Addressing Classes by Differentiating Values and Properties in OSC

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ABSTRACT

An approach for creating structured Open Sound Control (OSC) messages by separating the addressing of node *values* and node *properties* is suggested. This includes a method for querying values and properties. As a result, it is possible to address complex nodes as classes inside of more complex tree structures using an OSC namespace. This is particularly useful for creating flexible communication in modular systems. A prototype implementation is presented and discussed.

Keywords

OSC, namespace, Jamoma, standardization

1. INTRODUCTION

Open Sound Control (OSC)[1] has evolved into the de facto standard in the computer music community for communication in and between controllers and sound engines [10]. OSC is a protocol for transmitting messages where the addressing of nodes is based on a "slash" notation similar to URLs. As such, OSC is focused on standardizing the communication of messages. There is, however, no prescribed standardization of the namespaces or the structure of these namespaces.

The authors are involved in developing OSC namespaces for the Jamoma[2] project. Jamoma is a modular system for developing high-level modules in the Max/MSP/Jitter environment. It uses OSC for internal and external communication [5]. As Jamoma's modular structures grow more complex, we find the bi-dimensional namespace conventions of OSC to be inadequate for addressing our constructs. OSC standardizes the addressing of a node, but it becomes increasingly unclear what to do once we reach the node. The problem is exacerbated when the node itself implements its own OSC namespace, as is the case with Jamoma.

The OSC 1.0 specification [7] considers nodes only in terms of their methods: "OSC Methods are the potential destinations of OSC messages received by the OSC server and correspond to each of the points of control that the application makes available. 'Invoking' an OSC method is analogous to a procedure call; it means supplying the method with arguments and causing the method's effect to take place."

Our proposal extends current OSC concepts by considering nodes to represent classes in an object-oriented sense, rather than simple methods. For the purposes of this discussion, we will be considering only nodes that contain one or more methods and/or properties. Properties provide additional information concerning how the node behaves and responds to methods, e.g. by specifying *how* a parameter interpolates to a new value. A node might or might not have a value. If it does possess a value property, that value may be set directly, as it is considered an implicit property of the node. A node may branch out to additional nodes, as in existing OSC practice.

This paper starts by reviewing various approaches to creating more complex communication using OSC. This is followed by a presentation and discussion of our suggested approach, introducing the use of a colon for differentiating between values and properties. Finally, a prototype implementation built in Jamoma is presented and discussed.

2. COMPLEX STRUCTURES IN OSC

The original idea of OSC is that it is tree-structured into a hierarchy called the *address space*, where each of the nodes has a symbolic name and is a potential destination of OSC messages [9]. In contrast to the static schema of MIDI, the *open* nature of OSC means that the address space is defined and created by the "implementor´s idea of how these features should be organized" [10, p153].

This open approach has made OSC useful in a broad range of applications, and adaptable to situations not foreseen by its developers [8]. However, this lack of standardization in namespace schemas is also likely a major reason that OSC has not gained more widespread use in commercial software applications.

2.1 OSC Namespace Standardization

A growing expanse of projects, including the research on

[1] `http://www.opensoundcontrol.org`
[2] `http://www.jamoma.org`

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mapping between controllers and sound engines, require the ability to discover and query namespaces using a known and common syntax [4]. Other projects, such as LIBOSCQS[3] attempt to solve the problem of disparate namespaces by providing a query system and service discovery for applications using the OSC protocol [2, 6].

Several projects have undertaken a standardization of OSC messages, and OSC syntax, for different purposes. In actual practice, these various independent efforts at standardizing namespaces incorporate syntactic elements with conflicting meanings as compared to each other. However, there are some commonalities to these efforts and the problems that they try to address.

2.1.1 Querying Nodes

A primary concern in many of these efforts is the ability to query a node for it's value. The Integra project[4] uses a `.get` appended to the node's address. Meanwhile, Jazzmutant's OSC 2.0 Draft Proposal suggests repurposing the reserved `?` to query for the value of a node [3]. We agree that this functionality is needed, and that a standardized way of doing it is essential. However, we propose that users are interested not only in querying the value of the node, but other properties of that node as well.

2.1.2 Specifying Additional Information

The standardization of OSC namespaces for interfacing with VST Plug-ins was suggested in [11], where units may be specified for the value that is being sent to or from a node. In this proposal the units are specified within the namespace. For example, `/low/output` and `/low/dBoutput` are two ways of controlling the same thing (gain) but specified using different units. This approach is similar to how we have previously addressed different units in Jamoma, e.g. for specifying gain in either MIDI units (`/audio/gain/midi`) or dB (`/audio/gain`).
While such an approach may be beneficial in some contexts, we find that a more structured approach could be beneficial in more complex setups. We therefore propose that the units should be specified as a property of that node, rather than contaminating the namespace itself.

2.1.3 Augmented Syntax

A review of the myriad of attempts at creating standardized OSC schemas, and standardized means of discovering and querying namespaces, indicates that additional syntax is needed for clarifying function, address, or both when working with a complex OSC system. Integra, Jazzmutant, and Jamoma are all examples where additional symbols, such as the colon, have reserved (if different) meanings.

To investigate possible alternatives for sending this structured information, it is useful to observe how existing methodologies represent and send data over a network.

2.2 XML

Extensible Markup Language (XML)[5] is a particularly relevant analogue to OSC. XML defines a means for formatting data, but not the data or anything specific to a schema or namespace [1].

[3] `http://liboscqs.sourceforge.net`
[4] `http://www.integralive.org`
[5] `http://www.w3.org/XML/`

A number of standardized namespaces using XML have gained wide adoption, including Scalable Vector Graphics (SVG)[6], XHTML[7] and SOAP[8]. SOAP is of particular interest because it is designed as a protocol for exchanging structured information.

Using XML, information is encapsulated into elements. These elements form a tree structure analogous to an OSC message. Using XML elements, one way to represent the preceding audio gain example is thus:

```
<audio><gain> 0 </gain></audio>
```

This is clearly more cumbersome to manually type this XML than the equivalent OSC message:

```
/audio/gain 0
```

It is also more work for the receiving processor to parse and it uses more bandwidth.[9] However, XML elements are able not only to express a value (*content* in xml parlance) between the tags, but also they can provide properties (*attributes*) to the node. For example, we may provide the unit for specifying the gain:

```
<audio><gain unit='dB'> 0 </gain></audio>
```

We suggest a model where it is possible to fork an OSC address to access not only the value of the node, but also the properties of that node, much like what is possible in other existing models such as XML.[10]

2.3 OSC Nodes as Classes

In the introduction we made reference to the OSC 1.0 Specification, which states an OSC node represents a function call on a server. We propose that OSC nodes may represent more complex classes, and thus require a mechanism to address the members of these classes. A class *member* may be a *property* or a *method*.

In the Figure 1, the OSC namespace from the previous examples is shown across the x-axis. Traversing the OSC namespace is an action making a horizontal traversal across the figure. In the next section, we will suggest a new syntax for traversing this diagram on the y-axis to address the members inside of these nodes.

2.4 Introducing the Colon Separator

In addition to the ASCII symbols already reserved for specific purposes within the OSC protocol [9], we introduce the colon ":" as a separator between the OSC address of a node and the namespace for accessing the members of the node:

```
<node address> <value>
<node address>:<member address> <value>
```

The former message sets the value of the node just as it would using the existing OSC conventions. This is because a property named *value* is considered to be implicitly addressed if there is no specific member address given. The latter form calls or sets a member of the node. The member itself is addressed using a fully-qualified OSC namespace.

[6] `http://www.w3.org/Graphics/SVG/`
[7] `http://www.w3.org/TR/xhtml1/`
[8] `http://www.w3.org/TR/soap/`
[9] The Efficient XML Interchange (EXI) Format solves many of these concerns with XML, but at the expense of human readability because it is a binary format. `http://www.w3.org/TR/2007/WD-exi-20071219/`
[10] A more concise option than XML, albeit with less clarity and interoperability than OSC, is JSON (`http://www.json.org`)

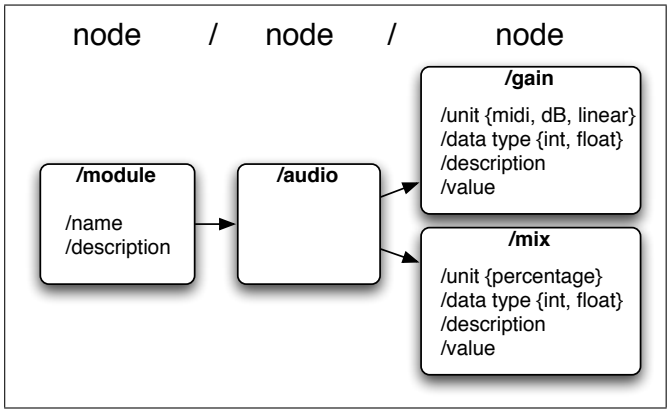

Figure 1: An OSC address tree, with some nodes as classes

Again using gain as an example, we can send two messages: one for setting the unit property and one for setting the value.

```
/module/audio/gain:/unit midi
/module/audio/gain 120
```

Section 3 provides an illustration of the ideas suggested here. In the remainder of the discussion, the address of the node will be omitted for the sake of brevity; e.g. `/computer/module/parameter:/member` will be abbreviated as `:/member`.

2.5 Standardizing Members

To make working with classes in OSC practical, it is important to have some standard members in place. At present we recommend standardizing the following member methods, and reserving their syntax:

- `:/get` returns the value of the node.
- `:/dump` returns the state of the node, which is to say the values of all of the properties including the value itself.
- `:/namespace` returns the namespace implemented at this node.
- `:/catalog` returns an enumeration of available options for a node, if relevant.

3. A PROTOTYPE IMPLEMENTATION

The general concepts introduced in this paper form the basis of the standardized namespace for node members used in Jamoma. The following uses select aspects of the Jamoma node namespace to illustrate how class-oriented addressing in OSC can provide users with extended and structured control of available nodes.

Jamoma distinguishes between the *parameters* and *messages* of a module. Both parameters and messages are addressed as OSC *nodes*. The primary difference is that parameter nodes implement a value property. The remaining properties of these nodes are shared.

3.1 Node Type

The type of the node can be specified. Possible types are *none*, *boolean*, *integer*, *float32*, *symbol* and *list*. If one do not want to restrict the type of the node, it can be set to *generic*. The *none* type is only valid for messages. Some of the properties below will only be valid for certain types of nodes. The type property is accessed thus:

```
:/type   :/type:/get
```

3.2 Controlling the Node Itself

As the node value is considered an implicit property, it can be set and retrieved as such. If the node is an integer, float or list type it can also be stepwise increased or decreased. If so the size of the steps is itself a property:

```
:/value            :/value:/get
:/value/stepsize   :/value/stepsize:/get
:/value/inc
:/value/dec
```

3.3 Controlling the Range

For integer, float and list nodes a range can be specified. This can be useful for setting up auto-scaling mappings from one value to another, or for clipping the output range. The clipping property can be *none*, *low*, *high* or *both*. The range properties are accessed thus:

```
:/range/bound      :/range/bound:/get
:/range/clipmode   :/range/clipmode:/get
```

3.4 Ramping to New Values

The ability to smoothly move from one value to another is fundamental to any kind of transition and transformation of musical or artistic material. Jamoma offers the possibility of interpolating from the current to a new value in a set amount of time. While the OSC message

```
/myComputer/myModule/myParameter 1.0
```

will set the parameter value to 1.0 immediately, the message

```
/myComputer/myModule/myParameter 1.0 ramp 2000
```

will cause the value to interpolate, or ramp, to 1.0 over 2000 milliseconds. Ramping in Jamoma works with messages and parameters of type integer, float and list.

Jamoma offers vastly extended possibilities in how ramping can be done as compared to Max. In Jamoma the process of ramping is made up from the combination of two components: A *drive* mechanism triggers calculations of new values at desired intervals during the ramp, while a set of *functions* offers a set of curves for the ramping. Libraries for both components are implemented as C++ APIs, and can easily be extended.

3.4.1 Ramp Drive

The ramp drive in Jamoma is implemented as a library of self-contained classes, coined *RampUnits*. The existing classes include a *scheduler* drive using the Max scheduler, a *queue* drive running in the Max queue, and an *async* drive which calculates output only when an update is requested.

The ramp units internally perform normalized linear ramps. The values are then mapped using the appropriate FunctionUnit as discussed in Section 3.4.2 and scaled to the appropriate range.

3.4.2 Ramp Function

The ramp function in Jamoma is handled by the Jamoma *FunctionLib*. The FunctionLib provides normalized mappings of values $x \in [0, 1]$ to $y \in [0, 1]$ according to functions $y = f(x)$. Currently five *FunctionUnits* are implemented: Linear, cosine, lowpass series, power function and hyperbolic tangent. There are plans to expand the FunctionLib with additional functions.

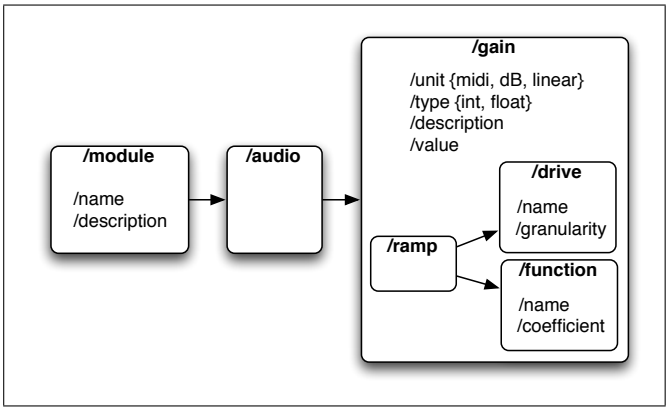

Figure 2: An example OSC address tree to nodes within another node

3.4.3 OSC Namespace for Ramping Properties

Ramping properties are addressed using `:/ramp/drive` and `:/ramp/function` OSC name classes.

The ramping case provides an example of a node class which contains other node classes, as illustrated in Figure 2. As discussed in Section 2.5 information on all available ramp units or functions can be requested with the standardized `:/catalog` method. If the current function or ramp unit contains additional parameters, the namespace of the unit can be retrieved by the `:/namespace` method, while `:/dump` returns the state of the node:

```
:/ramp/drive                    :/ramp/drive:/get
:/ramp/drive:/catalog
:/ramp/drive:/dump
:/ramp/drive:/namespace
:/ramp/drive:/catalog
:/ramp/function                 :/ramp/function:/get
:/ramp/function:/catalog
:/ramp/function:/dump
:/ramp/function:/namespace
```

For instance the user can control how often the *scheduler* RampUnit is to update by setting the `:/granularity` property of the ramp:

```
:/ramp/drive:/granularity
:/ramp/drive:/granularity:/get
```

The same principles apply to the function units used for ramping.

3.5 DataspaceLib

In addition to the current RampLib and FunctionLib, work has started on the implementation of a DataspaceLib. The DataspaceLib will enable nodes to be addressed using one of several interchangeable measurement units. For example a gain parameter can be set using MIDI, dB or linear amplitude depending on the context and preferences of the user. The OSC representation of this will be implemented as a set of properties to the node. The DataspaceLib is also meant to offer mapping between more complex interrelated coordinate systems, so that e.g. Cartesian and spherical coordinates can be used interchangeably for description of points in space.

4. DISCUSSION

As discussed in Section 2.1.1 other projects have also proposed standardizing the means of querying values of OSC nodes and the OSC namespace in general. They propose syntax that differs or conflicts with the suggestions put forward in this paper as well as each other. The authors call on the OSC developer community to work towards a standardized query system to extend the current OSC 1.0 specification, resolving these conflicts in the process.

At the same time we would like to point out that the proposal put forward in this paper broadens the scopes of the Integra project and Jazzmutant OSC 2 proposals by integrating a querying system with the notion of nodes as classes. The proposal set forward in this paper could thus be considered one step in the direction of a more object oriented approach to Open Sound Control.

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