RESTful Application Protocols

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ThoughtWorks®

Getting Things Done

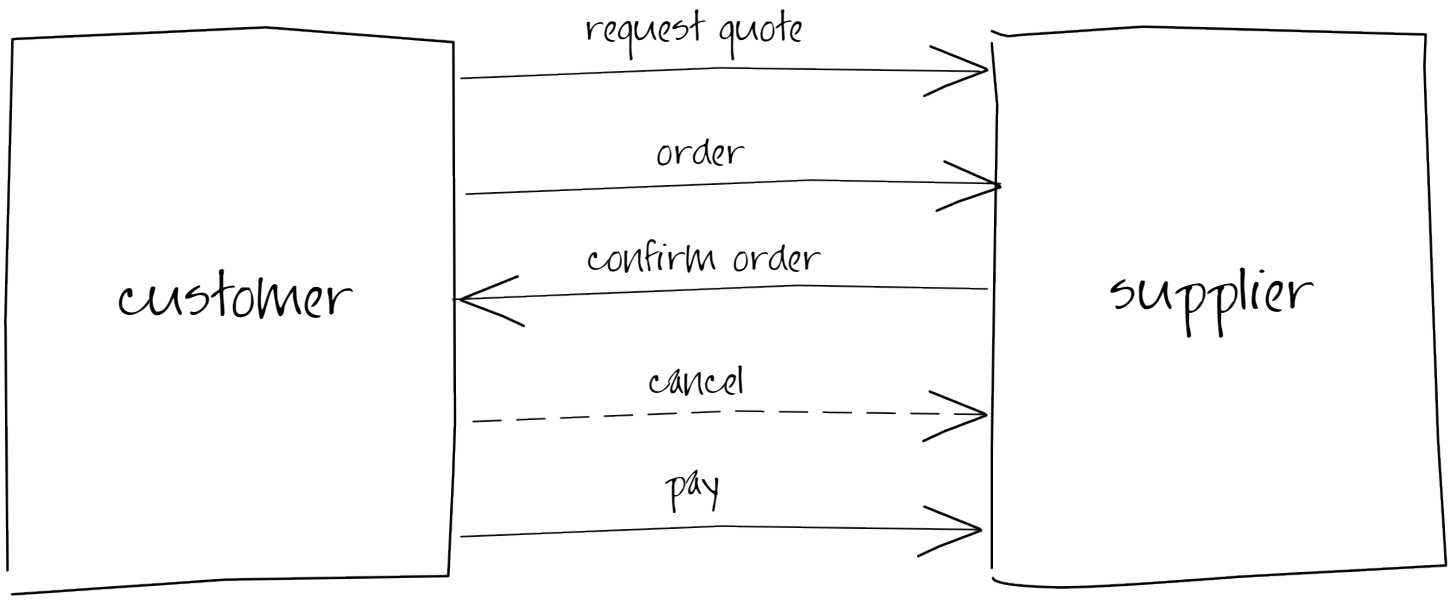
The hypermedia constraint

Hypermedia
as
the

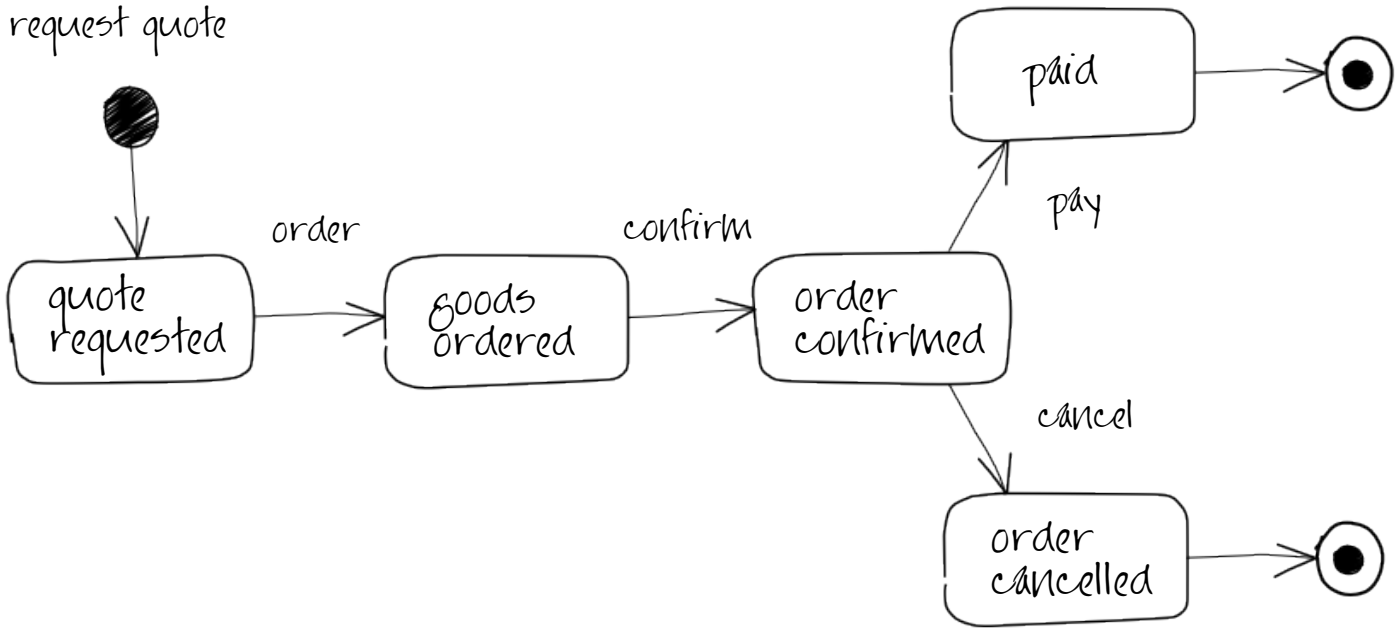
Engine
of

Application State

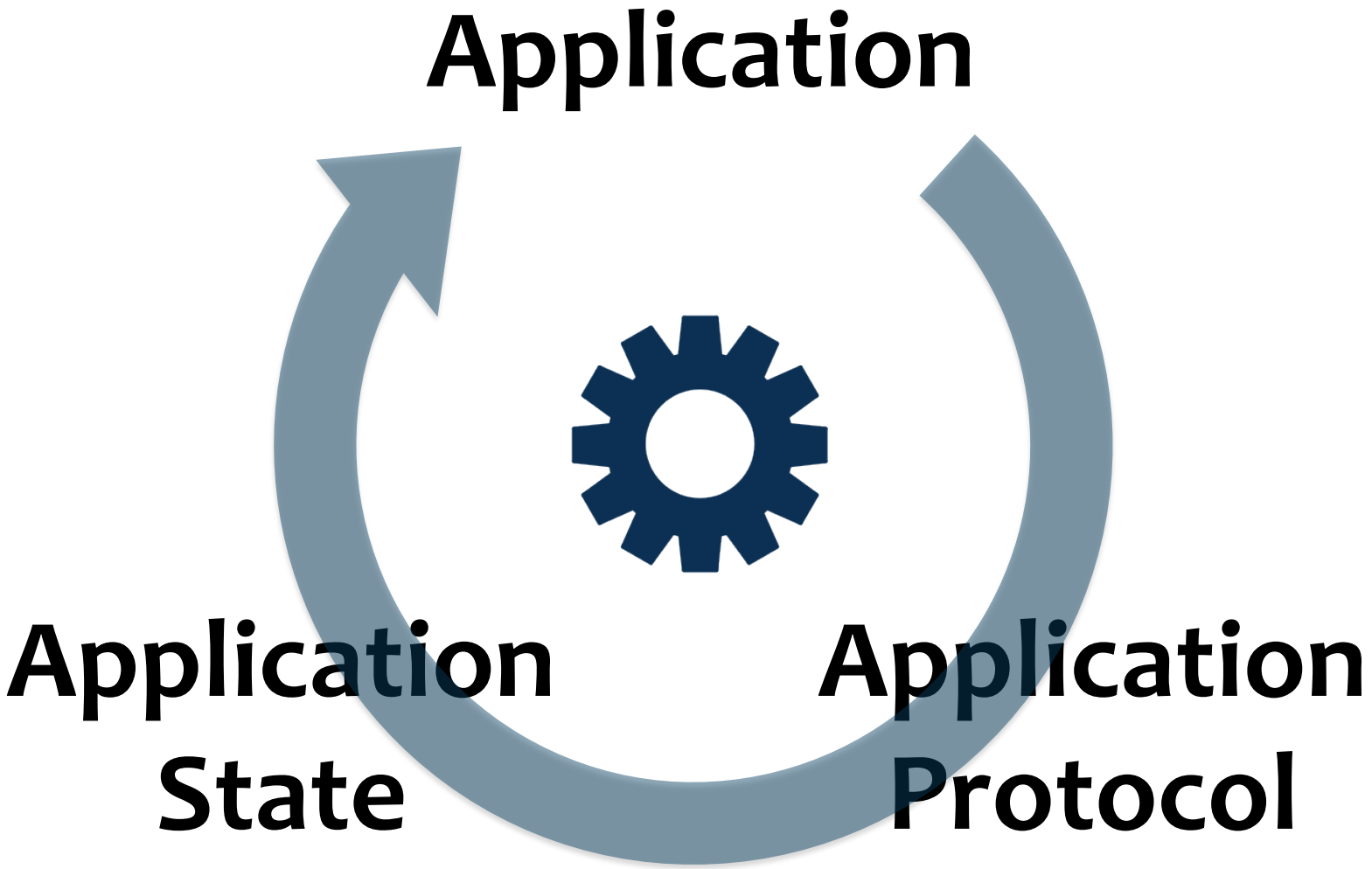
Procurement



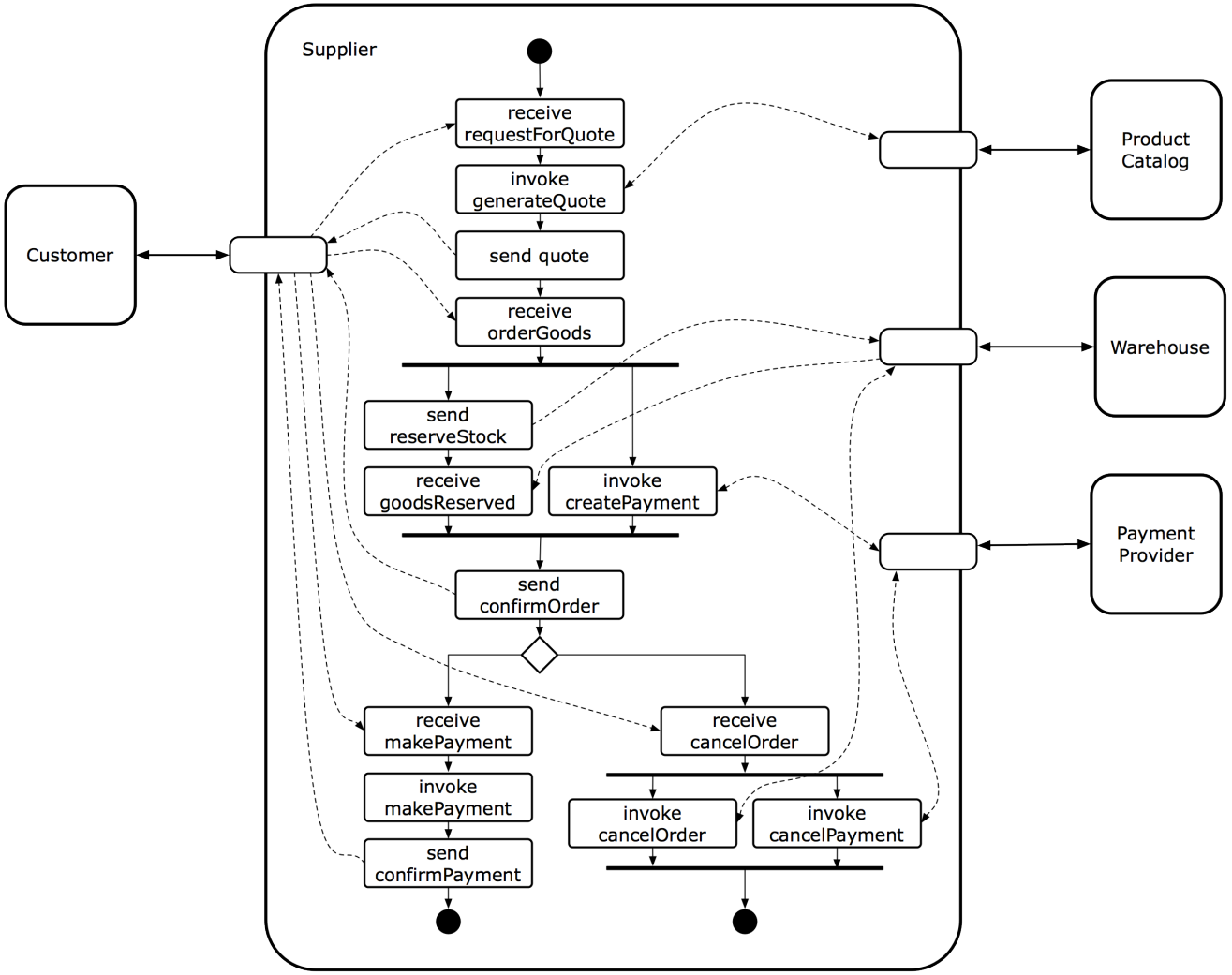
Procurement application state transitions



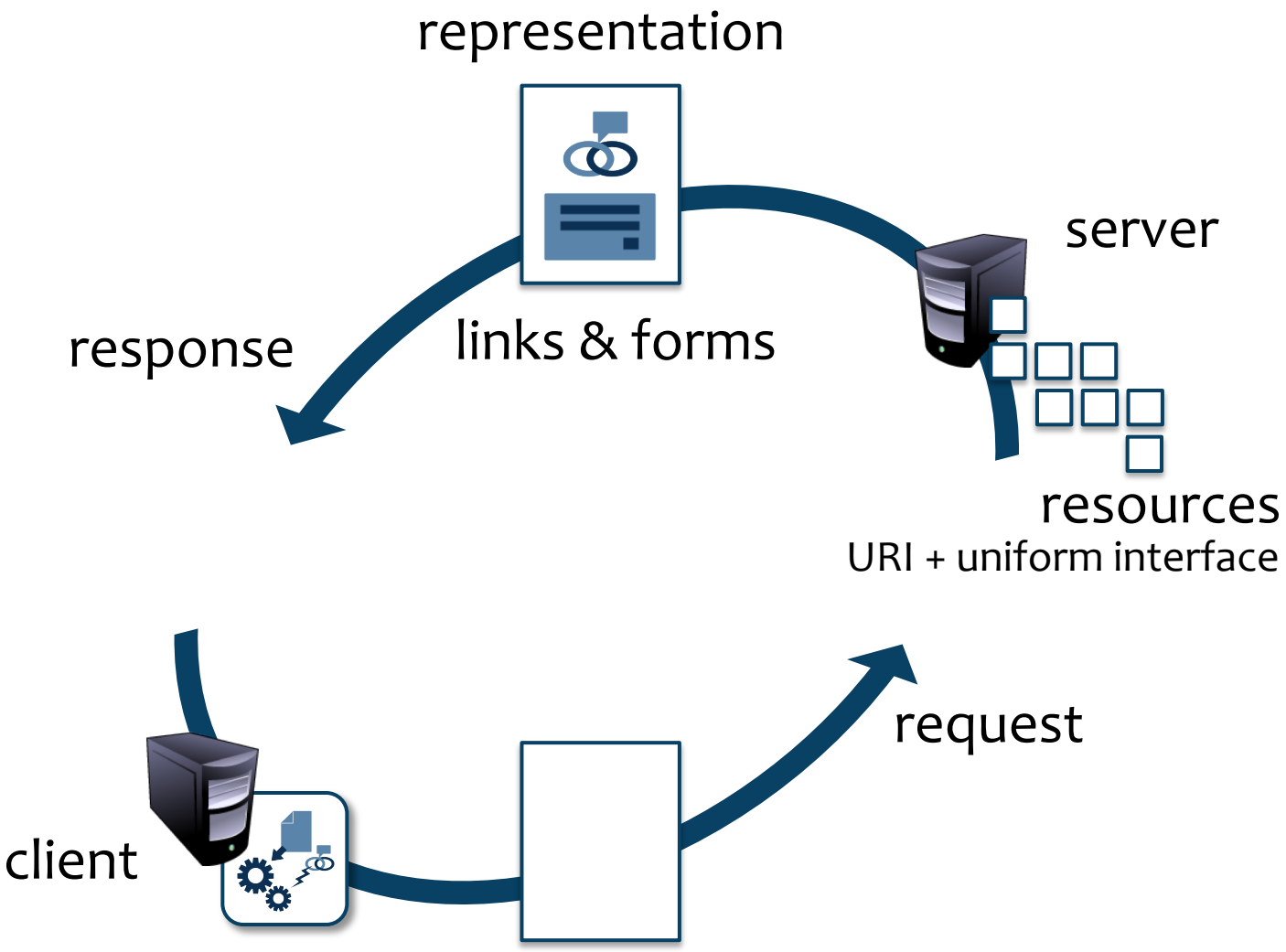
Releasing value



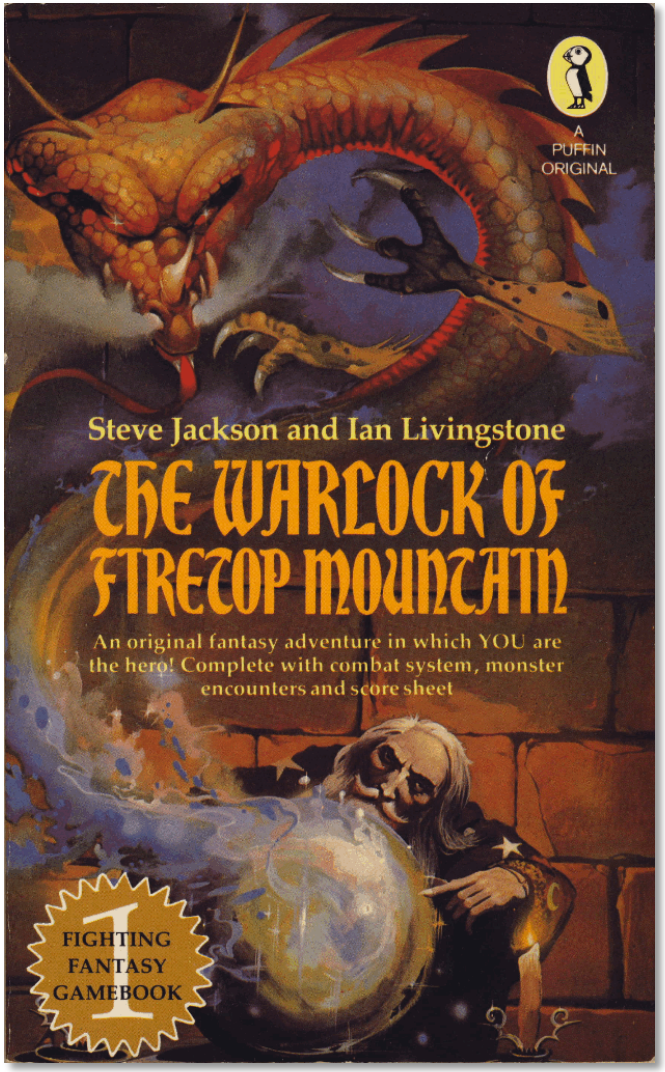
Composition service



Hypermedia systems transform application state



Pick your path protocols



79–80

hinges. Listening at the door, you hear strange mutterings and the clatter of what could be pots and pans. Whatever is in there, there are several of them. Do you want to go through the door (turn to **159**) or turn back (turn to **237**)?

79

The passageway ends in front of you in a dead end If you wish to search for secret passageways, turn to **137**. If not, return to the crossroads at **267**

80

The key fits the lock and opens the door You find yourself in a large boathouse. Various boats, in different stages of construction, are lying around Apart from the door behind you there is another in the north wall. As you enter, the Skeletons stop their work and crane their bony necks around to look at you. They pick up planks of wood and hammers and advance towards you There are five of them. Do you.

Smile nervously and back out of the door into the passage? Turn to **129**
Tell them you've come about buying a boat? Turn to **123**
Tell them you're their new boss and order them back to work? Turn to **195**
Draw your sword and prepare for battle? Turn to **140**

195–197

flies through the air directly at him, stops centimetres from his chest and falls to the floor. He looks up and smiles at you with an evil, gloating smile. What can you do:

Draw your sword and advance? Turn to **142**
Try something else from your backpack? Turn to **105**

195

This is a rather unlikely story, considering that they see very few humans around. Nevertheless, Skeletons are pretty dim – you knew this and that's why you tried the story. Roll one die. If you roll a 1 or 2, they don't believe you and keep on advancing. Turn to **140**.

A 3 or 4 means that they aren't sure, and send two of their number off through the north door whilst the rest hold you at bay with their weapons. Turn to **164**

A roll of 5 or 6 means they've believed you and they all get back to work! Turn to **9**. Add 2 LUCK points

196

You search the room. Try as you may you cannot find the secret switch to open the door in the bookshelf – the old man must have locked it from the inside. You do find 5 Gold Pieces in a drawer in the table. You decide to return to the junction to the south Turn to **280**

197

At the top of the stairs the passage turns sharply to

Hypermedia controls: links

HTML

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

Atom

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

OpenSearch

```
<Url type="application/restbucks+xml"
  template="/orders/?start={startPage?}"/>
```

Semantic context: typed links and link relations

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

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

Registered

`payment`

Indicates a resource where payment is accepted

Extension

`rb:order-form`

Indicates a resource where orders may be submitted

Hypermedia controls: forms

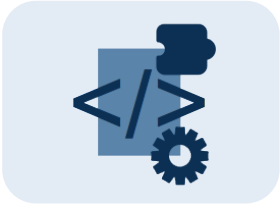
HTML

```
<form name="input"
  action="/registration"
  method="post"
  enctype="application/x-www-form-urlencoded">
  <input type="text" name="user" />
  <input type="submit" value="Submit" />
</form>
```

XForms

```
<model xmlns="http://www.w3.org/2002/xforms"
  schema="http://schemas.restbucks.com/rfq.xsd">
  <instance/>
  <submission
    resource="http://restbucks.com/quotes"
    method="post"
    mediatype="application/restbucks+xml"/>
</model>
```

RESTful API

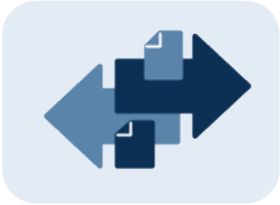


Media Types

Representation formats
Hypermedia controls
Processing models

Link Relations

Semantic context for links



HTTP Idioms

Coordinate data transfer

Example: Procurement App

Application start

Request

```
GET /shop HTTP/1.1
Host: restbucks.com
```

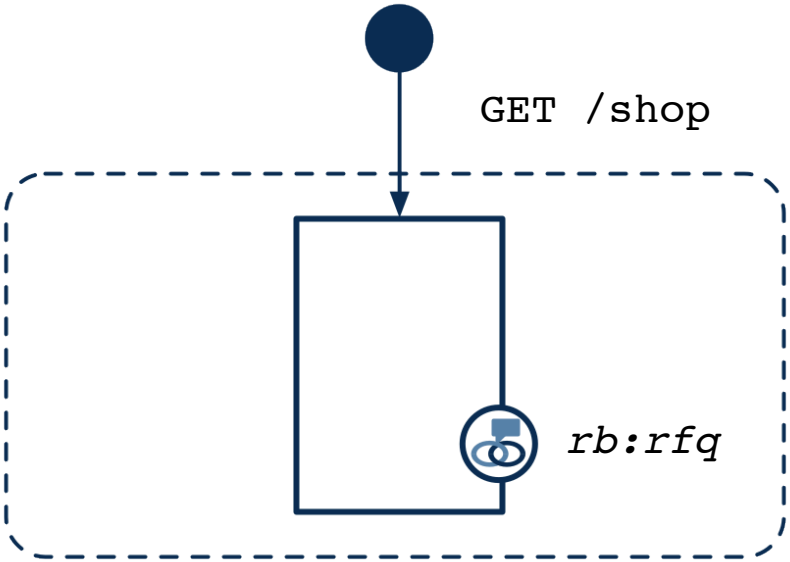
Response

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

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

Started

Started



Design strategies

Entry point

Advertise capabilities

Caching

Store infrequently changing representations closer to client

Get request-for-quote form

Request

```
GET /request-for-quote HTTP/1.1
Host: restbucks.com
```

Response

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

<model xmlns="http://www.w3.org/2002/xforms"
  schema="http://schemas.restbucks.com/shop.xsd">
  <instance/>
  <submission
    resource="http://restbucks.com/quotes"
    method="post"
    mediatype="application/restbucks+xml"/>
</model>
```

Submit request for quote

Request

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

<shop xmlns="http://schemas.restbucks.com/shop">
  <items>
    <item>
      <description>Costa Rica Tarrazu</description>
      <amount>250g</amount>
    </item>
    <item>
      <description>Elephant Beans</description>
      <amount>250g</amount>
    </item>
  </items>
</shop>
```

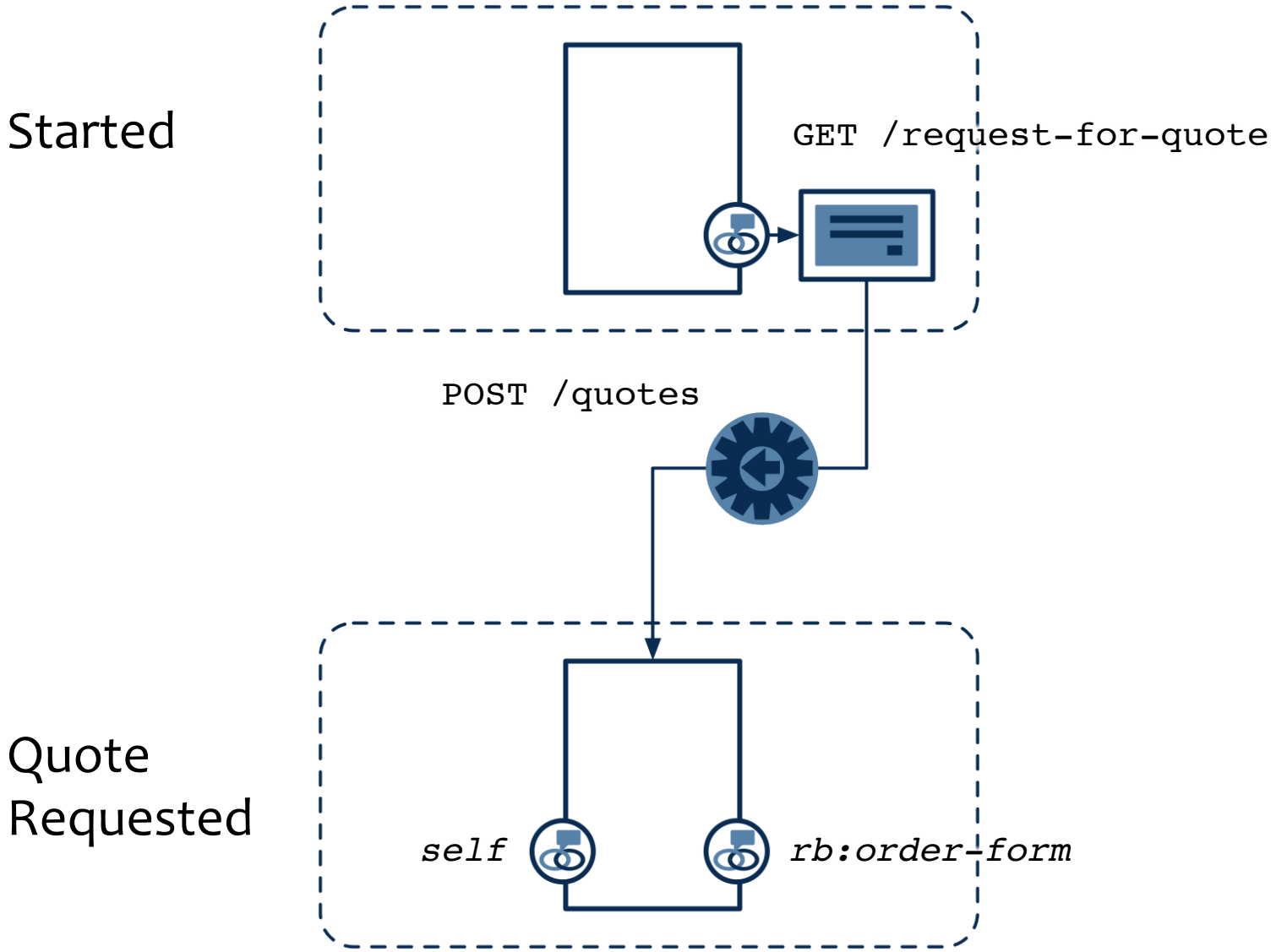
Return quote

Response

```
HTTP/1.1 201 Created
Date: Mon, 26 Jul 2010 10:01:00 GMT
Location: http://restbucks.com/quotes/1234
Content-Type: application/restbucks+xml
Content-Length: ...

<shop xmlns="http://schemas.restbucks.com/shop"
  xmlns:rb="http://relations.restbucks.com/">
  <items>
    <item>...</item>
    <item>...</item>
  </items>
  <link rel="self"
        href="http://restbucks.com/quotes/1234"
        type="application/restbucks+xml"/>
  <link rel="rb:order-form"
        href="http://restbucks.com/order-forms/1234"
        type="application/restbucks+xml"/>
</shop>
```

Started to Quote Requested



Design strategies

Typed link to form

Link relation describes meaning of form in context of current representation

Inline control data

Form provides inline control data—HTTP idioms

Collection

POST form to collection resource

Navigate to order form

Request

```
GET /order-forms/1234
Host: restbucks.com
```

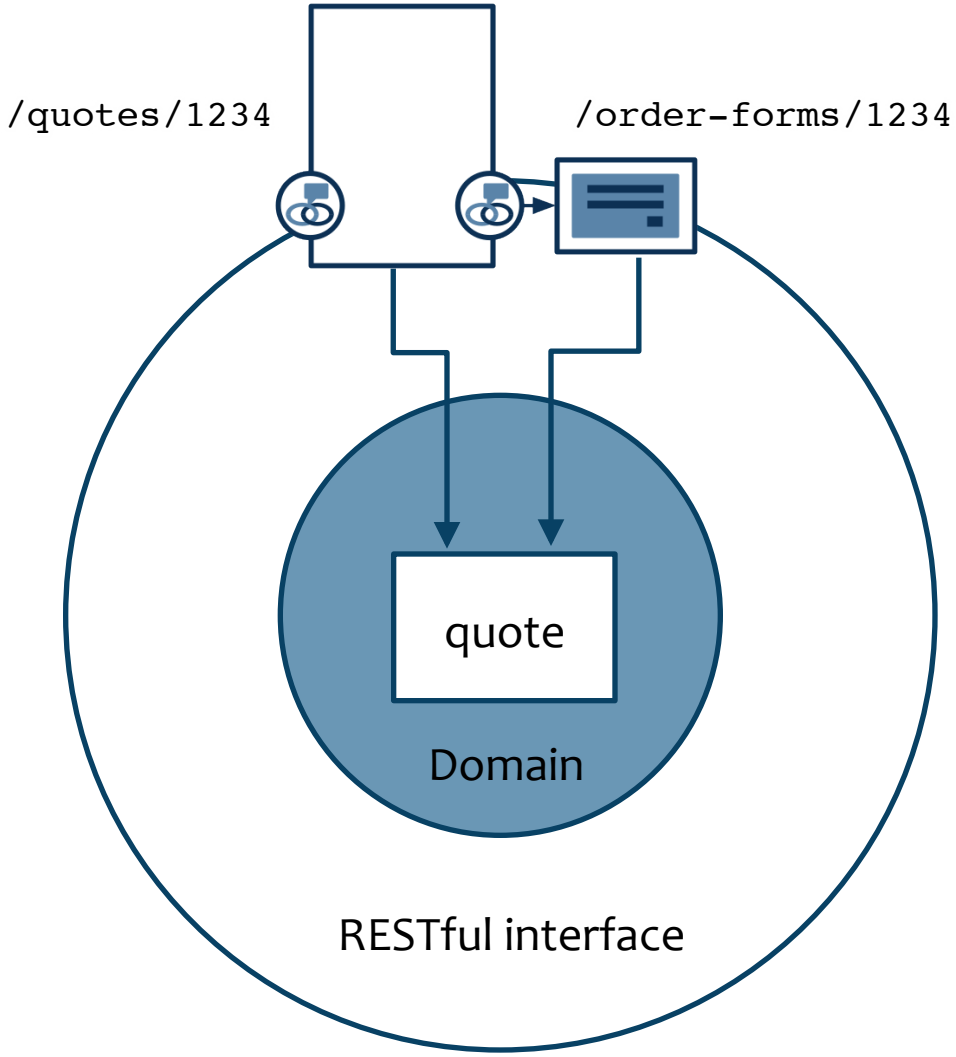
Return order form

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/restbucks+xml
Content-Length: ...
Content-Location: http://restbucks.com/quotes/1234

<model xmlns="http://www.w3.org/2002/xforms">
  <instance>
    <shop xmlns="http://schemas.restbucks.com/shop">
      <items>...</items>
      <link rel="self"
            href="http://restbucks.com/quotes/1234"
            type="application/restbucks+xml"/>
    </shop>
  </instance>
  <submission
    resource="http://restbucks.com/orders?c=99fe97e1
      ➥ &s=k2awEpciJkd2X8rt3NmgDg8AyUo%3D"
    method="post"
    mediatype="application/restbucks+xml"/>
</model>
```

Resources adapt the domain for hypermedia clients



Submit order form

Request

```
POST /orders?c=99fe97e1&s=k2awEpciJkd2X8rt3NmgDg8AyUo%3D HTTP/1.1
Host: restbucks.com
Content-Type: application/restbucks+xml
Content-Length: ...

<shop xmlns="http://schemas.restbucks.com/shop">
  <items>
    <item>
      <description>Costa Rica Tarrazu</description>
      <amount>250g</amount>
      <price currency="GBP">4.40</price>
    </item>
    <item>
      <description>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/restbucks+xml"/>
</shop>
```

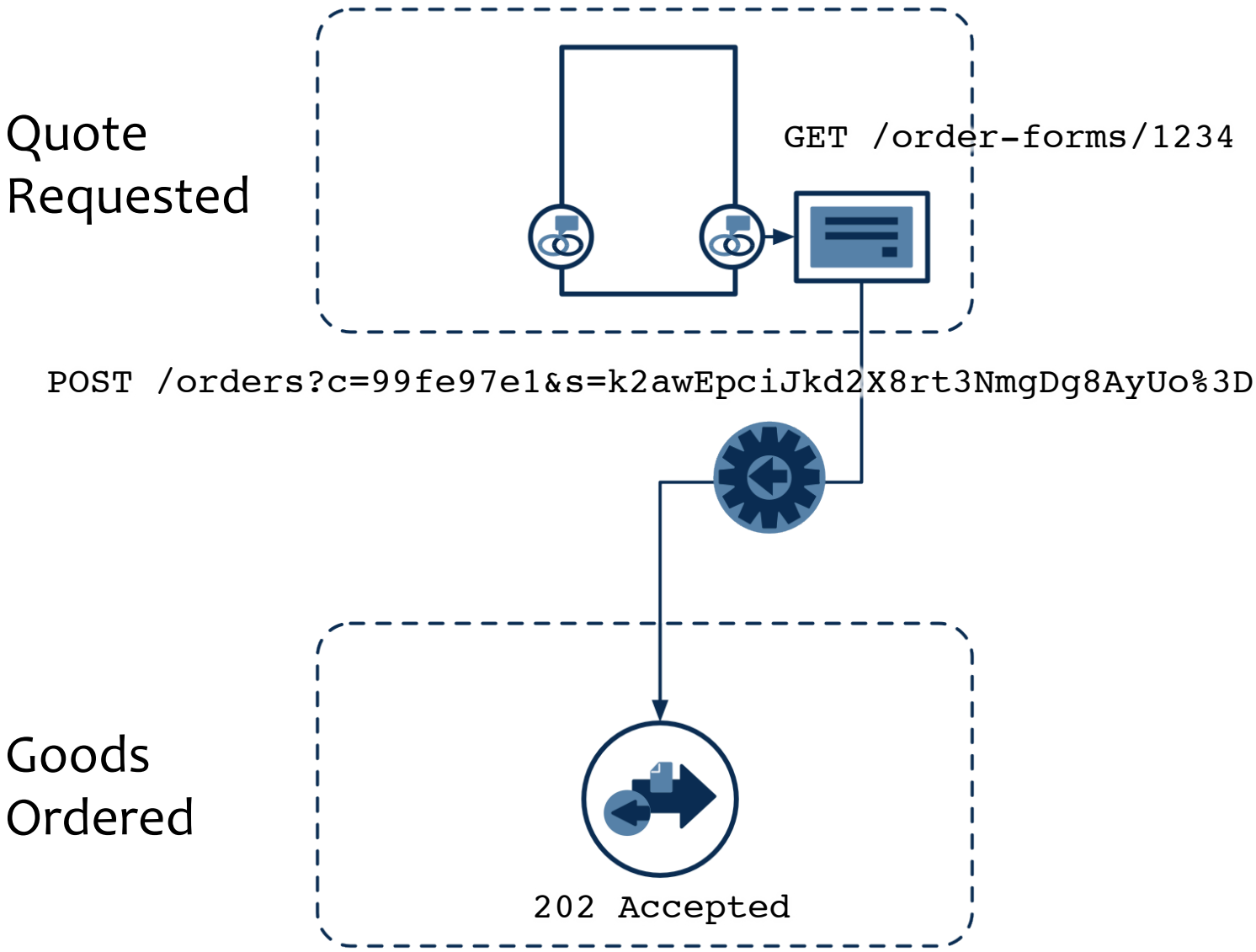
Indicate order submitted successfully

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/restbucks+xml
Content-Length: ...

<shop xmlns="http://schemas.restbucks.com/shop"
  xmlns:rb="http://relations.restbucks.com/">
  <status>Initializing</status>
  <link rel="rb:order"
    href="http://restbucks.com/orders/9876"
    type="application/restbucks+xml"/>
</shop>
```

Quote Requested to *Goods Ordered*



Design strategies

Prefilled form

Alternate representation of quote data, adapted for submitting an order

One-time URI

Tamper proofing

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
```

Response

```
HTTP/1.1 404 Not Found
```

Check state of order again

Request

```
GET /orders/9876 HTTP/1.1
Host: restbucks.com
```

Return order

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/restbucks+xml

<shop xmlns="http://schemas.restbucks.com/shop"
  xmlns:rb="http://relations.restbucks.com/">
  <status>Awaiting Payment</status>
  <items>...</items>
  <link rel="self"
        href="http://restbucks.com/orders/9876"
        type="application/restbucks+xml"/>
  <link rel="rb:quote"
        href="http://restbucks.com/quotes/1234"
        type="application/restbucks+xml"/>
  <link rel="payment"
        href="https://example.org/payments/1010"
        type="application/xhtml+xml"/>
  <link rel="rb:cancellation"
        href="http://restbucks.com/orders/9876/cancel"
        type="application/restbucks+xml"/>
</shop>
```

ETag header

Opaque “checksum” of resource state
When resource changes, entity tag changes
Strategies: hash, file attribute, GUID, version number, etc.

Conditional GET

`If-None-Match: <etag value>`

“Return a full response only if the resource *has* changed”

`304 Not Modified`

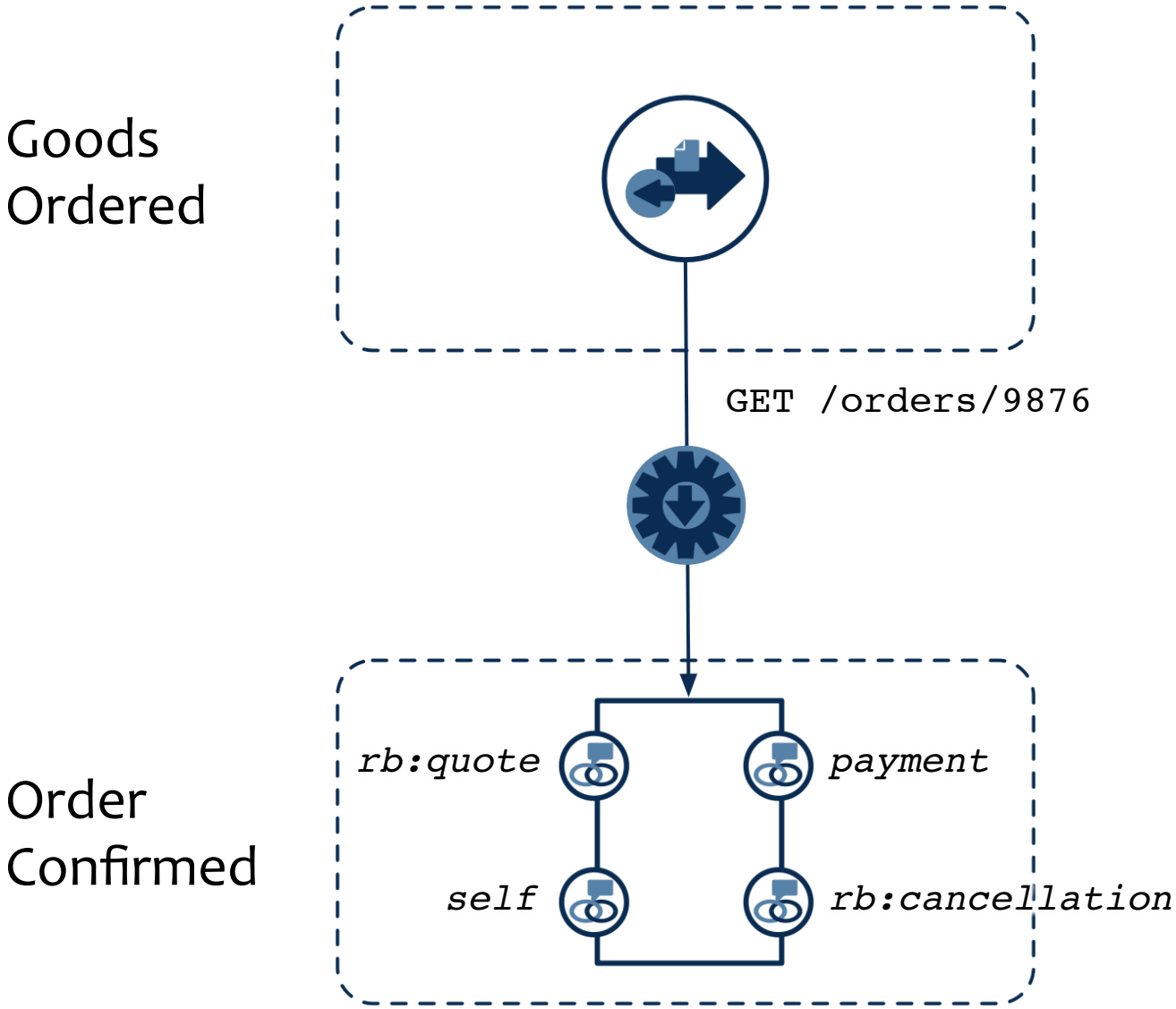
Conditional POST/PUT

`If-Match: <etag value>`

“Process this request only if the resource *hasn’t* changed”

`412 Precondition Failed`

Goods Ordered to 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://example.org/payments/1010 HTTP/1.1
```

Return payment form

Response

```
HTTP/1.1 200 OK
Cache-Control: no-store
Date: Mon, 26 Jul 2010 10:05:05 GMT
Content-Type: application/xhtml+xml
Content-Length: ...

<html xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <title>Payment</title>
  </head>
  <body>
    <form method="post"
      action="https://example.org/payments/1010"
      enctype="application/x-www-form-urlencoded">
      <input type="text" name="card-type"/>
      <input type="text" name="name"/>
      <input type="text" name="card-number"/>
      <input type="text" name="security-code"/>
      <input type="submit" value="Submit"/>
    </form>
  </body>
</html>
```

Submit payment details

Request

```
POST https://example.org/payments/1010 HTTP/1.1
Content-Type: application/x-www-form-urlencoded
Content-Length: ...

card-type=Visa+Debit&name=MR+JOHN+SMITH
➥ &card-number=4876512418675010&security-code=212
```

Confirm payment

Response

```
HTTP/1.1 200 OK
Cache-Control: no-store
Date: Mon, 26 Jul 2010 10:06:00 GMT
Content-Type: application/xhtml+xml
Content-Length: ...

<html xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <title>Payment Confirmation</title>
  </head>
  <body>
    <form method="post"
      action="http://restbucks.com/payments/9876"
      enctype="application/x-www-form-urlencoded">
      <input type="hidden"
        name="confirmation-id">6a0806ca</input>
      <input type="continue" value="Continue"/>
    </form>
  </body>
</html>
```

Notify Restbucks

Request

```
POST /payments/9876 HTTP/1.1
Host: restbucks.com
Content-Type: application/x-www-form-urlencoded
Content-Length: ...

confirmation-id=6a0806ca
```

Response

```
HTTP/1.1 303 See Other
Date: Mon, 26 Jul 2010 10:06:02 GMT
Location: http://restbucks.com/orders/9876
```

Get order

Request

```
GET /orders/9876 HTTP/1.1
Host: restbucks.com
If-None-Match: "4d3e88c9"
```

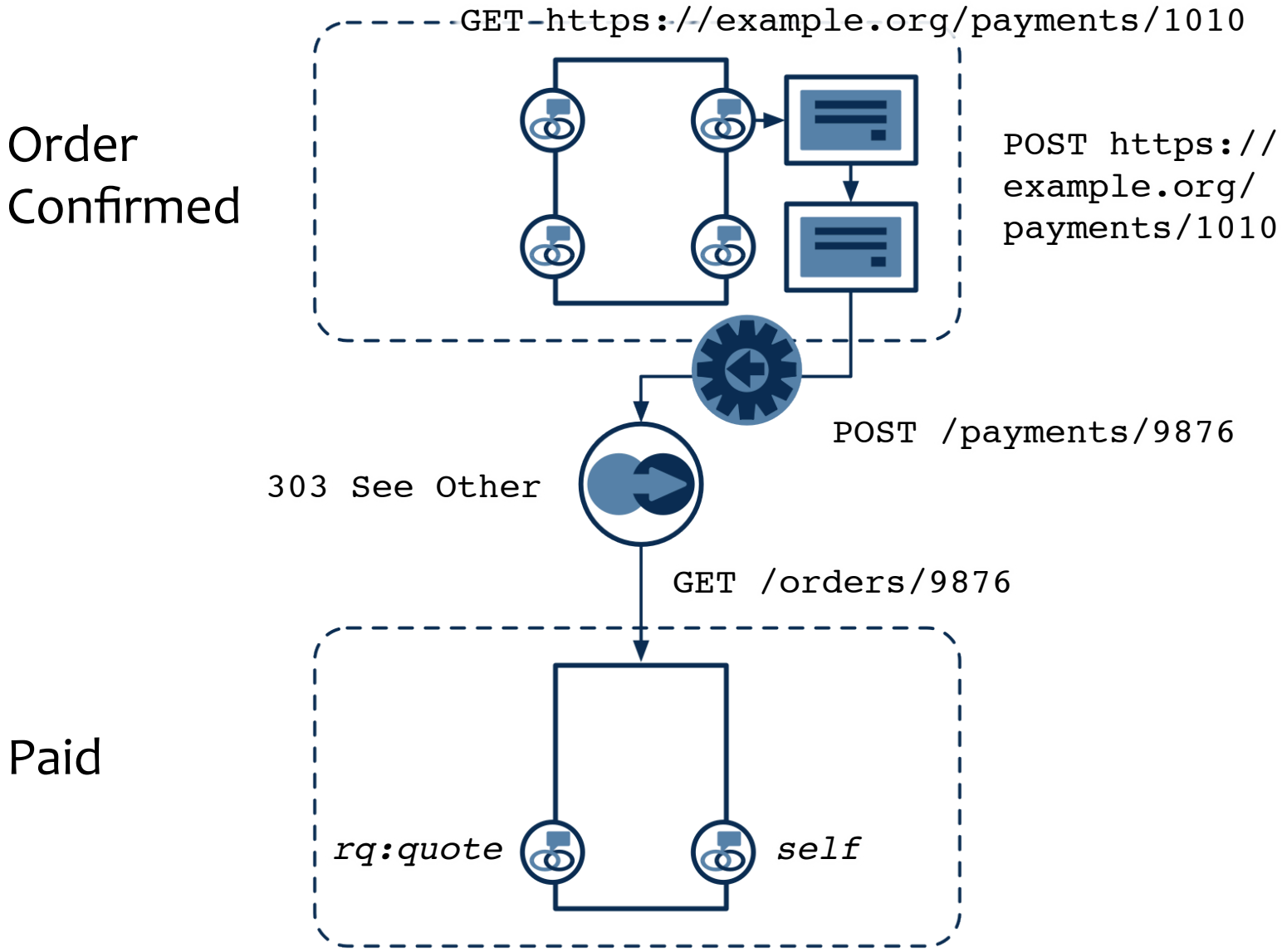
Return order

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/restbucks+xml
Content-Length: ...

<shop xmlns="http://schemas.restbucks.com/shop"
  xmlns:rb="http://relations.restbucks.com/">
  <status>Paid</status>
  <items>
    <item>...</item>
    <item>...</item>
  </items>
  <link rel="self"
        href="http://restbucks.com/orders/9876"
        type="application/restbucks+xml"/>
  <link rel="rb:quote"
        href="http://restbucks.com/quotes/1234"
        type="application/restbucks+xml"/>
</shop>
```

Order Confirmed to Paid



Design strategies

Protocol and media type composition

3rd party resources and protocol

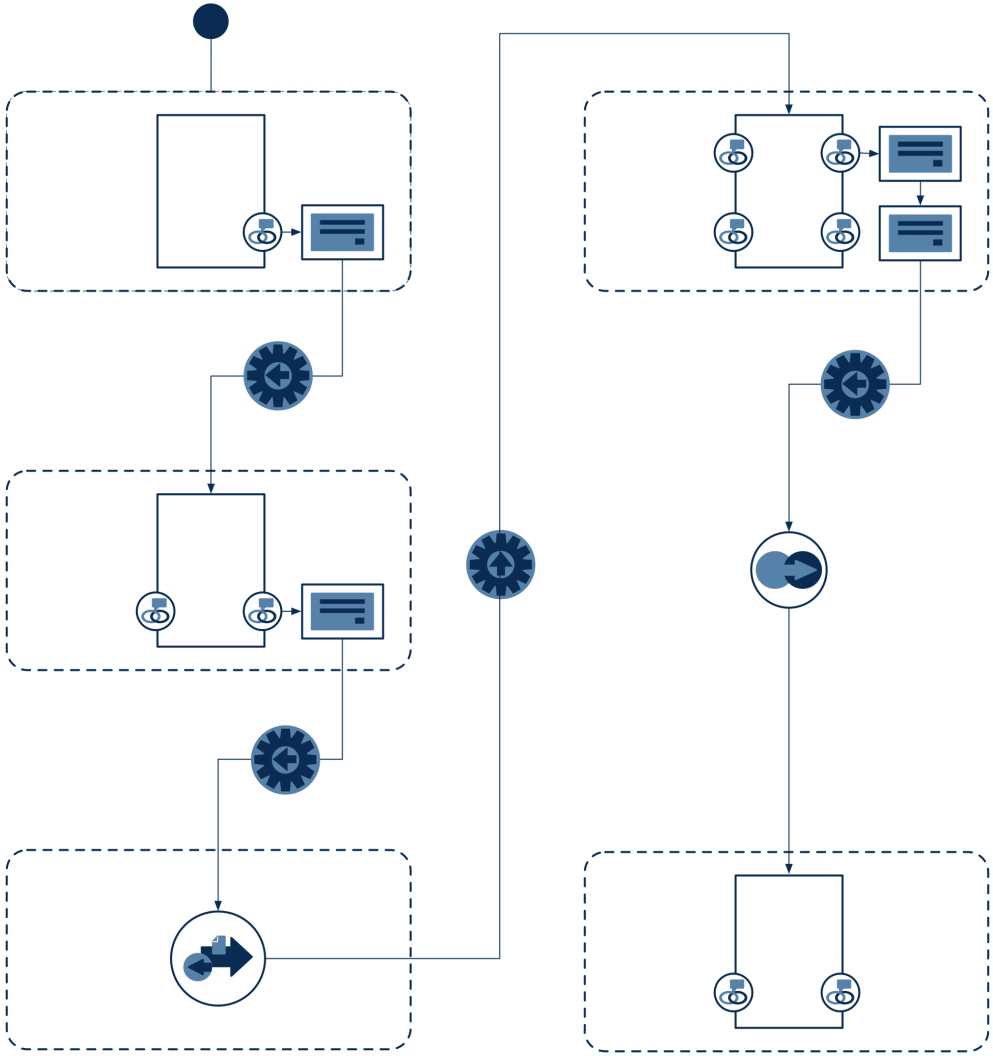
Idempotent POST

Implement idempotency on server side
Client still expects `POST` to be non-idempotent
`405 Method Not Allowed` for subsequent `POST`s

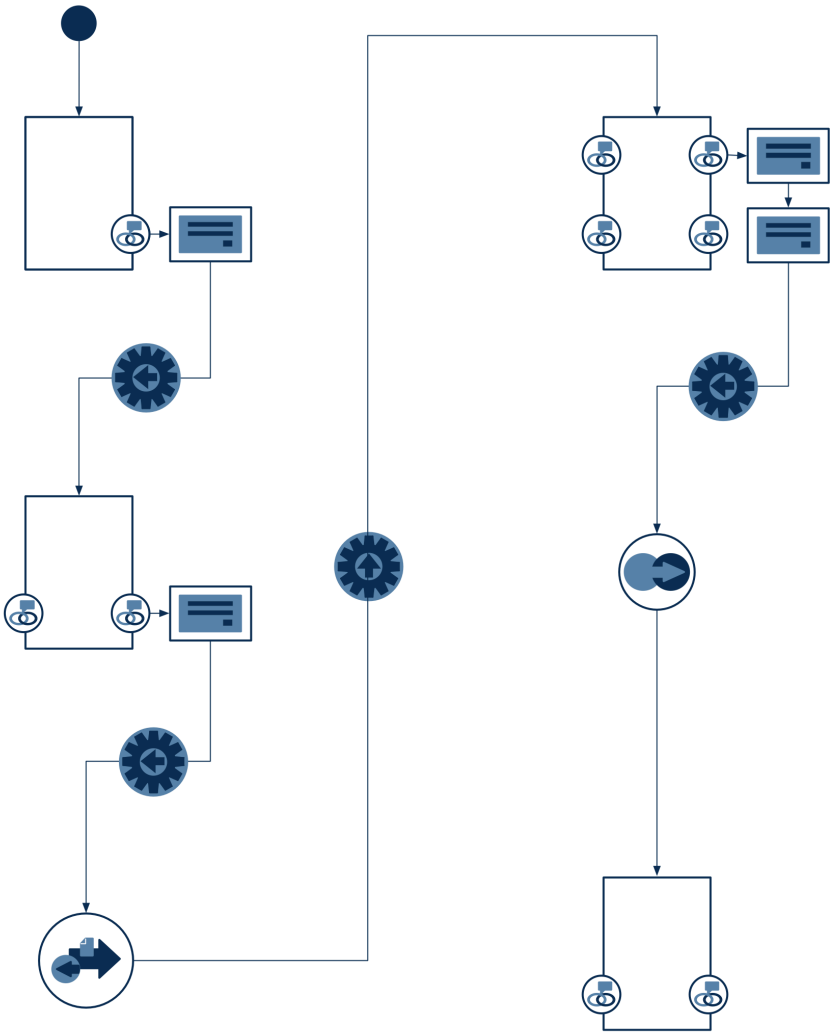
Resource state as a function of state of other resources

Order state partly function of state of payment resource

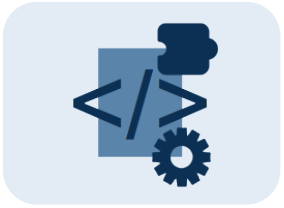
Enriching and transitioning application state



A community of resources



Procurement API



Media Types

```
application/restbucks+xml
application/xhtml+xml
```

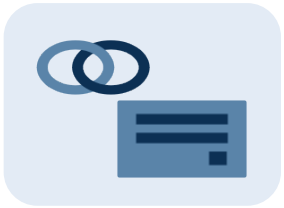
Link relations

```
self
payment
```

application/restbucks+xml

Schemas

`http://schemas.restbucks.com/shop`



Hypermedia controls

`<link>` element

XForms 1.1

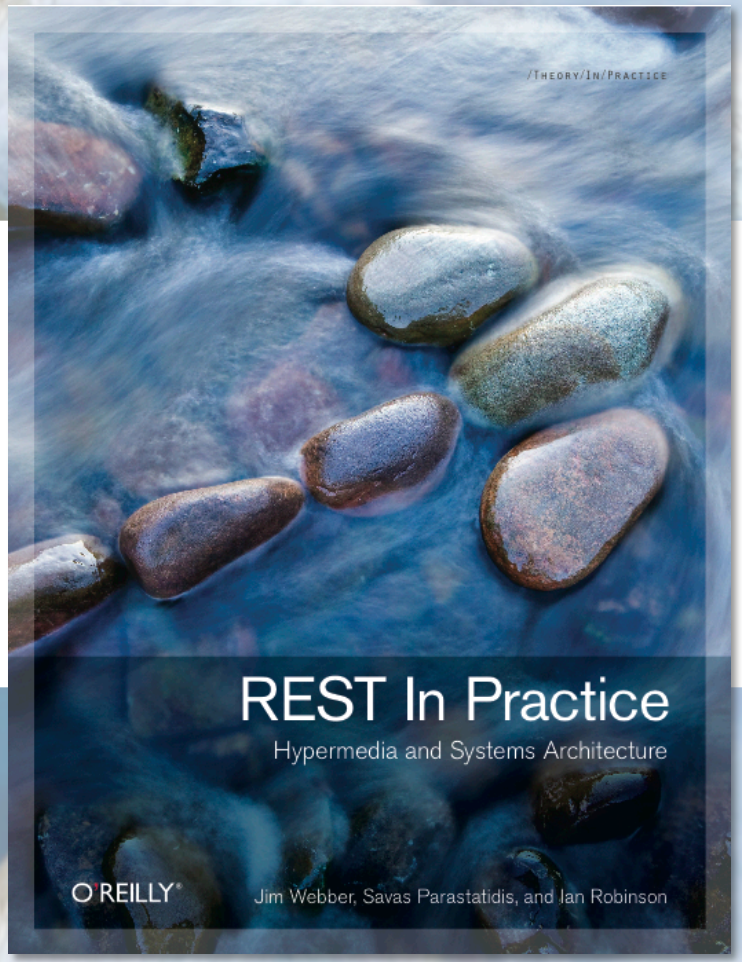
Link relations

`rb:quote`
`rb:cancellation`
`rb:rfq`
`rb:order-form`
`rb:order`

Processing model

XForms 1.1 Core

Thank you



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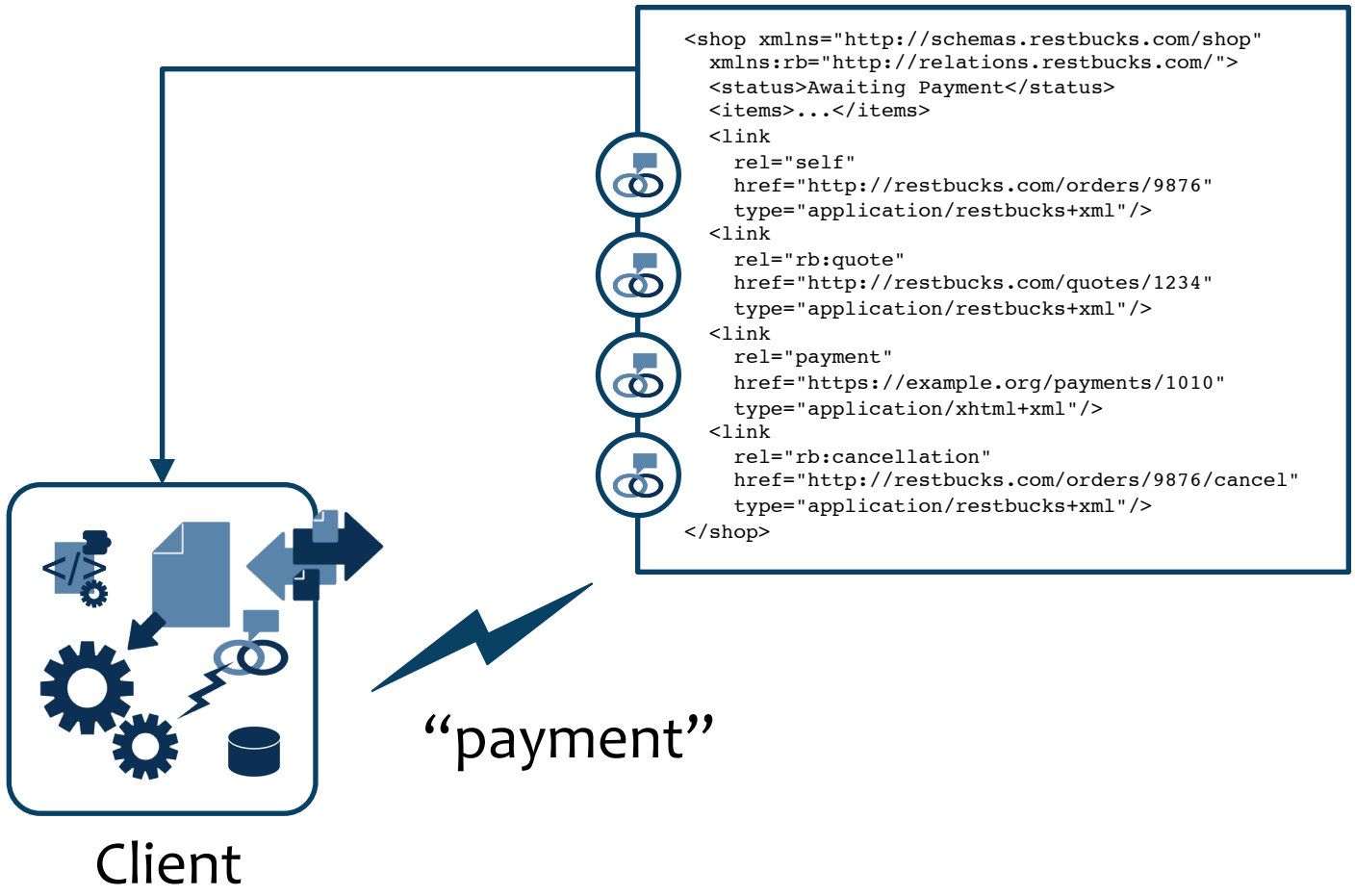
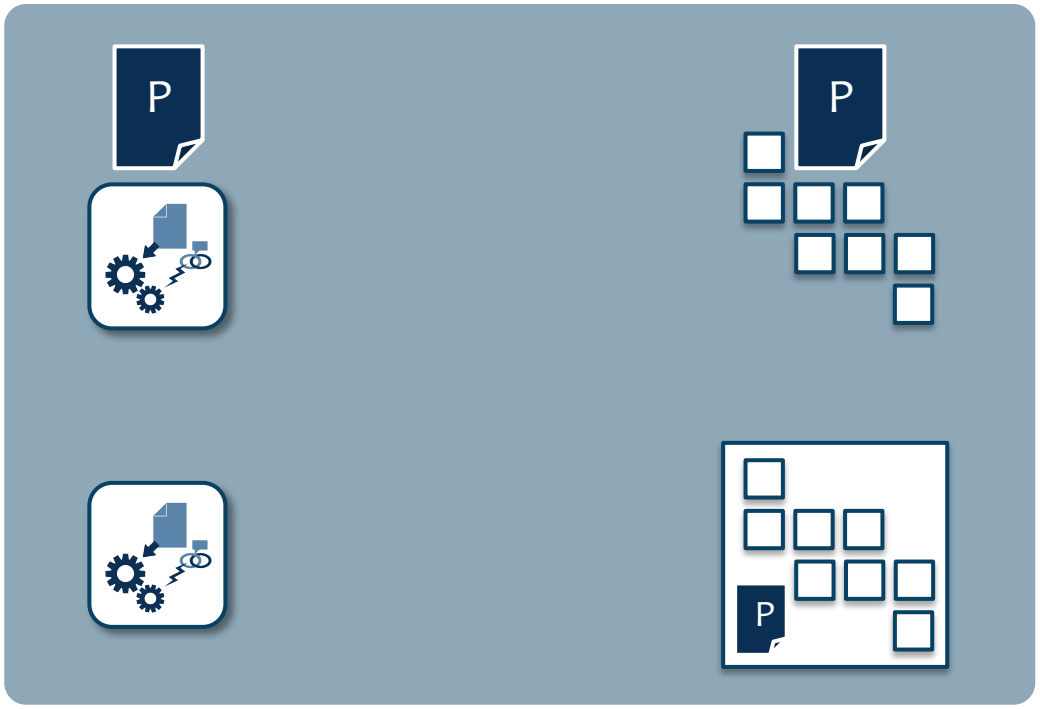
Agents, events and hypermedia event handlers



Who applies the protocol?



Strong coupling

"Orchestration"

Application state

Bottleneck

"Choreography"

Resource state

Distributable

Discretely testable