Product Usage Schemas

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Background
What is Rackspace?

• A Hosting Company
What is Rackspace?

• “The Open Cloud Company”

200,000+ CUSTOMERS
90,000+ SERVERS
26,000+ VM
≅ 70 PB STORED

GLOBAL FOOTPRINT
CUSTOMERS IN 120+ COUNTRIES

9 WORLDWIDE DATA CENTERS
Cloud Computing…

• A major shift in IT…
  • Enables you to provision (or deprovision) computing infrastructure and software platforms dynamically

• Computing resources can be hosted…
  • On premise (private cloud)
  • Off premise (public cloud)
  • Both (hybrid cloud)
Cloud Bursting...

• The ability to scale work to a public cloud when a private cloud’s capacity is exceeded...
Cloud Bursting…

- We can achieve bursting because cloud platforms make extensive use concepts expressed by Service Oriented Architecture (SOA)
- Loosely coupled cloud services written using the REST architectural style
- **Resources**: Compute Nodes, Load Balancers, Databases, Storage Volumes etc…
- Accessed via URIs
- Via uniform interface provided by the HTTP protocol
- This simplifies dynamic provisioning, deprovisioning, configuration etc…
Utility Computing

- Customer pays only for resources consumed
- Providers implement metering in order to track usage
  - Services sold at different pricing tiers known as **flavors**

<table>
<thead>
<tr>
<th>Flavor</th>
<th>Disk Space</th>
<th>VCPUs</th>
<th>Memory</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>512 MB Standard</td>
<td>20 GB</td>
<td>1</td>
<td>512 MB</td>
<td>$0.022/Hr</td>
</tr>
<tr>
<td>2 GB Performance</td>
<td>20 GB (SSD)</td>
<td>2</td>
<td>2048 MB</td>
<td>$0.08/Hr</td>
</tr>
<tr>
<td>90 GB Performance</td>
<td>40 GB (SSD)</td>
<td>24</td>
<td>92160 MB</td>
<td>$5.44/Hr</td>
</tr>
</tbody>
</table>
Utility Computing

- A Customer is allowed to change a resource’s flavor at will, this is known as **resizing**
- A resize operation may upgrade or downgrade a resource

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</tr>
</tbody>
</table>
Datacenters and Regions

• Customers may provision resources at different geographical regions in order to...
  • Control Network Latency
  • Achieve high availability and fail over
  • Abide by governmental restrictions

• A region may encompass more than one data center
  • Customer controls region…provider controls data center

• At Rackspace we use Airport codes to identify regions
  • DFW, LON, HKG, etc…
Creating an Invoice

- Usage data, must be collected for
  - Individual Products:
    - Compute
    - Load Balancers
    - Object Storage
    - Databases, …
  - Across all regions
    - DFW, ORD, LON, HKG, …
Mediation

- Usage data is aggregated along a number of dimensions:
  - The owner of the resource (the tenant)
  - The resource itself (individual compute node, load balancer, database)
  - The billable usage created by the resource (CPU cycles, bandwidth, etc.)
- The data is enriched with additional info such as the billable account number
- Daily summaries are produced
- The whole process is known as Mediation
Mediation

- Products generate **raw usage**
- Mediation takes **raw usage** and creates **mediated usage**
- Mediated usage is then consumed by a number of billing services that rate the usage and produce invoices…
The Problem
Initial Implementation

• Mediation system consumed raw usage directly from products
• Products were in complete control of the data format
• There were different methods of obtaining the data
  • FTP
  • HTTP
  • Direct Database Access
  • ...
Problems…

• Common cross-product attributes differed from one product to the next
  • Different names, timezones (GMT, CST), etc
• Attributes change as product evolves
  • No process to notify mediation team of changes
• Difficult to catch errors (even after extensive testing)
• Errors found in later stages of billing pipeline
  • Best case: Reprocess data
  • Worst case: Compensate customer or observe loss
First Steps
Standardization

• All products transmit messages to centralize AtomPub server using the Atom Syndication Protocol
• Standard event format for common cross-product attributes
  • Enforce GMT timezone
  • Validate against XSD
• Fail fast if something validation fails
• Products specific attributes defined in their own XSD and also validated..
Why Atom?

• Rackspace standardized on REST, AtomPub is an authoritative example of a RESTful protocol.
• Backed by a large number of implementations, Rackspace implemented its own AtomPub server: **Atom Hopper**
• Atom is extensible, easy to make it suite our needs
• Atom has a standard archiving extension (RFC 5005) — good model for providing access to long term archives for auditing purposes
Raw Usage in Atom Feeds and Entries

• Raw usage is packaged into discrete events in Atom Entries
• These entries are collected in feeds, one feed per product
• The feeds are mapped to a specific URI at a shared endpoint
• In order to avoid network delays, one instance of Atom Hopper is deployed per region…
• The mediation service extracts messages from all regions
Atom Feeds…

DFW:

- DATABASES
  - http://feeds.dfw.rackspace.com/dbaas/events

- LOAD BALANCERS
  - http://feeds.dfw.rackspace.com/lbaas/events

LON:

- DATABASES
  - http://feeds.lon.rackspace.com/dbaas/events

- LOAD BALANCERS
  - http://feeds.lon.rackspace.com/lbaas/events
USAGE Events

• Capture utility of a resource over a time duration
• Emitted at constant intervals throughout the day,
• after a resize operation, or when a resource is deleted
USAGE_SNAPSHOT events

• Captures cases that do not correspond directly to the utility model:
  • One Time Charges
  • Subscriptions
• Emitted on an ad hoc basis.
The Usage Event Format

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry xmlns="http://docs.rackspace.com/core/event"
    xmlns:atom="http://www.w3.org/2005/Atom"
    xmlns:lbaas="http://docs.rackspace.com/usage/lbaas">
    <atom:title type="text">LBAAS</atom:title>
    <atom:content type="application/xml">
        <event type="USAGE" version="1"
            tenantId="3737"
            resourceName="MyLoadBalancer"
            endTime="2012-06-15T10:19:52Z"
            startTime="2012-06-14T10:19:52Z"
            region="DFW"
            dataCenter="DFW1"
            id="b79cc3de-b399-3883-b555-61829bb7f966"
            resourceId="b79cc3de-b399-3883-b555-61829bbccd38">
            <lbaas:product serviceCode="CloudLoadBalancers"
                resourceType="LOADBALANCER" version="1"
                sslMode="MIXED" vipType="PUBLIC" numVips="44"
                numPolls="10"
                bandwidthOutSsl="345345346" bandwidthInSsl="364646770"
                bandwidthOut="3460346" bandwidthIn="43456346"
                avgConcurrentConnectionsSsl="4566.0"
                avgConcurrentConnections="30000.0"
                status="ACTIVE"/>
        </event>
    </atom:content>
</atom:entry>
```
The Usage Event Format

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry xmlns="http://docs.rackspace.com/core/event"
            xmlns:atom="http://www.w3.org/2005/Atom"
            xmlns:lbaas="http://docs.rackspace.com/usage/lbaas">
    <atom:title type="text">LBAAS</atom:title>
    <atom:content type="application/xml">
        <event
            tenantId
            resourceName
            endTime
            startTime
            region
            id
            resourceId
            resourceType
            sslMode
            numPolls
            bandWidthOutSsl
            bandWidthOut
            avgConcurrentConnectionsSsl
            avgConcurrentConnections
            status
        </event>
    </atom:content>
</atom:entry>
```
The Usage Event Format

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry
            
            
    <atom:title
    <atom:content
     ...         avgConcurrentConnections
                           status
        </event>
    </atom:content>
</atom:entry>
```

Event, captures common cross product attributes
The Usage Event Format

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry
    <atom:title
    <atom:content
     ...         avgConcurrentConnections
                           status
        </event>
    </atom:content>
</atom:entry>
```

Product Specific Attributes

```xml
<lbaas:product serviceCode="CloudLoadBalancers"
        resourceType="LOADBALANCER" version="1"
        sslMode="MIXED" vipType="PUBLIC" numVips="44"
        numPolls="10"
        bandWidthOutSsl="345345346" bandWidthInSsl="364646770"
        bandWidthOut="3460346" bandWidthIn="43456346"
        avgConcurrentConnectionsSsl="4566.0"
        avgConcurrentConnections="30000.0"
        status="ACTIVE"/>
```

```xml
</event>
</atom:content>
</atom:entry>
```
The Usage Event Format

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry
    xmlns:lbaas="http://docs.rackspace.com/usage/lbaas"
    xmlns="http://docs.rackspace.com/usage">
    <atom:title>
    <atom:content
     ...         avgConcurrentConnections
                           status
        </event>
    </atom:content>
</atom:entry>

<xmlns:lbaas="http://docs.rackspace.com/usage/lbaas"
    xmlns="http://docs.rackspace.com/usage"

    <lbaas:product serviceCode="CloudLoadBalancers"
        resourceType="LOADBALANCER" version="1"
        sslMode="MIXED" vipType="PUBLIC" numVips="44"
        numPolls="10"
        bandWidthOutSsl="345345346" bandWidthInSsl="364646770"
        bandWidthOut="3460346" bandWidthIn="43456346"
        avgConcurrentConnectionsSsl="4566.0"
        avgConcurrentConnections="30000.0"
        status="ACTIVE"/>

Note product attribute are in their own namespace.
```
The Usage Event Format

<?xml version="1.0" encoding="UTF-8"?>
<atom:entry
    xmlns:lbaas="http://docs.rackspace.com/usage/lbaas"
    <atom:title
    <atom:content
     ...         avgConcurrentConnections
                           status
        </event>
    </atom:content>
</atom:entry>

These are common cross-product attributes with product specific validation rules
Validating Events

- Validation achieved via Repose
- Programmable HTTP proxy
- Capable of validating REST APIs described by a WADL
Validating Events

- All Rackspace Specific Business Logic is encapsulated by Repose
- Atom Hopper (AtomPub server) is unaware of validation rules.
Atom Hopper WADL

<?xml version="1.0"?>
<application xmlns="http://wadl.dev.java.net/2009/02">
  <grammars>
    <include href="core_xsd/entry.xsd"/>
  </grammars>
  <resources base="http://localhost/">
    <resource path="autoscale/events" type="wadl/feed.wadl#AtomFeed wadl/feed.wadl#Unvalidated"/>
    <resource path="backup/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudBackup"/>
    <resource path="bigdata/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#BigData"/>
    <resource path="cbs/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudBlockStorage"/>
    <resource path="files/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudFiles"/>
    <resource path="glance/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#Glance"/>
    <resource path="lbaas/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudLoadBalancers"/>
    <resource path="meta/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#AtomHopper"/>
    <resource path="monitoring/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudMonitoring"/>
    <resource path="netdevice/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#NetDevice"/>
    <resource path="nova/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudServersOpenStack wadl/product.wadl#RHEL"/>
    <resource path="queues/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudQueues"/>
    <resource path="servers/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudServers wadl/product.wadl#RHEL"/>
    <resource path="sites/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudSites"/>
    <resource path="ssl/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#Ssl"/>
    <resource path="support/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#Support"/>
  </resources>
</application>
Atom Hopper WADL

```xml
<?xml version="1.0"?>
<application
    <grammars>
        <include
    </grammars>
    <resources
        ...
        wadl/product.wadl#RHEL"
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
    </resources>
</application>
```

Common cross feed properties (GET operations)
Atom Hopper WADL

<?xml version="1.0"?>
<application
    <grammars>
        <include
    </grammars>
    <resources
        ...        wadl/product.wadl#RHEL"
        <resource
        <resource
        <resource
        ...        wadl/product.wadl#CloudLoadBalancers"/>
        <resource path="lbaas/events" type="wadl/feed.wadl#AtomFeed wadl/product.wadl#CloudLoadBalancers"/>
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        </resources>
    </application>

Product Specific properties prevent cross posting of events assign product specific assertions
Atom Hopper WADL

<?xml version="1.0"?>
<application>
    <grammars>
        <include
    </grammars>
    <resources
        ...
        wadl/product.wadl#RHEL"
        <resource
        ...
    </resources>
</application>

Product Specific properties named after the service code which uniquely ID the product

wadl/product.wadl#RHEL"

wadl/product.wadl#RHEL"
Atom Hopper WADL

```xml
<?xml version="1.0"?>
<application
    <grammars>
        <include
    </grammars>
    <resources
        ...        wadl/product.wadl#RHEL"
        <resource
        <resource
        <resource
    </resources>
</application>
```

Properties can be shared across feeds
Atom Hopper WADL

<?xml version="1.0"?>
<application
    <grammars>
        <include
    </grammars>
    <resources
        ...        wadl/product.wadl#RHEL"
        <resource
        <resource
        <resource
    </resources>
</application>

An unvalidated feed.
Useful for onboarding
Atom Hopper WADL

<?xml version="1.0"?>
<application
    <grammars>
        <include
            href="core_xsd/entry.xsd"/>
    </grammars>
    <resources
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource
        <resource

wadl/product.wadl#RHEL"

wadl/product.wadl#RHEL"

XSD grammar used when validating usage messages...defines Atom entries that contain usage data
The Atom XSD

• We provide our own schema for atom that strictly requires the event element in the content...

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry xmlns="http://docs.rackspace.com/core/event"
          xmlns:atom="http://www.w3.org/2005/Atom"
          xmlns:lbaas="http://docs.rackspace.com/usage/lbaas">
  <atom:title type="text">LBAAS</atom:title>
  <atom:content type="application/xml">
    <event type="USAGE" version="1"
          tenantId="3737"
          resourceName="MyLoadBalancer"
          endTime="2012-06-15T10:19:52Z"
          startTime="2012-06-14T10:19:52Z"
          region="DFW"
          dataCenter="DFW1"
          id="b79cc3de-b399-3883-b555-61829bb7f966"
          resourceId="b79cc3de-b399-3883-b555-61829bbccd38">
      <lbaas:product serviceCode="CloudLoadBalancers"
                     resourceType="LOADBALANCER" version="1"
                     sslMode="MIXED" vipType="PUBLIC" numVips="44"
                     numPolls="10"
                     bandWidthOutSsl="345345346" bandWidthInSsl="364646770"
                     bandWidthOut="3460346" bandWidthIn="43456346"
                     avgConcurrentConnectionsSsl="4566.0"
                     avgConcurrentConnections="30000.0"
                     status="ACTIVE"/>
    </event>
  </atom:content>
</atom:entry>
```
The Atom XSD

- In the definition of the event itself we allow an element from a foreign namespace that must be strictly valid against an XSD.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry xmlns="http://docs.rackspace.com/core/event"
xmlns:atom="http://www.w3.org/2005/Atom"
xmlns:lbaas="http://docs.rackspace.com/usage/lbaas">
  <atom:title type="text">LBAAS</atom:title>
  <atom:content type="application/xml">
    <event type="USAGE" version="1"
      tenantId="3737"
      resourceName="MyLoadBalancer"
      endTime="2012-06-15T10:19:52Z"
      startTime="2012-06-14T10:19:52Z"
      region="DFW" dataCenter="DFW1"
      id="b79cc3de-b399-3883-b555-61829bb7f966"
      resourceId="b79cc3de-b399-3883-b555-61829bbccd38">
      <lbaas:product serviceCode="CloudLoadBalancers"
resourceType="LOADBALANCER" version="1"
sslMode="MIXED" vipType="PUBLIC" numVips="44"
numPolls="10"
bandWidthOutSsl="345345346" bandWidthInSsl="364646770"
bandWidthOut="3460346" bandWidthIn="43456346"
avgConcurrentConnectionsSsl="4566.0"
avgConcurrentConnections="30000.0"
status="ACTIVE"/>
    </event>
  </atom:content>
</atom:entry>
```
The Product XSDs

- We initially required products to define their own elements and attributes in product specific XSDs

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry xmlns="http://docs.rackspace.com/core/event"
    xmlns:atom="http://www.w3.org/2005/Atom"
    xmlns:lbaas="http://docs.rackspace.com/usage/lbaas">
    <atom:title type="text">LBAAS</atom:title>
    <atom:content type="application/xml">
        <event type="USAGE" version="1"
            tenantId="3737"
            resourceName="MyLoadBalancer"
            endTime="2012-06-15T10:19:52Z"
            startTime="2012-06-14T10:19:52Z"
            region="DFW"
            dataCenter="DFW1"
            id="b79cc3de-b399-3883-b555-61829bb7f966"
            resourceId="b79cc3de-b399-3883-b555-61829bbccd38">
            <lbaas:product serviceCode="CloudLoadBalancers"
                resourceType="LOADBALANCER" version="1"
                sslMode="MIXED" vipType="PUBLIC" numVips="44"
                numPolls="10"
                bandWidthOutSsl="345345346" bandWidthInSsl="364646770"
                bandWidthOut="3460346" bandWidthIn="43456346"
                avgConcurrentConnectionsSsl="4566.0"
                avgConcurrentConnections="30000.0"
                status="ACTIVE"/>
        </event>
    </atom:content>
</atom:entry>
```
The Product XSDs

- Additionally we required products to annotate product attributes with instructions to help guide the mediation process

```xml
<?xml version="1.0" encoding="UTF-8"?>
<atom:entry xmlns="http://docs.rackspace.com/core/event"
            xmlns:atom="http://www.w3.org/2005/Atom"
            xmlns:lbaas="http://docs.rackspace.com/usage/lbaas">
    <atom:title type="text">LBAAS</atom:title>
    <atom:content type="application/xml">
        <event type="USAGE" version="1"
               tenantId="3737"
               resourceName="MyLoadBalancer"
               endTime="2012-06-15T10:19:52Z"
               startTime="2012-06-14T10:19:52Z"
               region="DFW" dataCenter="DFW1"
               id="b79cc3de-b399-3883-b555-61829bb7f966"
               resourceId="b79cc3de-b399-3883-b555-61829bbccd38">
            <lbaas:product serviceCode="CloudLoadBalancers"
                            resourceType="LOADBALANCER" version="1"
                            sslMode="MIXED" vipType="PUBLIC" numVips="44"
                            numPolls="10"
                            bandWidthOutSsl="345345346" bandWidthInSsl="364646770"
                            bandWidthOut="3460346" bandWidthIn="43456346"
                            avgConcurrentConnectionsSsl="4566.0"
                            avgConcurrentConnections="30000.0"
                            status="ACTIVE"/>
        </event>
    </atom:content>
</atom:entry>
```

```
<attribute name="avgConcurrentConnections" use="required"
type="p:avgConcurrentConnections1Type">
    <documentation>
        <html:p>The amount of concurrent connections.</html:p>
    </documentation>
    <appinfo>
        <usage:attributes aggregateFunction="WEIGHTED_AVG"
                          unitOfMeasure="COUNT"
                          groupBy="false"/>
    </appinfo>
</attribute>
```
Overview…

- Repose reads AtomHopper.WADL which refers to:
  - Feed.wadl (Common cross feed WADL resource types)
  - Product.wadl (Product specific WADL resource types)
  - entry.xsd (Describes Atom Entries that contain Usage Data)
  - product.xsds (Describe product specific elements)
Problems with the initial approach…

• Having product teams define their own XSDs meant that they had to knowledge of XML — something a lot of product teams don’t have…

• The XSDs produced by products needed to conform to a number rules (element named product, with service code attribute, with attribute annotations etc). These rules had to be checked.

• The resource types in product.wadl were manually maintained which was tedious and error prone.
Product Usage Schema
Generate Artifacts from a Simplified Description: Product Usage Schema

• XProc Pipeline is used to generate product.xsds and the product.wadl from a simplified schema description
• Service Teams are required to use that description instead of an XSD
Generate Artifacts from a Simplified Description: Product Usage Schema

- Lowers barriers for service teams: removes idiosyncrasies of XSD…is customize to our use case…
- Helps automate the process: eliminates manual checks, helps catch errors quickly
Product Schema

```xml
<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
    namespace="http://docs.rackspace.com/usage/lbaas"
    serviceCode="CloudLoadBalancers"
    version="1"
    resourceTypes="LOADBALANCER">

    <description>
        Lbaas load balancer usage fields.
    </description>

    <attribute name="avgConcurrentConnections" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent connections.
    </attribute>

    <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent ssl connections.
    </attribute>

    <attribute name="bandWidthIn" type="unsignedLong" use="required"
        unitOfMeasure="B" aggregateFunction="SUM" min="0"
        max="10995116277760">
        The amount of bandwidth in, in bytes.
    </attribute>

    <attribute name="vipType" type="string" use="required"
        allowedValues="PUBLIC SERVICENET">
        The vip type associated with the load balancer.
    </attribute>

</productSchema>
```
  <description>
    Lbaas load balancer usage fields.
  </description>
  <attribute name="avgConcurrentConnections" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent connections.
  </attribute>
  <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent ssl connections.
  </attribute>
  <attribute name="bandWidthIn" type="unsignedLong" use="required"
    unitOfMeasure="B" aggregateFunction="SUM" min="0"
    max="10995116277760">
    The amount of bandwidth in, in bytes.
  </attribute>
  <attribute name="vipType" type="string" use="required"
    allowedValues="PUBLIC SERVICENET">
    The vip type associated with the load balancer.
  </attribute>
</productSchema>
Product Schema

```xml
<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
    namespace="http://docs.rackspace.com/usage/lbaas"
    serviceCode="CloudLoadBalancers"
    version="1"
    resourceTypes="LOADBALANCER">

    <description>
        Lbaas load balancer usage fields.
    </description>

    <attribute name="avgConcurrentConnections" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent connections.
    </attribute>

    <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent ssl connections.
    </attribute>

    <attribute name="bandWidthIn" type="unsignedLong" use="required"
        unitOfMeasure="B" aggregateFunction="SUM" min="0"
        max="10995116277760">
        The amount of bandwidth in, in bytes.
    </attribute>

    <attribute name="vipType" type="string" use="required"
        allowedValues="PUBLIC SERVICENET">
        The vip type associated with the load balancer.
    </attribute>

</productSchema>
```

Common cross product attributes are required
Product Schema

```xml
<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
    namespace="http://docs.rackspace.com/usage/lbaas"
    serviceCode="CloudLoadBalancers"
    version="1"
    resourceTypes="LOADBALANCER">
  <description>
    Lbaas load balancer usage fields.
  </description>
  <attribute name="avgConcurrentConnections" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent connections.
  </attribute>
  <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent ssl connections.
  </attribute>
  <attribute name="bandWidthIn" type="unsignedLong" use="required"
    unitOfMeasure="B" aggregateFunction="SUM" min="0" max="10995116277760">
    The amount of bandwidth in, in bytes.
  </attribute>
  <attribute name="vipType" type="string" use="required"
    allowedValues="PUBLIC SERVICENET">
    The vip type associated with the load balancer.
  </attribute>
</productSchema>
```

Human readable documentation is required for each attribute…
Product Schema

<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
    namespace="http://docs.rackspace.com/usage/lbaas"
    serviceCode="CloudLoadBalancers"
    version="1"
    resourceTypes="LOADBALANCER">
  <description>
    Lbaas load balancer usage fields.
  </description>
  <attribute name="avgConcurrentConnections" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent connections.
  </attribute>
  <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent ssl connections.
  </attribute>
  <attribute name="bandWidthIn" type="unsignedLong" use="required"
    unitOfMeasure="B" aggregateFunction="SUM" min="0"
    max="10995116277760">
    The amount of bandwidth in, in bytes.
  </attribute>
  <attribute name="vipType" type="string" use="required"
    allowedValues="PUBLIC SERVICENET">
    The vip type associated with the load balancer.
  </attribute>
</productSchema>

Mediation annotations are simply part of the attribute description.
Product Schema

Some attributes correspond directly to their equivalent in XSD.

```xml
<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
    namespace="http://docs.rackspace.com/usage/lbaas"
    serviceCode="CloudLoadBalancers"
    version="1"
    resourceTypes="LOADBALANCER">
    <description>
        Lbaas load balancer usage fields.
    </description>
    <attribute name="avgConcurrentConnections" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent connections.
    </attribute>
    <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent ssl connections.
    </attribute>
    <attribute name="bandWidthIn" type="unsignedLong" use="required"
        unitOfMeasure="B" aggregateFunction="SUM" min="0"
        max="10995116277760">
        The amount of bandwidth in, in bytes.
    </attribute>
    <attribute name="vipType" type="string" use="required"
        allowedValues="PUBLIC SERVICENET">
        The vip type associated with the load balancer.
    </attribute>
</productSchema>
```
Product Schema

<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
    namespace="http://docs.rackspace.com/usage/lbaas"
    serviceCode="CloudLoadBalancers"
    version="1"
    resourceTypes="LOADBALANCER">
    <description>
        Lbaas load balancer usage fields.
    </description>
    <attribute name="avgConcurrentConnections" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent connections.
    </attribute>
    <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
        aggregateFunction="WEIGHTED_AVG"
        unitOfMeasure="COUNT" min="0" max="1000000">
        The amount of concurrent ssl connections.
    </attribute>
    <attribute name="bandWidthIn" type="unsignedLong" use="required"
        unitOfMeasure="B" aggregateFunction="SUM" min="0"
        max="10995116277760">
        The amount of bandwidth in, in bytes.
    </attribute>
    <attribute name="vipType" type="string" use="required"
        allowedValues="PUBLIC SERVICENET">
        The vip type associated with the load balancer.
    </attribute>
</productSchema>

Similarly enumerations are defined directly…
Product Schema

There are only a finite set of simple types. Most borrowed from XSD… but we have specific types such as UUID.

```xml
<productSchema xmlns="http://docs.rackspace.com/core/usage/schema"
  namespace="http://docs.rackspace.com/usage/lbaas"
  serviceCode="CloudLoadBalancers"
  version="1"
  resourceTypes="LOADBALANCER">
  <description>
    Lbaas load balancer usage fields.
  </description>
  <attribute name="avgConcurrentConnections" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent connections.
  </attribute>
  <attribute name="avgConcurrentConnectionsSsl" type="double" use="required"
    aggregateFunction="WEIGHTED_AVG"
    unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent ssl connections.
  </attribute>
  <attribute name="bandWidthIn" type="unsignedLong" use="required"
    unitOfMeasure="B" aggregateFunction="SUM" min="0"
    max="10995116277760">
    The amount of bandwidth in, in bytes.
  </attribute>
  <attribute name="vipType" type="string" use="required"
    allowedValues="PUBLIC SERVICENET">
    The vip type associated with the load balancer.
  </attribute>
</productSchema>
```
Dates are always in GMT…

Whitespace separated lists denoted with a star(*)

Int* string*
XSD Translation…

```xml
<attribute name="avgConcurrentConnections" use="required" type="p:avgConcurrentConnections1Type">
    <annotation>
        <documentation>
            The amount of concurrent connections.
        </documentation>
        <appinfo>
            <usage:attributes aggregateFunction="WEIGHTED_AVG" unitOfMeasure="COUNT" groupBy="false"/>
        </appinfo>
    </annotation>
</attribute>

<attribute name="avgConcurrentConnections" type="double" use="required" aggregateFunction="WEIGHTED_AVG" unitOfMeasure="COUNT" min="0" max="1000000">
    The amount of concurrent connections.
</attribute>

<simpleType name="avgConcurrentConnections1Type">
    <restriction base="xsd:double">
        <minInclusive value="0"/>
        <maxInclusive value="1000000"/>
    </restriction>
</simpleType>
```
XSD Translation…

<attribute name="vipType" use="required" type="p:vipType1Enum">
  <annotation>
    <documentation>
      <html:p>The vip type associated with the load balancer.</html:p>
    </documentation>
    <appinfo>
      <usage:attributes aggregateFunction="NONE" groupBy="false"/>
    </appinfo>
  </annotation>
</attribute>

<attribute name="vipType" type="string" use="required" allowedValues="PUBLIC SERVICENET">
  The vip type associated with the load balancer.
</attribute>

<simpleType name="vipType1Enum">
  <restriction base="xsd:string">
    <enumeration value="PUBLIC"/>
    <enumeration value="SERVICENET"/>
  </restriction>
</simpleType>
Assertions

• It became evident that we couldn’t catch all errors unless we add support for assertions…

• Assertions have what we call a scope (product, entry)
  • Determines the current node is the XPath expression

```xml
<xpathAssertion test="if (@sslMode = 'OFF') then
  ((@bandWidthInSsl = 0) and (@bandWidthOutSsl = 0) and (@avgConcurrentConnectionsSsl = 0)) else true()">  
  If SslMode is OFF then bandWidthInSsl, bandWidthOutSsl, and avgConcurrentConnectionsSsl should all be 0. 
</xpathAssertion>

<xpathAssertion test="$event/@resourceId castable as xs:integer" scope="entry">  
  The resourceId for a VIP should be an integer. 
</xpathAssertion>
```
**Assertions**

- When the scope is entry we define: the variables $entry, $event, and $product to reach into different parts of the message.

```xml
<xpathAssertion test="if (@sslMode = 'OFF') then
    (@bandWidthInSsl = 0) and (@bandWidthOutSsl = 0) and
    (@avgConcurrentConnectionsSsl = 0)) else true()">
  If SslMode is OFF then bandWidthInSsl, bandWidthOutSsl, and
  avgConcurrentConnectionsSsl should all be 0.
</xpathAssertion>
```

```xml
<xpathAssertion test="$event/@resourceId castable as xs:integer" scope="entry">
  The resourceId for a VIP should be an integer.
</xpathAssertion>
```
Assertions

• How the assertion get’s generated depends on the scope.
• Product scope assertions are generated directly into the XSD...(we use XSD 1.1)

```xml
<assert vc:minVersion="1.1"
    test="if (@sslMode = 'OFF') then ((@bandWidthInSsl = 0) and (@bandWidthOutSsl = 0) and (@avgConcurrentConnectionsSsl = 0)) else true()"
    xerces:message="If SslMode is OFF then bandWidthInSsl, bandWidthOutSsl, and avgConcurrentConnectionsSsl should all be 0."
    saxon:message="If SslMode is OFF then bandWidthInSsl, bandWidthOutSsl, and avgConcurrentConnectionsSsl should all be 0.">
    <annotation>
        <documentation>
            <html:p>Assertion: If SslMode is OFF then bandWidthInSsl, bandWidthOutSsl, and avgConcurrentConnectionsSsl should all be 0.</html:p>
        </documentation>
    </annotation>
</assert>
```
Assertions

• How the assertion get’s generated depends on the scope.
  • Entry scope assertions are generated directly into the product WADL via XSLT preprocess extension…
  • Identity transform with a choose statement…
  • WADL does offer support for XPath assertions in the spec, but we’d lose the ability to set variables like $event

```xml
<xsl:choose>
  <xsl:when test="$event/@resourceId castable as xs:integer"/>
  <xsl:otherwise>
    <xsl:message terminate="yes">The resourceId for a load balancer should be an integer.</xsl:message>
  </xsl:otherwise>
</xsl:choose>
```
Versioning

• Our versioning strategy requires that versions remain backwards compatible as much as possible
  • Clients don’t have to change
  • We don’t have to POST multiple versions of the same message
  • Version numbers are there to set different validation rules
Versioning

• You can create multiple product schemas with the same namespace and the same service code…but different versions

• These multiple schemas generate a single XSD with an alternative element that selects a different complex type

```xml
<element name="product" vc:minVersion="1.1" type="p:BaseBigDataType">
  <alternative test="(@version eq '1')" type="p:BigData1Type"/>
  <alternative test="(@version eq '2')" type="p:BigData2Type"/>
</element>
```
Future Work

• Better XSD 1.0 support
  • Teams use JAXB etc. We take advantage of the conditional inclusion support XSD 1.1, but the generated XSDs still require some manual tweaking…

• JSON Support
  • Generating JSON Schema, allowing JSON messages
  • GUIs and Wizards for producing product schema…to lower barriers even more.

• Improve load time. Compiling WADLs, XSLTs, and XSDs is currently taking about 5 mins!
Conclusion

• We transform our existing billing pipeline from one in which usage data was defined in irregular and inconsistent ways to one in which strict standards were followed.

• Product schema allowed us to leverage advance features in XSD and WADL without having product teams deal with the idiosyncrasies of these languages.

• We can now produce product specific usage data in a highly consistent manner and to communicate requirements to the usage mediation team accurately.
THANK YOU

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