, or until it ultimately reaches the **callControl** object, where it will be processed by a system-default event handler.

At a minimum, all events have a `srcElement` sub-property that refers to the object that generated an event. You can tell, for example, which **call** was disconnected when you get a `call.disconnected` event by examining `event.srcElement`.

Other properties of events depend on the individual event in question.

3.1.2.4 Lifetime of Objects

Objects such as **conference**s and **call**s do not spontaneously disappear. For example, a **call** object does not destroy itself just because of a call disconnect. The programmer must explicitly destroy the object when finished with it.

Objects are persistent regardless of how many **window**s are opened or closed. All the objects are accessible to any child **window** of a single **browser**. The objects are destroyed when the **browser** exits, however.

The programmer must typically create objects needed before using them. The only exceptions are as follows:

- A **conference** object and a **call** object are spontaneously created on an incoming call.
- The programmer has no control over what **address**es a **provider** offers; **address**es cannot be created or destroyed, they are essentially a platform provisioning issue.

3.1.2.5 Associating Media Streams with SALT Tags

Because each window is defined to have a single PromptQueue object (for audio output) and single active `listen` and/or `dtmf` object (for audio input), the SALT browser implementation will connect the audio input or output to telephony streams as it deems appropriate.

Each telephony media stream is represented by a channel. Each **call** object typically has two channels: `channel[0]` for audio output, and `channel[1]` for audio input. Each **conference** object also has a `channel[0]` whose audio is "split out" to each child **call** of the **conference**, and a `channel[1]` comprised of the mixed input audio of all child **call**s of a **conference**.

The programmer has some control over which specific audio input channel and/or audio output channel are in use. See the description of `mediaSrc` and `mediaDest` properties in the **callControl** object section below.

Note: Any SALT document that needs to process more than one input stream or output stream concurrently will require the use of multiple windows. The implications of multi-window browsing are still under consideration.

3.1.2.5.1 Associating Telephone Call Disconnect with SALT Tags

When an active telephone call that has associated media streams disconnects (either by the remote end hanging up, or by the local end executing the `disconnect()` method), the platform will cause the following actions to occur:

- Any active speech objects in the **window** will be made inactive by having its `Stop()` method invoked, in this order:
  - All active **<listen>** objects
  - All active **<dtmf>** objects
  - In profiles where the **PromptQueue** is supported, the **PromptQueue** object
  - In profiles where the PromptQueue is not supported, playback of **<prompts>** will be stopped.
- A `call.disconnected` event will be thrown by the **call** object upon which the disconnect occurred. This event will invoke any attached ECMAScript handlers on that **call** object, or on any ancestor object in the DOM if the event bubbles up through the DOM (bubbling is the default behavior unless overridden).

3.1.2.6 Support for a Call Distributor

A Call Distributor is an application program that waits for incoming calls and then dispatches sub-programs to service them. In VoiceXML platforms, the Call Distributor behavior is either provided by (i) the platform vendor and inaccessible to the programmer, or (ii) CCXML scripts may be used to program the same functionality.

SALT provides a method of the **callControl** object named `spawn()` to assist the coding of a Call Distributor in ECMAScript. Programmers may use this facility if they wish, but they are not required to do so.

The following steps are suggested to implement a Call Distributor behavior:

- Code a SALT document to act as the parent **window** that waits for incoming calls, and another SALT document to act as the child **window** to process the call.
- Upon receipt of an incoming call indication (`conference.created` and `call.created` events), the `callControl.spawn()` method may be invoked with an HTML document URL (the child SALT document) as a parameter, and the object ID of the new **conference**.
- The parent **window** will "donate" the **conference** object (and its children) to the child **window**. The object will be deleted from the DOM of the parent **window**, and appear in the DOM of the child **window**. The parent document can go back to listening for more incoming calls. Note that the "donated" **conference** is *not* destroyed; it is merely re-parented from one DOM to another.
- The child document will receive the incoming call indication (`conference.created` and `call.created` events), as if the call had come into the child window in the first place. ECMAScript code in the child document can now process the call.
- The child **window** may terminate itself by calling the `window.close()` method.

3.1.3 Call Control Object Dictionary

The descriptions of object properties below contain abbreviations "R/O" for Read Only and "R/W" for Read / Write. "Read Only" properties can only be examined, not set. "Read / Write" properties may be examined and/or set.

3.1.3.1 Events

All events have at least the following properties, and may have more, depending upon the particular event in question.

3.1.3.1.1 Properties

- `cause` – R/O – the reason the event was thrown.
- `srcElement` – R/O – reference to the object that threw the event.

3.1.3.2 callControl Object

The **callControl** object is the top-level browser object for call control interface. It is a child of each **window** object.

3.1.3.2.1 Properties

- `capabilities` – R/O – an XML `documentElement` listing the functionality supported by the call control implementation. Scripts can use XML DOM methods, e.g., `selectNodes()`, to discover what capabilities are supported before trying to use them. An implementation that conforms fully to this specification may minimally supply a string value of `<conformance version="X.Y" />` where `X.Y` is the version number of the SALT specification (e.g., "`1.0`"). If the implementation deviates by subsetting features (e.g., not supporting conferencing) or by extending features (e.g., by adding call center methods to the **call** object), then this string must represent a valid XML document with all the referred namespaces fully decorated and their schemas publicly discoverable.
- `id` – R/O – symbolic globally unique id of this object assigned by the platform (URN format).
- `mediaDest` – R/W – controls where audio output, i.e. the output from the **PromptQueue**, is heard. If null, output is sent to the device's speaker (or is lost if there is no speaker). If it contains a reference to the output channel of a **conference**, the audio is heard by all calls in the conference. If it contains the output channel of a call object, the output is sent to and only heard by the specific **call** referenced, (such a scenario is sometimes referred to as "whisper", in which only one conference participant hears the message). If `mediaDest` is null and a **conference** is created, `mediaDest` is automatically set to that **conference** object's `channel[0]`. If `mediaDest` refers to a **conference** that is destroyed, `mediaDest` is automatically set to null. If a prompt is playing while `mediaDest` changes, the precise timing of when the actual audio switchover takes place is platform-specific. For example, platforms may implement the switchover immediately, at the end of the current prompt, or at the end of all queued prompts. However, the switchover is guaranteed to take place prior to playing a subsequent prompt once the **PromptQueue** is empty or is stopped.
- `mediaSrc` – R/W – controls where audio input is sourced for **<listen>** objects (speech recognition and/or audio recording). If null, input is received from the device's microphone. If it contains a reference to the input channel of a **conference** object, input is received from a mixture of all of the **call**s in the **conference**. If it contains a reference to the input channel of a **call** object, input is received from only the specific **call** referenced. If `mediaSrc` is null and a **conference** is created, `mediaSrc` is automatically set to that **conference** object. If `mediaSrc` refers to a **conference** that is destroyed, `mediaSrc` is automatically set to null. If a **<listen>** is in progress while `mediaSrc` changes, the precise timing of when the actual audio switchover takes place is platform-specific. For example, platforms may implement the switchover immediately, at the end of the current **<listen>**. However, the switchover is guaranteed to take place prior to beginning a subsequent **<listen>** operation.
- `provider`[] – R/O -- array of **provider**s configured into the system and accessible through the **browser**.
- `provider.length` – R/O -- number of **provider**s configured into the system

3.1.3.2.2 Methods

- `spawn(`*uri, [conf]*`)` -- create a new **window** object using the URI parameter as the start document, and begin a new sandboxed thread of execution. The new **window** will have its own **callControl** object. If the optional *conf* parameter is specified, it refers to a **conference** object that the parent **window** will donate to the new child **window**. The child **window** will receive a `conference.created` event for the **conference** and a `call.created` event for each **call** object that is a child of the **conference** object being donated. The donated **conference** and its child objects will be deleted from the DOM of the donating parent **window**. This is how a parent **window** can "hand off" a **conference** and/or **call** to a child **window** for processing. Scripts in the child **window** can be written with the belief that the events represent one or more incoming calls.

3.1.3.2.3 Events

The **callControl** object does not throw any events; however, it is usually useful to attach an event handler to this object to catch events that bubble up from lower-level objects in the hierarchy.

3.1.3.3 Provider Object

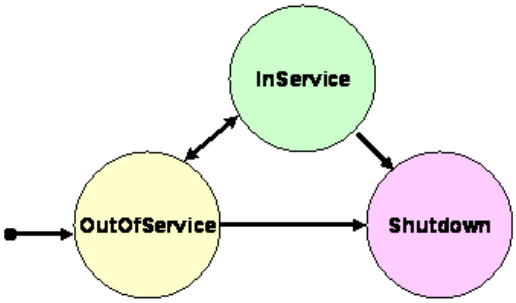
A **provider** represents an abstracted interface to an implementation of a telephony protocol stack; it is the SALT document's "window" into the telephony platform.

Example **provider**s can include SS7-ISUP, ISDN, POTS, SIP, and H.323. Vendors may choose to develop one or more of these as separate **provider**s, or a single (multi-protocol) **provider** giving an abstracted view of one or more of these.

The **provider** object(s) visible to a SALT document are *instances* of interfaces to the platform's implementation, and when any SALT document manipulates it's own provider instance, it does *not* affect the instances of any other running SALT document (i.e., it is a misconception that invoking the `shutdown()` method will shutdown the provider for the entire system).

The methods, properties, and events of **provider** objects and all derivative call control objects are themselves protocol and implementation independent.

3.1.3.3.1 State Machine



The **provider** object state machine has three states:

- `InService` – This state indicates that the **provider** is currently alive and available for use.
- `OutOfService` -- This state indicates that a **provider** is temporarily not available for use. Many methods in this API are invalid when the **provider** is in this state. **Provider**s may come back in service at any time (due to system provisioning by the administrator); however, the application can take no direct action to cause this change.
- `Shutdown` -- This state indicates that a **provider** is permanently no longer available for use by this SALT document. Most methods in the API are invalid when the **provider** is in this state. Applications may use the `shutdown()` method on this interface to cause a **provider** to move into the `Shutdown` state.

3.1.3.3.2 Properties

- `address`[] – R/O -- array of **address**es hosted by the **provider**.
- `address.length` – R/O -- number of listenable **address**es hosted by the **provider**.
- `conference`[] – R/O -- array of **conference**s.
- `conference.length` – R/O -- number of child **conference**s currently in existence.
- `id` – R/O – symbolic globally unique id of this object assigned by the platform (URN format).
- `parent` – R/O – the object id of the **callControl** object the **provider** instance is within.
- `state` – R/O -- the current state of the **provider** object's finite state machine. String value, see section "*State Machine*" above.

3.1.3.3.3 Methods

- `createConference` – create a child **conference** object.
- `shutdown` – completely shut down the **provider** (this **provider** instance of a given **window** cannot be restarted). This function performs object memory cleanup in a typical implementation. Some platforms may not need to implement the `shutdown()` function, in which case it silently ignores such calls made by scripts.

3.1.3.3.4 Events

- `provider.inService` -- the **provider** is available for use by the script.
- `provider.outOfService` -- the **provider** is unavailable.
- `provider.shutdown` -- the **provider** has been shut down.

3.1.3.4 Address Object

An **address** is a connectable endpoint. In order to receive incoming calls, you must listen on a particular **address**.

In a traditional Public Switched Telephone Network (PSTN) environment, **address**es are known as "telephone numbers". They are represented in RFC 2806 compliant URL format, e.g., "`tel:+1-888-555-1212`".

In Voice over IP (VoIP) environments, **address**es are represented as SIP URLs (q.v., RFC 2543) appearing typically like electronic mail addresses (e.g., "`sip:fred@flintstone.com`") or as H.323 URLs (q.v., RFC 2000) which may appear as electronic mail addresses, simple IP addresses, or free-form gatekeeper aliases (e.g., "`h323:barney@rubble.org`", "`h323:134.128.1.10`", or "`h323:arbitrary-alias`").[24]

How an application registers one or more **address**es with a directory service in order to receive incoming calls is beyond the scope of this specification.

Note that applications never explicitly create new **address** objects. Which **address**es are available for use is a **provider** provisioning/configuration issue.

3.1.3.4.1 State Machine

The **address** object has no associated state machine.

3.1.3.4.2 Properties

- `id` – R/O – symbolic globally unique id of this object assigned by the platform (URN format).
- `parent` – R/O -- id of the **provider** this **address** is a member of.
- `state` – R/O -- the current "listen" state of the **address** object. String value, either "`Listening`" or "`Idle`".
- `uri` – R/O -- URI of the **address**. Must be an RFC 2806 URI, a SIP URI, or an H.323 URI.

3.1.3.4.3 Methods

- `listen(`*state, [answer]*`)` – begin listening for incoming calls on this **address** (*state* is `True`) or stop listening (*state* is `False`). This function allows the programmer to have control over exactly which **address**es may receive incoming calls, which is useful on platforms (especially servers) that have multiple **address**es. Some implementations may choose to automatically listen by default, in which case an explicit call to `listen()` is not necessary. The optional parameter *answer* is a boolean indicating whether incoming **call**s are automatically accepted (value `True`, the default) so that explicit invocations of `accept()` are not required; or whether incoming **call**s must be explicitly accepted or rejected (value False) in order to leave the `Alerting` state. Note that if you call `listen(True)`, the address will continue listening until you call `listen(False)`, i.e., the listen state is not automatically reset when an incoming call occurs.

3.1.3.4.4 Events

The **address** object throws no events. Incoming calls will generate `conference.created` and `call.created` events.

3.1.3.5 Conference Object

A **conference** is a logical grouping of **call**s that can share their media streams.

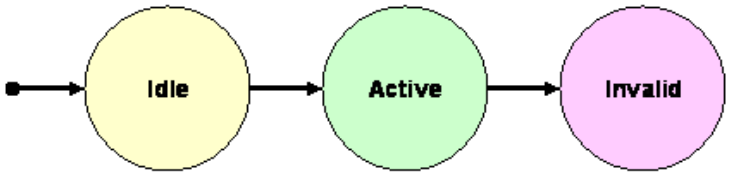
[24] The "`callto:`" URI namespace as used in Microsoft NetMeeting was never formally registered with the IETF and is deprecated by RFC 2806.

Every **call** must be created as a member of some **conference**, even if it is in a **conference** all by itself. For example, a voicemail application would typically use a **conference** object with only one **call**: the person who called in to leave or retrieve messages.

When more than one **call** is a child of the same **conference** object, these **call**s become "conferenced together".

Conference objects are only good for one "lifetime". When the last **call** leaves a **conference**, the **conference** enters the `Invalid` state. No new **call**s can enter an `Invalid` **conference**. Properties may be examined, and then the **conference** can be destroyed, and a new one created if needed.

3.1.3.5.1 State Machine



The **conference** object state machine has three states:

- `Active` – A **conference** with some current ongoing activity is in this state. **Conference**s with one or more associated **call**s must be in this state.
- `Idle` -- This is the initial state for all **conference**s, immediately after creation. In this state, the conference has zero **call**s.
- `Invalid` -- This is the final state for all **conference**s. **Conference** objects which lose all of their **call** objects (via a transition of the last **call** object into the `Disconnected` state) moves into this state. **Conference**s in this state have zero **call**s and these **conference** objects may not be used for any future action.

3.1.3.5.2 Properties

- `call[]` – R/O -- array of the **call**s in the **conference**.
- `call.length` – R/O -- number of active **call**s in the **conference**.
- `channel[]` – R/W – channels of the **conference**'s media mixer … channel[0] is the audio output channel which can be used as a `mediaDest` for **`<prompt>`** tags, allowing beeps or intrusion messages to be played into conferences (e.g., "the conference will end in five minutes") … channel[1] is the audio input channel which can be used as a `mediaSrc` for recording, so that you can record the entire conference.
- `channel.length` – R/O – number of channels of the **conference**.
- `id` – R/O – symbolic globally unique id of this object assigned by the platform (URN format).
- `parent` – R/O -- id of the **provider** this **conference** is a member of.
- `state` – R/O -- the current state of the **conference** object's finite state machine. String value, see section "*State Machine*" above.

3.1.3.5.3 Methods

- `createCall()` – create a **call** as a member of this **conference**.
- `destroy()` – destroy the **conference** object. If a **conference** is in the `Active` state at the time it is destroyed, the following sequence will occur:
    - All connected child **call**s are disconnected, resulting in `call.disconnected` events being thrown. See section 3.1.2.5.1 for a list and order of actions that occur in response to a disconnect.
    - All child **call** objects are destroyed.
    - A `conference.invalid` event is thrown, and then the **conference** object is destroyed.
    - The **document** script will now get a chance to respond to the pending events. Note that this implies that the `call.disconnected` event handler will not be able to query the state of the **call** object because it

has already been destroyed. If this behavior is not desired, then the connected **call**s should be individually disconnected before destroying the parent **conference**.

Also note that the **conference** object will be automatically destroyed if its parent **provider** is shutdown.

3.1.3.5.4 Events

- `conference.active` -- the first **call** has joined the **conference**.
- `conference.created` – the **conference** has been created.
- `conference.invalid` -- the last **call** has left the **conference**.

3.1.3.6 Call Object

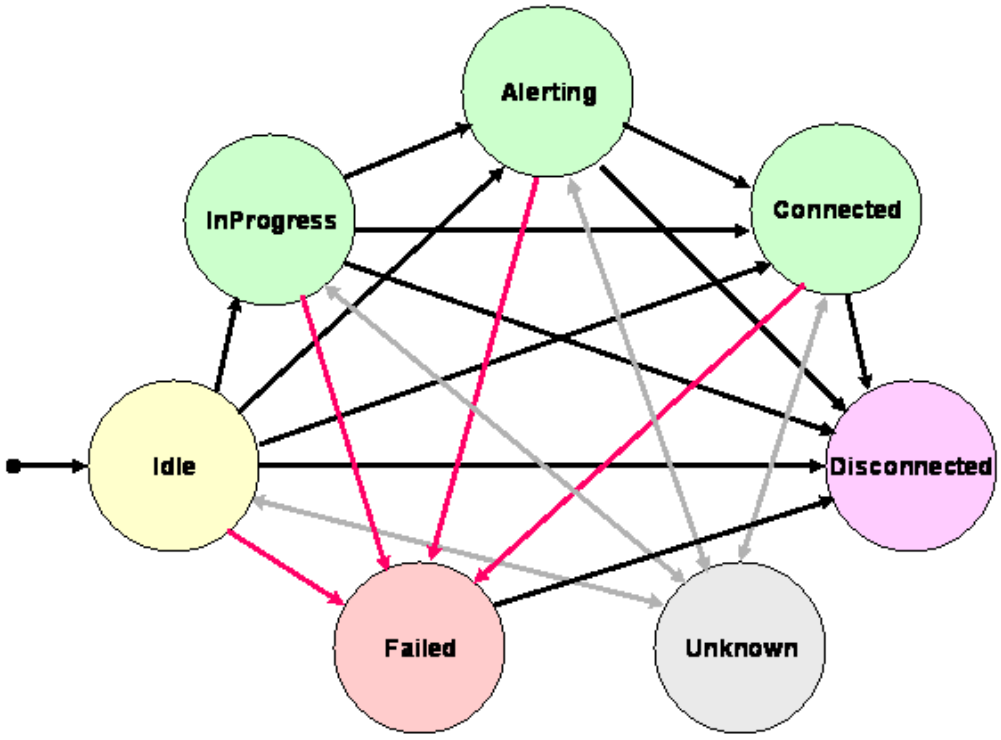
A **call** is a connection between an external endpoint **address** and an endpoint **address** on the platform.

A **call** can be created in order to place an outgoing call, or may be created as a result of an incoming call.

The external endpoint **address** is known as the `remote.uri` and the platform endpoint **address** is known as the `local.uri`. They retain these relationships regardless of whether the call was incoming or outgoing (unlike ANI and DNIS who switch senses depending upon the direction of the call).

For **call**s that have at least one audio output channel and at least one audio input channel, the primary audio output channel is channel[0] and the primary audio input channel is channel[1]. The direction is with respect to the platform upon which SALT is executing.

3.1.3.6.1 State Machine



The **call** object state machine has seven states:

- `Alerting` -- This state implies notification of an incoming call.
- `Connected` -- This state implies that a **call** is actively part of a telephone call. In common terms, two people talking to one another are represented by two **call**s of a single **conference** in the `Connected` state. A person interacting with a dialog script only requires a single **call**.

- `Disconnected` -- This state implies the **call** is no longer part of an active telephone call. A **call** in this state is interpreted as once previously belonging to this telephone call.
- `Failed` -- This state indicates that a **call** has failed for some reason. One reason why a **call** would be in the `Failed` state is because the destination party of an outgoing call was busy.
- `Idle` -- This state is the initial state for all new **call**s. **Call**s which are in the `Idle` state are not actively part of a telephone call. **Call**s typically do not stay in the `Idle` state for long, quickly transitioning to other states.
- `InProgress` -- This state implies that the **call** object has been contacted by the origination side or is contacting the destination side. The contact happens as a result of the underlying protocol messages. Under certain circumstances, the **call** may not progress beyond this state. Extension packages elaborate further on this state in various situations.
- `Unknown` – This state implies that the implementation is unable to determine the current state of the **call** (perhaps due to limitations or latency in underlying signaling). Typically, methods are invalid on **call**s that are in this state. **Call**s may move in and out of the `Unknown` state at any time.

3.1.3.6.2 Properties

- `channel[]` – R/O -- array of the channels of the **call**; channel[0] is the audio output channel which can be used as a `mediaDest` for **<prompt>** tags, allowing beeps or messages to be played into calls … channel[1] is the audio input channel which can be used as a `mediaSrc` for recording, so that you can record the entire call.
- `channel.length` – R/O -- number of active channels of the **call**.
- `id` – R/O – symbolic globally unique id of this object assigned by the platform (URN format).
- `local.pi` – R/O – presentation indicator, set as a result of specifying *pi* in the `connect()` method. See acceptable values in the table in a section below.
- `local.si` – R/O -- screening indicator, set as a result of specifying *si* in the `connect()` method. See acceptable values in the table in a section below.
- `local.uri` – R/W -- URI of the local **address** endpoint of the **call**; for incoming calls, this is equivalent to (and may be mapped from) DNIS. The ability to programmatically change `local.uri` on outgoing calls is **provider** implementation dependent. This field is in RFC 2806 format.
- `parent` – R/O -- id of the **conference** this **call** is a member of.
- `redirect[]` – R/O – array of redirections of the **call** (e.g., occurrences of the call being forwarded)
- `redirect.length` – R/O – length of the `redirect[]` array, i.e., the number of entries.
- `redirect[].reason` – R/O – reasons for each of the redirections.
- `redirect[].uri` – R/O – URI(s) of the intermediate **address**(es) that redirected the **call** (e.g., call forwarded); for incoming calls, this is equivalent to (and may be mapped from) RNE. The order of redirect entries is from least recent to most recent: `redirect[0].uri` is the first number that call was redirected from, and `redirect[redirect.length - 1].uri` is the last.
- `remote.pi` – R/O – presentation indicator of the remote phone, set as a result of an incoming call or connection of an outgoing call by the `connect()` method. See acceptable values in the table in a section below.
- `remote.si` – R/O -- screening indicator of the remote phone, set as a result of an incoming call or connection of an outgoing call by the `connect()` method. See acceptable values in the table in a section below.
- `remote.uri` – R/O -- URI of the remote **address** endpoint of the **call**; for incoming calls, this is equivalent to (and may be mapped from) ANI. This field is in RFC 2806 format.
- `state` – R/O -- the current state of the **call** object's finite state machine. String value, see section "*State Machine*" above.

3.1.3.6.3 Methods

- `accept()` – answer an `Alerting` **call** (in response to receiving a `call.alerting` event), moving it to the `Connected` state. Accepting a call will cause a `call.connected` event.

- `connect(`*uri, [pi, si]*`)` – place an outbound call on a **call**. This is only valid if the **call** is in the `Idle` state. The URI parameter is in RFC 2806 format.[25] The presentation indicator *pi* and the screening indicator *si* are optional parameters that may be used to control permissions for how caller ID information will be displayed, if the call control implementation supports such functionality. See acceptable values in the table in a section below.
- `destroy()` – destroy the **call** object. If the **call** was connected at the time it is destroyed, it will be disconnected first. The **call** object will be automatically destroyed if any of its ancestor objects in the DOM are destroyed. See section 3.1.2.5.1 for a list and order of actions that occur in response to a disconnect.
- `disconnect()` -- hang up on a **call**. See section 3.1.2.5.1 for a list and order of actions that occur in response to a disconnect.
- `join(`*conference*`)` -- remove call from existing parent **conference** object and add **call** to this **conference** object.
- `reject(`*[reason]*`)` – reject an `Alerting` call (in response to receiving a `call.alerting` event), moving it to the `Disconnected` state. Rejecting a call will cause a `call.disconnected` event. The optional reason parameter is a character string describing the reason the call was rejected, it may be one of the following: `busyOverflow`, `queueTimeOverflow`, `capacityOverfow`, `calendarOverflow`, `unKnownOverflow`. See section 3.1.2.5.1 for a list and order of actions that occur in response to a disconnect.
- `transfer(`*uri, [bridge, pi, si]*`)` -- transfer a **call** from its current endpoint (the telephony platform) to some other destination specified by the URI parameter. The optional *bridge* parameter is a request that the platform perform a "trombone" transfer (when `True`) or a "release trunk" transfer (when `False`). In a "trombone" transfer, the SALT browser remains a party to the call, a new **call** object is added to the **conference** object and a `call.connected` event occurs when the third-party answers. In a "release trunk" transfer, the SALT browser is disconnected from the call and receives a `call.disconnected` event. The default value is `False`. The presentation indicator *pi* and the screening indicator *si* are optional parameters that may be used to control permissions for how caller ID information will be displayed, if the call control implementation supports such functionality. See acceptable values in the table in a section below.

3.1.3.6.4 Values for Presentation Indicator and Screening Indicator

- Presentation Indicator *pi*: An indicator whether the URI and name fields are allowed to be presented (if available) to the user. This field is optional; if not supported, value is undefined. If supported, the default value is `presentation-allowed`.

Value	***Description***
`presentation-allowed`	Display URI and name.
`presentation-restricted`	Do not display URI and name: show "private".
`number-lost-due-to-interworking`	Information not available for display: show "unknown" or "out of area".
`reserved-value`	Implementation specific.

- Screening Indicator *si*: An indicator of which party or network element has set and/or verified the URI and name fields. This field is optional; if not supported, value is undefined. If supported, the default value is `user-provided-unscreened`.

Value	***Description***
`user-provided-unscreened`	The application set URI and name, and has not screened it.
`user-provided-passed`	The application set URI and name, has screened it, and it passed screening.
`user-provided-screening-failed`	The application set URI and name, has screened it, and it failed screening.
`network-provided`	The network set URI and name.

3.1.3.6.5 Events

[25] Please consult the RFC 2806 document for format details. RFC 2806 contains a very rich syntax, including such things as wait-for-dialtone and calling-card DTMF sending for the "`tel:`" URI, as well as modem dialing strings for the "`modem:`" URI.

- `call.alerting` -- an incoming call is "ringing".
- `call.connected` -- the call has been answered and connected to both local and remote endpoints; for outgoing calls this event may have a `type` property indicating the type of device that answered (e.g., `voice`, `fax`, `modem`).
- `call.created` -- the **call** object was created, either it is an incoming call, or the script explicitly used the `createCall()` method of a **conference** object.
- `call.disconnected` -- the **call** has been disconnected, either by the remote end, or by the near end using the `disconnect()` method; this event will have a `cause` property indicating the disconnect reason and a properties for the call start time and call end time for billing purposes.
- `call.failed` -- the **call** has experienced an unexpected failure, or the method could not be performed, e.g., an outgoing call attempt could not connect; this event will have a `cause` property indicating the failure reason.
- `call.inProgress` -- an outbound call is in the process of connecting to the remote end.
- `call.unknown` – the **call** is in an unknown state.

The `cause` property may be one of the following: `normal`, `unknown`, `busy`, `callCancelled`, `destNotObtainable`, `incompatibleDestination`, `lockout`, `resourceNotAvailable`, `networkCongestion`, or `networkNotObtainable`.

3.2 SALT CallControl illustrative examples

3.2.1 Cooperative call control libraries

The `CallControl` object can be implemented natively, or it can be implemented as a scripting library that, for example, uses a messaging layer to access underlying call control engines such as ECMA 323 or CCXML. In both cases, applications should use the `CallControl` object interface directly, and thereby allow interoperability of the application on a wide variety of platforms. Direct use of `smex` for call control is not necessary in these cases. Where a platform implements additional proprietary features beyond the `CallControl` object, this should be done by extending the scripting library.

3.2.1.1 CCXML

This example shows how a library script can use CCXML to answer a telephone call, launch a SALT document, and then handle `disconnect` or `transfer` requests from the SALT document[26]. This example does not preclude the CCXML interpreter process from running on the same system as the SALT browser or on a different system in a distributed fashion.

The platform supplies the call control library script and corresponding CCXML script. The SALT application programmer is therefore only responsible for supplying the SALT code. For example:

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>call control example using CCXML library</title>
</head>
<script language="JavaScript" src="http://vendor/saltcc.js"></script>
<script language="JavaScript">
      var caller;
      callControl.attachEvent("call.connected", procConnected);
      callControl.attachEvent("call.disconnected", window.close);
function procConnected(event) { //incoming call
      caller = event.srcElement;
      query_action.Start();
      get_action.Start();
```

[26] Note that to date, the W3C has not selected a standard protocol for transmitting event messages or even the format of event messages like shown here. The Multimodal Working Group (MMWG) may in the future recommend a mechanism and format for passing XML Events (q.v., http://www.w3.org). The SOAP specification is one likely contender for this mechanism. Assuming that the message format is XML-based (likely), the `bind` tag may be used inside `smex` to parse the return message from CCXML.

```
}
function handleAction() {
      if (action.value == 'disconnect') {
            caller.disconnect();
            window.close();
      } elseif (action.value == 'transfer') {
            query_number.Start();
            get_number.Start();
      }
}
</script>
<body>
      <salt:prompt id="query_action">
            Do you want to disconnect or transfer?
      </salt:prompt>
      Action: <input name="action" type="text" value="disconnect" />
      <salt:listen id="get_action" onreco="javascript:handleAction();">
            <salt:grammar>
                  <!--
                        grammar enables "disconnect | transfer" as input
                        and returns this value in "ACTION" node
                  -->
            </salt:grammar>
            <bind targetelement="action" value="//ACTION" />
      </salt:listen>
      <salt:prompt id="query_number">
            What number do you want to transfer to?
      </salt:prompt>
      Telephone number: <input name="number" type="text" />
      <salt:listen id="get_number" onreco='javascript:caller.transfer("tel:" +
number.value);();'>
            <grammar src="./telephone_number.grxml" />
            <bind targetelement="number" value="//NUMBER" />
      </salt:listen>
      <salt:smex id="cc_socket" onreceive="javascript:cc_Receive();">
            <salt:param name="target">ccxml_server.mycompany.com:7777</salt:param>
            <salt:param name="protocol">SOAP</salt:param>
      </salt:smex>
</body>
</html>
```

Note that other than the declaration of the smex object and of the saltcc.js include script, the application is coded no differently than if the call control object was implemented natively by the platform.

The platform implementation supplies the call control library and corresponding CCXML scripts. For illustrative purposes, only a subset of the complete library and CCXML scripts is shown here. The saltcc.js library implements the call control object methods by calling smex, for example:

```
function cccalltransfer(uri) {
      var msg = '<event value="salt_request.transfer">';
            + '<phone_number value="' + number.value + '" />';
            + '</event>';
      cc_socket.sent = msg;
}

function cccalldisconnect(uri) {
      cc_socket.sent = '<event value="salt_request.disconnect" />';
}


function call(parent) {  // constructor
      this.parent = parent;
      call.prototype.transfer = cccalltransfer;
```

```
      call.prototype.disconnect = cccalldisconnect;
}

var cccaller;
function cc_Receive ( ) {
      var event;
      switch (cc_socket.received) {
            case 'salt_response.connected':
                        cccaller = new call();
                        event.srcElement = cccaller;
                        event.reason = "call.connected";
                        callControl.fire(event);
                        break;
            case 'salt_response.transferred':
                        event.srcElement = cccaller;
                        event.reason = "call.transferred";
                        callControl.fire(event);
                        break;
            case 'salt_response.disconnected':
                        event.srcElement = cccaller;
                        event.reason = "call.disconnected";
                        callControl.fire(event);
                        break;
}
```

The CCXML script handles CCXML events and handles smex messages, for example:

```
<?xml version="1.0"?>
<ccxml version="1.0">
      <authenticate server="radius.mycompany.com" userid="johnq" password="secret" />
      <var name="salt_sessionid" />
      <eventhandler>
            <transition event="call.CALL_CONNECTED">
                  <dialogstart src="mysession.html" type="text/html" />
            </transition>
            <transition event="dialog.started">
                  <assign name="salt_sessionid" expr="_event.sessionid" />
                  <send target="salt_sessionid" event="salt_response.connected" />
      </transition>
            <transition event="salt_request.disconnect">
                  <disconnect />
                  <send target="salt_sessionid" event="salt_response.disconnected" />
            </transition>
            <transition event="salt_request.transfer">
                  <transfer dest="_event.phone_number" />
                  <send target="salt_sessionid" event="salt_response.transferred" />
            </transition>
      </eventhandler>
</ccxml>
```

3.2.2 Call Control use case examples

3.2.2.1 Voicemail incoming call

In this example, a caller reaches the number of a network service provider based voice mail service. The service determines whether the caller is the voice mail subscriber or not, and performs the appropriate action.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>Voicemail incoming call</title>
<script type="text/javascript"><![CDATA[
      // Events conference.created and call.created will automatically
      // occur upon incoming calls.
```

```
      // With autoAnswer=True, the call will automatically
      // accept as well, causing call.connected.
      // Attach an event handler to catch the incoming call connected event.

      callControl.attachEvent("call.connected", procConnected);
      function procMailbox() {
            window.navigate("subscriber.asp?mailbox=" + recoMailbox.value);
      }
      function procConnected(event) {
            // call object that caused this event
            var caller = event.srcElement;
            if (0 == caller.redirect.length) {
                  // call dialed into voicemail system directly
                  // (was not forward-no-answer)
                  if (hasVoicemail(caller.remote.uri)) {
                        // subscriber called-in from own office phone,
                        // no need to ask for mailbox
                        window.navigate("subscriber.asp?mailbox="
                              + caller.remote.uri);
                  } else {
                        // subscriber called-in from another phone
                        askMailbox.start();
                        recoMailbox.start();
                  }
            } else {
                  // someone called subscriber, but got forward-no-answer,
                  // so now wants to leave a message
                  window.navigate("message.asp?mailbox="
                        + caller.redirect[caller.redirect.length-1].uri);
            }
      }
]]></script>
</head>
<body>
      <salt:prompt id="askMailbox">
            Welcome, please say your mailbox number.
      </salt:prompt>
      <salt:listen id="recoMailbox" onreco="javascript:procMailbox()">
            <salt:grammar src="./digits.grxml" />
      </salt:listen>
</body>
</html>
```

3.2.2.2 Notification call

In this example, a notification service dials an outbound call to a subscriber to notify him of a pending dentist appointment.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>Notification call</title>
<script type="text/javascript"><![CDATA[
      var callee, conf;
      function procOnLoad() {
            conf = callControl.provider[0].createConference();
            callee = conf.createCall();
            callee.attachEvent("call.connected", procConnected);
            callee.connect("tel:+1-415-555-1212");
      }
      function procConnected(event) {
            sayReminder.start();
      }
]]></script>
</head>
<body onLoad="javascript:procOnLoad()">
```

```
      <salt:prompt id="sayReminder" oncomplete="javascript:callee.disconnect()">
            Hello, this call is to remind you of your dentist appointment tomorrow.
Goodbye.
      </salt:prompt>
</body>
</html>
```

3.2.2.3 Notification call with Caller Line Identity set

This is an elaboration of the dentist appointment example, illustrating how to set the Caller ID that would appear on the subscriber's phone.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>Notification call with arbitrary CLI (calling line identity)</title>
<script type="text/javascript"><![CDATA[
      var callee, conf;
      function procOnLoad() {
            conf = callControl.provider[0].createConference();
            callee = conf.createCall();
            callee.attachEvent("call.connected", procConnected);
            callee.local.uri = "tel:+1-408-555-1212";
            callee.connect("tel:+1-415-555-1212");
      }
      function procConnected(event) {
            sayReminder.start();
      }
]]></script>
</head>
<body onLoad="javascript:procOnLoad()">
      <salt:prompt id="sayReminder" oncomplete="javascript:callee.disconnect()">
            Hello, this call is to remind you
            of your dentist appointment tomorrow. Goodbye.
      </salt:prompt>
</body>
</html>
```

3.2.2.4 Voice Activated Dialing

In this example, a subscriber calls a voice activated dialing service, speaks the number to dial, and the service places the call using network transfer facilities.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>Voice Activated Dialing - Intelligent Network Transfer</title>
<script type="text/javascript"><![CDATA[
      var caller;
      callControl.attachEvent("call.connected", procConnected);
      function procConnected(event) { //incoming call
            caller = event.srcElement;
            askPhoneNumber.start();
            recoPhoneNumber.start();
      }
      function procPhoneNumber() {
            caller.transfer("tel:" + recoPhoneNumber.value);
      }
]]></script>
</head>
<body>
      <salt:prompt id="askPhoneNumber">
            What phone number would you like to dial?
      </salt:prompt>
      <salt:listen id="recoPhoneNumber" onreco="javascript:procPhoneNumber()">
            <salt:grammar src="./phone.grxml" />
```

```
      </salt:listen>
</body>
</html>
```

3.2.2.5 Voice Activated Dialing with Active Listen

This is a slightly different example of voice activated dialing. The subscriber calls the service, speaks the number to dial, and is connected using a "trombone" (or "hairpin") of the two call legs in a single conference.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>Voice Activated Dialing - Trombone Conference with Active Listen</title>
<script type="text/javascript"><![CDATA[
      var caller, callee;
      callControl.attachEvent("call.connected", procConnected);
      function procConnected(event) { //incoming call
            caller = event.srcElement;
            askPhoneNumber.start();
            recoPhoneNumber.start();
      }
      function procPhoneNumber() {
            callee = caller.parent.createCall();
            callee.attachEvent("call.connected", calleeConnected);
            askHangup.start();
            callee.connect(recoPhoneNumber.value);
            recoHangup.start();
            dtmfPoundPound.start();
      }
      function calleeConnected(event) { //outgoing call connected
            // note that incoming & outgoing calls now conferenced.
      }
      function procHangup(callee) { // request to hangup on callee
            // allow caller to place another call
            callee.disconnect();
            askPhoneNumber.start();
            recoPhoneNumber.start();
      }
]]></script>
</head>
<body>
      <salt:prompt id="askPhoneNumber">
            What phone number would you like to dial?
      </salt:prompt>
      <salt:listen id="recoPhoneNumber" onreco="javascript:procPhoneNumber()">
            <salt:grammar src="./phone.grxml" />
      </salt:listen>
      <salt:prompt id="askHangup">
            I am now placing the call. To hang-up, say 'Please hang up now'.
      </salt:prompt>
      <salt:listen id="recoHangup" onreco="javascript:procHangup(callee)">
            <salt:grammar src="./hangup.grxml" />
      </salt:listen>
      <salt:dtmf id="dtmfPoundPound" onreco="javascript:procHangup(callee)">
            <salt:grammar>
                  <!-- grammar enabling "##" as input  -->
            </salt:grammar>
      </salt:dtmf>
</body>
</html>
```

3.2.2.6 Find Me

This is more elaborate example of the "trombone" scenario above. An arbitrary caller dials a subscriber, the service attempts to contact three locations the subscriber might be at using parallel dialing. When the subscriber answers one of the three lines, he is connected to the caller using a "trombone" conference, and the other two lines are disconnected.

```
<html xmlns:salt="http://www.saltforum.org/2002/SALT">
<head>
<title>Find Me - Simultaneously Dial Several Numbers</title>
<script type="text/javascript"><![CDATA[
      var caller, callee[3], answerer;
      var phoneNumber[3];
      phoneNumber[0] = "tel:+1-408-555-1212";
      phoneNumber[1] = "tel:+1-415-555-1212";
      phoneNumber[2] = "tel:+1-925-555-1212";
      var timeoutID;
      callControl.attachEvent("call.connected", procCallerConnected);
      function procCallerConnected(event) { //incoming call
            caller = event.srcElement;
            caller.attachEvent("call.disconnected", procCallerDisconnected);
            askPleaseWait.start();
            // abort if no answer within 60 seconds
            timeoutID = setTimeout(procTimeout, 60000);
            for (var i = 0; i < phoneNumber.length; i++) {
                  var conf = callControl.createConference();
                  callee[i] = conf.createCall();
                  callee[i].attachEvent("call.connected", procCalleeConnected);
                  callee[i].connect(phoneNumber[i]);
            }
      }
      function procCalleeConnected(event) { // got a callee to answer
            answerer = event.srcElement;
            callControl.mediaDest = event.srcElement.channel[0];
            callControl.mediaSrc = event.srcElement.channel[1];
            askTakeCall.start();
            recoTakeCall.start();
      }
      function procTakeCall() {
            callControl.mediaDest = caller.parent.channel[0];
            callControl.mediaSrc = caller.parent.channel[1];
            if (recoTakeCall.value == "yes") {
                  clearTimeout(timeoutID);
                  // disconnect all other outgoing calls
                  for (var i = 0; i < phoneNumber.length; i++) {
                        if (answerer != callee[i]) {
                              callee[i].parent.destroy();
                        }
                  }
            }
            var conference = answerer.parent;
            answerer.join(caller.parent); // join outgoing call to incoming
                                          // call's conference
            conference.destroy(); // destroy the now empty outgoing conference
      }
      function procTimeout()  {
            promptQueue.stop();
            callControl.mediaDest = caller.channel[0];
            // disconnect all outgoing calls
            for (var i = 0; i < phoneNumber.length; i++) {
                  callee[i].parent.destroy();
            }
            sayNotAvailable.start();
      }
]]></script>
```

```
</head>
<body>
      <salt:prompt id="askPleaseWait">
            Please hold while I attempt to reach him.
      </salt:prompt>
      <salt:prompt id="askTakeCall">
            Someone is trying to reach you, do you want to take the call?
      </salt:prompt>
      <salt:listen id="recoTakeCall" onreco="javascript:procTakeCall()">
            <salt:grammar src="./yesno.grxml" />
      </salt:listen>
      <salt:prompt id="sayNotAvailable" oncomplete="javascript:caller.disconnect()">
            Sorry, he is not available. Goodbye.
      </salt:prompt>
</body>
</html>
```

4 SALT conformance

This section specifies the conformance criteria for SALT browsers in rendering a SALT document. The SALT modules referenced in this chapter are defined in section 2.8.1.

In this section, uses of the words 'must', 'should' and 'may' are to be interpreted as "MUST" (REQUIRED), "SHOULD" (RECOMMENDED) and "MAY" (OPTIONAL), respectively, as defined in IETF RFC 2119 (http://www.ietf.org/rfc/rfc2119.txt).

Generally speaking, SALT browsers should conform to any interoperability criteria required by the hosting environment. For example:

- SALT platforms should support openly specified Internet application-level protocols, e.g. HTTP 1.1 (IETF RFC 2616), for retrieval of XML or HTML documents containing SALT markup.
- SALT platforms which support the Basic Media Playback module or the Recording module must support ITU G.711 audio encoding (as noted in sections 2.1.1.3 and 2.2.8.1.1, respectively) and may support other standard audio encodings.
- SALT platforms which support the Basic Media Playback module or the Recording module should support audio/basic (IETF RFC 1341), or audio/wav media types for playback and/or recording of audio content, and openly specified Internet protocols for audio transmittal.
- SALT platforms which support the Basic Media Playback module or the Recording module may support RTSP (IETF RFC 2326) and RTP (IETF RFC1889), if streaming audio playback or recording.
- SALT platforms which support telephony interfaces should support openly specified telephony signaling and media transport protocols, such as standards published by IETF, ITU, ECMA or other organizations.
- SALT platforms which support remote speech synthesis and recognition services should support openly specified standard protocols for remote speech services such as standards published by IETF, W3C, ETSI or other organizations.

4.1 Portable extensibility

A SALT compliant browser must allow standardized extensibility in XML and make publicly discoverable (1) all the namespaces it natively recognizes, and (2) the policy of processing a non-natively recognized namespace, which may range from as simple as ignoring the namespace to as sophisticated as publishing the UDDI providers the browser will use to obtain a list of Web services that can potentially resolve the namespace. A SALT application must be able to ascertain whether a compliant SALT browser can render XML extensions in a SALT document, or the extensions must be translated before a SALT document is served to the browser.

A SALT compliant browser must recognize the namespaces for W3C speech recognition grammar (SRGS) and speech synthesis markup language (SSML) for inline grammar and synthesis markups once they reach W3C Recommendation status. In addition, it is recommended that SALT browsers recognize the specifications for W3C Semantic Interpretation for Speech Recognition specification once it reaches Recommendation.

4.2 Browser types

Within the SALT namespace, the compliance criteria are based on the modularization described above, and can be summarized in the following table where M stands for Mandatory, O for Optional, and N/A for not applicable[27]. A SALT browser must specify which category (column) it claims compliance. A browser claiming compliance to a particular category must support all the mandatory modules for the category, and within each module, all the behavior required in the module definition (section 2.8.1) must be implemented.

For modules which are optional, browsers which implement functionality similar to the functionality provided in the optional module are strongly encouraged to support such functionality exactly according to the module definition, that is to support the SALT module rather than proprietary methods, in order to allow greater portability of applications.

	Smart Clients w/o Scripting	Smart Clients w/Scripting	Rich Clients	Telephony Servers

[27] "Mandatory" and "Optional" should be interpreted as equivalent to "REQUIRED" and "OPTIONAL", respectively, as defined in IETF RFC 2119 (http://www.ietf.org/rfc/rfc2119.txt)

Declarative Programming	M	O	M	M
Basic Recognition	M	M	M	O
Basic Recording	O	O	M	M
Concurrent Recognition and Recording	O	O	M	O (M if Basic Recognition is supported)
Basic Media Playback	O	O	M	M
Speech Synthesis	O	O	O	O
Messaging	O	O	M	M
DTMF	O	O	O	M
Prompt Queue	N/A	O	O	M
Logging	N/A	O	O	M
Call Control	*O*	*O*	*O*	*O*

Support for the Call Control module is described in further detail below.

As noted in the definition of the Basic Recognition module (2.8.1.2), "automatic" mode recognition is the minimum level of compliance. Browsers must also make publicly discoverable all recognition modes which are natively implemented.

4.3 Call control support

As indicated in the table above, support of the telephony call control module in SALT is optional for all browser types. However, in order to permit applications which use call control to be portable across browsers, SALT browsers may also make a Portability Claim, as described below.

Portability Claim

In addition to claiming conformance to one of the SALT browser types in 4.2, SALT browsers may claim application portability if the telephony call control functions are provided through either (1) the message formats defined in ECMA-323 using the `smex` object, or (2) the `CallControl` object model defined in Part II of the SALT specification.

When a portability claim is made based on ECMA-323, browsers implement the functionality of one or more profiles of ECMA-269 (as defined in section 2.1.3 of the ECMA-269 specification, http://www.ecma.ch/ecma1/STAND/ecma-269.htm), and adhere to the conformance criteria of ECMA 323 (http://www.ecma.ch/ecma1/STAND/ecma-323.htm). Browsers should make publicly discoverable the ECMA-269 profiles which are implemented and the XML namespaces which are recognized.

When portability claim is made based on the `CallControl` object model, browsers must implement the capability discovery in the `CallControl` object and make discoverable the XML schema of the capability description. The `CallControl` object model does not necessarily have to be provided as a browser native feature. As a result, telephony platforms using private messages other than ECMA 323 can claim application portability if a `CallControl` object library exists to translate the private messages.