OpenStack API Extensions

Jorge L. Williams

rackspace® HOSTING

Agenda

- The Problem
- Extensions
- Extensions in REST
- Promoting Extensions to new Features
- Challenges
- Summary
- Questions?

The Problem

Standardization vs Innovation and Differentiation

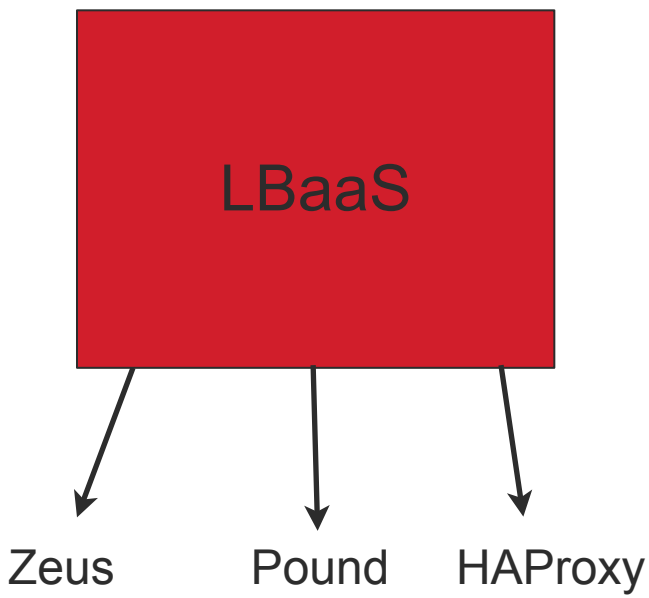
- We want our APIs to be Open Standards...
  - Defining Standard APIs good for OpenStack, and our Customers
  - We want to encourage others to implement our APIs
  - Standards need to be stable
    - Hard to develop against something that's in constant flux
  - Standards need to be general
    - May be impossible for someone to adopt our standards if they contain niche functionality.
  - The more general and stable the API, the more likely others will adopt it.
- We want to innovate
  - Quickly add features that differentiate one implementation from other implementations
    - Without breaking our clients
    - Without going through an approval process
  - We want to allow others to also make changes to the API
    - More likely to adopt OpenStack APIs if they can be modified
    - We may all benefit from these changes
  - Developers should feel free to experiment and develop new features without worrying about the implications to the API as a standard.

There are a number of problem that we're trying to solve: One is there always seems to be a conflict between

One goal is to create this ubiquitous cloud technology

Pluggability

- OpenStack services should be pluggable.
  - One OpenStack Service...Many Backends:
- Backends contain a set of shared capabilities, widely applicable to all deployments
- However, each backend may contain special features and niche functionality
- How do we provide access to special features, while still abstracting away the details of the backend?



hypervisors in compute, network switches in NaaS, etc.

Implemented via drivers

Open Source

- Open source presents another interesting challenge: Others can make changes to the code.
  - OpenStack stock Compute API vs.
    - Rackspace Version vs.
    - Other Modified versions.
  - What does OpenStack Compute API 1.1 mean if we have different implementations all with different capabilities?
  - How do we ensure compatibility among the different versions?

Extensions

Case Study: OpenGL

- The problem we're facing is not new.
  OpenGL faced a similar problem in the 90's
  - How do you define an open graphics library that:
    - Is considered a standard specification
    - Allows vendors to differentiate their products by adding special features
    - And yet is a governed spec
      - An architecture review board (ARB):
        - » Proposes and approves specification changes
        - » Makes new releases
        - » Ensures conformance testing
  - The solution was to allow extensions in the specification
    - Vendors can define special features as extensions
  - A very successful strategy
    - The core OpenGL API is general and uncluttered and an accepted standard.
    - Over 500 extensions have been defined over OpenGL's lifetime
      - Best become standard features; others abandoned
      - Different extensions for the same feature? Let the best one win.
      - Many innovations came via the extension process: vertex and fragment shaders, etc.
      - Extensions have been defined by many different vendors: NVidia, ATI, Apple, IBM, Intel, …

Extensions

So what are extensions...

- Extensions add capability to the API beyond those of the specification
- An API specification must be written to allow for extensibility
  - We need flexibility in the contract to allow for new data elements, actions, states, headers, parameters, and resource types.
  - The core API specification defines the extension mechanism, but extensions themselves are not part of the core.
- Implementors are only required to implement the core API
  - But they must implement the core API completely, this way clients can expect a minimum level of functionality.
- Extensions can be promoted
  - Extensions follow a promotion path, at the end of which an extension may become part of the next version of the core API.
  - Niche extensions, may never be promoted to the core.

If 90% of calls return unimplemented then what's the point of having a core API?

Extensions vs. Versions

Versions	Extensions
Centralized: Versions are maintained by the entity that controls the API Spec: The OpenStack Architecture Board. Only the ARB can create a new version, only the ARB defines what OpenStack Compute 1.1 means.	**Decentralized:** Extensions are maintained by third parties: Rackspace, OpenStack developers, etc. Anyone can create an Extension.

Extensions vs. Versions

Versions	Extensions
Centralized: Versions are maintained by the entity that controls the API Spec: The OpenStack Architecture Board. Only the ARB can create a new version, only the ARB defines what OpenStack Compute 1.1 means.	**Decentralized:** Extensions are maintained by third parties: Rackspace, OpenStack developers, etc. Anyone can create an Extension.
Deal with **Core Functionality**	Deal with **Specialized/Niche Functionality**

Can be applicable to a wide degree of backends...many hypervisors...many load balancers...etc.

Extensions vs. Versions

Versions	Extensions
Centralized: Versions are maintained by the entity that controls the API Spec: The OpenStack Architecture Board. Only the ARB can create a new version, only the ARB defines what OpenStack Compute 1.1 means.	**Decentralized:** Extensions are maintained by third parties: Rackspace, OpenStack developers, etc. Anyone can create an Extension.
Deal with **Core Functionality**	Deal with **Specialized/Niche Functionality**
Appear infrequently: Versions provide a stable platform on which to develop.	**Appear frequently:** Extensions bring new features to the market quickly, and in a compatible manner.

Extensions vs. Versions

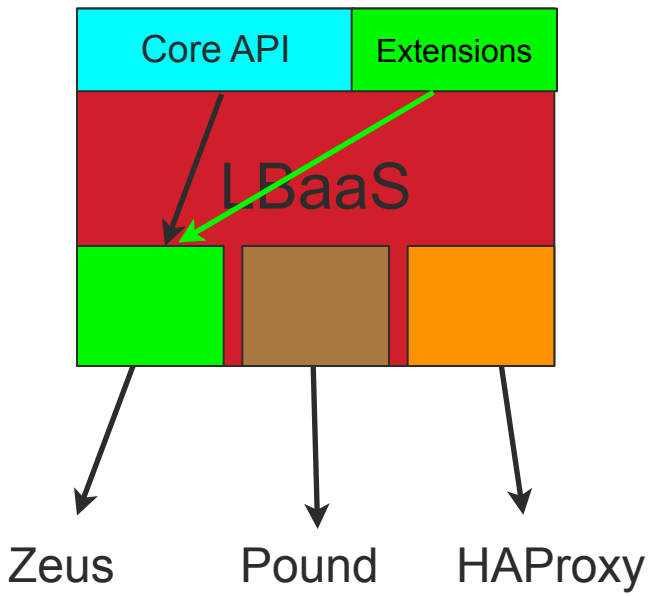
Versions	Extensions
Centralized: Versions are maintained by the entity that controls the API Spec: The OpenStack Architecture Board. Only the ARB can create a new version, only the ARB defines what OpenStack Compute 1.1 means.	**Decentralized:** Extensions are maintained by third parties: Rackspace, OpenStack developers, etc. Anyone can create an Extension.
Deal with **Core Functionality**	Deal with **Specialized/Niche Functionality**
Appear infrequently: Versions provide a stable platform on which to develop.	**Appear frequently:** Extensions bring new features to the market quickly, and in a compatible manner.
Are Queryable: You can programmatically tell what versions are available by doing a GET on the base URL (/) of the API endpoint.	**Are Queryable:** You can programmatically tell what extensions are available by doing a GET on the extensions resource (/v1.1/extensions).

Extensions vs. Versions

- Our APIs should be both Extensible and Versionable

Extensions and Plug-ability go Hand in Hand

Each driver may expose functionality that a client may access via an extension.



Extensions in REST

What can be extended

- Extensions may define:
  - New elements/attributes
  - New actions
  - New headers
  - New parameters
  - New states
  - New resources
  - New mime-types (support for Atom representation or plist representation)
  - New capabilities (the ability to edit an otherwise un-editable attribute)

Extensions are queryable

- You should be able to tell what extensions are available by making a single call.
- If you use extensions as a client this is the first call you'll probably make

Sample Extension Query

- Extensions are queryable via */extensions*

```
<extensions xmlns="http://docs.openstack.org/api-specs/v1.0"
            xmlns:atom="http://www.w3.org/2005/Atom"
            >
    <extension name="Public Image Extension"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
               alias="RAX-PIE"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie-20111111.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie.wadl"/>
        <description>
            Adds the capability to share an image with other users.
        </description>
    </extension>
    <extension name="Cloud Block Storage"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/cbs/v1.0"
               alias="RAX-CBS"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs-20111201.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs.wadl"/>
        <description>
            Allows mounting cloud block storage volumes.
        </description>
    </extension>
</extensions>
```

Sample Extension Query

- Human Readable Name and Description

```
<extensions xmlns="http://docs.openstack.org/api-specs/v1.0"
            xmlns:atom="http://www.w3.org/2005/Atom"
            >
    <extension  name="Public Image Extension"
                namespace="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
                alias="RS-PIE"
                >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie-20111111.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie.wadl"/>
        <description>
            Adds the capability to share an image with other users.
        </description>
    </extension>
    <extension name="Cloud Block Storage"
                namespace="http://docs.rackspacecloud.com/servers/api/ext/cbs/v1.0"
                alias="RS-CBS"
                >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs-20111201.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs.wadl"/>
        <description>
            Allows mounting cloud block storage volumes.
        </description>
    </extension>
</extensions>
```

Sample Extension Query

- Links to Documentation (in different formats)

```
<extensions xmlns="http://docs.openstack.org/api-specs/v1.0"
            xmlns:atom="http://www.w3.org/2005/Atom"
            >
    <extension name="Public Image Extension"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
               alias="RS-PIE"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie-20111111.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie.wadl"/>
        <description>
            Adds the capability to share an image with other users.
        </description>
    </extension>
    <extension name="Cloud Block Storage"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/cbs/v1.0"
               alias="RS-CBS"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs-20111201.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs.wadl"/>
        <description>
            Allows mounting cloud block storage volumes.
        </description>
    </extension>
</extensions>
```

Sample Extension Query

- Unique Extension IDs

```
<extensions xmlns="http://docs.openstack.org/api-specs/v1.0"
            xmlns:atom="http://www.w3.org/2005/Atom"
            >
    <extension name="Public Image Extension"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
               alias="RAX-PIE"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie-20111111.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie.wadl"/>
        <description>
            Adds the capability to share an image with other users.
        </description>
    </extension>
    <extension name="Cloud Block Storage"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/cbs/v1.0"
               alias="RAX-CBS"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs-20111201.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs.wadl"/>
        <description>
            Allows mounting cloud block storage volumes.
        </description>
    </extension>
</extensions>
```

Sample Extension Query

- Vendor Identifiers

```
<extensions xmlns="http://docs.openstack.org/api-specs/v1.0"
            xmlns:atom="http://www.w3.org/2005/Atom"
            >
    <extension name="Public Image Extension"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
               alias="RAX-PIE"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie-20111111.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-pie.wadl"/>
        <description>
            Adds the capability to share an image with other users.
        </description>
    </extension>
    <extension name="Cloud Block Storage"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/cbs/v1.0"
               alias="RAX-CBS"
               >
        <atom:link rel="describedby" type="application/pdf"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs-20111201.pdf"/>
        <atom:link rel="describedby" type="application/vnd.sun.wadl+xml"
                   href="http://docs.rackspacecloud.com/servers/api/ext/cs-cbs.wadl"/>
        <description>
            Allows mounting cloud block storage volumes.
        </description>
    </extension>
</extensions>
```

Vendor Identifiers

- An extension alias always contains a prefix that identifies the vendor.

```
<extension name="Public Image Extension"
               namespace="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
               alias="RAX-PIE">
```

Prefix	Vendor
OS	OpenStack
MLTI	Multi-Vendor
ARB	ARB Approved
RAX	Rackspace
NASA	Nasa
CTX	Citrix
...	...

Vendor Identifiers

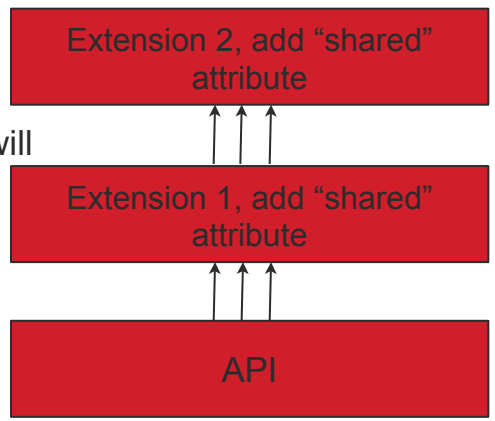
- Namespaces also help ID the vendor

Namespace	Vendor
http://docs.openstack.com/ext/OS/...	OpenStack
http://docs.openstack.com/ext/ARB/...	ARB Approved
http://docs.rackspacecloud.com/...	Rackspace
http://docs.nasa.org/...	Nasa
http://docs.citrix.com/....	Citrix
...	...

Vendor Identifiers

- The idea is to help prevent clashes between extensions.
  - **RAX-PIE**
    - NonXML media types (JSON), headers, parameters
  - **http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0**
    - XML based media types
- Extensions are likely to be implemented by middleware, clashes are likely unless we standardize on an approach

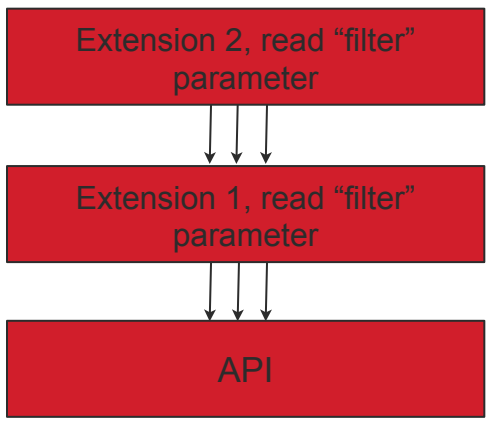
Two extensions add a "shared" attribute one will override the other.



Vendor Identifiers

- The idea is to help prevent clashes between extensions.
  - **RAX-PIE**
    - NonXML media types (JSON), headers, parameters
  - **http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0**
    - XML based media types
- Extensions are likely to be implemented by middleware, clashes are likely unless we standardize on an approach

Two extensions read a "filter" parameter, both will be activated.



We need some way to make sure extensions don't clash with each other and can co-exist

Vendor ID Registry

- OpenStack should maintain a registry of Vendor IDs (prefix and namespaces).
- Anyone should be able to register a Vendor ID.

There shouldn't be a process by which you get approved or anything.

Anyone should be able to register a vendor id.

Data Extensions

- Add additional Data.
  - In XML, attribute may be added to elements so long as they are in the extension namespace
  - In XML, Elements added after last element assuming “Unique Particle Attribution” is not violated
  - In JSON, use alias followed by a colon “:”

```
<image xmlns="http://docs.rackspacecloud.com/servers/api/v1.0"
       xmlns:RAX-PIE="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
       id="1" name="CentOS 5.2"
       serverId="12"
       updated="2010-10-10T12:00:00Z"
       created="2010-08-10T12:00:00Z"
       status="ACTIVE"
       RAX-PIE:shared="true"
       />
```

```
{
    "image" : {
        "id" : 1,
        "name" : "CentOS 5.2",
        "serverId" : 12,
        "updated" : "2010-10-10T12:00:00Z",
        "created" : "2010-08-10T12:00:00Z",
        "status" : "ACTIVE",
        "RAX-PIE:shared" : true
    }
}
```

New Actions

- In XML, actions are defined in the extension namespace
- In JSON, use alias followed by a colon ":" for the action name

```
<mount_volume xmlns="http://docs.rackspacecloud.com/servers/api/ext/cbs/v1.0"
    CBSID="123"/>
```

```
{
    "RAX-CBS:mount_volume" : {
        "CBSID" : "123"
    }
}
```

New Headers and States

- With headers, append name with an X- followed by the alias
  - X-**RAX-CBS**-Header1: Value
  - X-**RAX-CBS**-Header2: Value
- With states, use alias followed by a ":"

```
<image xmlns="http://docs.rackspacecloud.com/servers/api/v1.0"
       xmlns:RS-PIE="http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0"
       id="1" name="CentOS 5.2"
       serverId="12"
       updated="2010-10-10T12:00:00Z"
       created="2010-08-10T12:00:00Z"
       status="RAX-PIE:PrepareShare" progress="80"
       RS-PIE:shared="true"
       />
```

```
{
    "image" : {
        "id" : 1,
        "name" : "CentOS 5.2",
        "serverId" : 12,
        "updated" : "2010-10-10T12:00:00Z",
        "created" : "2010-08-10T12:00:00Z",
        "status" : "RAX-PIE:PrepareShare",
        "progress" : 80,
        "RS-PIE:shared" : true
    }
}
```

New Resources

- Extensions are always defined at /path/to/resource/**ext/ext-alias/newResource**
  All major resources can reference a /ext

Promoting Extensions

Specification Governance

- In order to be successful extensions need to be governed
- The architecture review board (ARB) is responsible for this. It...
  - Proposes and approves specification changes
  - Decides which extensions are promoted to the core API
  - Ensures that each core API provides a minimal set of widely applicable capabilities
  - Ensures conformance testing
- Who's in the ARB?
  - The exact makeup still needs to be determined
  - However, short term, probably OpenStack governance team in collaboration with the project team lead (PTL) of each team.
- How does the ARB got about promoting extensions?

The governance team concerned with consistency between APIs..

..team leads concern with functionality of their own service

Governance doesn't necessarily need to be a heavy weight process...

+1 in an e-mail

ARB Approved Extensions

- The ARB “blesses” an extension by making it an ARB-approved extension.
- ARB-approved extensions use ARB as the vendor prefix.
- An ARB-approved extension denotes
  - That the extension is being considered for the next revision of the specification OR
  - That extension is a niche extension that is very useful; it may not make it as a standard feature, but implementors are encouraged to implement it nonetheless, clients can rely on it being there in most cases.

Promotion Path

- Extensions may follow a promotion path
  - Vendor Specific → ARB Approved → Core Feature
- Some extensions may be developed by multiple vendors; these are known as Multi-Vendor extension, the prefix is MLTI.
  - Multi-Vendor (MLTI) → ARB Approved → Core Feature
- An extension may start as a vendor specific extension and become a multi-vendor extension.
  - Vendor Specific → Multi-Vendor (MLTI) → ARB Approved → Core Feature

New Features Should Start as Extensions

- This gives us the ability to try things out before a feature enters the standard.
- Allows competing extensions to co-exist
- That means that our API specs are written bottom-up rather than top-down
  - Implementations determine new features
  - The API is not designed in a vacuum

Promotion Path

- Not all extensions should be promoted to core features
  - Extensions may implement niche functionality that doesn't make sense in the core API.
  - Or they may implement functionality that can't make it to core because it would prevent a particular backend from implementing the full set of core features.
- Example: The ability to dynamically change the port number for a load balancer.
  - Most Load Balancers support this, but not all -- can't be in the core
  - We can add that capability as an extension
  - This will be a pretty standard extension that will probably start off as an ARB-approved extension...

Challenges

Language Bindings

- Extensions should be supported at the language binding layer
  - A simple approach may be to allow the language bindings themselves to be extensible, so that extensions may be simply added to an existing binding.

JSON and Collections

- How do you extend the collection of public addresses below?
  - Where do you put additional attributes?

```
{
   "networks" : {
      "public" : [
         "67.23.10.132",
         "67.23.10.131"
      ],
      "private" : [
         "10.176.42.16"
      ]
   }
}
```

JSON and Collections

- Obviously, you'd need to wrap the array into an object

```
{
   "networks" : {
      "public" : {
         "EXT-H: hello" : "hi",
         "addresses": [
            "67.23.10.132",
            "67.23.10.131"
         ]
      },
      "private" : {
         "addresses" : [
            "10.176.42.16"
         ]
      }
   }
}
```

JSON and Collections

- Work's great but what do you call a collection of servers?

```
{
   "servers" : [....]
}
```

JSON and Collections

- Servers?

```
{
   "servers" : {
      “servers” : [
        ...
      ]
   }
}
```

JSON and Collections

- I'd prefer having a single name for the array
  - It's more generalizable...it always works...
  - Limits the introduction of entities not found in other representations

```
{
   "servers" : {
      “values” : [
        ...
      ]
   }
}
```

A common pattern for collections...others call the array "memebers"

JSON and Collections

- There are other approach we can take ranging from generalizable “values” to ad hock.
- Each approach has it’s advantages and disadvantages
- It may be that there is no approach that’s truly JSONic when dealing with collections.
- We want extensibility in JSON, but we want to avoid BadgerFish:

```
{
   "alice" : {
      "bob" : {
         "$" : "david" ,
         "@xmlns" : {
            "charlie" : "http:\/\/some-other-namespace" ,
            "$" : "http:\/\/some-namespace"
         }
      } ,
      "charlie:edgar" : {
         "$" : "frank" ,
         "@xmlns" : {
            "charlie": "http:\/\/some-other-namespace",
            "$" : "http:\/\/some-namespace"
         }
      },
      "@xmlns" : {
         "charlie" : "http:\/\/some-other-namespace",
         "$" : "http:\/\/some-namespace"
      }
   }
}
```

Using alias prefixes get gives us a lot

Summary

Why Extensions?

- Stable Core with Support for Innovation
- New features can come quickly without and in a backward compatible manner
- Pluggability - allow supporting the capabilities of different backends
- Ensure compatibility between different kinds of OpenStack deployments
- Allow vendors to differentiate their products with niche features
- Allow new features to be tested before they become part of the core

How Extensions?

- Extensions are queryable via a GET to **/extensions**
- An individual extension via GET to **/extensions/{EXT-ALIAS}**
- To help prevent clashes between extensions, use aliases and namespaces:
  - **RAX-PIE**
    - NonXML media types (JSON), headers, parameters
  - **http://docs.rackspacecloud.com/servers/api/ext/pie/v1.0**
    - XML based media types
- Extensions can be promoted
  - Vendor Specific → ARB Approved → Core Feature
  - ARB Approved extensions likely part of the core distribution, likely to be implemented

Questions?