RESTful Application Protocols

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Procurement

customer

request quote

order

confirm order

cancel

pay

cancel

supplier
Application, application protocol, application state

Application protocol

Application state
Orchestration

[Diagram of a procurement process with nodes and arrows indicating the flow of actions such as SubmitQuoteRequest, SubmitOrderRequest, ReceiveOrderConfirmation, etc.]
Operation-oriented vs. resource-oriented design

CreateQuote
SubmitQuote
AddItem
AmendOrder
ReserveItem
CancelOrder
RemoveItem

Operations

GET
PUT
POST
DELETE

Resources

GET
PUT
POST
DELETE
Quote
Order
Item
Coordinating interactions: the hypermedia constraint

Hypermedia
as
the
Engine
of
Application
State
Hypermedia controls: links

**HTML**

```html
<a href="http://restbucks.com/orders">Orders</a>
```

**Atom**

```html
<link type="application/vnd.restbucks.com" href="http://restbucks.com/orders"/>
```

**OpenSearch**

```html
<Url type="application/vnd.restbucks.com" template="/orders/?start={startPage?}"/>
```
Hypermedia controls: forms

**HTML**

```html
<form name="input" action="/registration"
  method="post">
  <input type="text" name="user" />
  <input type="submit" value="Submit" />
</form>
```

**XForms**

```xml
<model>
  <instance>
    <request-for-quote>
      <items/>
    </request-for-quote>
  </instance>
  <submission
    resource="http://restbucks.com/quotes"
    method="post"
    mediatype="application/vnd.restbucks+xml"/>
</model>
```
Semantic context: typed links and link relations

- `<link rel="payment" href="https://payments.example.org/payments/1010" type="application/vnd.example.org+xml"/>

- `<link rel="http://relations.restbucks.com/order-form" href="http://restbucks.com/order-forms/1234" type="application/vnd.restbucks+xml"/>

Registered payment
Indicates a resource where payment is accepted

Extension
http://relations.restbucks.com/order-form
Indicates a resource where orders may be submitted
Anatomy of a hypermedia control

<link
  rel="http://relations.restbucks.com/order"
  type="application/vnd.restbucks+xml"
  href="http://restbucks.com/orders/9876"/>

**Semantic context**
WHY access the linked resource?

**Address**
WHERE does the linked resource reside?

**Interpretation**
HOW ought the response be interpreted?
Hypermedia systems transform application state
Client sends request to server

GET /request-for-quote HTTP/1.1
HTTP/1.1 200 OK

<model>
  <instance>
    <request-for-quote>
      <items/>
    </request-for-quote>
  </instance>
  <submission
    resource="http://restbucks.com/quotes"
    method="post"
    mediatype="application/vnd.restbucks+xml"/>
</model>
HTTP/1.1 200 OK

<model>
  <instance>
    <request-for-quote>
      <items/>
    </request-for-quote>
  </instance>
</model>
Client activates control

POST /quotes HTTP/1.1

<request-for-quote>
  <items>
    <item>
      <description>Costa Rica Tarrazu</description>
      <amount>250g</amount>
    </item>
    <item>
      <description>Guatemala Elephant Beans</description>
      <amount>250g</amount>
    </item>
  </items>
</request-for-quote>
quote requested

HTTP/1.1 201 Created
<quote>
  <items>
    ...
  </items>
  <link rel="self"
    href="http://restbucks.com/quotes/1234"
    type="application/vnd.restbucks+xml"/>
  <link rel="http://relations.restbucks.com/order-form"
    href="http://restbucks.com/order-forms/1234"
    type="application/vnd.restbucks+xml"/>
</quote>
Documenting a RESTful protocol

- Media types
- Link relations
- HTTP idioms
- Protocol
  - Schemas
  - Hypermedia controls
  - Link relations

Media types
Link relations
HTTP idioms
Atom Publishing Protocol

AtomPub

HTTP idioms

application/atomsvc+xml
application/atomcat+xml
application/atom+xml
edit
edit-media

feed
entry
<link/>
self
alternate
via
enclosure
related

application/atom+xml
Distributed application design and implementation guidelines

1. Model applications in terms of *application state machines*
2. Implement them in terms of *resource lifecycles* and the *rules that associate resources*
3. Advertise and execute them using *media types*, *link relation values* and *HTTP idioms*
Procurement protocol resources (first pass)

quotes → quote

orders → order

order → payment
Application start

Request
GET /shop HTTP/1.1
Host: restbucks.com
Accept: application/vnd.restbucks+xml

Response
HTTP/1.1 200 OK
Date: Mon, 26 Jul 2010 10:00:00 GMT
Cache-Control: public, max-age=86400
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<shop>
  <link rel="http://relations.restbucks.com/rfq"
    href="http://restbucks.com/request-for-quote"
    type="application/vnd.restbucks+xml"/>
</shop>
GET /shop

.../rfq

started
Design strategies

Entry point

Advertise capabilities
Get request-for-quote form

Request
GET /request-for-quote HTTP/1.1
Host: restbucks.com
Accept: application/vnd.restbucks+xml

Response
HTTP/1.1 200 OK
Date: Mon, 26 Jul 2010 10:00:05 GMT
Cache-Control: public, max-age=86400
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

&lt;model&gt;
  &lt;instance&gt;
    &lt;request-for-quote&gt;
      &lt;items/&gt;
    &lt;/request-for-quote&gt;
  &lt;/instance&gt;
  &lt;submission resource="http://restbucks.com/quotes" method="post" mediatype="application/vnd.restbucks+xml"/&gt;
&lt;/model&gt;
 Submit request for quote

Request

POST /quotes HTTP/1.1
Host: restbucks.com
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<request-for-quote>
  <items>
    <item>
      <description>Costa Rica Tarrazu</description>
      <amount>250g</amount>
    </item>
    <item>
      <description>Guatemala Elephant Beans</description>
      <amount>250g</amount>
    </item>
  </items>
</request-for-quote>
HTTP/1.1 201 Created
Cache-Control: public
Date: Mon, 26 Jul 2010 10:01:00 GMT
Location: http://restbucks.com/quotes/1234
Expires: Mon, 02 Aug 2010 10:01:00 GMT
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<quote>
  <items>
    ...
  </items>
  <link rel="self"
     href="http://restbucks.com/quotes/1234"
     type="application/vnd.restbucks+xml"/>
  <link rel="http://relations.restbucks.com/order-form"
     href="http://restbucks.com/order-forms/1234"
     type="application/vnd.restbucks+xml"/>
</quote>
Request quote

GET /request-for-quote

POST /quotes

quote requested

.../order-form

Location: http://restbucks.com/quotes/1234
Design strategies

**Typed link to form**
Link relation describes meaning of form in context of current representation

**Collection**
POST form to collection resource

**Caching**
Store infrequently changing representations closer to client
Navigate to order form

Request
GET /order-forms/1234
Host: restbucks.com
Accept: application/vnd.restbucks+xml
Return order form

Response

HTTP/1.1 200 OK
Cache-Control: public
Date: Mon, 26 Jul 2010 10:01:05 GMT
Expires: Mon, 02 Aug 2010 10:01:00 GMT
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<model>
  <instance>
    <quote>
      <items>
        ...
      </items>
      <link rel="self"
        href="http://restbucks.com/quotes/1234"
        type="application/vnd.restbucks+xml"/>
    </quote>
  </instance>
  <submission
    resource="http://restbucks.com/orders"
    method="post"
    mediatype="application/vnd.restbucks+xml"/>
</model>
Submit order form

Request

POST /orders HTTP/1.1
Host: restbucks.com
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<quote>
  <items>
    <item>
      <description>Costa Rica Tarrazu</description>
      <amount>250g</amount><price currency="GBP">4.40</price>
    </item>
    <item>
      <description>Guatemala Elephant Beans</description>
      <amount>250g</amount><price currency="GBP">5.30</price>
    </item>
  </items>
  <link rel="self"
       href="http://restbucks.com/quotes/1234"
       type="application/vnd.restbucks+xml"
       etag="quot;2ce742d8quot;"/>
</quote>
Indicate order submitted successfully

Response

HTTP/1.1 202 Accepted
Cache-Control: no-store
Date: Mon, 26 Jul 2010 10:02:00 GMT
Location: http://restbucks.com/orders/9876
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<link rel="http://relations.restbucks.com/order"
      href="http://restbucks.com/orders/9876"
      type="application/vnd.restbucks+xml"/>
Order

GET /order-forms/1234

POST /orders

goods ordered

202 Accepted
Design strategies

202 Accepted

Long-running operations
Successfully accepted request but result is not immediately available
Check state of order

Request
GET /orders/9876 HTTP/1.1
Host: restbucks.com
Accept: application/vnd.restbucks+xml

Response
HTTP/1.1 404 Not Found
Check state of order again

Request

GET /orders/9876 HTTP/1.1
Host: restbucks.com
Accept: application/vnd.restbucks+xml
Response

HTTP/1.1 200 OK
Cache-Control: public, max-age=0
Date: Mon, 26 Jul 2010 10:05:00 GMT
Etag: "4d3e88c9"
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<order>
  <status>Awaiting Payment</status>
  ...
  <link rel="self"
       href="http://restbucks.com/orders/9876"
       type="application/vnd.restbucks+xml"/>
  <link rel="http://relations.restbucks.com/quote"
       href="http://restbucks.com/quotes/1234"
       type="application/vnd.restbucks+xml"/>
  <link rel="payment"
       href="https://payments.example.org/payments/1010"
       type="application/vnd.example.org+xml"/>
  <link rel="http://relations.restbucks.com/cancellation"
       href="http://restbucks.com/orders/9876/cancellation"
       type="application/vnd.restbucks+xml"/>
</order>
Confirm order

GET /orders/9876

.../cancellation

payment

.../quote

self

order confirmed
Design strategies

Polling
Client guarantees delivery of notification

ETag
Efficient re-querying

Cache but revalidate strategy
Tradeoff between bandwidth usage and consistency
Navigate to payment form

Request
GET https://payments.example.org/payments/1010 HTTP/1.1
Accept: application/vnd.example.org+xml
Return payment form

Response

HTTP/1.1 200 OK
Cache-Control: private, max-age=3600
Date: Mon, 26 Jul 2010 10:05:05 GMT
Content-Type: application/vnd.example.org+xml
Content-Length: ...

<model>
  <instance>
    <payment>
      <link rel="http://relations.restbucks.com/order"
href="http://restbucks.com/orders/9876"
type="application/vnd.restbucks+xml"/>
      <card-type/>
      <name/>
      <card-number/>
      <security-code/>
    </payment>
  </instance>
  <submission
resource="https://payments.example.org/payments/1010"
method="post"
mediatype="application/vnd.example.org+xml"/>
</model>
Submit payment details

Request

POST https://payments.example.org/payments/1010 HTTP/1.1
Content-Type: application/vnd.example.org+xml
Content-Length: ...

<payment>
  <link rel="http://relations.restbucks.com/order"
       href="http://restbucks.com/orders/9876"
       type="application/vnd.restbucks+xml"/>
  <card-type>Visa Debit</card-type>
  <name>MR JOHN SMITH</name>
  <card-number>4876512418675010</card-number>
  <security-code>212</security-code>
</payment>
Get order

Request

GET /orders/9876 HTTP/1.1
Host: restbucks.com
Accept: application/vnd.restbucks+xml
If-None-Match: "4d3e88c9"
Response

HTTP/1.1 200 OK
Cache-Control: public, max-age=0
Date: Mon, 26 Jul 2010 10:06:05 GMT
Etag: "5612cfaa"
Content-Type: application/vnd.restbucks+xml
Content-Length: ...

<order>
  <status>Paid</status>
  <items>
    ...
  </items>
  <link rel="self"
    href="http://restbucks.com/orders/9876"
    type="application/vnd.restbucks+xml"/>
  <link rel="http://relations.restbucks.com/quote"
    href="http://restbucks.com/quotes/1234"
    type="application/vnd.restbucks+xml"/>
  <link rel="http://relations.restbucks.com/cancellation"
    href="http://restbucks.com/orders/9876/cancellation"
    type="application/vnd.restbucks+xml"/>
</order>
GET https://payments.example.org/payments/1010

POST https://payments.example.org/payments/1010

303 See Other

GET /orders/9876

paid

.../cancellation

self

.../quote
Design strategies

Protocol and media type composition
3rd party resources and protocol

POST Once Exactly (POE)
405 Method Not Allowed for subsequent POSTs

Resource state as a function of state of other resources
Order state partly function of state of payment resource
Enriching and transitioning application state

- Start
- Quote requested
- Goods ordered
- Order confirmed
- Paid
Procurement protocol resources (revised)
Thank you

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