Media Objects Markup Language (MOML)
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Abstract

The Media Objects Markup Language (MOML) is used to define media processing objects which execute on media servers. It defines a set of primitive media objects (called primitives) and provides tools to group primitives together and specify how they interact with each other. Clients use MOML to create precisely tailored media processing objects which may be used as parts of application interactions with users or conferences or to transform media flowing internal to a media server. IVR is an example of an application interaction with a user.
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1. Introduction

This document describes a markup language to configure and define media resource objects within a media server. The language allows the definition of sophisticated and complex media processing objects which may be used for application interactions with users, i.e. as part of a user dialog, or as media transformation operations. Media Objects Markup Language (MOML) itself does not specify a language suitable for constructing complete user interfaces as does VoiceXML. Rather, it defines a language from which individual pieces of a dialog may be specified.

MOML is not a standalone language but will generally be used in conjunction with other languages such as the Media Sessions Markup
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Language (MSML) [8]. MSML is used to invoke and control many different services on a media server and to manipulate the flow of media streams within a media server. Future work will define how MOML may be used directly with SIP using mechanisms such as "Basic Network Media Services with SIP" [9], App-info [10], and SIP events [11].

MOML has both a framework, which describes the composition of media resource objects, and the definition of an initial set of primitive media resource objects. The following sections describe the structure and usage of MOML followed by sections defining all of the MOML XML elements.

This work has been influenced by concepts from VoiceXML [7], "MRCP: Media Resource Control Protocol", [2] and "Media Policy Manipulation in the Conference Policy Control Protocol" [3].

Simple media resources and their composition into more complex operations is a central concept of this specification. This concept is used to precisely define the required behaviors. It is not meant to imply that media servers must be implemented from the same building blocks used to describe the behavior.

2. Overview

MOML is an XML [4] language for composing complex media objects from a vocabulary of simple media resource objects called primitives. It is primarily a descriptive or declarative language to describe media processing objects. MOML does not directly define how objects get instantiated and used. Instead, it defines a minimal coordination mechanism between itself and its invocation environment through which that environment may cause objects to be instantiated and through which events can be sent or received.

MOML may be used to simply expose primitive media resource objects but will be used more often to describe dialog operations and media transformation objects which can be controlled via user interaction.

MOML does not contain any computation or flow control constructs. There are no results automatically generated when media operations complete. Users of MOML which require results must explicitly specify those results with a <send> or <exit> elements as part of the definition of the MOML object.

2.1 Primitives

Primitives perform a single function on a media stream such as generating audio, recognizing speech or DTMF, or adjusting the gain. They may be composed so that primitives execute concurrently. Primitives not composed for concurrent execution simply execute
sequentially in the order they occur in a MOML document. All concurrently executing primitives in the same MOML object (defined in one MOML document) can interact with each other through events.

Currently all primitives use audio media but primitives for text and video will be defined in a future version of this specification. Primitives can roughly be considered to fall into one of three descriptive categories.

- **Recognizers** have a media input but no output. They allow different things within a media stream to be recognized or detected and for events to be generated based upon received media.

- **Transformers** have one media input and output and may send and receive events;

- **Sources and Sinks** generate or consume media. They have either a media input or a media output but not both. They may receive and generate events.

Primitives may define different media processing behavior (states) based upon the events which they receive. Primitives which support different processing states must define their default starting state and should support the "initial" attribute to allow that state to be specified when the primitive is instantiated. All primitives must support the "terminate" event class.

The following types of primitives are defined within this specification:

<table>
<thead>
<tr>
<th>Recognizers</th>
<th>Transformers</th>
<th>Source/Sink</th>
</tr>
</thead>
<tbody>
<tr>
<td>dtmf</td>
<td>agc</td>
<td>play</td>
</tr>
<tr>
<td>faxtone</td>
<td>clamp</td>
<td>record</td>
</tr>
<tr>
<td>speech</td>
<td>gain</td>
<td>dtmfgen</td>
</tr>
<tr>
<td>vad</td>
<td>relay</td>
<td>faxsend</td>
</tr>
<tr>
<td></td>
<td></td>
<td>faxrcv</td>
</tr>
</tbody>
</table>

Primitives have shadow variables, similar to those within VoiceXML, which are automatically assigned values when the primitives are used. Upon initialization of a MOML context, all shadow variables have the string value "undefined". Each primitive has its own instance of shadow variables which are global in scope to the entire MOML context.

Names may be assigned to individual primitives when more than one primitive of the same type is used within one MOML document. Shadow
variables are overwritten if the primitive has not been named and is instanti-ated a second time.

Shadow variables cannot be modified under user control. They may be returned from the MOML context using the <send> element.

2.2 Groups

Primitives are composed for concurrent execution by placing them within a <group> element. Groups define how media flows between multiple concurrently executing primitives. They have one or more inputs and one or more outputs. A <group> represents the declaration of a complex media processing operation. The event interaction between primitives (see the following sub-section) is defined within the context of one or more groups. However groups themselves do not scope events, they simply define that primitives are concurrently executing and a primitive must be executing in order to receive an event.

Groups may be used to describe dialog commands, such as a play/collect or play/record. They may also be used to describe media objects which transform a media stream while optionally allowing application or user control of the transformation. For example a gain control could be defined which responds to user speech or DTMF input. In this case a recognition primitive would send events to a gain control primitive.

Groups have one attribute which defines the media flow within them. They also have a dimension which defines how many media inputs and outputs they have. Currently dimensions of 1 and 2 are supported based upon the group topology. These correspond to a group with one input and one output and a group with two inputs and two outputs.

Media flow to and from the primitives within the group is based upon a topology attribute of the <group> element. This attribute defines a topology schema and implies the group dimension. There are several common ways in which primitives are often connected together. A schema provides a convenient template which can be applied to multiple primitives without having to define all of the individual media relationships. The following two schemas are initially defined for 1 dimensional groups:

- parallel: specifies that media sent to the group is sent to every primitive which has an input. The group bridges the output from every primitive which has an output into a single common group output;
- serial: specifies that the first primitive listed in the group receives the media sent to the group. Its output is to be
connected to the input of the next primitive defined within the

group and so on until the last primitive within the group which

comes the group output.

Groups with these topologies are shown in the two diagrams below. The
group on the left has a parallel topology and that on the right has a
serial topology.

```
/--> P1 --\
  /  \
G(in) +--> P2 ----> G(out)  G(in) --> P1 --> P2 --> P3 --> G(out)
  \   /
  \-> P3 --/
```

More complex media flows may be created by nesting groups of serial
and parallel topologies within each other. For example, the diagram
below has a group with a serial topology nested within a star
topology.

```
/----- P1 ------------------------\
  /                                    \
Gs(in) +-> Gp(in) --> P2 --> P3 --> Gp(out) -+> Gs(out)
```

This combination could be used to create record operation where DTMF
was to be clamped from the recording itself, but a DTMF key press is
still used to stop the recording. In this case, P1 would be a DTMF
recognizer, P2 would be a clamp primitive, and P3 a recorder as shown
by the following example. This example omits child elements and
attributes not concerned with the core concept. The following section
discusses sending events and the details of each of the primitives is
defined in section 4.

```
<group topology="parallel">
    <dtmf/>
    <group topology="serial">
        <clamp/>
        <record/>
    </group>
</group>
```

A single schema, "fullduplex" is defined for a two dimensional group.
A full-duplex two dimensional group is has exactly two immediate
children. Those children may be primitives or other one dimensional
groups. A "fullduplex" group must only be used as the top most group
and must not be nested. Each primitive (P1) and group (G2) becomes
half of the full-duplex group as shown in the diagram below.
Full duplex groups are symmetrical when both halves are the same. They are asymmetrical when they differ. Asymmetric groups need to have a name associated with each side. The left side is defined as the input of the first child of the full-duplex group combined with the output of the second child. The right side is reverse. These sides were labeled A and B respectively in the preceding diagram.

An example of a full-duplex group is the user operated gain control mentioned at the beginning of this sub-section. The gain should operate on the audio which a user hears, but the gain is controlled by recognizing things such as DTMF or spoken commands in media which the user originates. The following shows the XML tag grouping which would accomplish this and corresponds to the media flow shown in the diagram above. If the user’s audio is not required for anything other than control of the gain, then the <relay> is not required and the internal group could be omitted. A complete XML description for this is included in the examples section.

```xml
<group topology="fullduplex">
    <group topology="parallel">
        <dtmf/>
        <relay/>
    </group>
    <gain/>
</group>
```

It is expected that additional topology schemas together with methods to allow media flow to be explicitly defined will be developed in a future version of this specification.

Primitives within a group begin concurrently but may finish asynchronously based upon events which they receive or their task completes. A group terminates when all of the primitives within it have completed. If the group contains a <groupexit> element, then the contents of that element are executed as part of group termination.

A group itself may receive a terminate event requesting termination. A terminate event sent to the group causes a terminate event to be sent to each of its currently active primitives. The <groupexit> element is not executed until all primitives have processed their respective terminate events.
2.3 Events

Events provide the mechanism for primitives to interact with each other and for a MOML context to interact with its external environment. The external environment is defined by the way in which a MOML context has been invoked. This will generally be through MSML but other languages and protocols may also be used.

Every primitive and group conceptually implements their own event queue. Events sent to them get placed into their associated queue. Events are removed from their queues and processed in order. Primitives within a group conceptually have their own thread of execution. Due to the asynchronous nature of servicing events from multiple queues, it cannot be assumed that several events sent in sequence to different queues, will be processed in the order in which they were sent. For example, if recognition of something led to sending events to both a <play> and a <record> in that order, it is possible that the <record> may process its event before the <play>

Primitives each define the set of events which they support and the behavior associated with their handling of each event. This allows many types of behaviors to be defined. For example, VCR type controls can be constructed by defining primitives which support events corresponding to each control. Media recognition/detection can be used to cause those events to be generated.

Alternatively, events can be originated elsewhere, such as from an application server, and simply received by the primitive implementing the control. Examples of the use of events include adjusting volume (gain) and pause and resume of both announcement playout and record creation.

Primitives act on events based upon the longest match of an event name. Event names are a period ‘.’ delimited sequence of tokens. The first token, or the root of the name, can be considered an event class. Matching allows a standard meaning to be defined and then extended based upon what triggers an event’s generation. For example, a record primitive has different behavior depending upon whether it completed because a user stopped speaking or because it was cancelled. The recording is retained in the first case but not the second.

Longest match allows new recognizers to be created and used without changing how existing primitives are defined. For example, a face recognition capability could be created which generates a terminate.frowning event when a user looks puzzled. Although no primitive directly defines this event, it will still effect a generic terminate action. Primitives which require specialized behavior based upon frowning may be extended to support this. As well, the event can
still be exported from the MOML context without requiring that primitives receiving the event understand facial expressions.

3. Structural Elements

Framework elements provide the structure for MOML.

3.1 <moml>

The root element for MOML. The contents of this element describe a complete execution context for a media resource object.

Attributes:

version: "1.0" Mandatory.

id: an identifier unique to this object. Events returned from MOML (the "target" attribute of a <send> is equal to "source") will be correlated with this identifier. Mandatory.

Events:

terminate: terminates the MOML context. A terminate event gets sent to the currently executing <group> or primitive.

3.2 <group>

The <group> element allows the contained primitives to be executed concurrently.

Attributes:

topology: specifies a schema which defines the flow of media within the group. Three schemas are initially defined. "fullduplex" is specified for use with two dimensional groups. "parallel" and "serial" are for use with one dimensional groups. The definition of these topologies is defined in section 2. Mandatory.

id: identifies name of the group. Mandatory when groups are nested.

Events:

terminate: causes a terminate event to be sent to each element contained within the group.
3.3 <groupexit>

The <groupexit> element allows events to be sent when group processing completes. Group processing completes when all contained primitives terminate.

Attributes:

none

Events:

none

3.4 <send>

Sends an event and optional namelist to the recipient identified by the target attribute. Event names are defined by the recipient. In the case where the recipient is a MOML group or primitive, the events are defined within this document. Other recipients may use names that are suitable for their environment.

Attributes:

    event: the name of an event.

    target: a type of primitive element or "group" or "source". When <send> is used within a group containing multiple instances of the same type of primitive, then the specific primitive must be identified by appending its name to the type separated by a period ".". The token "group" identifies the enclosing group and the token "source" identifies the context which invoked the MOML object.

    namelist: a list of zero or more shadow variables which are included with the event.

3.5 <exit>

Exit causes execution of the MOML object to terminate.

Attributes:

    namelist: a list of one or more shadow variables which may optionally be sent to the context which invoked the MOML object.
3.6 <disconnect>

Disconnect is similar to <exit> but has the additional semantics of indicating to the context which invoked the MOML object, that it should disconnect from a media server, the media stream associated with the object. The method of disconnection depends upon how the media stream was initially established. If SIP was used, a <disconnect> would cause a media server to issue a BYE request. The request would be sent for the SIP dialog associated with media session on which the MOML object was operating.

Attributes:

namelist: a list of one or more shadow variables which may optionally be sent to the context which invoked the MOML object.

4. Elements for Primitive Objects

The following information is described for each primitive:

- the function which it performs
- the attributes which may be used to tailor its behavior
- the events which it is capable of understanding
- the shadow variables which provide access to information determined as a result of the primitive’s operation.

Subsections of a primitive define child elements of that primitive and are not themselves considered primitives. They do not receive events or populate shadow variables.

4.1 <play>

Play is used to generate an audio stream. It plays in sequence the media created by the child media elements <audio>, <tts>, and <var>. When the play stops, either because the terminate event is received or all media generation has completed, the <playexit> element, if present, is executed. At least one media generation element must be present.

Play supports two states; generate and suspend. Media generation occurs in the generate state and is suspended in the suspend state. Once in the suspend state, media generation continues upon receiving the generate event. The default initial state is generate.
Audio may be generated in different languages by specifying the xml:lang attribute for <play> and/or the child elements of <play>. The language is inherited by the child elements but each child can specify its own language. Except for physical audio clips, it is an error if a language is specified but the media server can not render the audio in the requested language.

Attributes:

id: specifies an identifier for the audio stream sequence. The identifier, if specified, may be used to target events. Optional.

interval: specifies the delay between stopping one iteration and beginning another. The attribute has no effect if iterations is not also specified. Default is no interval.

iterate: specifies the number of times the media specified by the child media elements should be played. Defaults to once '1'.

initial: defines the initial state for the play element. Default is "generate".

maxtime: defines the maximum allowed time for the <play> to complete.

offset: defines an offset, measured in units of time, where the <play> is to begin media generation. Offset is only valid when all child media elements are <audio>.

skip: an amount, expressed in time, which will be used to skip through the media when "forward" and "backward" events are received. Default is 3s (three seconds).

xml:lang: specifies the language to use for content which can be rendered in different languages.

Events:

pause: causes the play to enter the suspend state.

resume: causes play to enter the generate state.

forward: skips forward through the media. Only has effect when all child media elements are <audio>.

backward: skips backward through the media. Only has effect when all child media elements are <audio>.
restart: skips to the beginning of the media. Only has effect when all child media elements are <audio>.

toggle-state: causes the suspend / generate state to toggle.

terminate: terminates the play and assigns values to the shadow variables.

Shadow Variables:

play.amt: identifies the length of time for which media was generated before the play was stopped. This does not include time which may have elapsed while the play was in the suspend state.

play.end: contains the event which caused the play to stop. When the play stops because all media generation has completed, end is assigned the value "play.complete".

4.1.1 Child Elements

4.1.1.1 <audio>

Identifies pre-recorded audio to play. Local URI references may resolve to a single physical audio clip, a logical clip, or a provisioned sequence of clips (physical or logical). A logical clip is one which can be rendered differently based on the language attribute. Logical clips are provisioned for each of the languages that a media server supports. Remote URI references are resolved according to the capabilities of the remote server.

Attributes:

uri: Identifies the location of the audio to be played. The file and http schemes are supported.

iterate: specifies the number of times the audio is to be played. Defaults to once `1`.

xml:lang: specifies the language to use when the URI identifies a logical clip, either directly, or as part of a sequence.

4.1.1.2 <tts>

Contents of the <tts> element are rendered using Text To Speech services and must be compliant to the SSML specification. Element content may be plain text, contain the SSML <speak> element, or the uri attribute should identify the location of text to be rendered.
Attributes:

uri: Identifies the location of the text to be rendered. The file and http schemes are supported.

iterate: specifies the number of times the text to speech block is to be rendered. Defaults to once ‘1’.

xml:lang: specifies the language to use when it is not explicitly specified as an attribute for <speak>.

4.1.1.3 <var>

Specifies the generation of audio from a variable using prerecorded audio segments. A variable represents a semantic concept (such as date or number) and dynamically produces the appropriate speech.

Prerecorded audio allows an application vendor or service provider to choose the exact voice for their audio and therefore completely control the "sound and feel" of the service provided to end users. It provides very high audio quality and allows the variables to blend seamlessly into the surrounding audio segments.

Text to speech (TTS) using SSML may also be used to render variables, but may not provide as good quality, or allow as complete control of the "sound and feel" or user experience. TTS is normally used for reading text such as emails and for very large vocabularies such as stock names. TTS results in a very clear difference between the variables and the surrounding audio segments.

Attributes:

  type: specifies the type of variable. Mandatory. Variable type must be one of "date", "digits", "duration", "month", "money", "number", "silence", "time", or "weekday".

  subtype: specifies an optional clarification of type. Specific values depend upon the type.

  value: text which should be rendered appropriate to the type and subtype attributes.

  xml:lang: specifies the language to use when rendering the variable.
4.1.1.4 <playexit>

The <playexit> element is invoked when generation of all content of the <play> has come to completion. The contents of this element may be used to send events.

Attributes:

none

4.2 <dtmfgen>

DTMF generator originates one or more DTMF digits in sequence.

Attributes:

digits: A string of characters from the alphabet "0-9a-d#*" which correspond to a sequence of DTMF tones. Mandatory.

level: used to define the power level for which the tones will be generated. Expressed in dBm0 in a range of 0 to -96 dBm0. Larger negative values express lower power levels. Note that values lower than -55 dBm0 will be rejected by most receivers (TR-TSY-000181, ITU-T Q.24A). Default is -6 dBm0.

dur: the duration in milliseconds for which each tone should be generated. Implementations may round the value if they only support discrete durations. Default 100 ms.

interval: the duration in milliseconds of a silence interval following each generated tone. Implementations may round the value if they only support discrete durations. Default 100 ms.

Events:

terminate: terminates DTMF generation and assigns values to the shadow variables.

Shadow Variables:

dtmfgen.end: contains the event which caused DTMF generation to stop.

4.2.1 Child Elements

4.2.1.1 <dtmfgenexit>

The <dtmfgenexit> element is invoked when the DTMF generation operation completes or is terminated as a result of receiving the
terminate event. The `<dtmfgenerexit>` element may be used to send events when the recording has completed.

Attributes:

none

4.3 `<record>`

Record creates a recording. Similar to play, `<record>` supports two states; create and suspend. Received media becomes part of the recording when `<record>` is in the create state and is discarded when it is in the suspend state.

Recording terminates when a terminate event is received or when a nospeech event is received and no audio has yet been recorded. `<record>` differentiates different types of terminate events.

Attributes:

id: an optional identifier which may be referenced elsewhere for sending events to the record primitive.

append: a boolean which defines whether the recording is allowed to be appended to an existing file if dest already exists. Default is "false". The attribute is ignored if the scheme is http.

dest: the destination for the recording. Recording may be either local or external based upon the attribute value. Currently the file and http schemes are supported.

format: defines the encoding and file type of the recording.

initial: defines the initial state for the record element. Default is "create".

maxtime: defines the maximum length of the recording in units of time.

Events:

pause: causes the record to enter the suspend state. Received media is discarded.

resume: causes record to resume if it was suspended. It has no effect otherwise.

toggle-state: causes the suspend / create state to toggle.
terminate: terminates the recording and assigns values to the shadow variables.

terminate.cancelled: terminates the recording and assigns values to the shadow variables. If the dest attribute used the file scheme, the local recording is deleted. Applications are responsible for removing external files created using the http scheme.

terminate.finalsilence: terminates the recording and assigns values to the shadow variables. If the dest attribute used the file scheme, the final silence is removed from the recording.

nospeech: terminates the recording and assigns values to the shadow variables if it is received and no recording has yet been created. The "nospeech" event is ignored if audio has already been recorded.

Shadow Variables:

record.len: the actual length of the recording measured in units of time. This does not include time which may have elapsed while the record was in the suspend state.

record.end: contains the event which caused the record to terminate. When the record terminates because maxtime is exceeded, end is assigned the value "record.timeexceeded".

4.3.1 Child Elements

4.3.1.1 <recordexit>

The <recordexit> element is invoked when the record operation completes or when the recording is terminated as a result of receiving the terminate event. The <recordexit> element may be used to send events when the recording has completed.

Attributes:

none

4.4 <dtmf>

DTMF input fulfills several roles within MOML. It is used to trigger events which will affect the media processing operation of other primitives. It is also used to collect DTMF digits from a media stream which are to be reported back to the user of MOML. Often DTMF detection is used for both purposes. Barge is the most common
example, where a prompt is stopped based upon DTMF input but more
digits may remain to be collected.

DTMF detection supports multiple simultaneous recognition patterns.
Different patterns can be used to trigger sending different events in
order to implement DTMF controls. Alternatively one pattern may be
used to represent a collection and another pattern, a substring of
the first, used as a barge indication.

Note that all patterns share the same digit collection buffer, inter-
digit timing, a single <nomatch> element, and a single <noinput>
element. As such, multiple patterns may not be suitable to support
simultaneous collections for different purposes. When this is
required, separate <dtmf> elements should be used instead.

<dtmf> terminates if any of the <pattern>, <noinput>, or <nomatch>
elements are matched the maximum number of times that they are
allowed. The number of times they may match may be specified as an
attribute of <dtmf> or of the individual child elements.

Attributes:

cleardb: a boolean indication of whether the buffer for digit
collection should be cleared of any collected digits when the
element is instantiated. If set to false, any digits currently
in the buffer are immediately compared against the pattern
elements.

fdt: defines the first-digit timer value. The first-digit timer
is started when DTMF detection is initially invoked. If no DTMF
digits are detected during this initial interval, the <noinput>
 element is invoked.

idt: defines the inter-digit timer to be used when digits are
being collected. When specified, the timers is started when the
first digit is detected and restarted on each subsequent digit.
Timer expiration is applied to all patterns. After that, if any
patterns remain active and a nomatch element is specified, the
nomatch is executed and DTMF input terminates. The idt
attribute should only be used when digit collection is being
performed. No default.

starttimer: boolean value which defines whether the first digit
timer (fdt) is started initially. When set to false, the
starttimer event must be received for it to start. Default
false.

iterate: specifies the number of times the <pattern>,
<noinput>, and <nomatch> elements may be executed unless those
elements specify differently. The value "forever" may be used to indicate that these may be executed any number of times. Default is once ‘1’.

Events:

starttimer: starts the first digit timer (fdt) if it has not already been started. Has no effect otherwise.

terminate: terminates the DTMF input and assigns values to the shadow variables.

Shadow Variables:

dtmf.digits: the string of DTMF digits which have been received (the contents of the digit buffer).

dtmf.len: the number of digits in the digit buffer.

dtmf.last: the last digit in the digit buffer.

dtmf.end: contains the event which caused the <dtmf> to terminate or is assigned one of "dtmf.match", "dtmf.noinput", or "dtmf.nomatch" depending upon which of the corresponding elements reached its maximum.

4.4.1 Child Elements

4.4.1.1 <pattern>

The pattern element describes one or more DTMF digits that are to be recognized. When the pattern is matched, the child elements are executed.

Attributes:

digits: The digit pattern which should be matched.

format: an enumerated value which defines the format used to express the digit pattern. The format may be "mgcp" or "megaco" for patterns expressed as digit map from those specifications, or as one of the simple built-in formats defined within this specification. Currently, a single built-in format "moml+digits" is defined which allows a match based on either one or more specific digits, or based upon a specific length specification with an optional return key. "moml+digits" is the default.
iterate: specifies the number of times the <pattern> may be matched. The value "forever" may be used to indicate that <pattern> may be matched any number of times. This value overrides any specified in <dtmf>. Default is once ’1’.

4.4.1.2 <detect>

The contents of the <detect> element are executed whenever any DTMF is first detected. It may be matched at most once.

Attributes:

none

4.4.1.3 <noinput>

The <noinput> element is used when DTMF is being collected. Children of the <noinput> element are executed when DTMF has not been detected and the first digit timeout occurs.

Attributes:

iterate: specifies the number of times the <noinput> may be triggered. The value "forever" may be used to indicate that <noinput> may be triggered any number of times. This value overrides any specified in <dtmf>. Default is once ’1’.

4.4.1.4 <nomatch>

The <nomatch> element is used when DTMF is being collected. Children of the <nomatch> element are executed when it is determined that none of the individual patterns can be matched.

Attributes:

iterate: specifies the number of times the <nomatch> may be triggered. The value "forever" may be used to indicate that <nomatch> may be triggered any number of times. This value overrides any specified in <dtmf>. Default is once ’1’.

4.4.1.5 <dtmfexit>

The <dtmfexit> element is invoked when the dtmf input completes because one of <pattern>, <noinput>, or <nomatch> occurred its maximum number of times.

Attributes:

none
4.5 <speech>

Activates grammars or user input rules associated with speech recognition. If multiple grammars are specified, all are activated. All active grammars share the same timers, recognition attributes, and <noinput> and <nomatch> elements. Each grammar may have its own <match> element.

<speech> terminates if any of the <grammar>, <noinput>, or <nomatch> elements are matched the maximum number of times that they are allowed. The number of times they may match may be specified as an attribute of <speech> or of the individual child elements.

Attributes:

- noint: specifies a time period during which speech input must be started, otherwise the associated <noinput> element is invoked.
- norect: specifies a maximum time period during which speech must begin to be matched, otherwise the associated <nomatch> element is invoked.
- spcmplt: specifies the length of silence necessary after speech before a result will be finalized in the case where there is a complete match of an active grammar. Following the silence, the appropriate <match> element will be triggered if the result is above the confidence level. Otherwise a <nomatch> element will be triggered.
- spincmplt: specifies the length of silence necessary after speech before a result will be finalized in the case where there is an incomplete match of all active grammars. Following the silence, the <nomatch> element will be triggered.
- confidence: the minimum confidence level which the recognizer must have to consider a recognition result as matching a grammar. Expressed as an integer between 1-100.
- sens: specifies the sensitivity of the recognizer to determine whether speech is present. Lower sensitivity may be required for the recognizer to work well in the presence of high background noise or line echo.
- starttimer: boolean value which defines whether the no input (noint) and no recognition (norect) are started initially. When set to false, the starttimer event must be received in order to start them. Default false.
iterate: specifies the number of times the <grammar>,
<noinput>, and <nomatch> elements may be executed unless those
elements specify differently. The value "forever" may be used
to indicate that these may be executed any number of times.
Default is once ‘1’.

Events:

sens: sets the sensitivity of the recognizer as described
above.

starttimer: starts the no input (noint) and no recognition
(norect) timers if they have not already been started. Has no
effect otherwise.

terminate: terminates the speech input and assigns values to
the shadow variables.

Shadow Variables:

speech.end: contains the event which caused the <speech> to
terminate or is assigned one of "speech.match",
"speech.noinput", or "speech.nomatch" depending upon which of
the corresponding elements reached its maximum.

speech.results: contains the results of a matched grammar. The
results are formatted using the Natural Language Semantics
Markup Language (NLSML) [6]. When this variable is referenced
to return results, the results are returned as a separate MIME
entity.

4.5.1 Child Elements

4.5.1.1 <grammar>

Specifies and activates a speech grammar based on Speech Recognition
Grammar Specification (SRGS) [5] XML notation. Grammars may be
referenced by a URI or defined inline. Child elements of <match> are
executed when the specified speech grammar is matched.

Attributes:

uri: specifies the location of an SRGS grammar when the grammar
is not defined inline.

iterate: specifies the number of times the <grammar> may be
matched. The value "forever" may be used to indicate that
<grammar> may be matched any number of times. This value
overrides any specified in <speech>. Default is once ‘1’.
4.5.1.2 <match>

<match> is a child of <grammar> and specifies the actions to take when the corresponding grammar is matched.

4.5.1.3 <noinput>

The <noinput> element is used when speech is being recognized. Children of the <noinput> element are executed when speech has not been detected and the no input timeout (noint) occurs.

Attributes:

iterate: specifies the number of times the <noinput> may be triggered. The value "forever" may be used to indicate that <noinput> may be triggered any number of times. This value overrides any specified in <speech>. Default is once ‘1’.

4.5.1.4 <nomatch>

The <nomatch> element is used when speech is being recognized. Children of the <nomatch> element are executed when it is determined that none of the active grammars will match.

Attributes:

iterate: specifies the maximum number of times the <nomatch> may be triggered. The value "forever" may be used to indicate that <nomatch> may be triggered any number of times. This value overrides any specified in <speech>. Default is once ‘1’.

4.5.1.5 <speechexit>

The <speechexit> element is invoked when the speech input completes because one of <grammar>, <noinput>, or <nomatch> occurred its maximum number of times.

Attributes:

none

4.6 <faxdetect>

Fax tone detection is used to detect the presence of the T.30 CNG tone in a media stream. Child elements of <faxtone> are executed when the CNG tone is detected.

Attributes:
4.7 <faxsend>

The <faxsend> primitive provides the functionality of a calling fax terminal. This typically means sending a set of pages. However, it can also mean requesting the called terminal to send pages instead of, or in addition to, sending pages. The fax images to send are defined by the <sendobj> elements, described below.

Requesting the called terminal to send pages happens when the <rxpoll> element is included as part of <faxsend>. This element may be included in addition to, or instead of, the <sendobj> element. One <sendobj> (at a minimum) or <rxpoll> element must be present. When both are present, a media server will first send pages and will then poll the other terminal, requesting pages.

Because fax is a distinct media type, the <faxsend> primitive is not expected to interact with other primitives. Rather, it will interact using fax protocols with a remote fax terminal (or gateway) and will send requested status events to its invoking environment. During fax operation, shadow variables are used to record the progress and parameters of the varying stages of fax operation.

Status events are requested by including one or more status request elements. These elements correspond to different stages or events in fax operation and cause pre-defined events to be sent to the invoking environment when they occur. Since the only recipient of these events is expected to be a fax application server, requests are simplified by associating a pre-defined namelist of shadow variables with each event. This decision may be revisited to allowed tailored namelists based on further implementation experience. Status requests apply both to sending and polling operation.

Attributes:

- lclid: the identifier that a media server uses to identify itself.
- minspeed: the minimum acceptable speed to negotiate for the operation.
- maxspeed: the maximum speed to negotiate for the operation. This attribute is primarily for testing purposes.
- ecm: specifies whether Error Correction Mode (ECM) is allowed to be used if supported by the remote terminal. Defaults to "true".
Events:

terminate: terminates the fax send operation.

Shadow Variables:

fax.rmtid: the identifier of the remote fax terminal.

fax.rate: the negotiated speed for the operation.

fax.resolution: identifies the resolution of the image. Both metric and inch based resolutions are defined.

faxpagesize: identifies the negotiated page size. Metric sizes are "A3", "A4", "A5", "A6", and "B4". Inch based page sizes are "Letter" and "Legal".

fax.encoding: identifies the image encoding utilized. Valid values are "MH", "R", "MMR", and "JPEG".

fax.ecm: identifies whether ECM operation was used.

fax.pagebadlines: the number of bad lines in a page.

fax.objbadlines: the number of bad lines in an object.

fax.opbadlines: the number of bad lines in an operation.

fax.objuri: the objuri of the current object.

fax.resendcount: the number of pages resent due to errors.

fax.totalpages: the number of pages processed or stored.

fax.totalobjects: the count of the objects used in the operation.

fax.duration: the duration of the operation expressed as a duration in seconds and milliseconds (e.g. "23s250ms").

fax.result: contains the reason which caused the fax operation to complete. When the operation completes successfully, the value will be assigned "fax.success". Other values include: "fax.partial", "fax.nofax", "fax.remotedisconnect", "fax.uri.access.error", and "fax.invalid.startpage". 
4.7.1 Child Elements

4.7.1.1 <sendobj>

<sendobj> is used to define a fax transmission. There may be multiple instances of the element which will be transmitted in order.

Attributes:

  objuri: a URI that points to the fax image that will be transmitted. Mandatory.

  startpage: the first page of a multi-page objuri to send.

  pagecount: page count.

4.7.1.2 <hdrfooter>

<hdrfooter> describes the header/footer that a media server will put on pages. The header or footer may be defined as the content of the <format> child element. The <format> element is only allowed if the type attribute has a value of "header" or "footer".

Attributes:

  type: specifies whether a header or a footer should be put on pages and identifies the source of the header or footer. The following enumerated values may be used:

    "header" indicates that the media server should put a header on pages using the contents of the <format> element.

    "nohdr" indicates that there should be no header or footer.

    "footer" indicates that the media server should put a footer on pages using the contents of the <format> element.

  style: defines the style of insertion onto a fax page that a media server should use for the header or footer. Valid styles are "append", "overlay", or "replace".

<format> is a child of the <hdrfooter> element that defines the style format to be used for the header or footer. It uses a "C" language style format statement to define the contents and layout of the header or footer.
4.7.1.3 <rxpoll>

<rxpoll> provides the information necessary for a receive polling operation to occur. The object(s) to be received are defined by one or more <rcvobj> elements. The <rcvobj> is defined further under the child elements of <faxrcv>. The <rxpoll> element may also include a description of the header/footer that a media server should put on received pages. The <hdrfooter> element and it’s usage is described above.

Attributes:

  rmtid: specifies the identifier of the remote fax terminal that to be associated with a polling operation. A media server must not execute a polling operation unless the value of rmtid matches that of the connected remote machine.

4.7.1.4 <faxstart>

Requests that an event be sent when fax operation has begun. When triggered, the following will be executed:

<send target="source" event="fax.start"/>

4.7.1.5 <faxnegotiate>

Requests that an event be sent when a negotiation has been completed. Multiple events may be sent each time a DCS frame is sent or received. When triggered, the following will be executed:

<send target="source" event="fax.negotiate"
   namelist="fax.rmtid
             fax.rate
             fax.resolution
             fax.pagesize
             fax.encoding
             fax.ecm"/>

4.7.1.6 <faxpagedone>

Requests that an event be sent when a page has been sent or received. When triggered, the following will be executed:

<send target="source" event="fax.pagedone"
   namelist="fax.resolution
             fax.pagesize
             fax.encoding
             fax.pagebadlines
             fax.resendcount"/>
4.7.1.7 <faxobjectdone>

Requests that an event be sent when an objuri has been completed. When triggered, the following will be executed:

```xml
<send target="source" event="fax.objectdone"
     namelist="fax.objuri
             fax.objbadlines
             fax.resendcount
             fax.totalpages
             fax.result"/>
```

4.7.1.8 <faxopcomplete>

Requests that an event be sent when an operation has been completed. When triggered, the following will be executed:

```xml
<send target="source" event="fax.opcomplete"
     namelist="fax.totalpages
             fax.opbadlines
             fax.resendcount
             fax.totalobjects
             fax.duration
             fax.result"/>
```

4.7.1.9 <faxpollstarted>

Requests that an event be sent when a polling operation has started. When triggered, the following will be executed:

```xml
<send target="source" event="fax.opcomplete"
     namelist="fax.rmtid
             fax.rate
             fax.resolution
             fax.pagesize
             fax.encoding
             fax.ecm"/>
```

4.8 <faxrcv>

The <faxrcv> primitive provides the functionality of a called fax terminal. Typically this type of operation is to receive pages. However, it can include sending pages instead of, or in addition to, receiving them. The fax objects to receive are defined by the <rcvobj> elements, described below.

A media server will send pages as a polled terminal when the <txpoll> element is included as part of <faxrcv>. This element may be included in addition to, or instead of, the <rcvobj> element. One <rcvobj> or
<txpoll> element must be present. When both are present, a media server will first receive pages and will then allow the other terminal to poll the media server, requesting pages.

Because fax is a distinct media type, the <faxrcv> primitive is not expected to interact with other primitives. Rather, it will interact using fax protocols with a remote fax terminal and will send requested status events to its invoking environment. During fax operation, shadow variables are used to record the progress and parameters of the varying stages of fax operation.

Status events are requested by including one or more status request elements. These elements correspond to different stages or events in fax operation and cause pre-defined events to be sent to the invoking environment when they occur. Since the only recipient of these events is expected to be a fax application server, requests are simplified by associating a pre-defined namelist of shadow variables with each event. This decision may be revisited to allowed tailored namelists based on further implementation experience. Status requests apply both to receiving and polling operation.

Attributes:

  lclid: the identifier that a media server uses to identify itself.

  ecm: specifies whether ECM mode is allowed to be used if supported by the remote terminal. Defaults to "true".

Events:

  terminate: terminates the fax reception operation.

Shadow Variables:

  <faxrcv> supports the same set of shadow variables as <faxsend>

4.8.1 Child Elements

In addition to the elements defined below, <faxrcv> may also have the following child elements which were defined under <faxsend>:

  o  <hdrfooter>
  o  <faxstart>
  o  <faxnegotiate>
  o  <faxpagedone>
  o  <faxobjectdone>
  o  <faxopcomplete>
  o  <faxpollstarted>
Their meaning and usage is the same as previously defined.

4.8.1.1 `<rcvobj>`

```
<rcvobj> is used to define fax objects that a media server will receive. There may be multiple instances of the element which will be used in order.
```

Attributes:

```
objuri: a URI that points to the location that a received image is to be stored. Mandatory.
```

```
maxpages: the maximum number of pages that will be stored in objuri.
```

4.8.1.2 `<txpoll>`

```
<txpoll> provides the information for a polling operation to occur as part of a fax receive operation. Multiple object(s) to be send may be supplied by one or more `<sendobj>` elements. In the event of multiple occurrences, a media server must select the `<sendobj>` element whose rmtid attribute matches that of the remote terminal.
```

The `<sendobj>` element was defined previously as a child element of `<faxsend>`. For `<txpoll>` is extended with an rmtid attribute that specifies the identifier of the remote fax terminal and is used to select the specific `<sendobj>` to send.

A media server will put a header/footer on transmitted pages based on any `<hdrfooter>` element included as part of `<txpoll>`.

Attributes:

```
none
```

4.9 `<vad>`

```
Voice activity detection (VAD) is used to detect voice and silence when speech recognition is not required. Similar to both speech and DTMF, a VAD has different media conditions which it can match. Those conditions can be qualified by a minimum length of time which is required for them to be considered recognized.
```

Attributes:

```
starttimer: boolean value which defines whether the timer is started to allow recognition of the initial condition (voice, silence). When set to false, the starttimer event must be
received in order for the initial condition to be recognized. The timer does not affect recognition of the transition conditions. Default false.

Events:

starttimer: starts the timer to allow recognition of the initial condition if it has not already been started. Has no effect otherwise.

terminate: terminates voice activity detection.

Shadow Variables:

none

4.9.1 Child Elements

4.9.1.1 <voice>, <silence>, <tvoice>, <tsilence>

Each child element corresponds to a condition which a VAD can detect. The first two detect when voice or silence has been initially present for a minimum length of time since the VAD was started. The second two require that a transition to the voice or silence condition first occur.

Attributes:

len: the length of time the condition must persist in order to be recognized. In the case of <tvoice> and <ttsilence>, the length of time applies only to the final recognized condition.

sen: the maximum length of time the condition not being detected may occur without causing the detector to begin measuring that condition.

4.10 <gain>

Gain is used to adjust the gain of a media stream by a specific amount.

attributes:

incr: an increment, expressed in dB, which will be used to adjust the gain when "louder" and "softer" events are received. Default is 3 dB.

amt: a specific gain to apply specified in dB.
events:

mute: self explanatory.

unmute: self explanatory.

reset: sets the gain to zero dB.

louder: makes the audio on a stream louder.

softer: makes the audio on a stream quieter.

amt: sets the gain to the specified value between -96 dB and 9 dB.

4.11 <agc>

Automatic gain control is used to have a media server automatically adjust the gain of a media stream.

attributes:

tgtlvl: the desired target level for AGC specified in dBm0.

maxgain: the maximum gain that AGC will apply specified in dB.

events:

mute: self explanatory.

unmute: self explanatory.

4.12 <clamp>

This element is used to filter DTMF tones from a media stream. Media other than DTMF tones is passed unchanged.

attributes:

none.

events:

none.

4.13 <relay>

This element is a simple primitive which copies its input to its output.
attributes:
none.

events:
none.

5. Examples

5.1 Announcement

The following is a simple announcement scenario. Two recorded audio files are played in sequence followed by generated speech followed by a variable. The results are reported once media generation completes.

```
<?xml version="1.0" encoding="UTF-8"?>
<moml version="1.0">
  <play>
    <audio uri="file://clip1.wav"/>
    <audio uri="http://host1/clip2.wav"/>
    <tts uri="http://host2/text.ssml"/>
    <var type="date" subtype="mdy" value="20030601"/>
  </play>
  <send target="source" event="done" namelist="play.amt play.end"/>
</moml>
```

5.2 Voice Mail Retrieval

Below is an example which shows a simple voice mail retrieval operation consisting of playing a message and allowing the user to pause and resume play using '5' to toggle the state. The operation would terminate when the play completed or the user entered '#'. During the play, the user can advance forward and backward through the message as well as rewinding to the beginning.

```
<?xml version="1.0" encoding="UTF-8"?>
<moml version="1.0">
  <group topology="parallel">
    <play>
      <audio uri="file://message.wav"/>
      <playexit>
        <send target="group" event="terminate"/>
      </playexit>
    </play>
    <dtmf iterate="forever">
      <pattern digits="5"/>
    </dtmf>
  </group>
</moml>
```
5.3 Play and Record

A more complex example is a play and record operation. This sources and sinks media and uses voice activity DTMF detection and recognition to influence behavior. Any DTMF input or voice activity will barge the play and cause the record to begin. However, if the prompt was barged with a DTMF digit of ‘#’, the record terminates without starting. When the play terminates, it send a starttimer event to the VAD to allow it to recognize an initial silence condition. The recording will be terminated (without starting) when the VAD detects an initial 3 seconds of silence.

Once resumed (based upon voice detection) the recording may be terminated under several conditions. It will terminate after 5 seconds of silence or after 60 seconds elapses. It will also terminate if a ‘#’ key is recognized. Every aspect of this behavior can be modified by changing what is recognized and the events which are sent.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<moml version="1.0">
  <group topology="parallel">
    <play>
      <audio uri="file://prompt.wav"/>
      <playexit>
        <send target="vad" event="starttimer"/>
      </playexit>
    </play>
    <dtmf>
      <pattern digits="#">
        <send target="record" event="terminate.termkey"/>
      </pattern>
    </dtmf>
  </group>
</moml>
```
5.4 Speech Recognition

The following simple example requests that a user speak the name of a city and returns the result.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<moml version="1.0">
  <group topology="parallel">
    <play>
      <audio uri="file://prompt.wav"/>
    </play>
    <speech>
      <grammar version="1.0">
        <rule id="city" scope="public">
          <item>
            <one-of>
              <item>vancouver</item>
              <item>new york</item>
              <item>london</item>
            </one-of>
          </item>
        </rule>
      </grammar>
    </speech>
  </group>
</moml>
```
5.5 Play and Collect

This example prompts a user to enter 4 DTMF digits terminated by the '# key. The prompt will be barged and the user has 10 seconds to begin entering input or no input will be indicated.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<moml version="1.0">
  <group topology="parallel">
    <play>
      <audio uri="file://prompt.wav"/>
      <playexit>
        <send target="dtmf" event="starttimer"/>
      </playexit>
    </play>
    <dtmf fdt="10s" idt="16s">
      <pattern digits="xxxx#">
        <send target="group" event="terminate"/>
      </pattern>
      <detect>
        <send target="play" event="terminate"/>
      </detect>
      <noinput>
        <send target="group" event="terminate"/>
      </noinput>
      <nomatch>
        <send target="group" event="terminate"/>
      </nomatch>
    </dtmf>
  </group>
</moml>
```
5.6 User Controlled Gain

This shows an example of nesting groups to create an arbitrary full duplex media control. DTMF is detected on media flowing in one direction and used to adjust the gain applied to media flowing in the opposite direction. Additionally, the stream which is used to detect DTMF has DTMF removed and its gain automatically adjusted before leaving the group. This widget could be used between a conference participant and a conference mixer.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<moml version="1.0">
  <group topology="fullduplex">
    <group topology="parallel">
      <dtmf>
        <pattern digits="1" iterate="forever">
          <send target="gain" event="louder"/>
        </pattern>
        <pattern digits="2" iterate="forever">
          <send target="gain" event="softer"/>
        </pattern>
      </dtmf>
      <group topology="serial">
        <clamp/>
        <agc tgtlvl="0"/>
      </group>
    </group>
  </group>
  <gain amt="0" incr="5"/>
</moml>
```

6. Change Summary

The following are the primary changes between this version of the draft and the -00 version.

- added primitives to detect, send, and receive fax
- added "xml:lang" attribute to `<play>`, `<audio>`, `<var>`, and `<tts>`. children of `<play>` inherit from play unless overridden.
8. Future Work

Some of the likely functions to be added in future release of MOML include:

- a mechanism for extending the language, similar conceptually to MGCP/MEGACO packages
- algorithmic tone generation and detection
- video and multimedia

8. XML Schema

The MOML schema uses one core schema which includes three other schema that share the same namespace.

The core schema is:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="unqualified"
    attributeFormDefault="unqualified">
    <xs:include schemaLocation="basic-primitives.xsd"/>
    <xs:include schemaLocation="fax-primitives.xsd"/>
```
<xs:element name="moml">
  <xs:complexType>
    <xs:choice ref="momlRequest"/>
    <xs:element name="event">
      <xs:complexType>
        <xs:sequence maxOccurs="unbounded">
          <xs:element name="name" type="xs:string"/>
          <xs:element name="value" type="xs:string"/>
        </xs:sequence>
        <xs:attribute name="name" type="xs:string" use="required"/>
        <xs:attribute name="id" type="xs:string" use="required"/>
      </xs:complexType>
    </xs:element>
  </xs:choice>
  <xs:attribute name="version" type="xs:string" use="required" fixed="1.0"/>
</xs:complexType>
</xs:element>
<xs:group name="momlRequest">
  <xs:choice maxOccurs="unbounded">
    <xs:group ref="executeType"/>
    <xs:element ref="send" maxOccurs="unbounded"/>
  </xs:choice>
</xs:group>
<xs:element name="primitive" type="primitiveType" abstract="true"/>
<xs:complexType name="primitiveType">
  <xs:attribute name="id" type="momlID.datatype"/>
</xs:complexType>
<xs:group name="executeType">
  <xs:choice maxOccurs="unbounded">
    <xs:element ref="primitive"/>
    <xs:element name="group">
      <xs:complexType>
        <xs:sequence>
          <xs:group ref="executeType"/>
          <xs:element name="groupexit" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="id" type="momlID.datatype"/>
      </xs:complexType>
    </xs:element>
  </xs:choice>
</xs:group>
<xs:element name="groupexit" minOccurs="0"/>
<xs:complexType>
  <xs:group ref="sendType"/>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:restriction base="xs:string">
  <xs:enumeration value="serial"/>
  <xs:enumeration value="parallel"/>
  <xs:enumeration value="fullduplex"/>
</xs:restriction>
</xs:simpleType>
</xs:attribute>
</xs:complexType>
</xs:element>
</xs:choice>
</xs:group>
<xs:group name="sendType">
  <xs:choice>
    <xs:element name="exit" type="exitType"/>
    <xs:element name="disconnect" type="exitType"/>
  </xs:choice>
  <xs:sequence>
    <xs:element ref="send" maxOccurs="unbounded"/>
    <xs:choice minOccurs="0">
      <xs:element name="exit" type="exitType"/>
      <xs:element name="disconnect" type="exitType"/>
    </xs:choice>
  </xs:sequence>
</xs:choice>
</xs:sequence>
</xs:choice>
</xs:group>
<xs:element name="send">
  <xs:complexType>
    <xs:attribute name="event" type="momlEvent.datatype" use="required"/>
    <xs:attribute name="target" type="momlTarget.datatype" use="required"/>
    <xs:attribute name="namelist" type="momlNamelist.datatype"/>
  </xs:complexType>
</xs:element>
<xs:complexType name="exitType">
  <xs:attribute name="namelist" type="momlNamelist.datatype"/>
</xs:complexType>
</xs:schema>

Following is the schema for the MOML primitives which were defined in the initial draft. This is not a stand alone schema which can be used to validate instances but instead must be included with the core schema as "basic-primitives.xsd". Note that several URLs have been spread across two lines for formatting reasons.

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="unqualified"
attributeFormDefault="unqualified">
<xs:include schemaLocation="moml-datatypes.xsd"/>
<xs:include schemaLocation="http://www.w3.org/TR/speech-synthesis/synthesis-core.xsd"/>
<xs:include schemaLocation="http://www.w3.org/TR/speech-grammar/grammar-core.xsd"/>
<xs:element name="play" substitutionGroup="primitive">
  <xs:complexType>
    <xs:complexContent>
      <xs:extension base="primitiveType">
        <xs:sequence>
          <xs:choice maxOccurs="unbounded">
            <xs:element name="audio">
              <xs:complexType>
                <xs:attribute name="uri" type="xs:anyURI" use="required"/>
                <xs:attribute name="iterate" type="iterate.datatype" default="1"/>
                <xs:attribute ref="xml:lang"/>
              </xs:complexType>
            </xs:element>
            <xs:element name="tts">
              <xs:complexType mixed="true">
                <xs:choice minOccurs="0">
                  <xs:element ref="speak"/>
                </xs:choice>
                <xs:attribute name="uri" type="xs:anyURI" use="required"/>
                <xs:attribute name="iterate" type="iterate.datatype" default="1"/>
                <xs:attribute ref="xml:lang"/>
              </xs:complexType>
            </xs:element>
            <xs:element name="var">
              <xs:complexType>
                <xs:attribute name="type" use="required">
                  <xs:simpleType>
                    <xs:restriction base="xs:string">
                      <xs:enumeration value="date"/>
                      <xs:enumeration value="digits"/>
                      <xs:enumeration value="duration"/>
                      <xs:enumeration value="month"/>
                      <xs:enumeration value="money"/>
                      <xs:enumeration value="number"/>
                    </xs:restriction>
                  </xs:simpleType>
                </xs:attribute>
              </xs:complexType>
            </xs:element>
          </xs:choice>
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
</xs:element>
</xs:complexType>
</xs:choice mixed="true">
  <xs:choice minOccurs="0">
    <xs:element ref="speak"/>
  </xs:choice>
  <xs:attribute name="uri" type="xs:anyURI" use="required"/>
  <xs:attribute name="iterate" type="iterate.datatype" default="1"/>
  <xs:attribute ref="xml:lang"/>
</xs:complexType>
</xs:element>
</xs:element>
</xs:complexType>
</xs:element>
</xs:complexType>
<xs:enumeration value="silence"/>
<xs:enumeration value="time"/>
<xs:enumeration value="weekday"/>
</xs:restriction>
</xs:simpleType>
</xs:attribute>
<xs:attribute name="subtype"
type="xs:string"/>
<xs:attribute name="value"
type="xs:string"
use="required"/>
<xs:attribute ref="xml:lang"
type="xs:language"/>
</xs:complexType>
</xs:element>
</xs:choice>
<xs:choice minOccurs="0">
<xs:element name="playexit">
<xs:complexType>
<xs:group ref="sendType"/>
</xs:complexType>
</xs:element>
</xs:choice>
</xs:sequence>
<xs:attribute name="interval"
type="posDuration.datatype"/>
<xs:attribute name="iterate" type="iterate.datatype"
default="1"/>
<xs:attribute name="offset" type="duration.datatype"/>
<xs:attribute name="initial" default="generate"/>
<xs:simpleType>
<xs:restriction base="xs:string">
<xs:enumeration value="generate"/>
<xs:enumeration value="suspend"/>
</xs:restriction>
</xs:simpleType>
</xs:attribute>
<xs:attribute name="maxtime"
type="posDuration.datatype"/>
<xs:attribute name="skip" type="duration.datatype"
default="3s"/>
<xs:attribute ref="xml:lang"/>
</xs:extension>
</xs:complexContent>
</xs:complexType>
</xs:element>
<xs:element name="record" substitutionGroup="primitive">
<xs:complexType>
<xs:choice minOccurs="0">

<xs:element name="recordexit">
  <xs:complexType>
    <xs:group ref="sendType"/>
  </xs:complexType>
</xs:element>

<xs:choice>
  <xs:attribute name="append" type="boolean.datatype"
    default="false"/>
  <xs:attribute name="dest" type="xs:anyURI" use="optional"/>
  <xs:attribute name="format" use="required">
    <xs:simpleType>
      <xs:restriction format="use="required">
        <xs:restriction base="xs:string"/>
        <xs:enumeration value="create"/>
        <xs:enumeration value="suspend"/>
      </xs:restriction>
    </xs:simpleType>
    <xs:attribute name="maxtime" type="posDuration.datatype" use="required"/>
    <xs:attribute name="initial" default="create">
      <xs:simpleType>
        <xs:restriction base="xs:string">
          <xs:enumeration value="create"/>
          <xs:enumeration value="suspend"/>
        </xs:restriction>
      </xs:simpleType>
    </xs:attribute>
  </xs:attribute>
</xs:complexType>
</xs:element>

<xs:element name="dtmf" substitutionGroup="primitive">
  <xs:complexType>
    <xs:complexContent>
      <xs:extension base="primitiveType">
        <xs:sequence>
          <xs:element name="pattern" maxOccurs="unbounded">
            <xs:complexType>
              <xs:group ref="sendType"/>
              <xs:attribute name="digits" type="xs:string" use="required"/>
              <xs:attribute name="format">
                <xs:simpleType>
                  <xs:restriction base="xs:string">
                    <xs:enumeration value="mgcp"/>
                    <xs:enumeration value="megaco"/>
                    <xs:enumeration value="moml+digits"/>
                  </xs:restriction>
                </xs:simpleType>
              </xs:attribute>
              <xs:attribute name="iterate" type="iterate.datatype" default="1"/>
            </xs:complexType>
          </xs:element>
        </xs:sequence>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>
</xs:element>
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</xs:complexType>
</xs:element>

<xs:element name="detect" minOccurs="0">
    <xs:complexType>
        <xs:group ref="sendType"/>
    </xs:complexType>
</xs:element>

<xs:element name="noinput" type="iterateSendType" minOccurs="0"/>
<xs:element name="nomatch" type="iterateSendType" minOccurs="0"/>
<xs:element name="dtmfexit" minOccurs="0">
    <xs:complexType>
        <xs:group ref="sendType"/>
    </xs:complexType>
</xs:element>

</xs:sequence>
<xs:attribute name="cleardb" type="boolean.datatype" default="true"/>
<xs:attribute name="fdt" type="posDuration.datatype" default="0s"/>
<xs:attribute name="idt" type="posDuration.datatype" default="4s"/>
<xs:attribute name="edt" type="posDuration.datatype" default="4s"/>
<xs:attribute name="starttimer" type="boolean.datatype" default="false"/>
<xs:attribute name="iterate" type="iterate.datatype" default="1"/>

</xs:extension>
</xs:complexContent>
</xs:complexType>
</xs:element>

<xs:element name="dtmfgen" substitutionGroup="primitive">
    <xs:complexType>
        <xs:choice minOccurs="0">
            <xs:element name="dtmfgenexit">
                <xs:complexType>
                    <xs:group ref="sendType"/>
                </xs:complexType>
            </xs:element>
        </xs:choice>
        <xs:attribute name="level" use="optional" default="-6">
            <xs:simpleType>
                <xs:restriction base="xs:nonPositiveInteger">
                    <xs:maxInclusive value="0"/>
                    <xs:minInclusive value="-96"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>

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<xs:simpleType>
<xs:attribute name="digits" type="dtmfDigits.datatype" use="required"/>
<xs:attribute name="dur" type="posDuration.datatype" use="optional" default="100ms"/>
<xs:attribute name="interval" type="posDuration.datatype" use="optional" default="100ms"/>
</xs:complexType>
</xs:element>
<xs:element name="speech" substitutionGroup="primitive">
<xs:complexType>
<xs:extension base="primitiveType">
<xs:sequence>
<xs:element name="grammar" maxOccurs="unbounded">
<xs:complexType>
<xs:complexContent>
<xs:extension base="grammar">
<xs:choice>
<xs:element name="match" type="iterateSendType" minOccurs="0"/>
</xs:choice>
<xs:attribute name="uri" type="xs:anyURI"/>
<xs:attribute name="iterate" type="iterate.datatype" default="1"/>
</xs:extension>
</xs:complexContent>
</xs:complexType>
</xs:element>
<xs:element name="noinput" type="iterateSendType" minOccurs="0"/>
<xs:element name="nomatch" type="iterateSendType" minOccurs="0"/>
<xs:element name="speechexit" minOccurs="0">
<xs:complexType>
<xs:group ref="sendType"/>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="noint" type="posDuration.datatype"/>
<xs:attribute name="norect" type="posDuration.datatype"/>
<xs:attribute name="spcmplt" type="posDuration.datatype"/>
</xs:complexType>
</xs:element>
<xs:attribute name="confidence">
    <xs:simpleType>
        <xs:restriction base="xs:positiveInteger">
            <xs:maxInclusive value="100"/>
        </xs:restriction>
    </xs:simpleType>
</xs:attribute>
<xs:attribute name="sens" type="xs:positiveInteger"/>
<xs:attribute name="starttimer" type="boolean.datatype" default="false"/>
<xs:attribute name="iterate" type="iterate.datatype" default="1"/>
</xs:extension>
</xs:complexContent>
</xs:complexType>
</xs:element>
<xs:element name="vad" substitutionGroup="primitive">
    <xs:complexType>
        <xs:complexContent>
            <xs:restriction base="primitive">
                <xs:all>
                    <xs:element name="voice" type="vadPatternType" minOccurs="0"/>
                    <xs:element name="silence" type="vadPatternType" minOccurs="0"/>
                    <xs:element name="tvoice" type="vadPatternType" minOccurs="0"/>
                    <xs:element name="tsilence" type="vadPatternType" minOccurs="0"/>
                </xs:all>
                <xs:attribute name="starttimer" type="boolean.datatype" default="false"/>
            </xs:restriction>
        </xs:complexContent>
    </xs:complexType>
</xs:element>
<xs:element name="gain" substitutionGroup="primitive">
    <xs:complexType>
        <xs:attribute name="incr" default="3">
            <xs:simpleType>
                <xs:restriction base="xs:positiveInteger">
                    <xs:maxInclusive value="96"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
        <xs:attribute name="amt" use="required">
            <xs:simpleType>
                <xs:restriction base="xs:integer">
                    <xs:minInclusive value="-96"/>
                    <xs:maxInclusive value="96"/>
                </xs:restriction>
            </xs:simpleType>
        </xs:attribute>
    </xs:complexType>
</xs:element>
Following is the schema for the fax primitives. This is not a stand alone schema which can be used to validate instances but instead must be included with the core schema as "fax-primitives.xsd".
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="qualified"
    attributeFormDefault="unqualified">
    <xs:include schemaLocation="moml-datatypes.xsd"/>
    <xs:element name="faxdetect" substitutionGroup="primitive">
        <xs:complexType>
            <xs:choice>
                <xs:group ref="sendType"/>
            </xs:choice>
        </xs:complexType>
    </xs:element>
    <xs:element name="faxsend" substitutionGroup="primitive">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="sendobj" type="sendobjType" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="hdrfooter" type="hdrfooterType" minOccurs="0"/>
                <xs:element name="rxpoll" minOccurs="0">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="rcvobj" type="rcvobjType" maxOccurs="unbounded"/>
                            <xs:element name="hdrfooter" type="hdrfooterType" minOccurs="0"/>
                        </xs:sequence>
                        <xs:attribute name="rmtid" type="faxid.datatype" use="required"/>
                    </xs:complexType>
                </xs:element>
                <xs:group ref="faxstatusrequest"/>
                <xs:attribute name="lclid" type="faxid.datatype"/>
                <xs:attribute name="minspeed" type="faxspeed.datatype"/>
                <xs:attribute name="maxspeed" type="faxspeed.datatype"/>
                <xs:attribute name="ecm" type="boolean.datatype"/>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
    <xs:element name="faxrecv" substitutionGroup="primitive">
        <xs:complexType>
            <xs:sequence>
                <xs:element name="rcvobj" type="rcvobjType" minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="hdrfooter" type="hdrfooterType" minOccurs="0"/>
                <xs:element name="txpoll" minOccurs="0">
                    <xs:complexType>
                        <xs:sequence>
                            <xs:element name="txobj" type="txobjType" minOccurs="0" maxOccurs="unbounded"/>
                            <xs:element name="hdrfooter" type="hdrfooterType" minOccurs="0"/>
                        </xs:sequence>
                        <xs:attribute name="lclid" type="faxid.datatype"/>
                        <xs:attribute name="minspeed" type="faxspeed.datatype"/>
                        <xs:attribute name="maxspeed" type="faxspeed.datatype"/>
                        <xs:attribute name="ecm" type="boolean.datatype"/>
                    </xs:complexType>
                </xs:element>
            </xs:sequence>
        </xs:complexType>
    </xs:element>
</xs:schema>
<xs:element name="sendobj" type="sendobjType"
    maxOccurs="unbounded"/>
<xs:element name="hdrfooter" type="hdrfooterType" minOccurs="0"/>
</xs:sequence>
<xs:attribute name="rmtid" type="faxid.datatype"/>
</xs:complexType>
</xs:element>
<xs:group ref="faxstatusrequest"/>
</xs:sequence>
<xs:attribute name="lcclid" type="faxid.datatype" />
<xs:attribute name="ecm" type="boolean.datatype"
    default="true"/>
</xs:complexType>
</xs:element>
<xs:group name="faxstatusrequest">
<xs:all>
    <xs:element name="faxstart" minOccurs="0"/>
    <xs:element name="faxnegotiate" minOccurs="0"/>
    <xs:element name="faxpagedone" minOccurs="0"/>
    <xs:element name="faxobjectdone" minOccurs="0"/>
    <xs:element name="faxopcomplete" minOccurs="0"/>
    <xs:element name="faxpollstart" minOccurs="0"/>
</xs:all>
</xs:group>
<xs:complexType name="hdrfooterType">
    <xs:choice>
        <xs:element name="format" type="xs:string"
            minOccurs="0" maxOccurs="unbounded"/>
    </xs:choice>
    <xs:attribute name="type" type="hdrfooter.datatype"/>
    <xs:attribute name="style" type="hdrfooterstyle.datatype"/>
</xs:complexType>
<xs:complexType name="formatType">
    <xs:simpleContent>
        <xs:extension base="xs:string">
            <xs:attribute name="style">
                <xs:simpleType>
                    <xs:restriction base="xs:string">
                        <xs:enumeration value="append"/>
                        <xs:enumeration value="overlay"/>
                        <xs:enumeration value="replace"/>
                    </xs:restriction>
                </xs:simpleType>
            </xs:attribute>
        </xs:extension>
    </xs:simpleContent>
</xs:complexType>
<xs:complexType name="rcvobjType">
<xs:attribute name="objuri" type="xs:anyURI" use="required"/>
<xs:attribute name="maxpages" type="xs:positiveInteger"/>
</xs:complexType>
<xs:complexType name="sendobjType">
  <xs:attribute name="objuri" type="xs:anyURI" use="required"/>
  <xs:attribute name="startpage" type="xs:positiveInteger"/>
  <xs:attribute name="pagecount" type="xs:positiveInteger"/>
</xs:complexType>
<xs:simpleType name="faxid.datatype">
  <xs:restriction base="xs:string">
    <xs:pattern value="[0-9+*- ]{20}"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="faxspeed.datatype">
  <xs:restriction base="xs:string">
    <xs:enumeration value="2400"/>
    <xs:enumeration value="4800"/>
    <xs:enumeration value="7200"/>
    <xs:enumeration value="9600"/>
    <xs:enumeration value="12000"/>
    <xs:enumeration value="14400"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="hdrfooter.datatype">
  <xs:restriction base="xs:string">
    <xs:enumeration value="header"/>
    <xs:enumeration value="footer"/>
    <xs:enumeration value="nohdr"/>
  </xs:restriction>
</xs:simpleType>
<xs:simpleType name="hdrfooterstyle.datatype">
  <xs:restriction base="xs:string">
    <xs:enumeration value="append"/>
    <xs:enumeration value="overlay"/>
    <xs:enumeration value="replace"/>
  </xs:restriction>
</xs:simpleType>
</xs:schema>

Following is the schema which defines the basic datatypes used by the other schemas. It is included in the core schema as "moml-datatypes.xsd".

<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  elementFormDefault="qualified"
  attributeFormDefault="unqualified">
  <xs:simpleType name="momlID.datatype">
    <xs:restriction base="xs:string"/>
  </xs:simpleType>
</xs:schema>
<xs:simpleType name="momlEvent.datatype">
  <xs:restriction base="xs:string">
    <xs:pattern value="[a-zA-Z0-9][a-zA-Z0-9._\-]*"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="momlNamelist.datatype">
  <xs:restriction base="xs:string"/>
</xs:simpleType>

<xs:simpleType name="dtmfDigits.datatype">
  <xs:restriction base="xs:string">
    <xs:pattern value="[0-9#\*]+"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="iterate.datatype">
  <xs:union memberTypes="xs:positiveInteger">
    <xs:simpleType>
      <xs:restriction base="xs:negativeInteger">
        <xs:minInclusive value="-1"/>
      </xs:restriction>
    </xs:simpleType>
    <xs:simpleType>
      <xs:restriction base="xs:string">
        <xs:enumeration value="forever"/>
      </xs:restriction>
    </xs:simpleType>
  </xs:union>
</xs:simpleType>

<xs:simpleType name="momlTarget.datatype">
  <xs:restriction base="xs:string">
    <xs:pattern value="[a-zA-Z0-9][a-zA-Z0-9._\-]*"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="boolean.datatype">
  <xs:restriction base="xs:string">
    <xs:enumeration value="true"/>
    <xs:enumeration value="false"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="duration.datatype">
  <xs:restriction base="xs:string">
    <xs:pattern value="(\+|\-)?([0-9]*\.)?[0-9]+(ms|s)"/>
  </xs:restriction>
</xs:simpleType>

<xs:simpleType name="posDuration.datatype">
  <xs:restriction base="xs:string">
    <xs:pattern value="(\+)?([0-9]*\.)?[0-9]+(ms|s)"/>
  </xs:restriction>
</xs:simpleType>
Security Considerations

MOML is invoked through other languages and protocols. Its security depends on that provided by those environments.

References


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