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A Couple of Ways to Skin an Internet-Scale Cat

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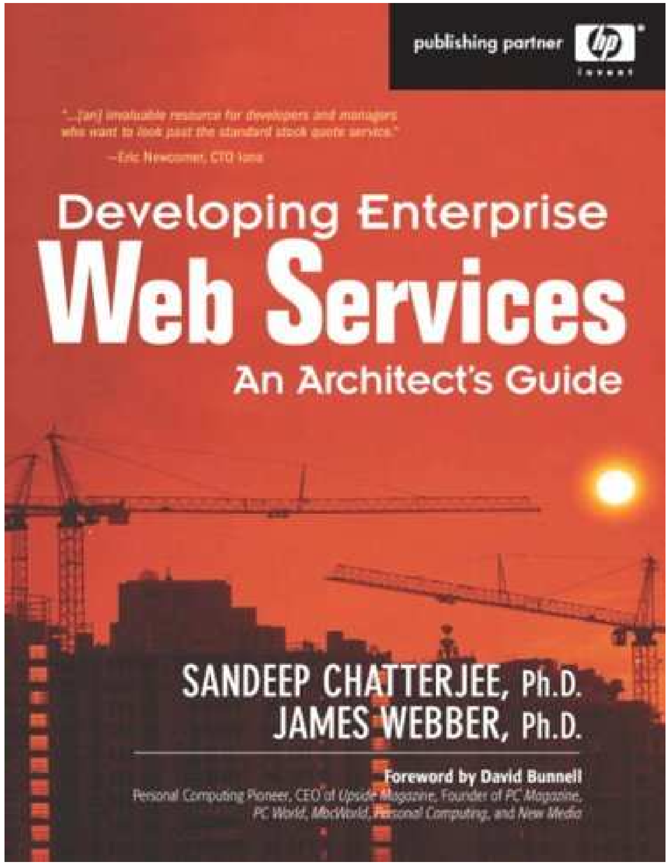
Roadmap

- A little Swedish
- Some home truths
  - About Web Services *and* the Web
- Implementing Workflows
  - The Starbuck's example
- Q&A

Jag heter Jim und kommer du England

- I like Web Services
  - I am a MESTian at heart
- I like the Web
  - I have sympathies that lie with the RESTafarians

- I wrote this book, about WS-*


publishing partner hp invent
"...[an] invaluable resource for developers and managers who want to look past the standard stock quote service."
—Eric Newcomer, CTO Iona
Developing Enterprise
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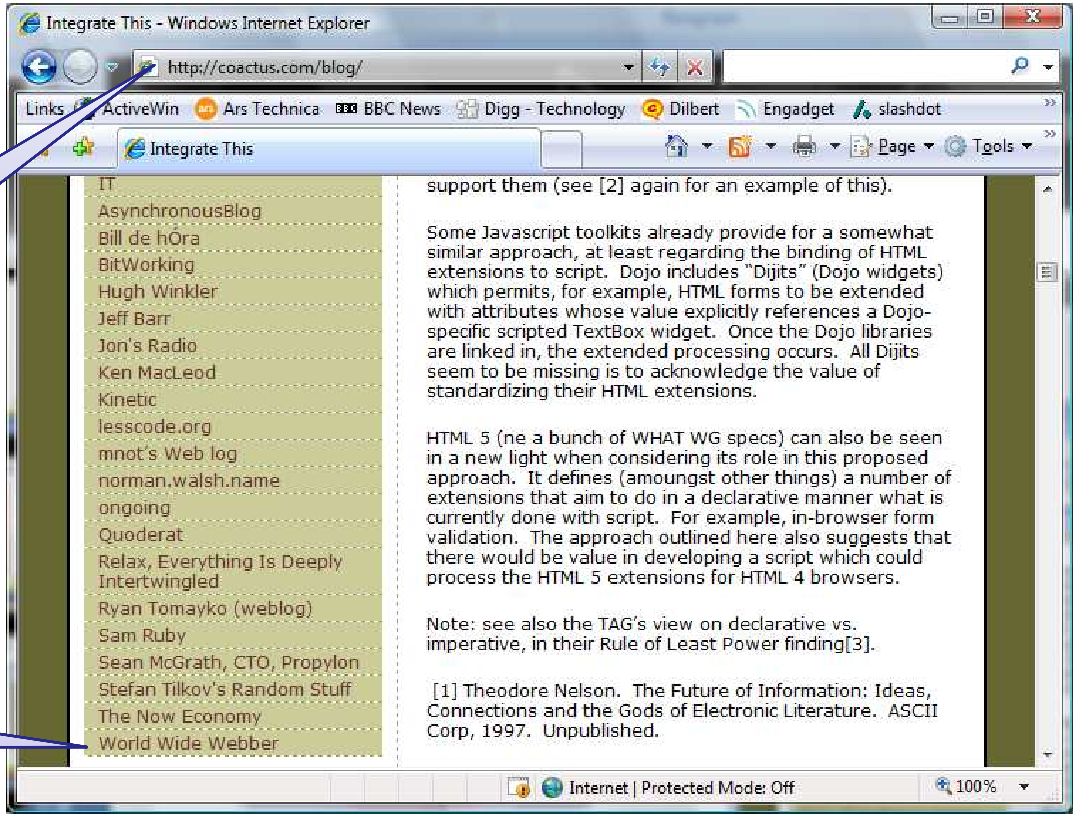
An Architect's Guide
SANDEEP CHATTERJEE, Ph.D.
JAMES WEBBER, Ph.D.
Foreword by David Bunnell
Personal Computing Pioneer, CEO of Upside Magazine, Founder of PC Magazine, PC World, MacWorld, Personal Computing, and New Media

Jag heter Jim und kommer du England

- I like Web Services
  - I am a MESTian at heart
- I like the Web
  - But I have sympathies that lie with the RESTafarians
- I am "similarly minded"



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ongoing
Quoderat
Relax, Everything Is Deeply Intertwingled
Ryan Tomayko (weblog)
Sam Ruby
Sean McGrath, CTO, Propylon
Stefan Tilkov's Random Stuff
The Now Economy
World Wide Webber

support them (see [2] again for an example of this).

Some Javascript toolkits already provide for a somewhat similar approach, at least regarding the binding of HTML extensions to script. Dojo includes "Dijits" (Dojo widgets) which permits, for example, HTML forms to be extended with attributes whose value explicitly references a Dojo-specific scripted TextBox widget. Once the Dojo libraries are linked in, the extended processing occurs. All Dijits seem to be missing is to acknowledge the value of standardizing their HTML extensions.

HTML 5 (ne a bunch of WHAT WG specs) can also be seen in a new light when considering its role in this proposed approach. It defines (amoungst other things) a number of extensions that aim to do in a declarative manner what is currently done with script. For example, in-browser form validation. The approach outlined here also suggests that there would be value in developing a script which could process the HTML 5 extensions for HTML 4 browsers.

Note: see also the TAG's view on declarative vs. imperative, in their Rule of Least Power finding[3].

[1] Theodore Nelson. The Future of Information: Ideas, Connections and the Gods of Electronic Literature. ASCII Corp, 1997. Unpublished.

Mark Baker's consulting company, Coactus

That's me

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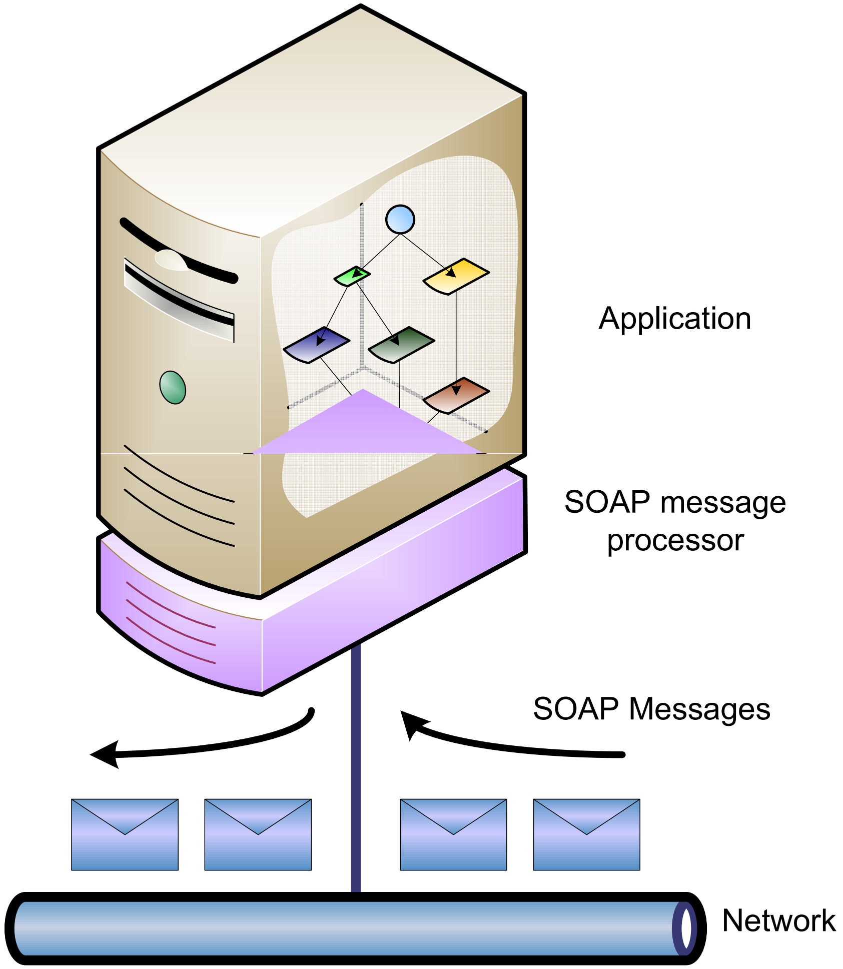
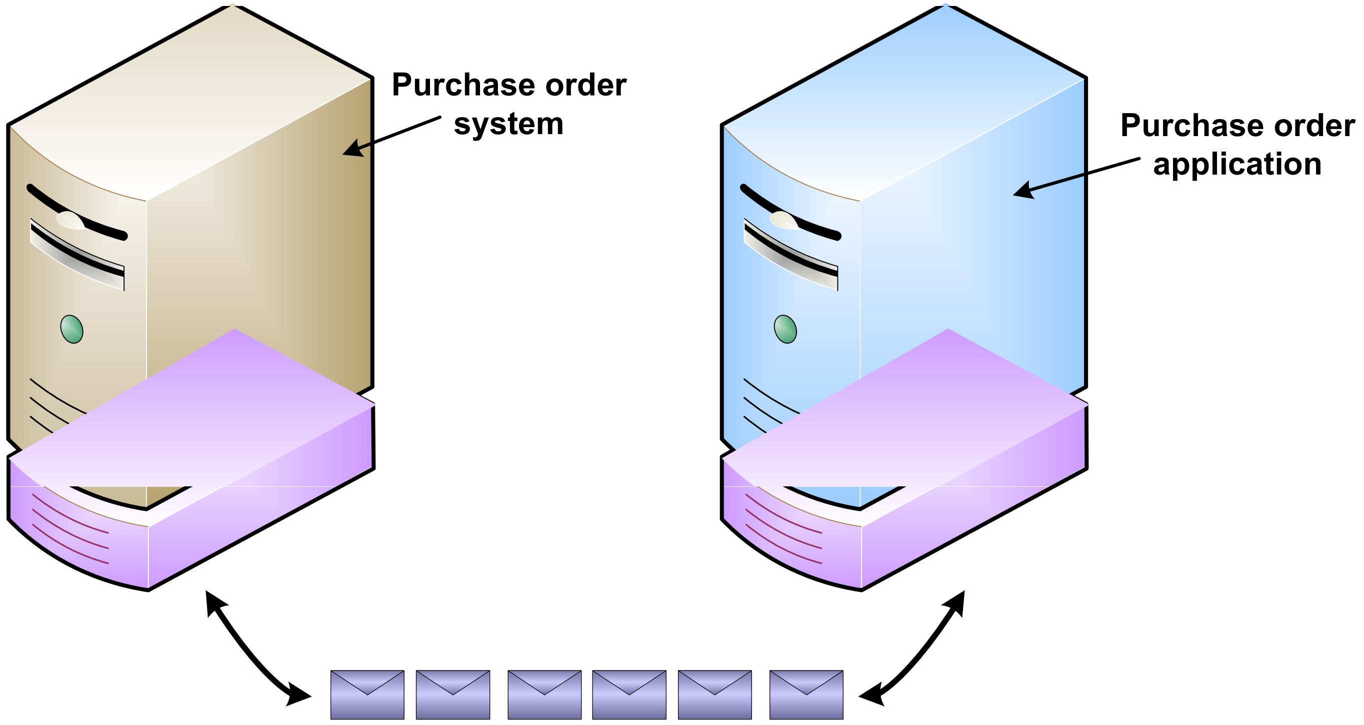
What is a Web Service?

- A Web Service is a system which exposes a message oriented-interface whose messages are in SOAP format
  - –SOAP is the lowest point in the WS stack
- A Web Service is just a technical mechanism for hosting a business process

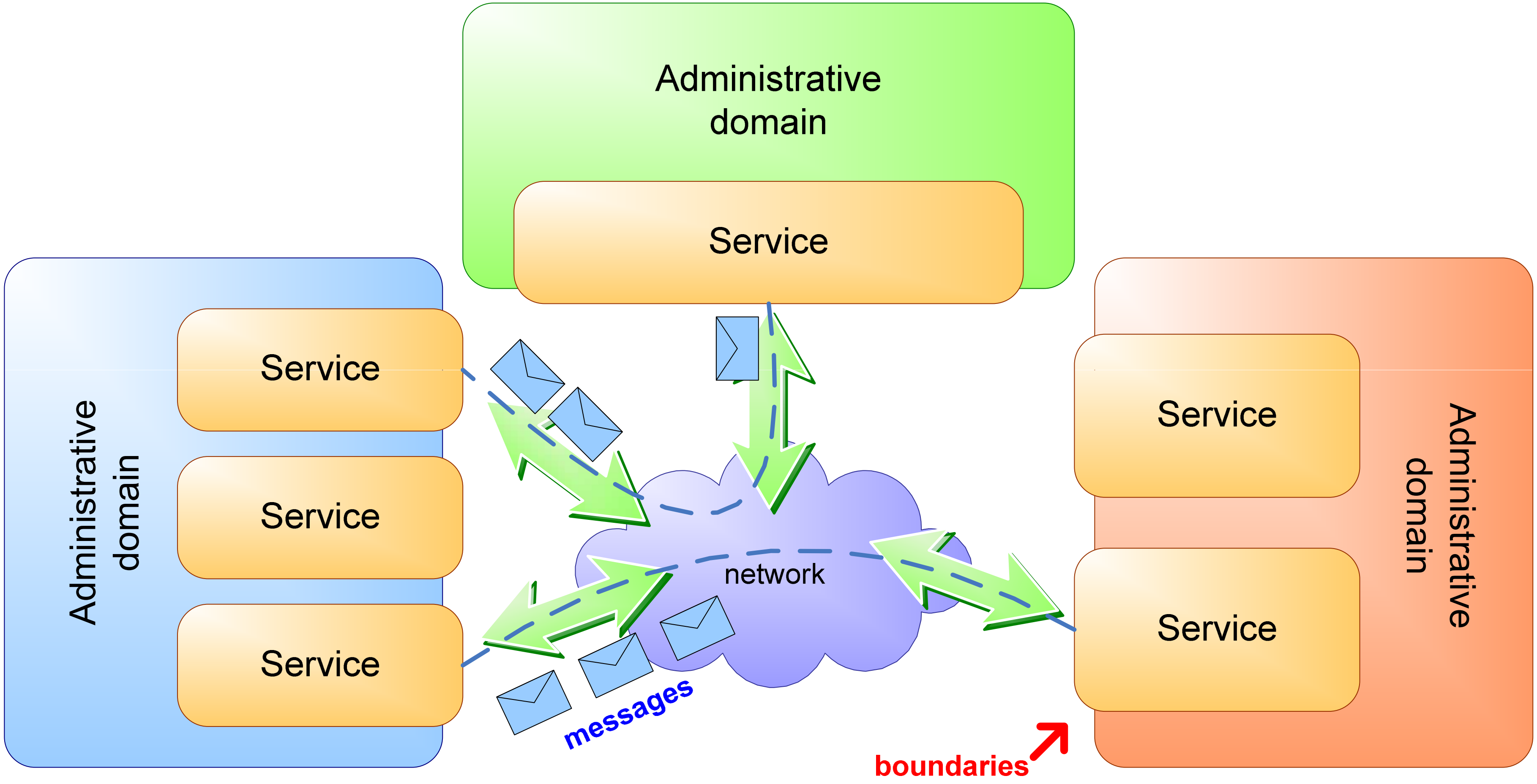


A Web Services Application

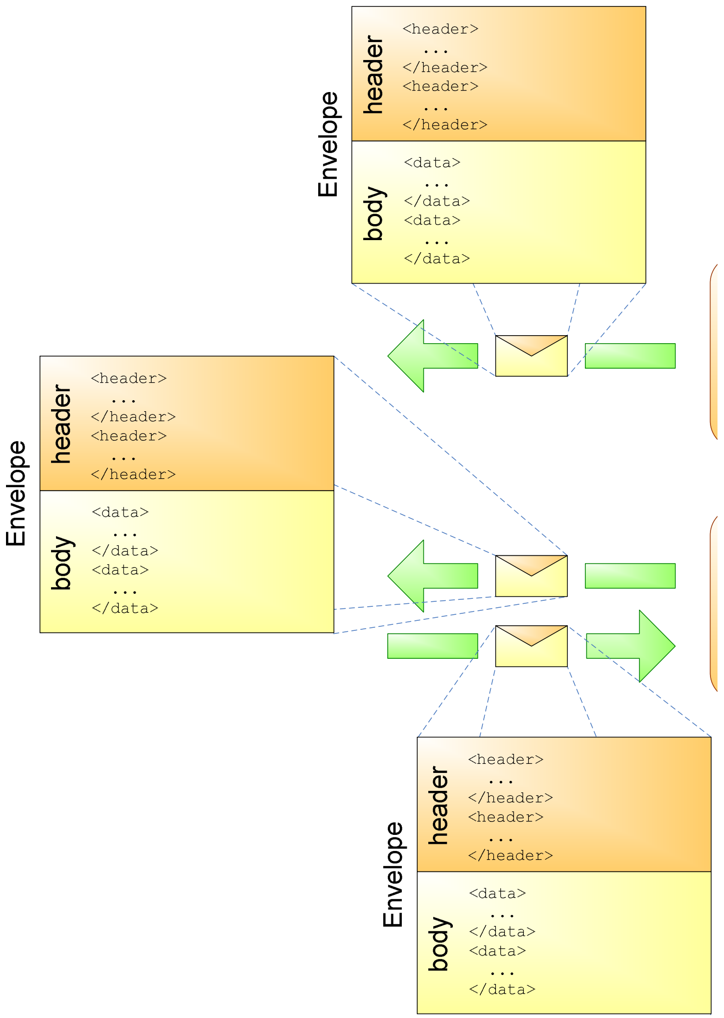


Example: ServiceA sends ServiceB a `MessageX`. ServiceB responds with a `MessageY` or a `MessageZ` depending on the content of the `MessageX` it received.

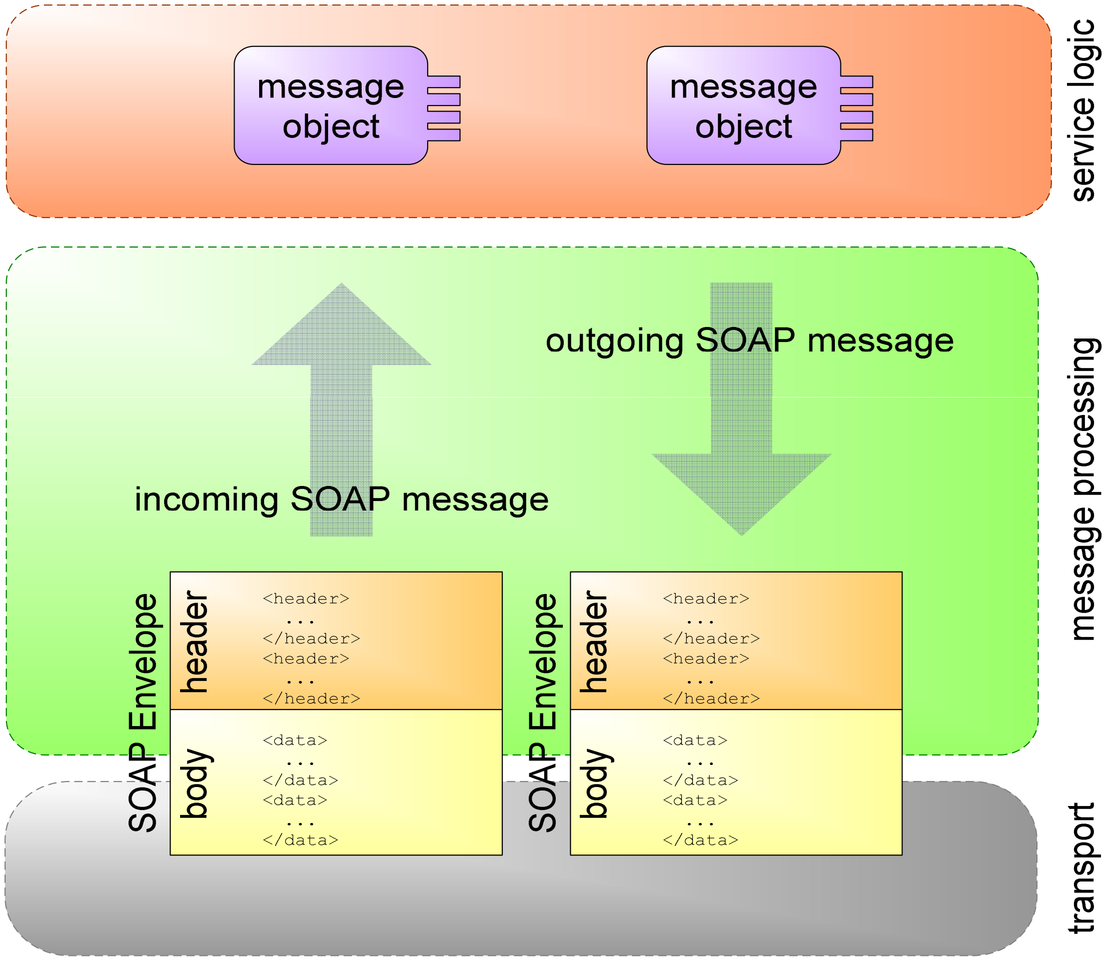
Typical SOA with Web Services



Services Support Protocols



Engineered for Loose Coupling


message object
message object
service logic
outgoing SOAP message
incoming SOAP message
message processing
SOAP Envelope
header
body
<header> ... </header> <header> ... </header>
<data> ... </data> <data> ... </data>
SOAP Envelope
header
body
<header> ... </header> <header> ... </header>
<data> ... </data> <data> ... </data>
transport

Web Services are Evil?

- Two things:
  - –WSDL
    - It's an XML IDL for RPC
    - Therefore ill-suited for Internet scale

Photo: Comedy Central

  - –All the superfluous WS-* standards and politics
    - Too many dumb WS-KitchenSink standards
      - – Not everything needs to be an OASIS standard!
    - Too many useful tools spent too long in standards wars
      - – 3 transactions specs? Anyone heard of consistency???
- Toolkits hide messaging model, provide leaky abstractions over a distributed system

SSDL Embraces Messages

- WSDL is limited to request-response interactions
  - Can theoretically augment with BPEL for conversations
  - In practice tool support is limited, approach is verbose and complex
- SOAP Service Description Language (SSDL) is better!
  - All messages are SOAP + WS-Addressing over arbitrary transports specified by URI
  - Metadata describes conversation state machine for 1...N services
    - It does what WS-Choreography does too!
  - Tool support: http://soya.sourceforge.net

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Why Web Services could Rock My World

- Good Web Services/SOA are message-oriented
  - TCP/IP is message-oriented and has scaled really well!
  - SOAP Service Description Language provides message-oriented metadata for services
    - WSDL must die, die, die!
- Business processes tend to be message-oriented
  - Easy to map workflows onto
- Loose coupling by default
- End-to-end processing model
  - Defined by SOAP, not WSDL!
- Composable model
  - You can ignore all the dumb stuff in the WS-* stack
    - Except WSDL because the toolkits embrace it ☹

Photo: Comedy Central

Web Abuse

- Two lo-fi approaches to "Web" integration
  - –URI tunnelling
  - –POX
- Both models treat HTTP as a transport
  - –More or less
- Yet some of the Web jihadists don't see this
- Both of these approaches overlay the Web with their own (weak) models...

Photo: Comedy Central

Web Tunnelling

- Web Services tunnel SOAP over HTTP
  - Using the Web as a transport only
  - Ignoring many of the features for robustness the Web has built in

Remember: SOAP + WS-Addressing is transport neutral

- Lots of Web people doing the same!
  - URI tunnelling, POX approaches are th most popular styles on today's Web
  - Worse than SOAP!
    - Less metadata!

But they claim to be "lightweight" and RESTful

URI Tunnelling Pattern

- Web servers understand URIs
- URIs have structure
- Methods have signatures
- Can match URI structure to method signature
- E.g.
  - `http://example.com/addNumbers?p1=10&p2=11`
  - `int addNumbers(int i, int j) { return i + j; }`

URI Tunnelling Strengths

- Very easy to understand
- Great for simple procedure-calls
- Simple to code
  - Do it with the servlet API, HttpListener, IHttpHandler, Rails controllers, whatever!
- Interoperable
  - It’s just URIs!

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URI Tunnelling Weaknesses

- It’s brittle RPC!
- Tight coupling, no metadata
  - No typing or “return values” specified in the URI
- Not robust – have to handle failure cases manually
- No metadata support
  - Construct the URIs yourself, map them to the function manually
- You can use GET (but also POST)
  - OK for functions, but contrary to the Web for functions with side-affects

POX Pattern

- Web servers understand how to process requests with bodies
  - Because they understand forms
- And how to respond with a body
  - Because that’s how the Web works
- POX uses XML in the HTTP request and response to move a call stack between client and server

POX Strengths

- Simplicity – just use HTTP POST and XML
- Re-use existing infrastructure and libraries
- Interoperable
  - It’s just XML and HTTP POST
- Can use complex data structures
  - By representing them in XML

POX Weaknesses

- Client and server must collude on XML payload
  - Tightly coupled approach
- No metadata support
  - Unless you're using a POX toolkit that supports WSDL with HTTP binding (like WCF)
- Does not use Web for robustness
- Does not use SOAP + WS-* for robustness

RPC is Commonplace Today

- To err is human, to really mess things up you need a computer
- To really, really mess things up you need a distributed system
  - "A Note on Distributed Computing"
- Bad Web Services and Web integration have much in common
  - It's RPC!
  - With latencies and nasty partial failure characteristics

</rant>

Web Fundamentals

- To embrace the Web, we need to understand how it works
  - Which means understanding RFC 2616 to a degree
- The Web is a distributed hypermedia model
  - It doesn't try to hide that distribution from you!
- Our challenge:
  - Figure out the mapping between our problem domain and the underlying Web platform

Web History

- Started as a distributed hypermedia platform
  - CERN, Berners-Lee, 1990
- Revolutionised hypermedia
  - Imagine emailing someone a hypermedia deck nowadays!
- Architecture of the Web largely fortuitous
  - W3C and others have since retrofitted/captured the Web’s architectural characteristics

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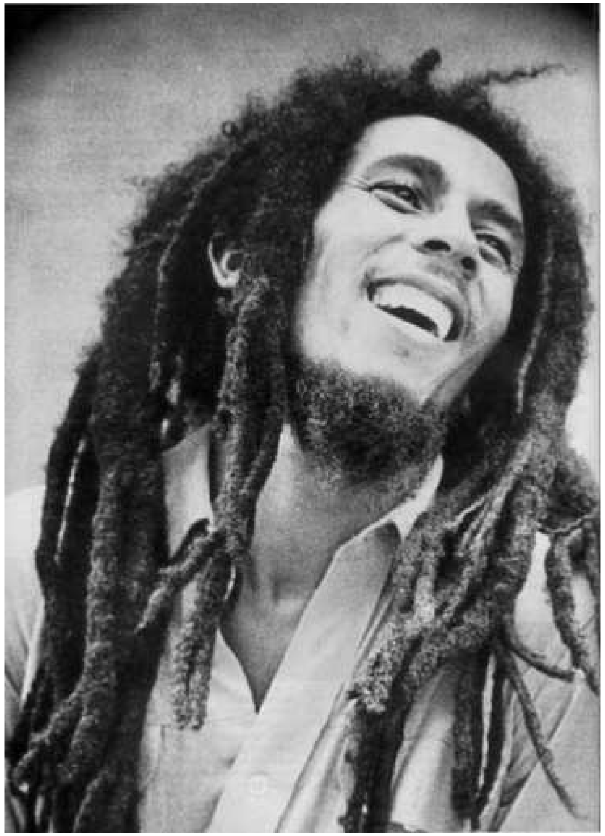
The REST Architectural Style

- Fielding captured his interpretation of the WWW architecture in his 2000 thesis
  - REpresentational State Transfer (REST)
- Since then the Web community has been working on ways to make distributed systems behave more like the Web
  - Championed by some very vocal people!

RESTafarians?



Bob Marley
Photo by PanAfrican.tv

Mark Baker,
Photo by Paul Downey

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Web Characteristics

- Scalable
- Fault-tolerant
- Recoverable
- Secure
- Loosely coupled

- Precisely the same characteristics we want in business software systems!

Scalability

- Web is truly Internet-scale
  - Uniform interface
    - HTTP defines a standard interface for all actors on the Web
    - Replication and caching is baked into this model
      - Caches have the same interface as real resources!
  - Stateless model
    - Supports horizontal scaling

Fault Tolerant

- The Web supports a stateless model
  - All information required to process a request must be present in that request
    - Sessions are still available, but must be handled in a Web-consistent manner
- Statelessness also means easy replication
  - One Web server is replaceable with another
  - Easy fail-over, horizontal scaling

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Recoverable

- The Web places emphasis on repeatable information retrieval
  - In failure cases, can safely repeat GET on resources
- HTTP verbs plus rich error handling help to remove guesswork from recovery
  - HTTP statuses tell you what happened!

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Secure

- HTTPs is a mature technology
  - Based on SSL for secure point-to-point information retrieval
- Isn’t sympathetic to Web architecture
  - Can’t cache!
- But $billions transacted through HTTPs everyday

Loosely Coupled

- Adding a Web site to the WWW does not affect any other existing sites
- All Web actors support the same, uniform interface
  - Easy to plumb new caches, proxies, servers, resources, etc into the Web

Tenets for Web-based Services

- Resource-based
  - Rather than service-oriented
- Addressability
  - Interesting things should have names
- Statelessness
  - No stateful conversations with a resource
- Representations
  - Resources can be serialised into representations
- Links
  - Resources
- Uniform Interface
  - No plumbing surprises!

Resources

- A resource is something “interesting” in your system
- Can be anything
  - Spreadsheet (or one of its cells)
  - Blog posting
  - Printer
  - Winning lottery numbers
  - A transaction
  - Others?
- Making your system Web-friendly increases its surface area
  - You expose many resources, rather than fewer endpoints

Resource Representations

- We deal with representations of resources
  - Not the resources themselves
    - "Pass-by-value" semantics
  - Representation can be in any format
    - Any media type
- Each resource has one or more representations
  - Representations like JSON or XML are good for Web-based services
- Each resource implements the uniform HTTP interface
- Resources have names and addresses (URIs)

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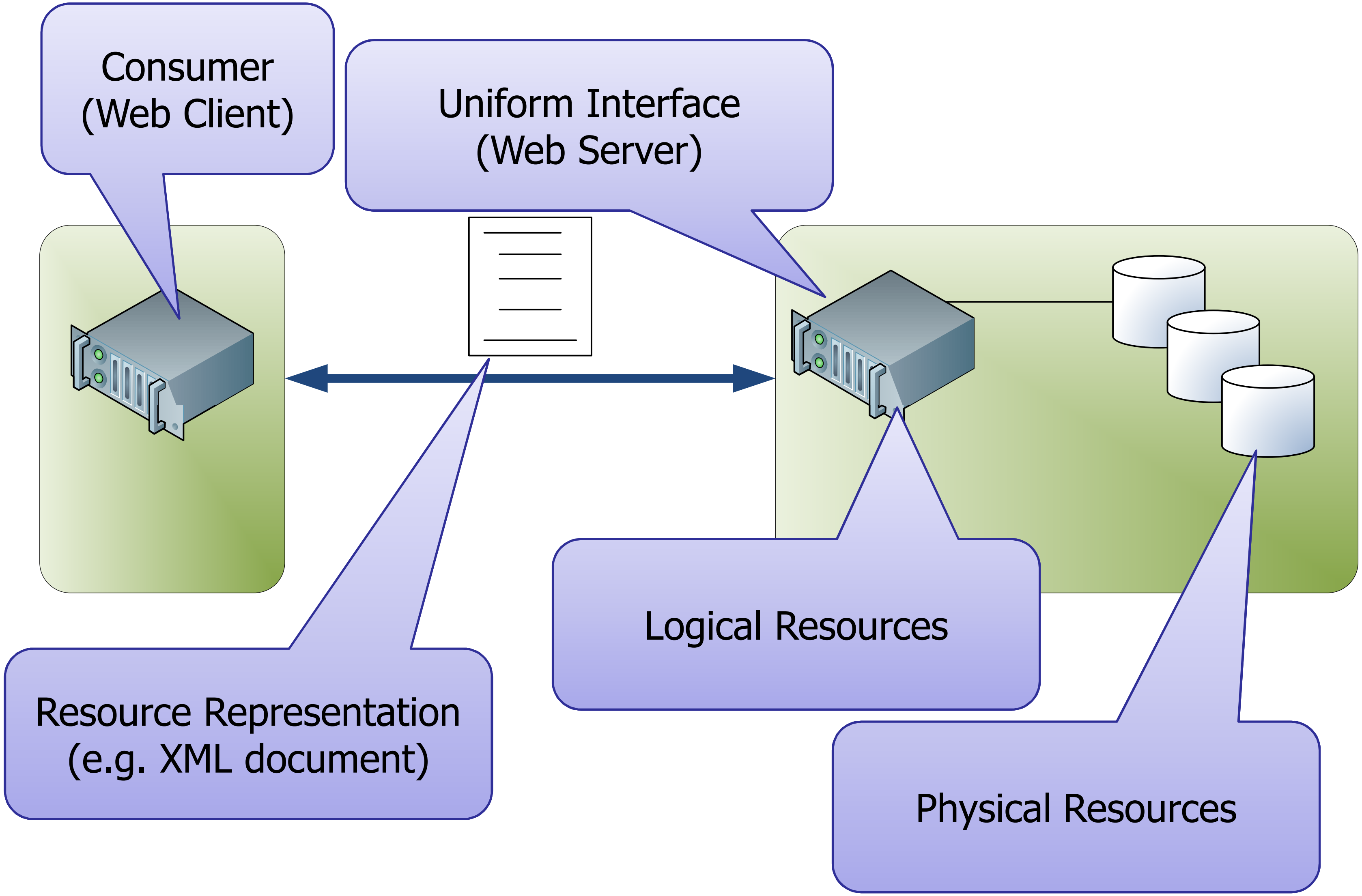
Resource Architecture


Consumer (Web Client)
Uniform Interface (Web Server)
Resource Representation (e.g. XML document)
Logical Resources
Physical Resources

URIs

See URI Templates later...

- Resource URIs should be descriptive, predictable?
  - http://spreadsheet/cells/a2,a9
  - http://jim.webber.name/2007/06.aspx
    - Convey some ideas about how the underlying resources are arranged
    - Can infer http://spreadsheet/cells/b0,b10 and http://jim.webber.name/2005/05.aspx for example
- URIs should be opaque?
  - http://tinyurl.com/6
  - TimBL says “opque URIs are cool”
    - Convey no semantics, can’t infer anything from them
      - Can’t introduce coupling

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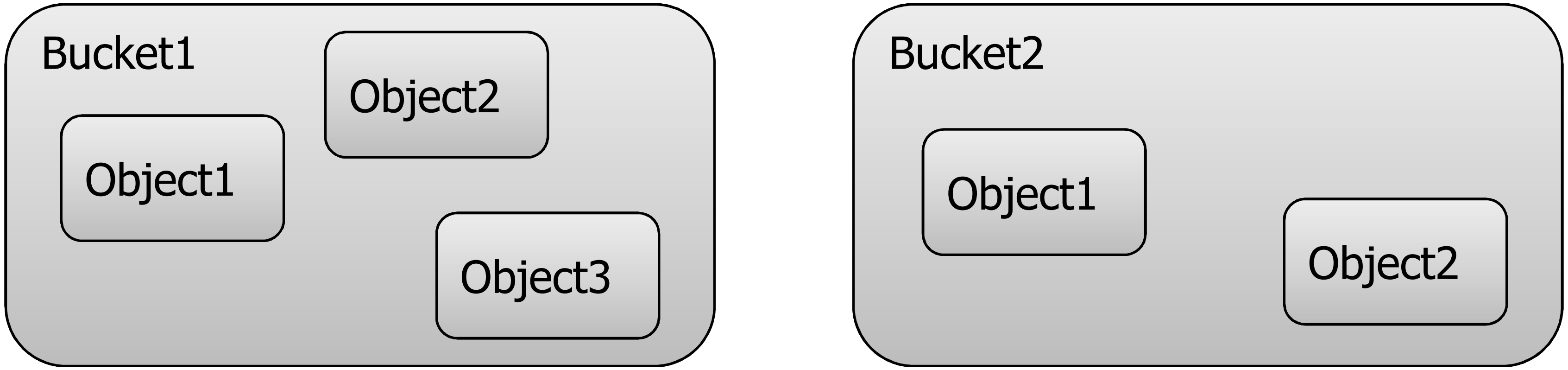
URI Templates, in brief

- Use URI templates to make your resource structure easy to understand – transparent!
- For Amazon S3 (storage service) it's easy:
  - `http://s3.amazon.com/{bucket-name}/{object-name}`



URI Templates in Action

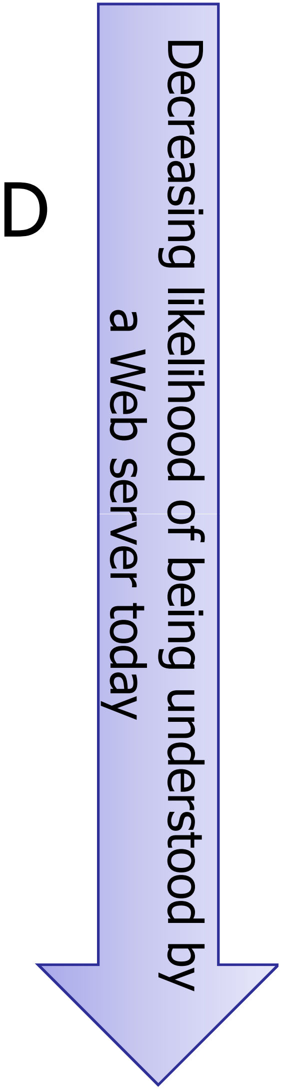
- Once you can reason about a URI, you can apply the standard HTTP techniques to it
  - Because of the uniform interface
- You have metadata for each resource
  - OPTIONS, HEAD
  - Which yield permitted verbs and resource representations
- Can program against this easily using Web client libraries and regular expressions

Links

- Connectedness is good in Web-based systems
- Resource representations can contain other URIs
  - Resources contain links (or URI templates) to other resources
- Links act as state transitions
  - Think of resources as states in a state machine
  - And links as state transitions
- Application (conversation) state is captured in terms of these states
  - Server state is captured in the resources themselves, and their underlying data stores

The HTTP Verbs

- Retrieve a representation of a resource: GET
- Get metadata about an existing resource: HEAD
- Create a new resource: PUT to a new URI, or POST to an existing URI
- Modify an existing resource: PUT to an existing URI
- Delete an existing resource: DELETE
- See which of the verbs the resource understands: OPTIONS



Decreasing likelihood of being understood by a Web server today

GET Semantics

- GET retrieves the representation of a resource
- Should be idempotent
  - Shared understanding of GET semantics
  - Don’t violate that understanding!

POST Semantics

- POST creates a new resource
- But the server decides on that resource's URI
- Common human Web example: posting to a blog
  - Server decides URI of posting and any comments made on that post
- Programmatic Web example: creating a new employee record
  - And subsequently adding to it

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POST Request

```
POST / HTTP/1.1
Content-Type: text/xml
Host: localhost:8888
Content-Length: ....
Connection: Keep-Alive

<buy>
  <symbol>ABCD</symbol>
  <price>27.39</price>
</buy>
```

Verb, path, and HTTP version

Content type (XML)

Content (again XML)

POST Response

```
201 CREATED
Location: /orders/jwebber/ABCD/2007-07-08-13-50-53
```

PUT Semantics

- PUT creates a new resource but the client decides on the URI
  - Providing the server logic allows it
- Also used to update existing resources by overwriting them in-place
- Don’t use POST here
  - Because PUT is idempotent!

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PUT Request

```
PUT /orders/jwebber/ABCD/2007-07-08-13-50-53 HTTP/1.1
Content-Type: text/xml
Host: localhost:8888
Content-Length: ....
Connection: Keep-Alive

<buy>
  <symbol>ABCD</symbol>
  <price>27.44</price>
</buy>
```

Verb, path and HTTP version

Updated content (higher buy price)

PUT Response

```
200 OK
Location: /orders/jwebber/ABCD/2007-07-080-13:50:53
Content-Type: application/xml

<nyse:priceUpdated .../>
```

Minimalist response might contain only status and location

DELETE Semantics

This is important for decoupling implementation details from resources

- Stop the resource from being accessible
  - Logical delete, not necessarily physical
- Request

```
DELETE /user/jwebber HTTP 1.1
Host: example.org
```

- Response

```
200 OK
Content-Type: application/xml
<admin:userDeleted>
  jwebber
</admin:userDeleted>
```

HEAD Semantics

- HEAD is like GET, except it only retrieves metadata
- Request

```
HEAD /user/jwebber HTTP 1.1
Host: example.org
```

- Response

```
200 OK
Content-Type: application/xml
Last-Modified: 2007-07-08T15:00:34Z
ETag: aabd653b-65d0-74da-bc63-4bca-
 ba3ef3f50432
```

Useful for caching, performance

OPTIONS Semantics

- Asks which methods are supported by a resource
  - Easy to spot read-only resources for example

- Request

```
OPTIONS /user/jwebber HTTP 1.1
Host: example.org
```

- Response

```
200 OK
Allowed: GET,HEAD,POST
```

You can only read and add to this resource

HTTP Status Codes

- The HTTP status codes provide metadata about the state of resources
- They are part of what makes the Web a rich platform for building **distributed** systems
- They cover five broad categories
  - 1xx - Metadata
  - 2xx – Everything’s fine
  - 3xx – Redirection
  - 4xx – Client did something wrong
  - 5xx – Server did a bad thing
- There are a handful of these codes that we need to know in more detail

Common Status Codes

- 100 – Continue
- 200 – OK
- 201 – Created
- 301 – Moved Permanently
- 303 – See Other
- 304 – Not Modified

- 400 – Bad Request
- 401 – Unauthorised
- 403 – Forbidden
- 404 – Not Found
- 405 – Method Not Allowed
- 500 – Internal Server Error

HTTP Headers

- Headers provide metadata to assist processing
  - Identify resource representation format (media type), length of payload, supported verbs, etc
- HTTP defines a wealth of these
  - And like status codes they are our building blocks for robust service implementations

Some Useful Headers

- Authorization
  - Contains credentials (basic, digest, WSSE, etc)
  - Extensible
- Content-Type
  - The resource representation form
    - E.g. application/xml, application/xhtml+xml
- ETag/If-None-Match
  - Opaque identifier – think “checksum” for resource representations
  - Used for conditional GET
- If-Modified-Since/Last-Modified
  - Used for conditional GET too
- Location
  - Used to flag the location of a created/moved resource
  - In combination with:
    - 201 Created, 301 Moved Permanently, 302 Found, 307 Temporary Redirect, 300 Multiple Choices, 303 See Other
- WWW-Authenticate
  - Used with 401 status
    - Tells client what authentication is needed

We have a comprehensive model for distributed computing…

… but we still need a way of programming it.

Describing Contracts with Links

- The value of the Web is its “linked-ness”
  - Links on a Web page constitute a contract/API for page traversals
- The same is true of the programmatic Web
- Use Links to describe state transitions in programmatic Web services
  - By navigating resources (aka application state)

Links as APIs

```
<confirm xmlns="...">
<link rel="payment"
 href="https://pay"
  type="application/xml"/>
<link rel="postpone"
 href="https://wishlist"
  type="application/xml"/>
</confirm>
```

- Following a link causes an action to occur
- This is the start of a state machine!
- Links lead to other resources which also have links
- Can make this stronger with semantics
  - –Microformats

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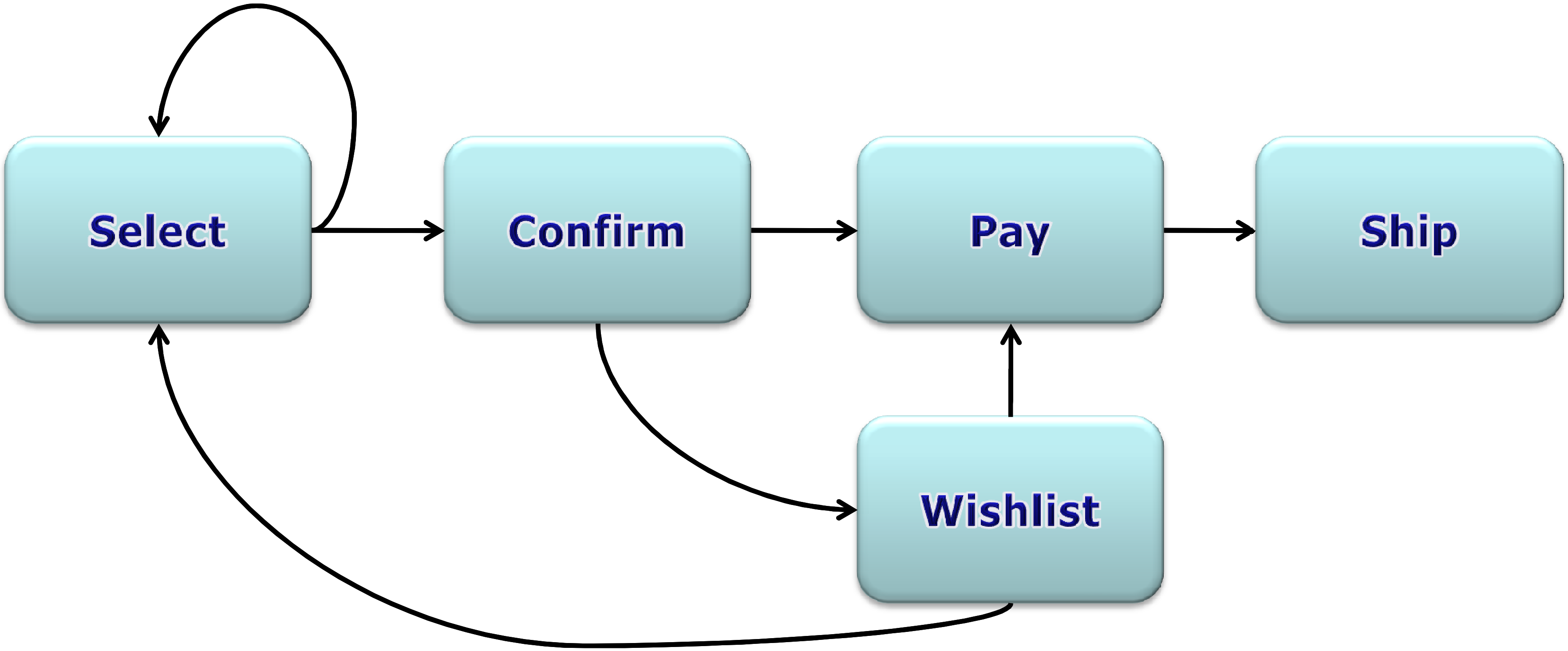
Links are State Transitions



Microformats

- Microformats are an example of little “s” semantics
- Innovation at the edges of the Web
  - Not by some central design authority (e.g. W3C)
- Started by embedding machine-processable elements in Web pages
  - E.g. Calendar information, contact information, etc
  - Using existing HTML features like `class`, `rel`, etc

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Microformats and Resources

- Use Microformats to structure resources where formats exist
  - I.e. Use hCard for contacts, hCalendar for data
- Create your own formats (sparingly) in other places
  - Annotating links is a good start
  - `<link rel="withdraw.cash" .../>`
  - `<link rel="service.post" type="application/x.atom+xml" href="{post-uri}" title="some title">`
- The `rel` attribute describes the semantics of the referred resource

“Subjunctive Programming”

- With changing contracts embedded as part of a resource, we can’t be too imperative anymore
- Think “subjunctive”
- Code for Web integration by thinking “what if” rather than “if then”
  - –The Web is declarative!

We have a framework!

- The Web gives us a processing and metadata model
  - Verbs and status codes
  - Headers

- Gives us metadata contracts or Web “APIs”
  - URI Templates
  - Links

- Strengthened with semantics
  - Little “s”

Workflow

- How does a typical enterprise workflow look when it’s implemented in a Web-friendly way?
- Let’s take Starbuck’s as an example, the happy path is:
  - Make selection
    - Add any specialities
  - Pay
  - Wait for a while
  - Collect drink

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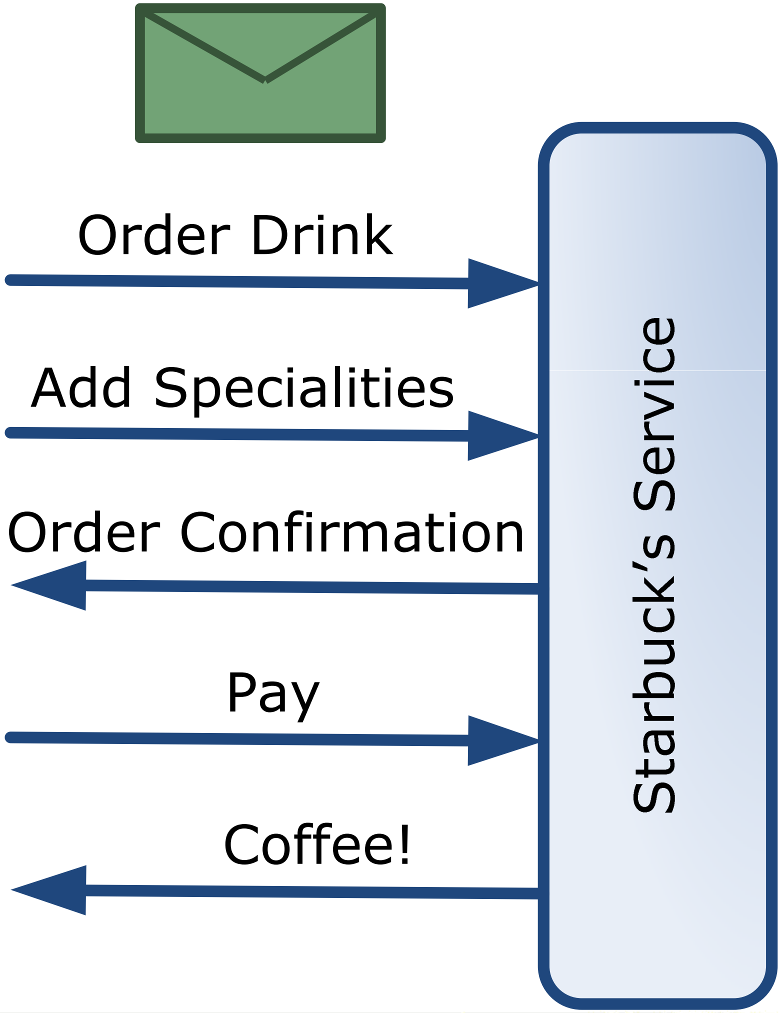
Workflow and MOM

- With Web Services we exchange messages with the service
- Resource state is hidden from view
- Conversation state is all we know
  - Advertise it with SSDL, BPEL
- Uniform interface, roles defined by SOAP
  - No "operations"

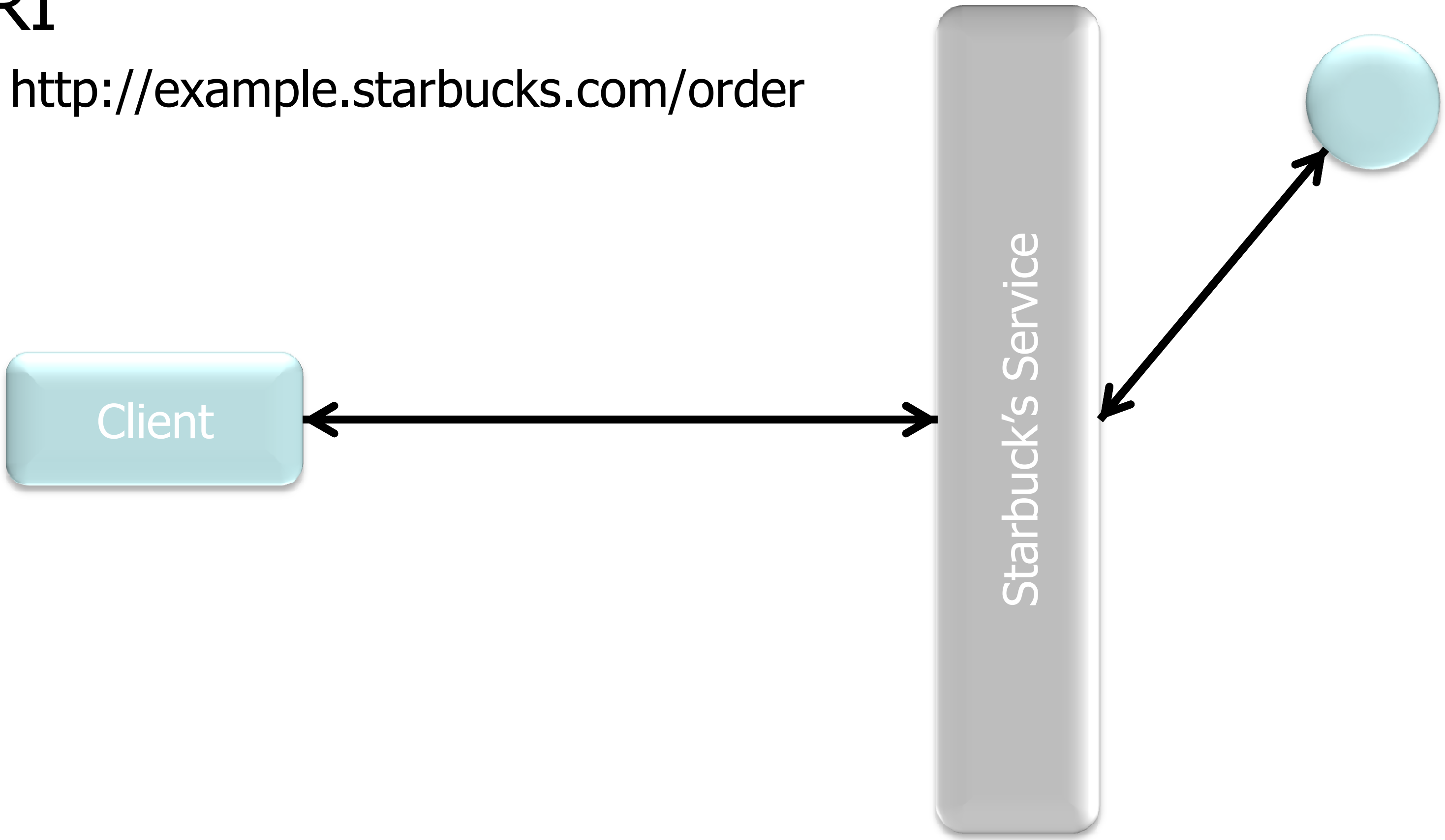


Web-friendly Workflow

- What happens if workflow stages are modelled as resources?
- And state transitions are modelled as hyperlinks or URI templates?
- And events modelled by traversing links and changing resource states?
- Answer: we get Web-friendly workflow
  - –With all the quality of service provided by the Web

Placing an Order

- Place your order by POSTing it to a well-known URI
  - http://example.starbucks.com/order



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Placing an Order: On the Wire

- Request

```
POST /order HTTP 1.1
Host: starbucks.example.com
Content-Type: application/xml
Content-Length: ...

<order xmlns="urn:starbucks">
  <drink>latte</drink>
</order>
```

- Response

```
201 Created
Location:
  http://starbucks.example.com/o
  rder?1234
Content-Type: application/xml
Content-Length: ...

<order xmlns="urn:starbucks">
  <drink>latte</drink>
 <link rel="payment"
  href="https://starbucks.exampl
  e.com/payment/order?1234"
  type="application/xml"/>
</order>
```

If we have a (private) microformat, this can become a neat API!

Whoops! A mistake

- I like my coffee to taste like coffee!
- I need another shot of espresso
  - –What are my OPTIONS?

Request

```
OPTIONS /order?1234 HTTP 1.1

Host: starbucks.example.com
```

Response

```
Allow: GET, PUT
```

Phew! I can update my order

Look Before You Leap

- See if the resource has changed since you submitted your order
  - If you're fast your drink hasn't been prepared yet

Request

```
PUT /order?1234 HTTP 1.1

Host: starbucks.example.com

Expect: 100-Continue
```

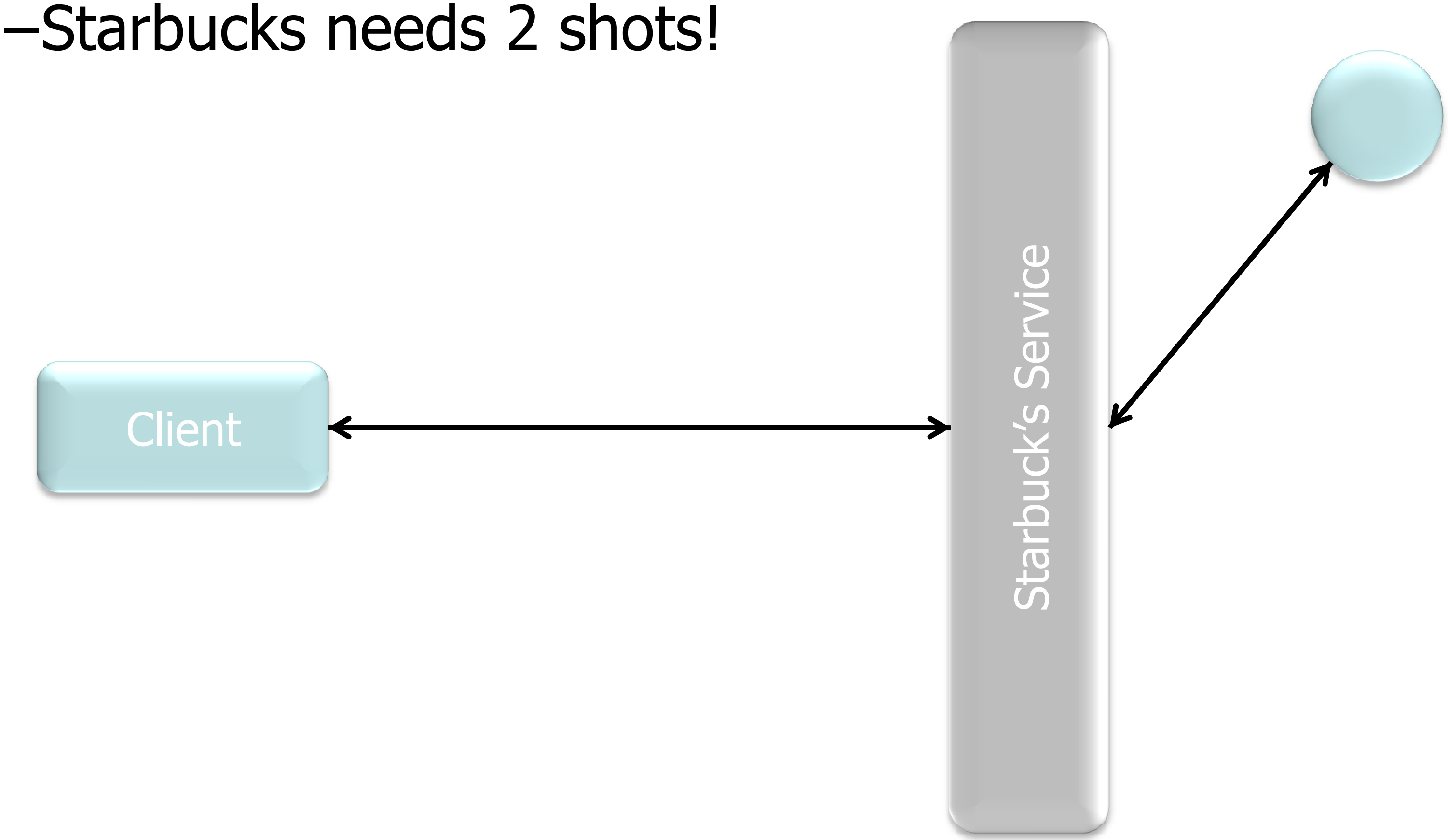
Response

```
200 OK
```

I can still PUT this resource, for now

Amending an Order

- Add specialities to you order via PUT
  - –Starbucks needs 2 shots!



Amending an Order: On the Wire

- Request

```
PUT /order?1234 HTTP 1.1
Host: starbucks.example.com
Content-Type: application/xml
Content-Length: ...

<order xmlns="urn:starbucks">
  <drink>latte</drink>
  <additions>shot</additions>
  <link rel="payment"
 href="https://starbucks.example.
 com/payment/order?1234"
  type="application/xml"/>
</order>
```

- Response

```
200 OK
Location:
 http://starbucks.example.com/ord
 er?1234
Content-Type: application/xml
Content-Length: ...

<order xmlns="urn:starbucks">
  <drink>latte</drink>
  <additions>shot</additions>
 <link rel="payment"
 href="https://starbucks.example.
 com/payment/order?1234"
  type="application/xml"/>
</order>
```

Statelessness

- Remember interactions with resources are stateless
- The resource "forgets" about you while you're not directly interacting with it
- Which means race conditions are possible
- Use `If-Unmodified-Since` to make sure
- You'll get a `412 – Precondition Failed` if you lost the race
  - But you'll avoid potentially putting the resource into some inconsistent state

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Warning: Don't be Slow!

- Can only make changes until someone actually makes your drink
  - Resources can change without your intervention

- Request

```
PUT /order?1234 HTTP 1.1
Host: starbucks.example.com
...
```

- Response

```
409 - Conflict
```

Too slow! Someone else has changed the state of my order

- Request

```
OPTIONS /order?1234 HTTP 1.1
Host: starbucks.example.com
```

- Response

```
Allow: GET
```

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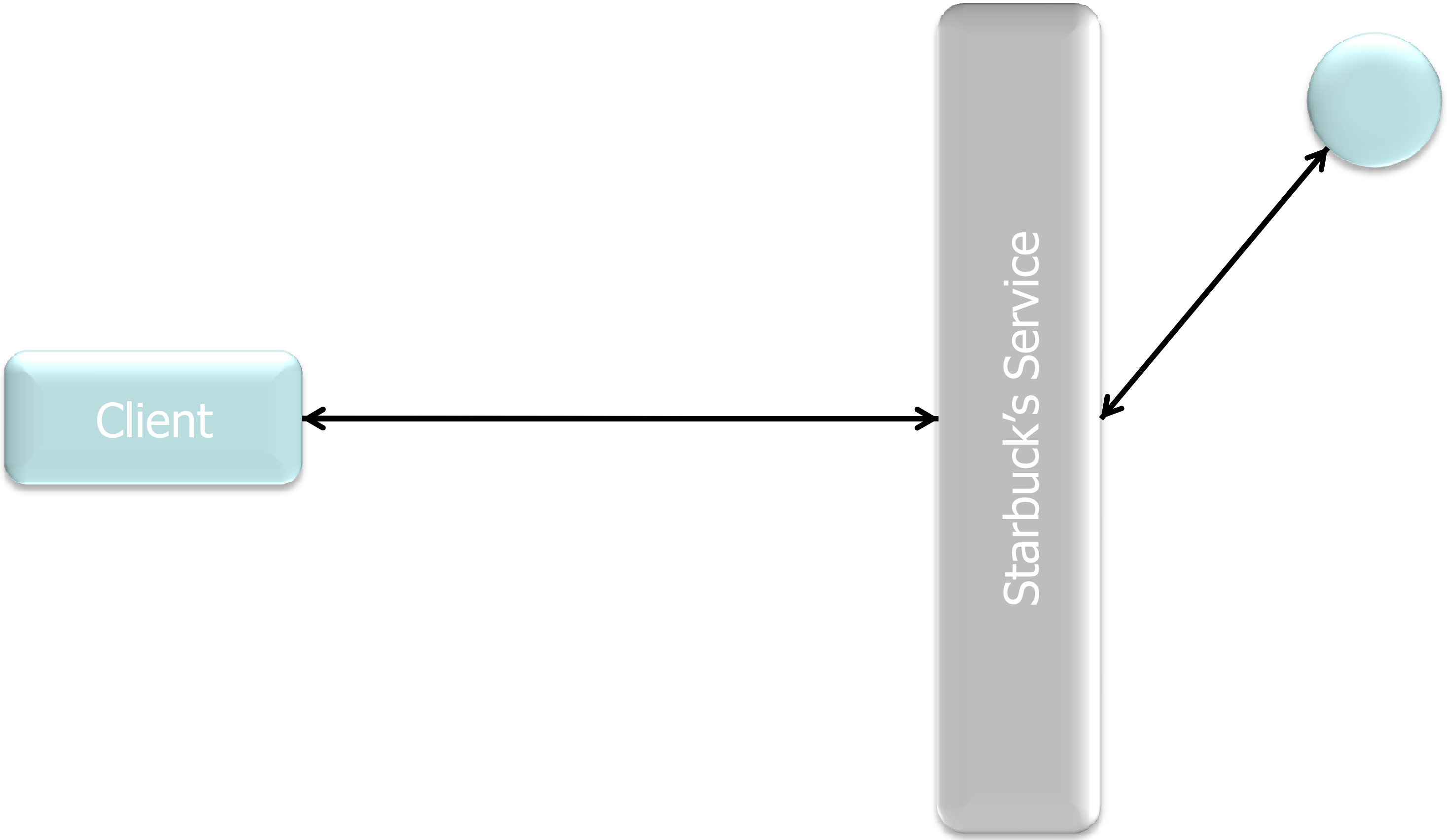
Order Confirmation

- Check your order status by GETing it



Order Confirmation: On the Wire

- Request

```
GET /order?1234 HTTP 1.1
Host: starbucks.example.com
Content-Type: application/xml
Content-Length: ...
```

- Response

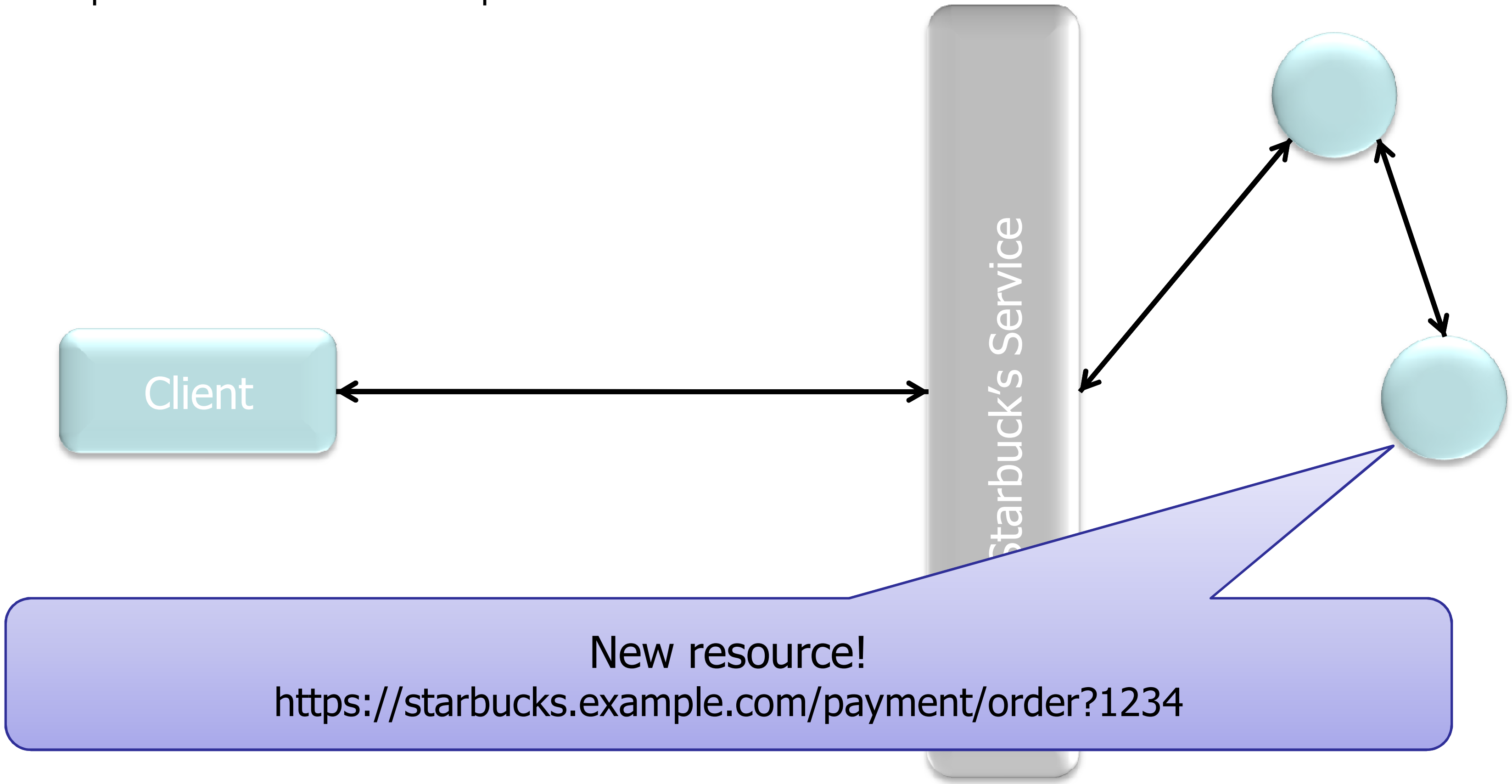
```
200 OK
Location:
  http://starbucks.example.com/order
  ?1234
Content-Type: application/xml
Content-Length: ...


<order xmlns="urn:starbucks">
  <drink>latte</drink>
  <additions>shot</additions>
 <link rel="payment"
  href="https://starbucks.example.co
  m/order?1234"
  type="application/xml"/>
</order>
```

Are they trying to tell me something?

Order Payment

- POST your payment to the order resource

```
https://starbucks.example.com/order?1234
```



New resource!
https://starbucks.example.com/payment/order?1234

How did I know to POST?

- The client knew the URI to POST to from the link
- Verified with OPTIONS
  - –Just in case you were in any doubt ☺

Request

```
OPTIONS /order?1234 HTTP 1.1

Host: starbucks.example.com
```

Response

```
Allow: GET, POST
```

Order Payment: On the Wire

- Request

```
POST /order?1234 HTTP 1.1
Host: starbucks.example.com
Content-Type: application/xml
Content-Length: ...

<payment xmlns="urn:starbucks">
  <cardNo>123456789</cardNo>
  <expires>07/07</expires>
  <name>John Citizen</name>
  <amount>4.00</amount>
</payment>
```

- Response

```
201 Created
Location:
  https://starbucks.example.com/payment/order?1234
Content-Type: application/xml
Content-Length: ...


<payment xmlns="urn:starbucks">
  <cardNo>123456789</cardNo>
  <expires>07/07</expires>
  <name>John Citizen</name>
  <amount>4.00</amount>
</payment>
```

Check that you've paid

- Request

```
GET /order?1234 HTTP 1.1
Host: starbucks.example.com
Content-Type: application/xml
Content-Length: ...
```

- Response

```
200 OK
Content-Type: application/xml
Content-Length: ...


<order xmlns="urn:starbucks">
  <drink>latte</drink>
  <additions>shot</additions>
</order>
```

My “API” has changed, because I’ve paid enough now

What Happened Behind the Scenes?

- Starbucks can use the same resources!
- Plus some private resources of their own
  - Master list of coffees to be prepared
- Authenticate to provide security on some resources
  - E.g. only Starbuck’s are allowed to view payments

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Master Coffee List

- `/orders` URI for all orders, only accepts GET
  - Anyone *can* use it, but it is only *useful* for Starbuck's
  - It's not identified in any of our public APIs anywhere, but the back-end systems know the URI

Request

```
GET /orders HTTP 1.1

Host: starbucks.example.com
```

Atom feed!

Response

```
200 OK
Content-Type: application/xml
Content-Length: ...

<?xml version="1.0" ?>
<feed xmlns="http://www.w3.org/2005/Atom">
 <title>Coffees to make</title>
 <link rel="alternate"
href="http://example.starbucks.com/order.atom"/>
 <updated>2007-07-10T09:18:43Z</updated>
 <author><name>Johnny Barrista</name></author>
 <id>urn:starkbucks:45ftis90</id>

 <entry>
  <link rel="alternate" type="application/xml"
href="http://starbucks.example.com/order?1234"/>
  <id>urn:starbucks:a3tfpfz3</id>
 </entry>
 ...
</feed>
```

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Payment

- Only Starbucks systems can access the record of payments
  - Using the URI template: `http://.../payment/order?{order_id}`
- We can use HTTP authorisation to enforce this

Request

```
GET /payment/order?1234 HTTP 1.1
Host: starbucks.example.com
```

Response

```
401 Unauthorized
WWW-Authenticate: Digest
realm="starbucks.example.com",
qop="auth", nonce="ab656...",
opaque="b6a9..."
```

Request

```
GET /payment/order?1234 HTTP 1.1
Host: starbucks.example.com
Authorization: Digest username="jw"
realm="starbucks.example.com“
nonce="..."
uri="payment/order?1234"
qop=auth
nc=00000001
cnonce="..."
reponse="..."
opaque="..."
```

Response

```
200 OK
Content-Type: application/xml
Content-Length: ...

<payment xmlns="urn:starbucks">
  <cardNo>123456789</cardNo>
  <expires>07/07</expires>
  <name>John Citizen</name>
  <amount>4.00</amount>
</payment>
```

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Finally drink your coffee...

Source: http://images.businessweek.com/ss/06/07/top_brands/image/starbucks.jpg

What did we learn from Starbuck's?

- HTTP has a header/status combination for every occasion
- APIs are expressed in terms of links, and links are great!
  - APP-esque APIs
- APIs can also be constructed with URI templates and inference
- XML is fine, but we could also use formats like APP, JSON or even default to XHTML as a sensible middle ground
- State machines (defined by links) are important
  - Just as in Web Services…

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Summary

- Both the Web and Web Services suffer from poor patterns and practices, awful tooling
- Both platforms are about externalising state machines when done well
  - –Conversation state machines for Web Services
  - –Hypermedia state machines for Web
- WS-* is bloated, but most of it can (should!) be safely ignored
- The Web is now starting to feel the love from middleware vendors too – beware!
- MEST and REST are both sensible approaches

Questions?

Developing Web-based Services
(working title)

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Coming 2008…

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