Università della Svizzera italiana

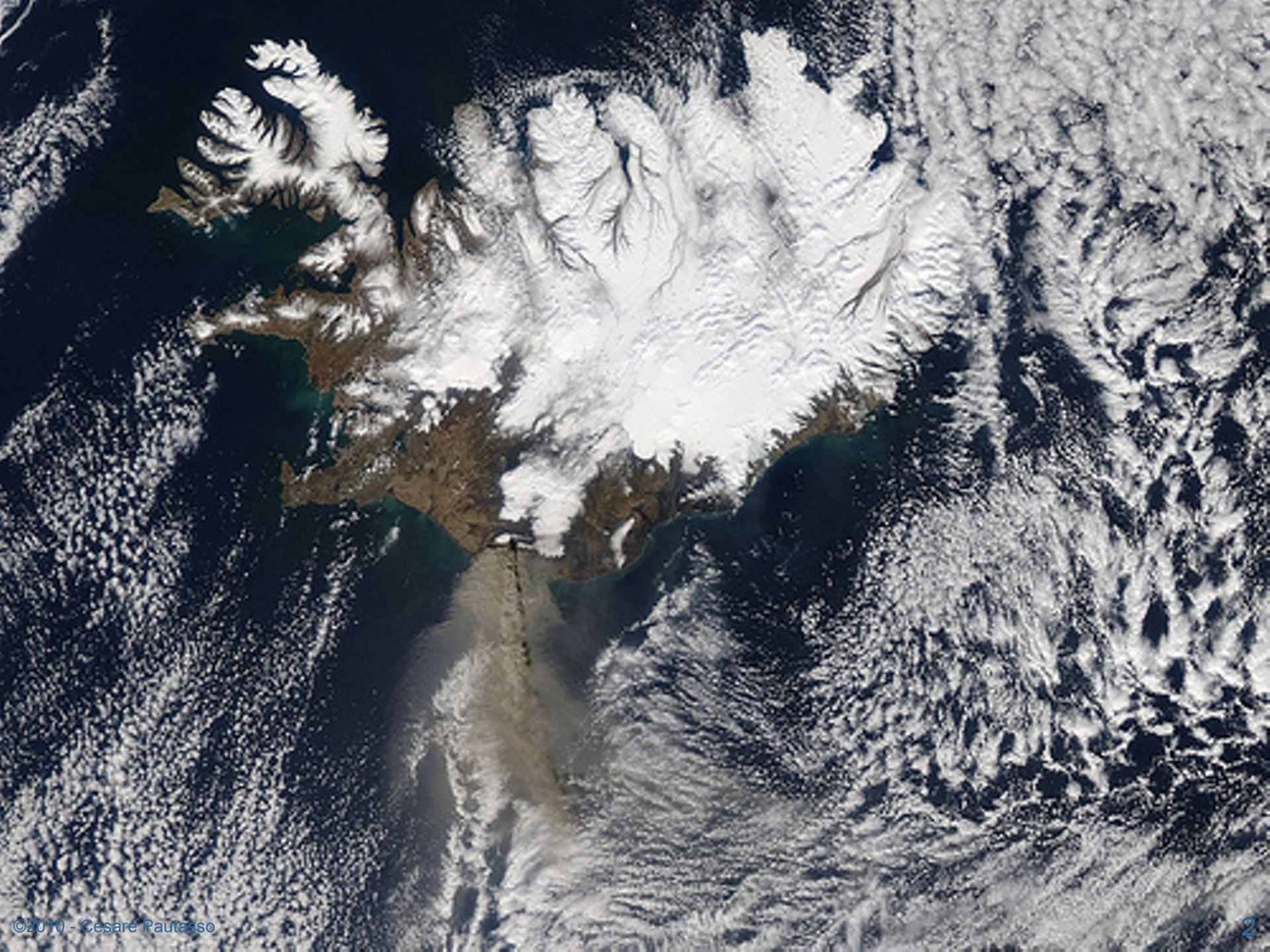
Faculty of Informatics

SOA Symposium

SOA with REST

Cesare Pautasso
Faculty of Informatics
University of Lugano, Switzerland

c.pautasso@ieee.org
http://www.pautasso.info



Abstract

- Recent technology trends in Web Services indicate that a solution eliminating the perceived complexity of the WS-* standard technology stack may be in sight: advocates of REpresentational State Transfer (REST) have come to believe that their ideas explaining why the World Wide Web works are just as applicable to solve enterprise application integration problems. In this talk we take a close look at the potential for convergence of service orientation and the REST architectural style. We highlight the benefits in terms of simplicity, loose coupling, and performance of a RESTful approach to SOA and discuss the most important SOA design patterns that become available once REST is introduced..

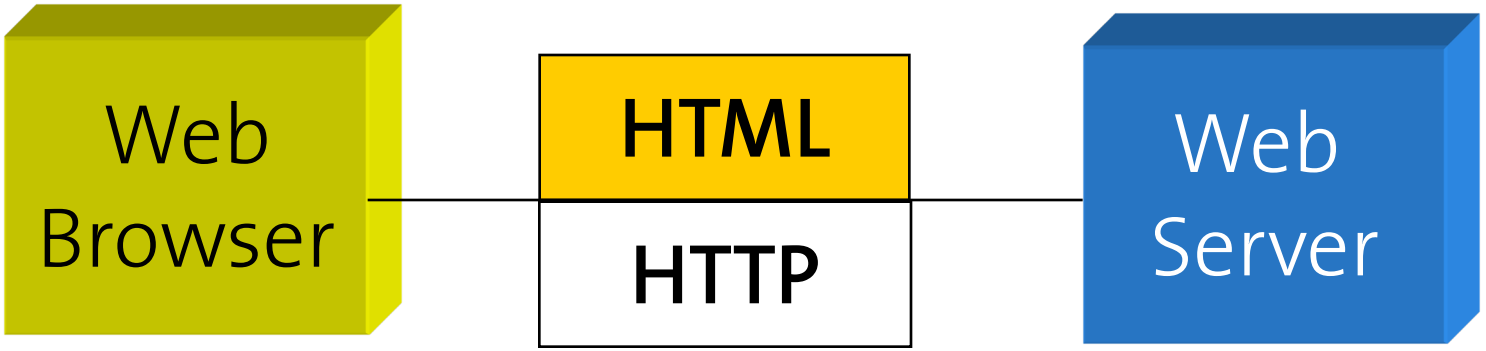
Acknowledgements

- The following distinguished individuals have contributed to the the patterns, ideas and reviewed some of the material presented in this talk:
  - Raj Balasubramanian
  - Benjamin Carlyle
  - Thomas Erl
  - Stefan Tilkov
  - Erik Wilde
  - Herbjorn Wilhelmsen
  - Jim Webber

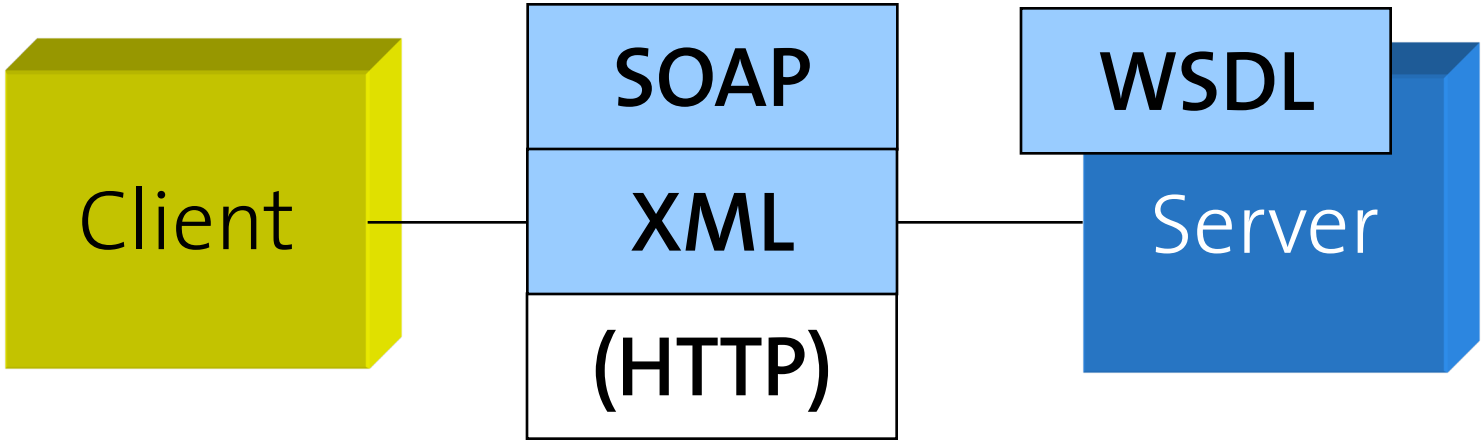
SOA with REST - Outline

- Introduction
- RESTful Service Design
- Simple Doodle Service Example & Demo
- Some REST-inspired SOA Design Patterns
  - Entity Endpoint
  - Uniform Contract
  - Endpoint Redirection
  - Content Negotiation
- Discussion

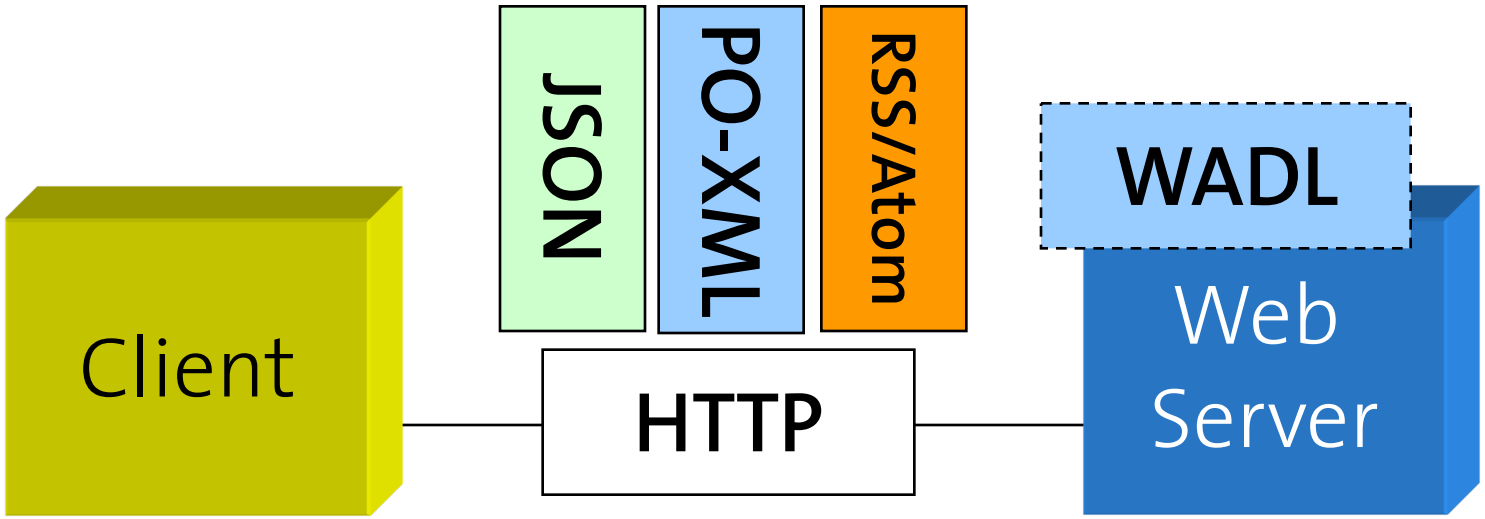
Web Sites (1992)



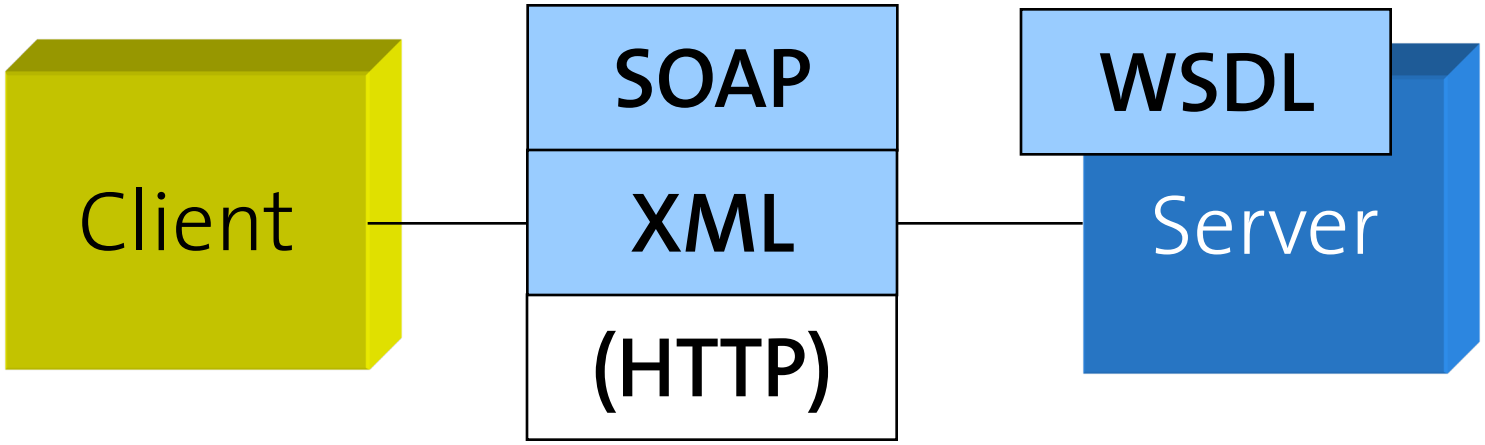
WS-* Web Services (2000)



RESTful Web Services (2007)



WS-* Web Services (2000)



Is REST being used?

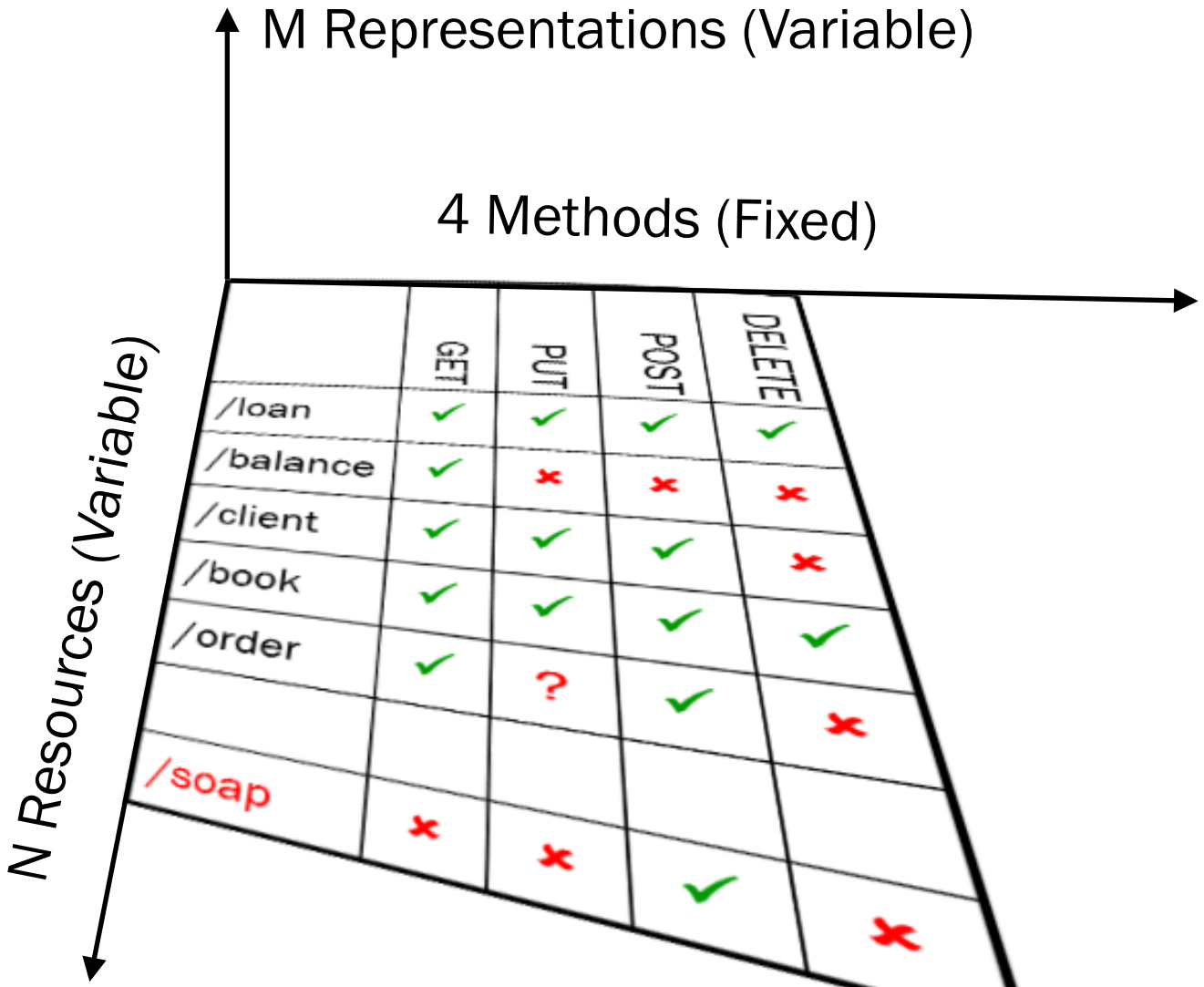
Slide from Paul Downey, BT

RESTful Service Design

1. Identify resources to be exposed as services (e.g., yearly risk report, book catalog, purchase order, open bugs, polls and votes)
2. Model relationships (e.g., containment, reference, state transitions) between resources with hyperlinks that can be followed to get more details (or perform state transitions)
3. Define “nice” URIs to address the resources
4. Understand what it means to do a GET, POST, PUT, DELETE for each resource (and whether it is allowed or not)
5. Design and document resource representations
6. Implement and deploy on Web server
7. Test with a Web browser

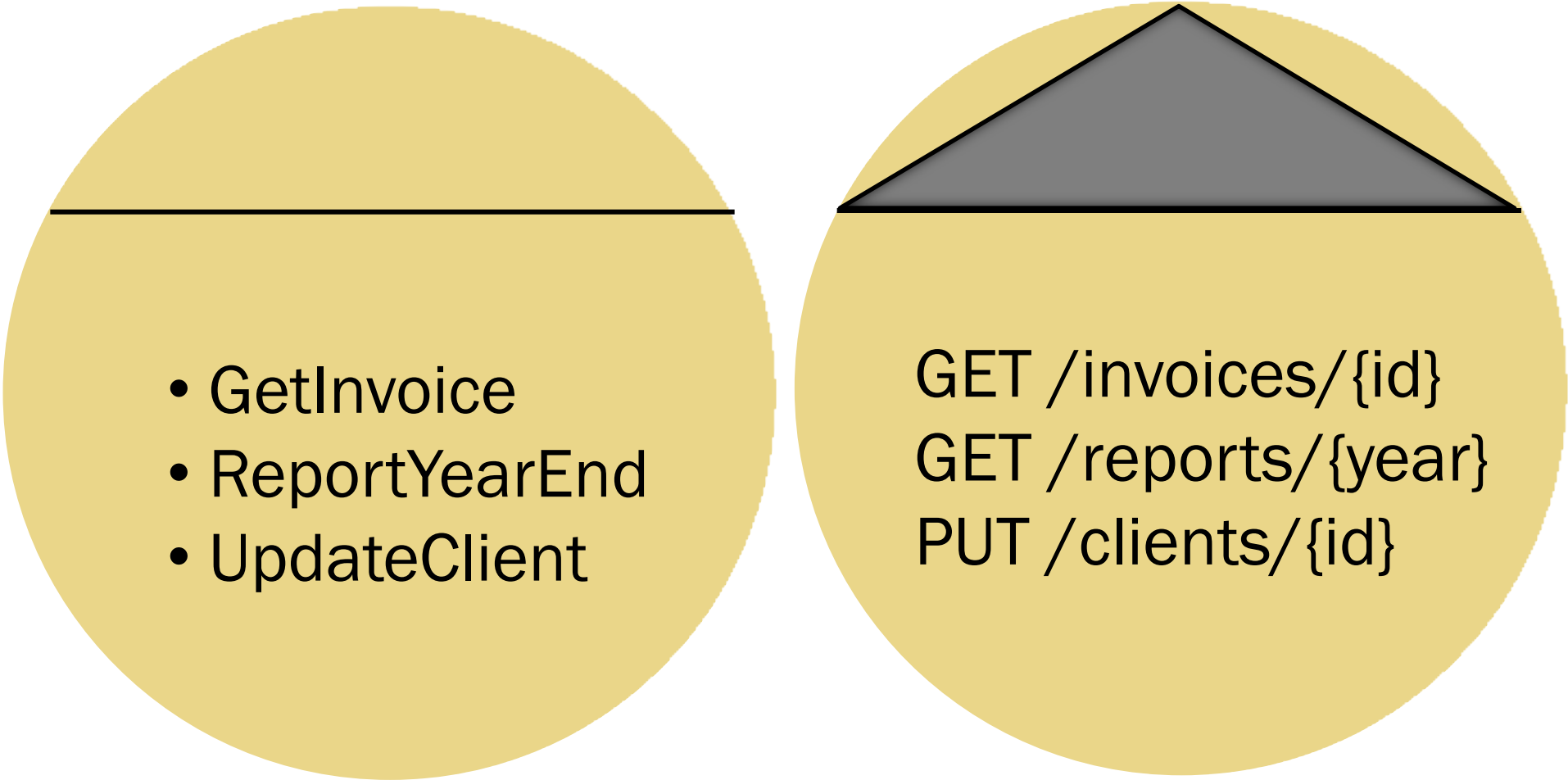
	GET	PUT	POST	DELETE
/loan	✓	✓	✓	✓
/balance	✓	✘	✘	✘
/client	✓	✓	✓	✘
/book	✓	✓	✓	✓
/order	✓	?	✓	✘
/soap	✘	✘	✓	✘

Design Space



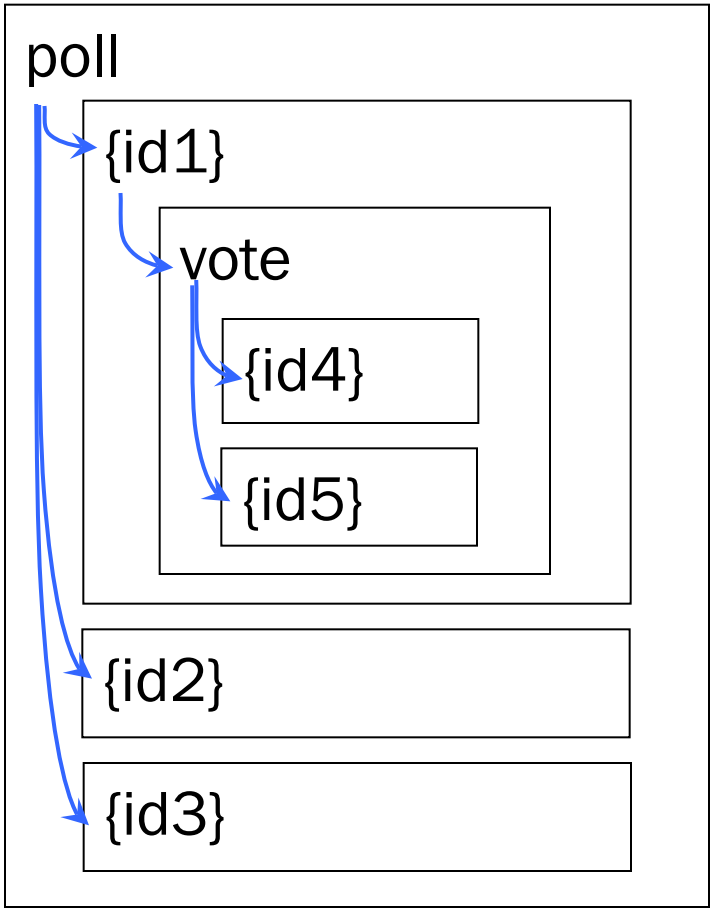
A new kind of Service

- From Service Capabilities to Resources
- From Service Contracts to the Uniform Contract



Simple Doodle REST API Example

1. Resources:
   polls and votes
2. Containment Relationship:

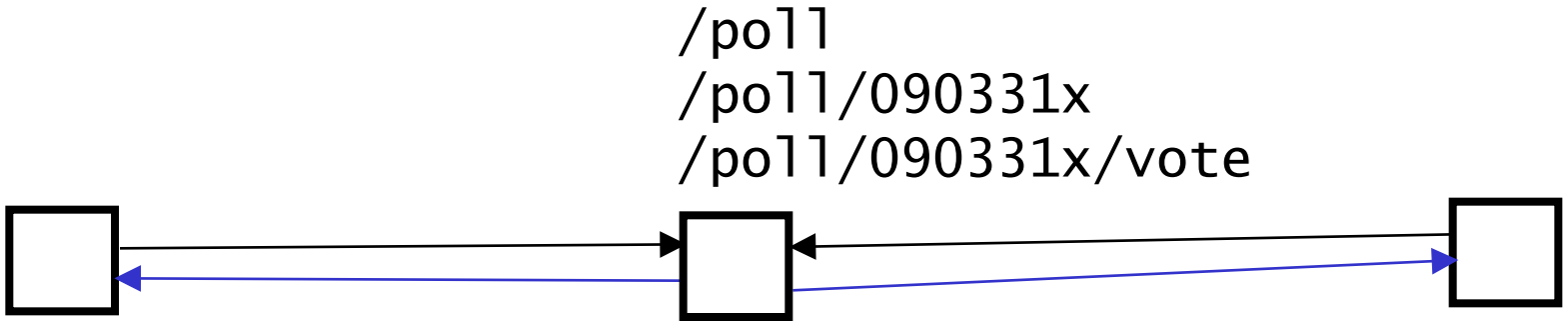


	GET	PUT	POST	DELETE
/poll	✓	✗	✓	✗
/poll/*{id}*	✓	✓	✗	✓
/poll/*{id}*/vote	✓	✗	✓	✗
/poll/*{id}*/vote/*{id}*	✓	✓	✗	?

3. URIs embed IDs of “child” instance resources
4. POST on the container is used to create child resources
5. PUT/DELETE for updating and removing child resources

Simple Doodle API Example

1. Creating a poll
(transfer the state of a new poll on the Doodle service)



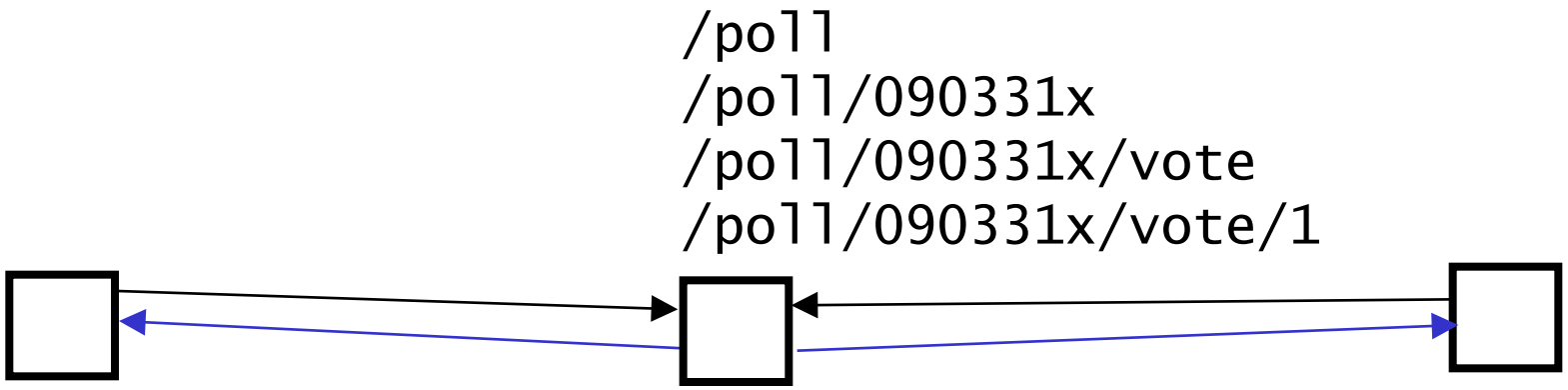

```
POST /poll
<options>A,B,C</options>

201 Created
Location: /poll/090331x
```

```
GET /poll/090331x

200 OK
<options>A,B,C</options>
<votes href="/vote"/>
```

2. Reading a poll
(transfer the state of the poll from the Doodle service)

Simple Doodle API Example

- Participating in a poll by creating a new vote sub-resource

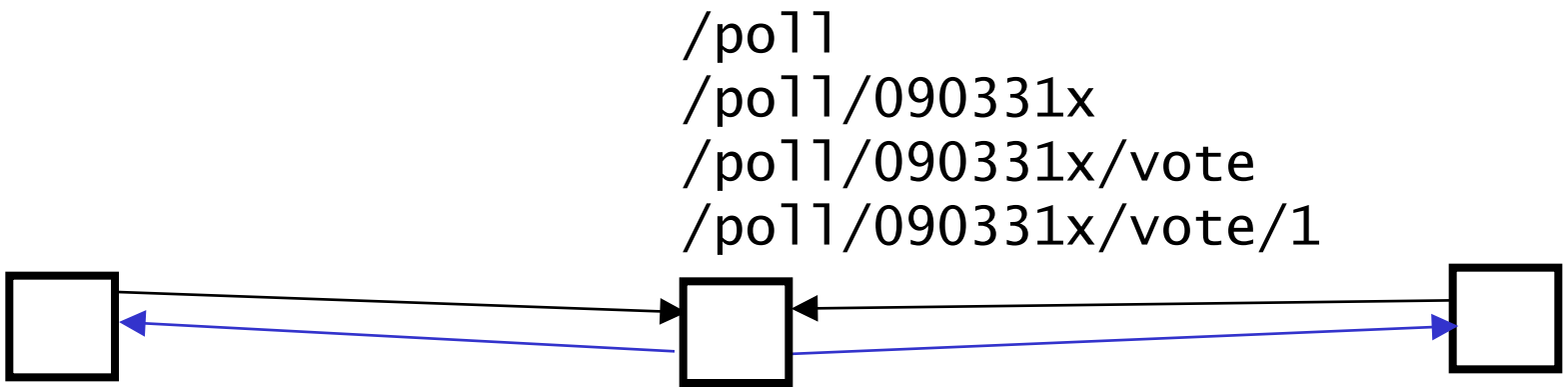



```
POST /poll/090331x/vote
<name>C. Pautasso</name>
<choice>B</choice>

201 Created
Location:
/poll/090331x/vote/1
```

```
GET /poll/090331x

200 OK
<options>A,B,C</options>
<votes><vote id="1">
<name>C. Pautasso</name>
<choice>B</choice>
</vote></votes>
```

Simple Doodle API Example

- Existing votes can be updated (access control headers not shown)

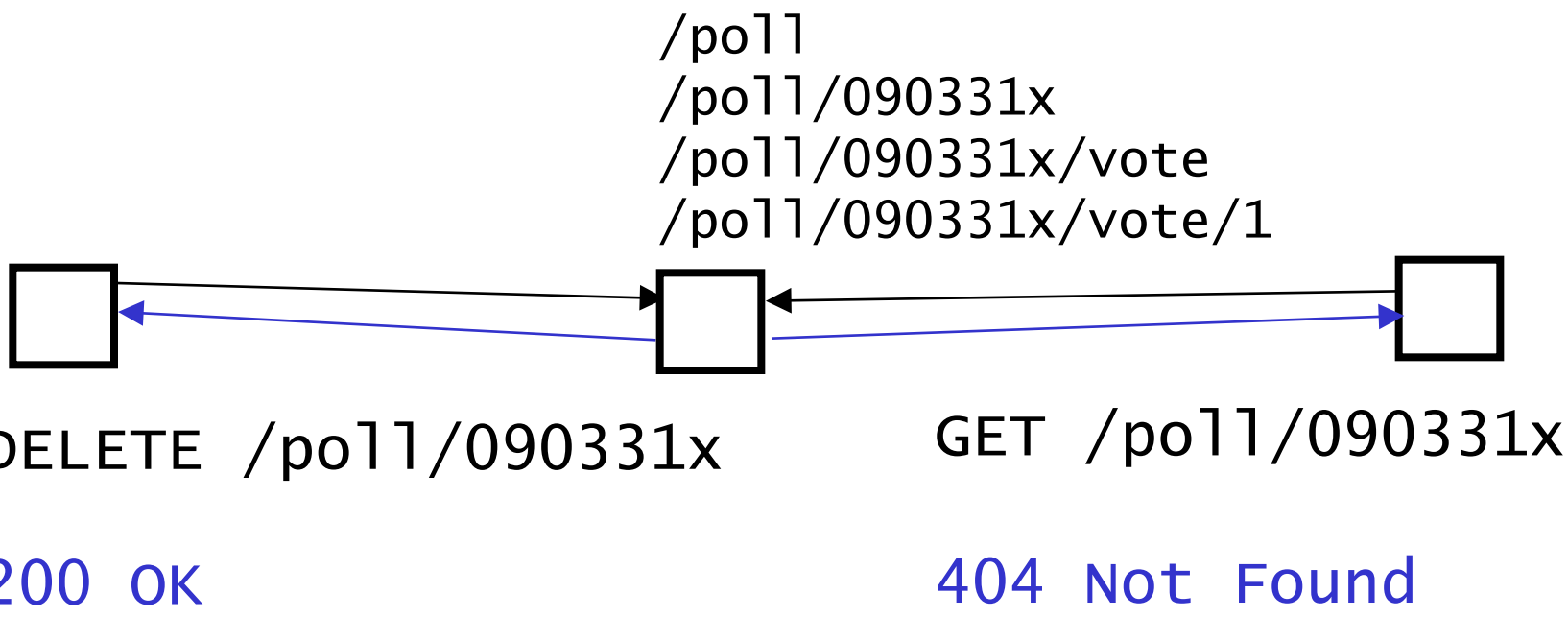



```
PUT /poll/090331x/vote/1
<name>C. Pautasso</name>
<choice>C</choice>

200 OK
```

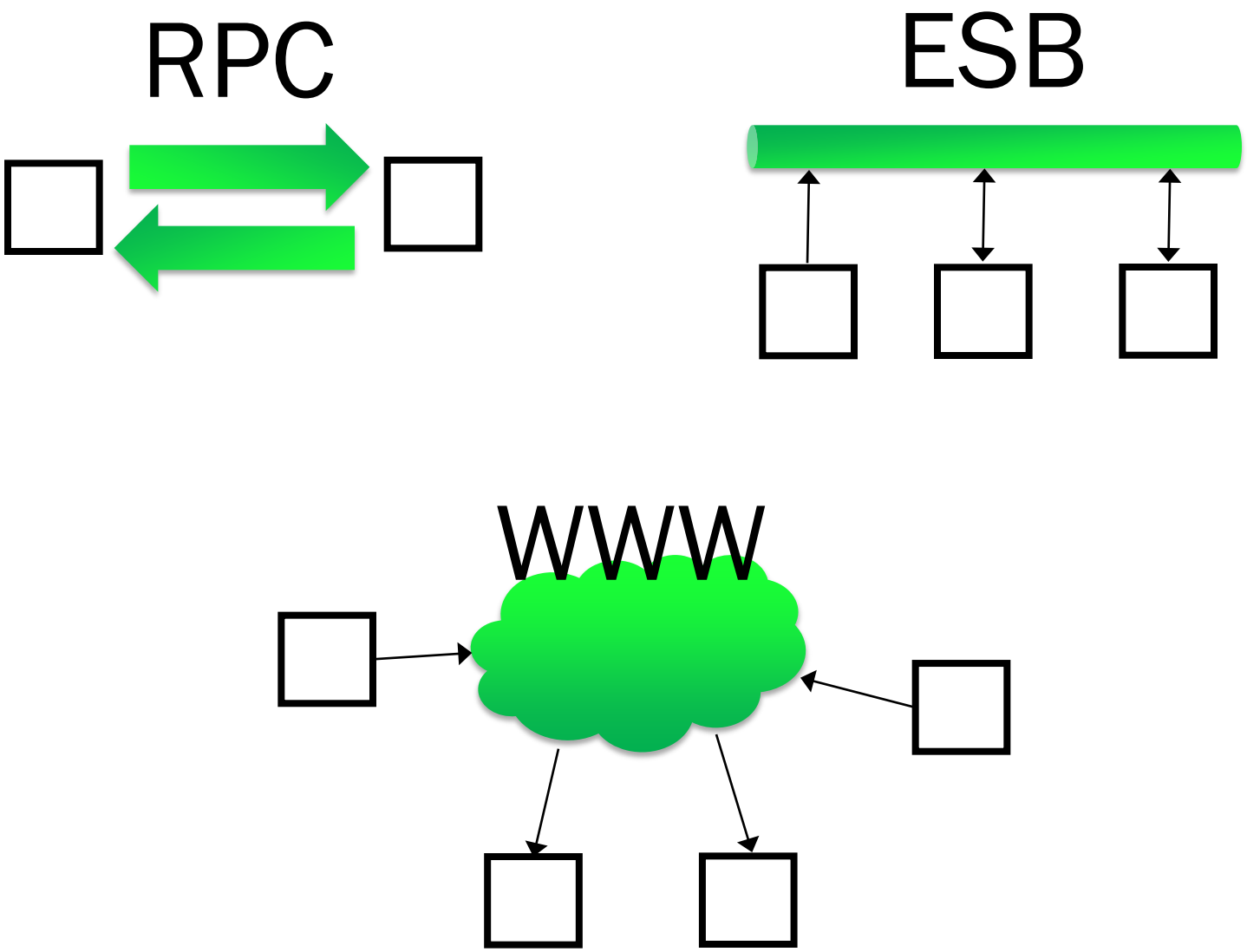
```
GET /poll/090331x

200 OK
<options>A,B,C</options>
<votes><vote id="/1">
<name>C. Pautasso</name>
<choice>C</choice>
</vote></votes>
```

Simple Doodle API Example

- Polls can be deleted once a decision has been made



What is your SOA Connector today?



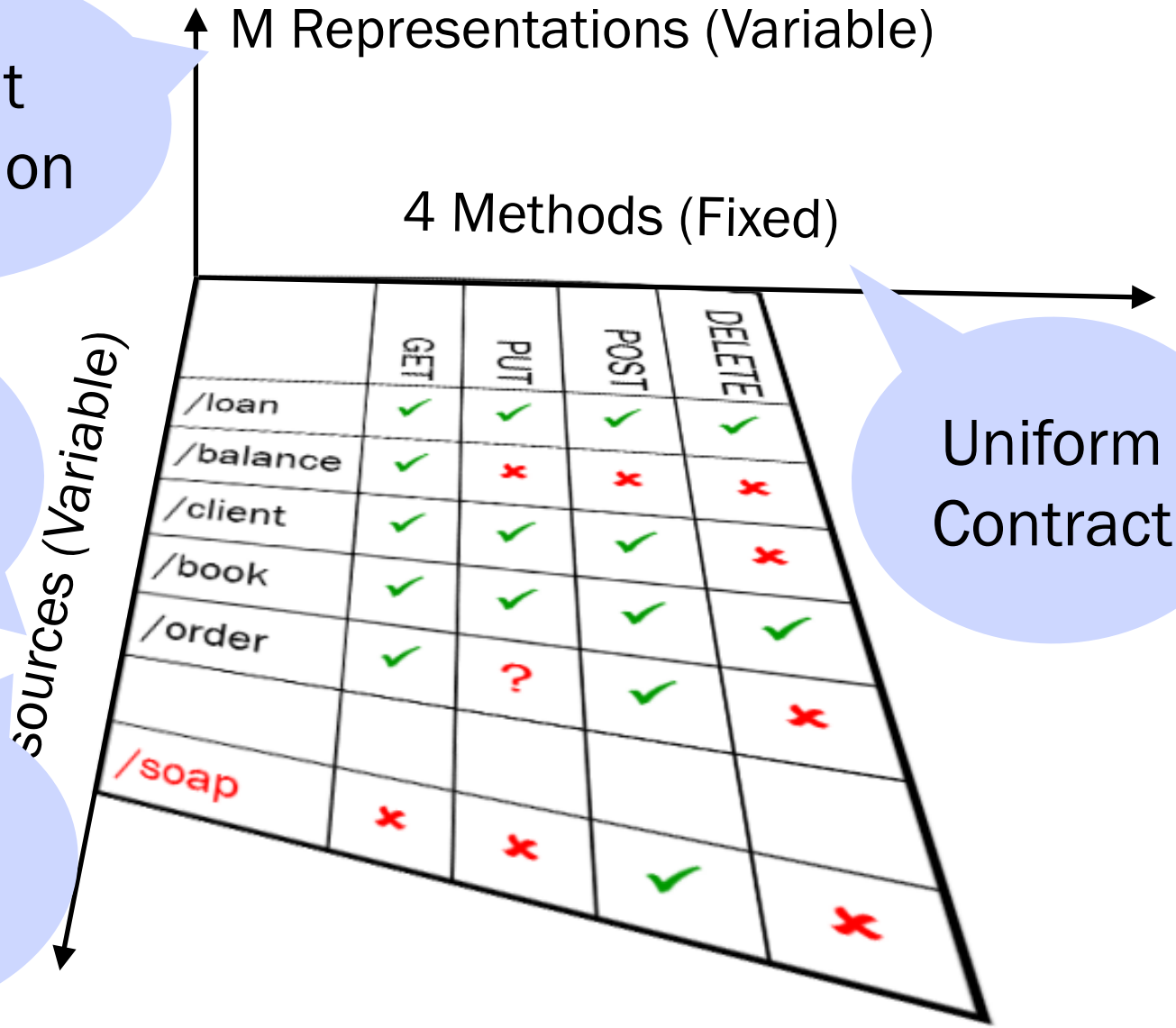
Design Patterns

Content Negotiation

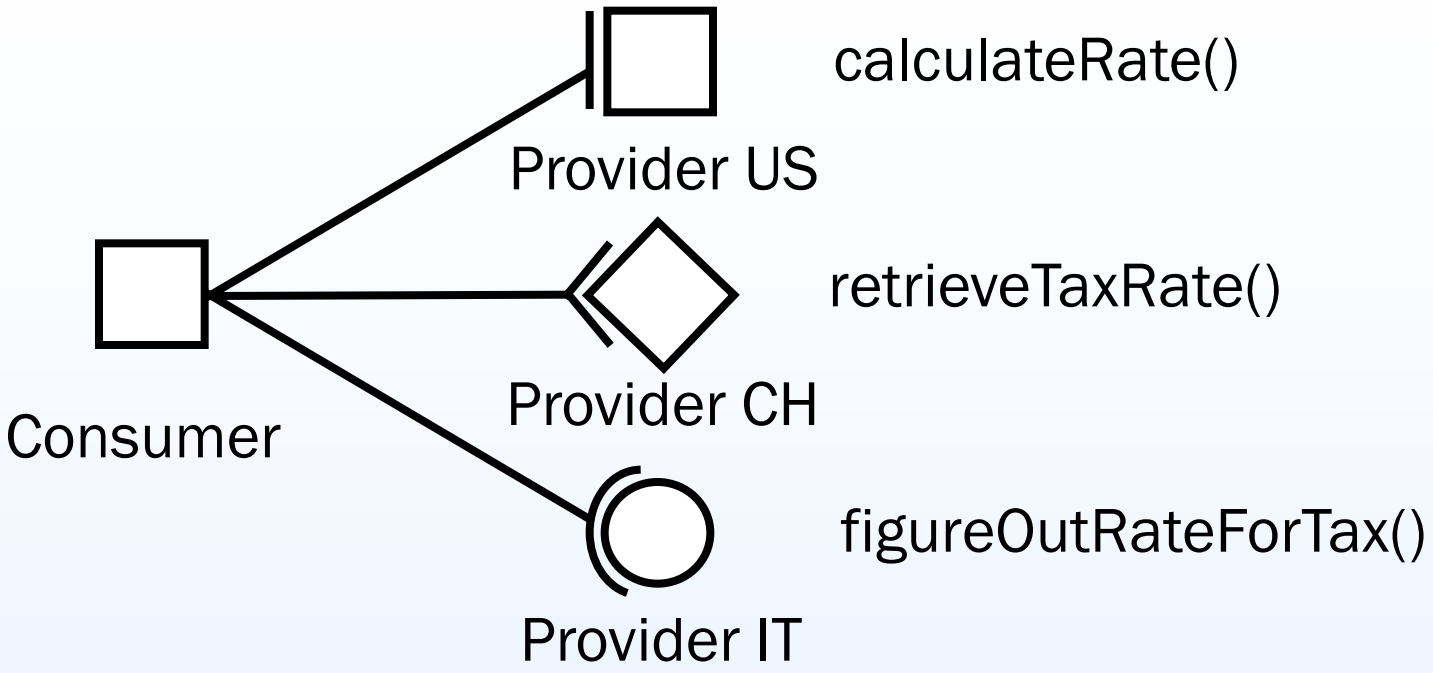
Entity Endpoint

Endpoint Redirect

Uniform Contract

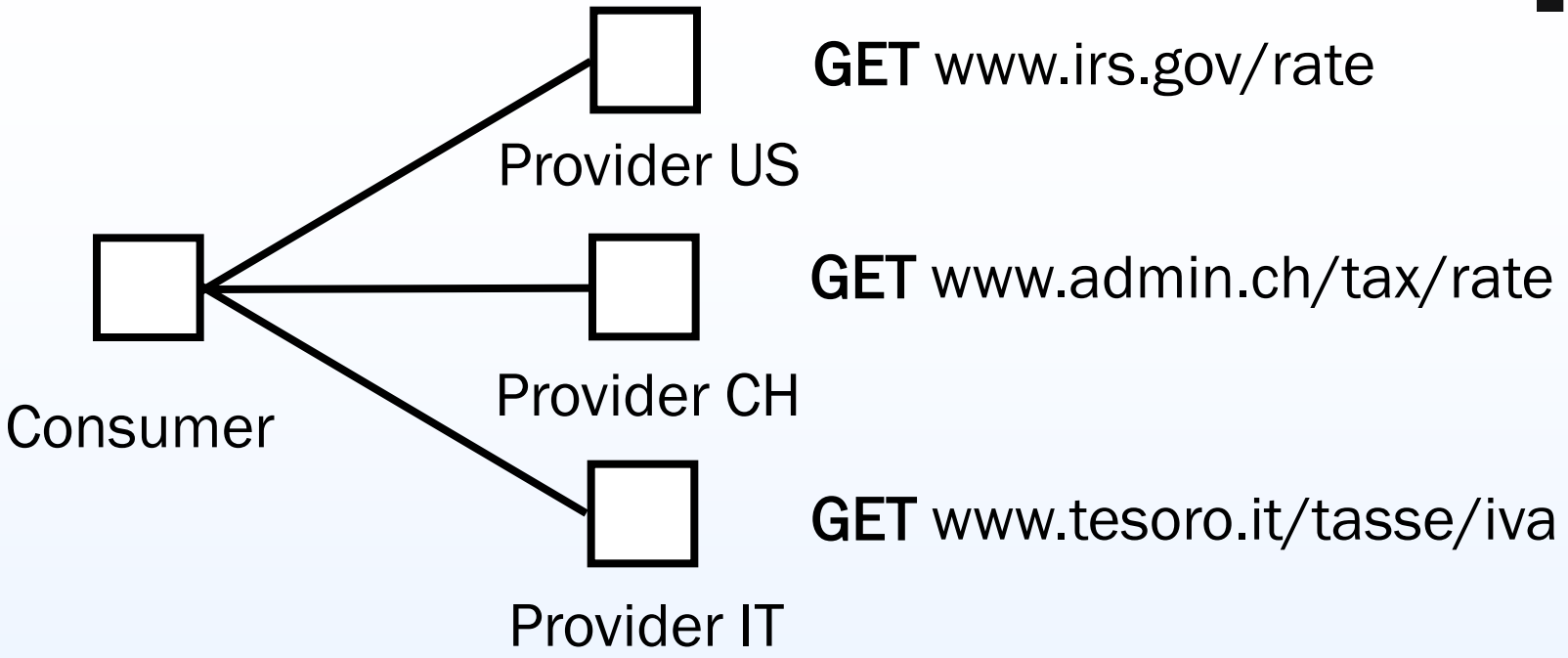


Pattern: Uniform Contract



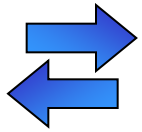
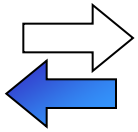
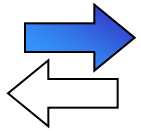
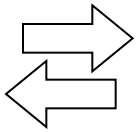
- How can consumers take advantage of multiple evolving service endpoints?
- **Problem:** Accessing similar services requires consumers to access capabilities expressed in service-specific contracts. ***The consumer needs to be kept up to date*** with respect to many evolving individual contracts.

Pattern: Uniform Contract



- Solution: **Standardize** a uniform contract across alternative service endpoints that is abstracted from the specific capabilities of individual services.
- Benefits: Service Abstraction, Loose Coupling, Reusability, Discoverability, Composability.

Example Uniform Contract

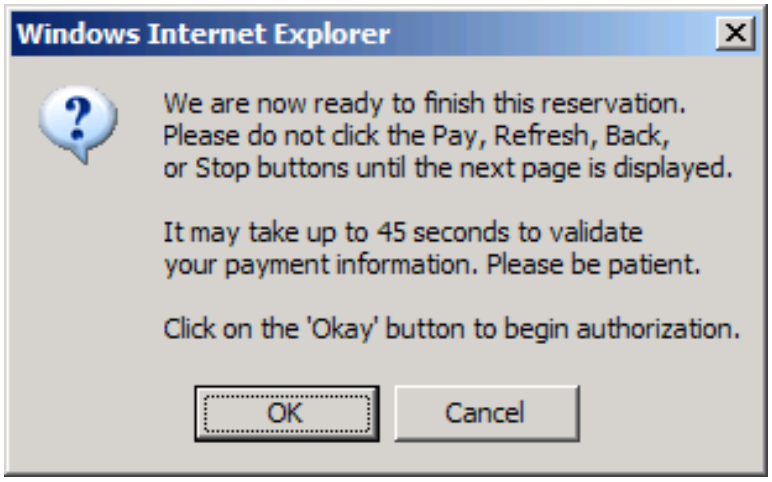
CRUD	HTTP	
CREATE	POST 	Create a sub resource
READ	GET 	Retrieve the *current state* of the resource
UPDATE	PUT 	Initialize or update the state of a resource at the given URI
DELETE	DELETE 	Clear a resource, after the URI is no longer valid

POST vs. GET

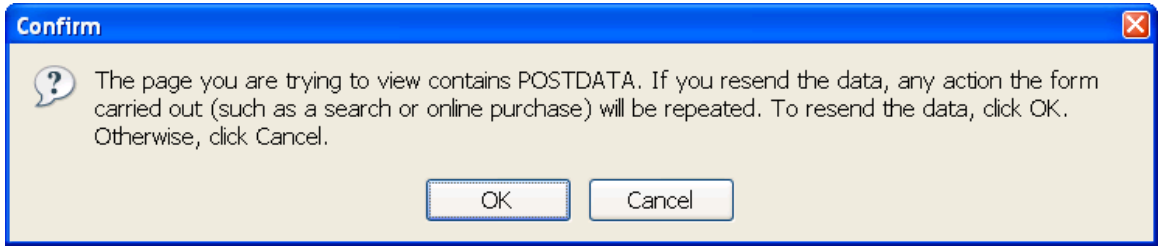
- GET is a **read-only** operation. It can be repeated without affecting the state of the resource (idempotent) and can be cached.

Note: this does not mean that the same representation will be returned every time.

- POST is a **read-write** operation and may change the state of the resource and provoke side effects on the server.

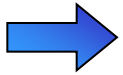


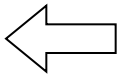
Web browsers warn you when refreshing a page generated with POST



POST vs. PUT

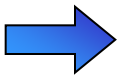
What is the right way of creating resources (initialize their state)?

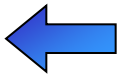

PUT /resource/{id}


201 Created

Problem: How to ensure resource {id} is unique?
(Resources can be created by multiple clients concurrently)

Solution 1: let the client choose a unique id (e.g., GUID)

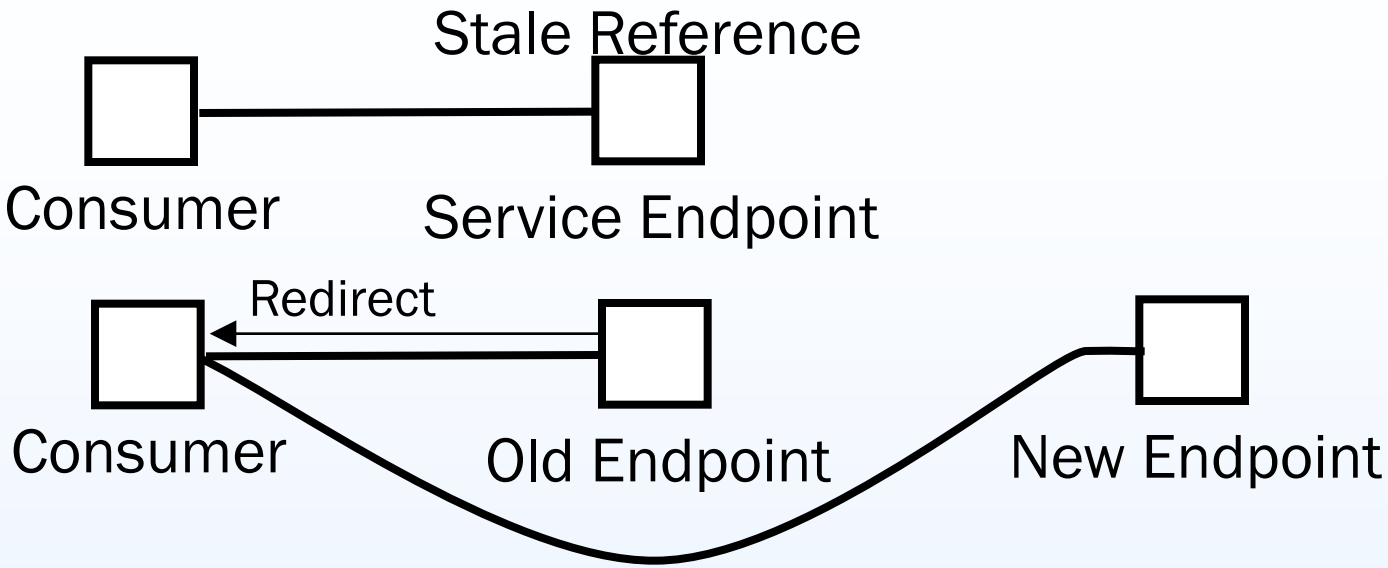

POST /resource


301 Moved Permanently
Location: /resource/{id}

Solution 2: let the server compute the unique id

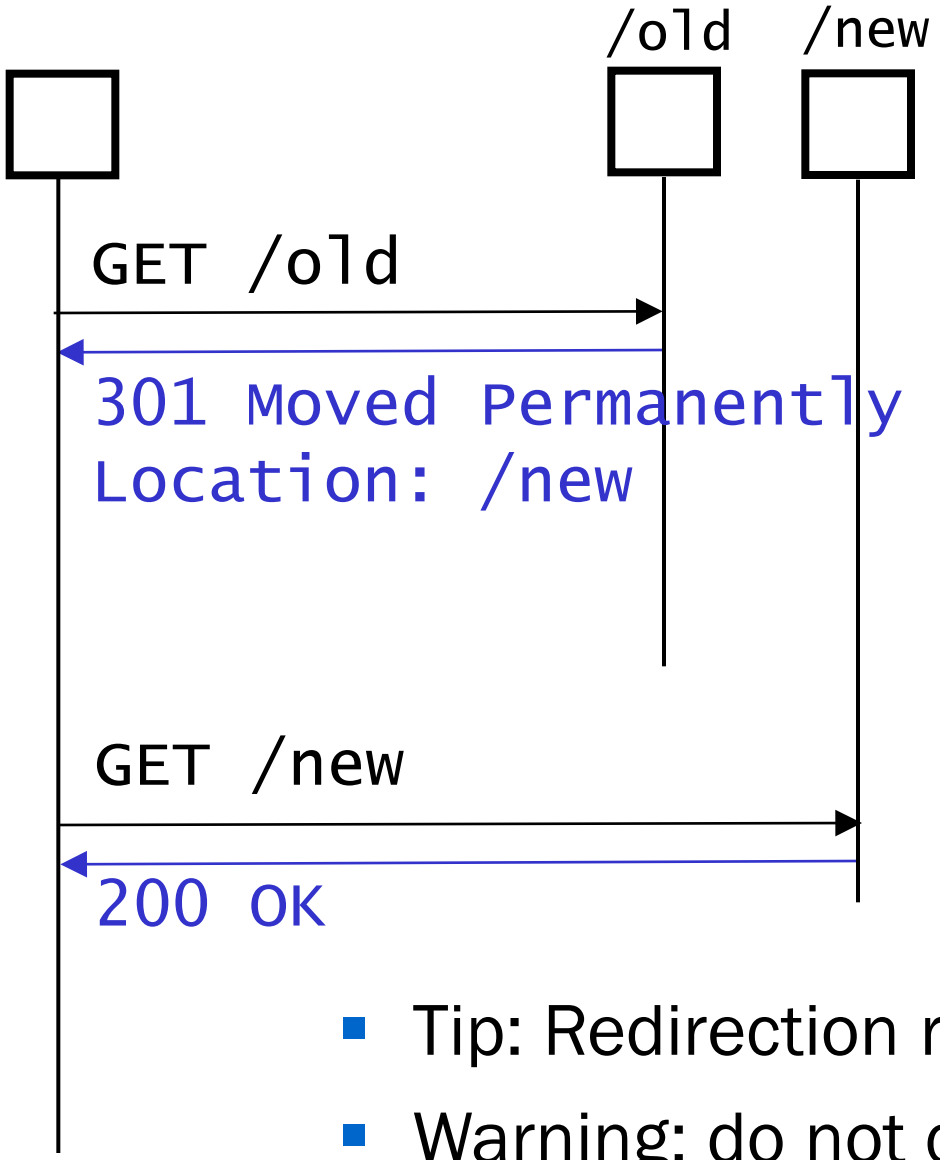
Problem: Duplicate instances may be created if requests are repeated due to unreliable communication

Pattern: Endpoint Redirection



- How can consumers of a service endpoint adapt when service inventories are restructured?
- Problem: Service inventories may change over time for business or technical reasons. It may not be possible to replace all references to old endpoints simultaneously.
- Solution: Automatically refer service consumers that access the stale endpoint identifier to the current identifier.

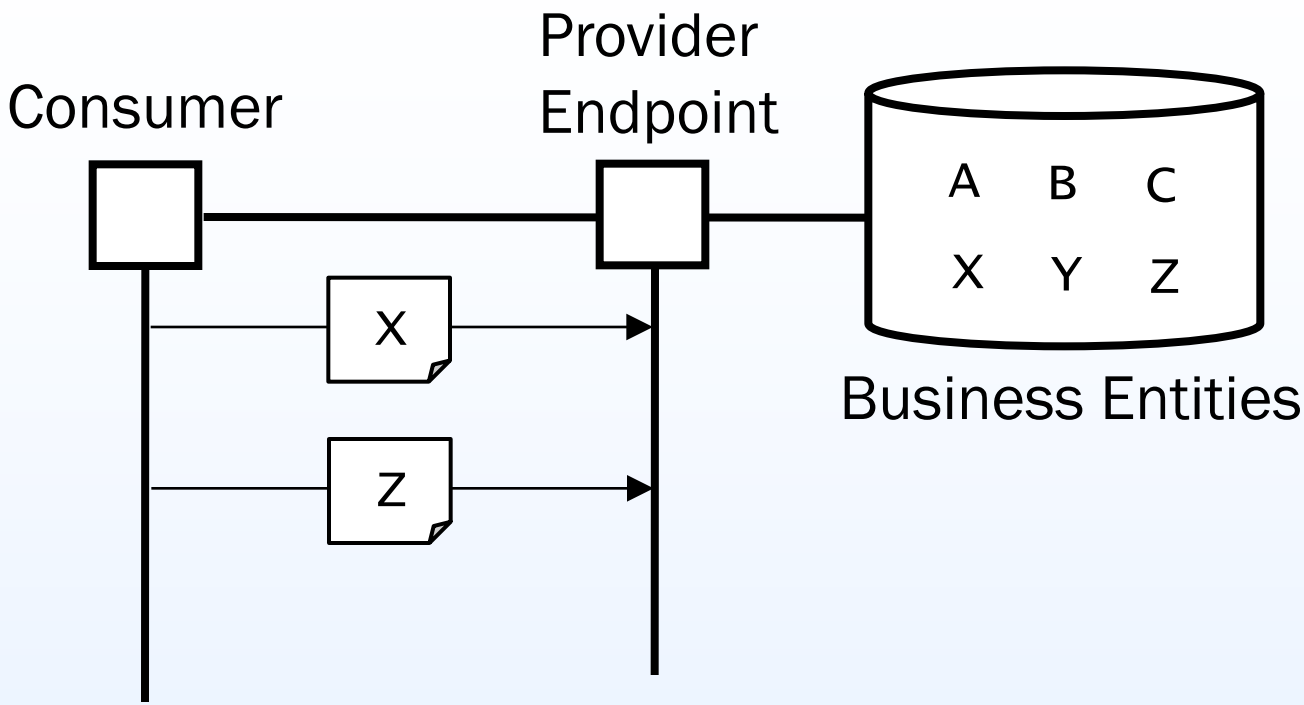
Endpoint Redirection with HTTP



- HTTP natively supports the Endpoint redirection pattern using a combination of 3xx status codes and standard headers:
  - 301 Moved Permanently
  - 307 Temporary Redirect
  - Location: /newURI

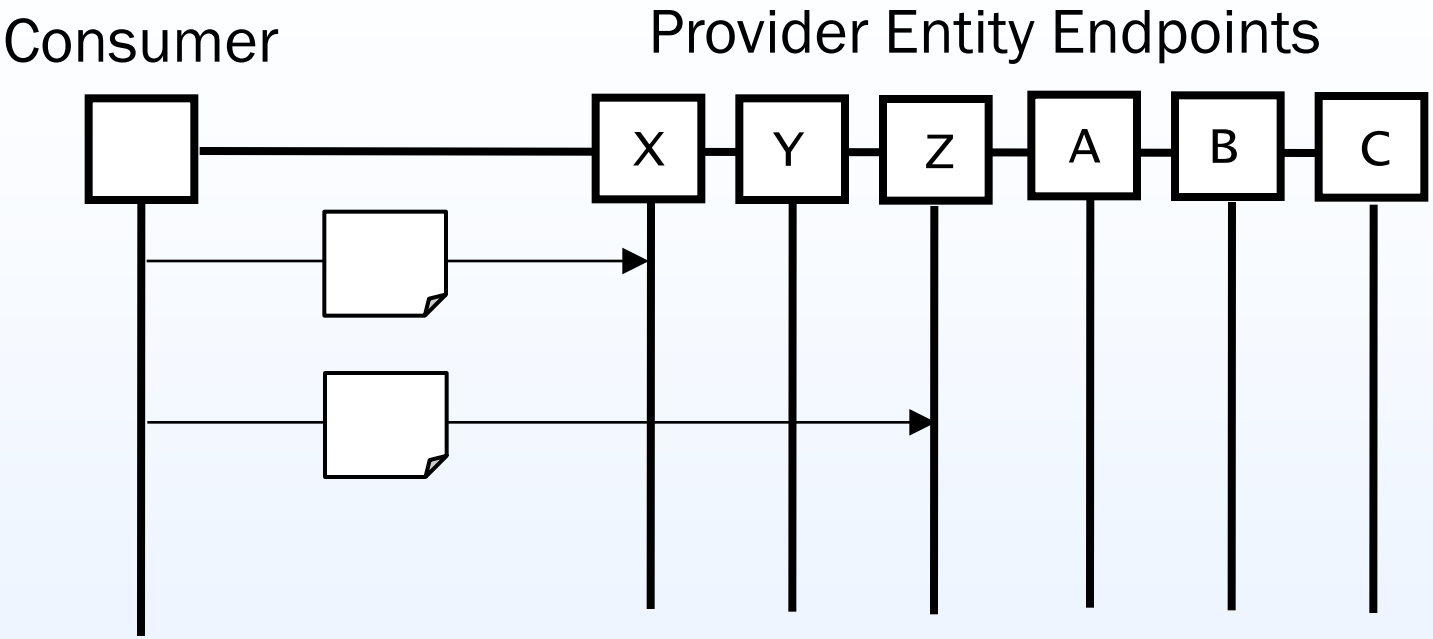
- Tip: Redirection responses can be chained.
- Warning: do not create redirection loops!

Pattern: Entity Endpoint



- How can entities be positioned as reusable enterprise resources?
- Problem: A service with a single endpoint is too coarse-grained when its capabilities need to be invoked on its data entities. A consumer needs to work with two identifiers: a global one for the service and a local one for the entity managed by the service. Entity identifiers cannot be reused and shared among multiple services

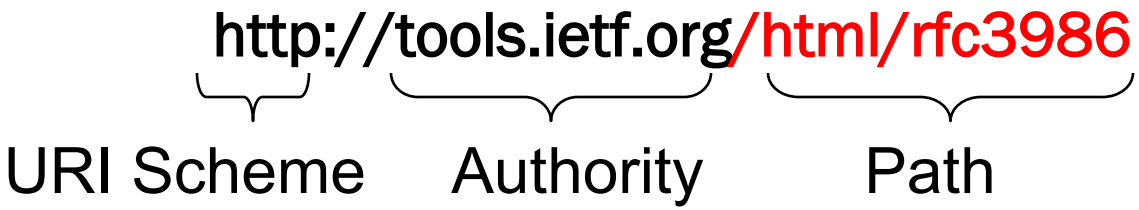
Pattern: Entity Endpoint



- Solution: expose each entitity as individual lightweight endpoints of the service they reside in
- Benefits: Global addressability of service entities

URI - Uniform Resource Identifier

- Internet Standard for resource naming and identification (originally from 1994, revised until 2005)
- Examples:

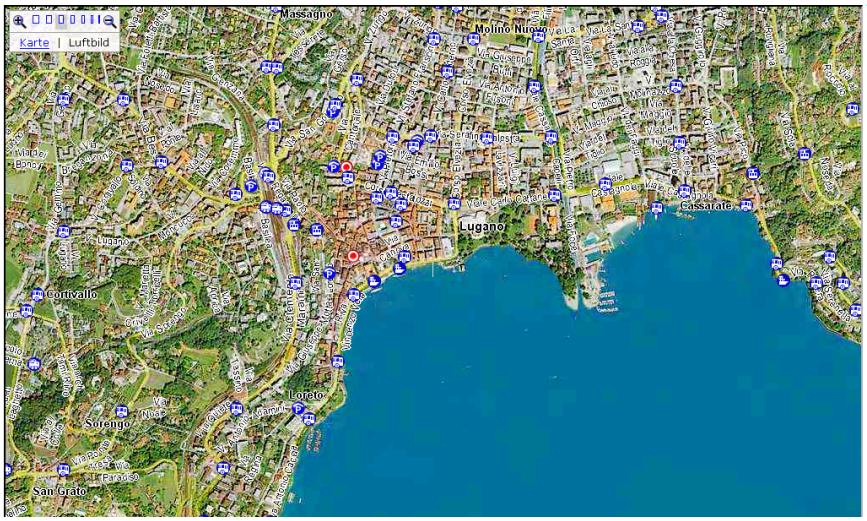


- REST does **not** advocate the use of “nice” URIs
- In most HTTP stacks URIs cannot have arbitrary length (4Kb)

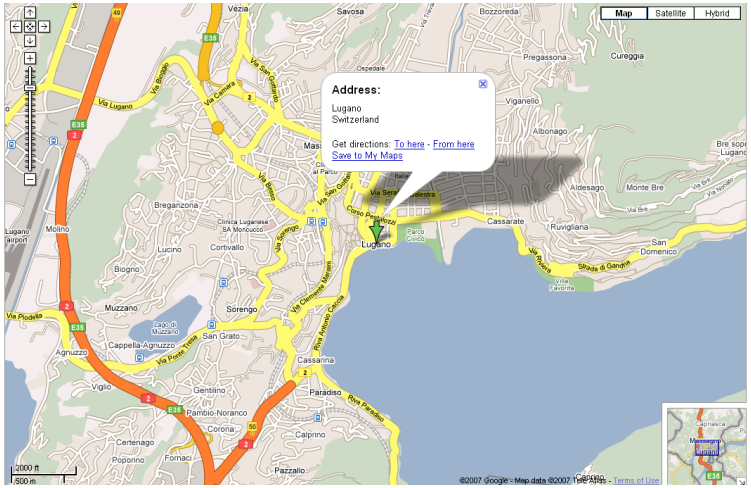
What is a “nice” URI?

A RESTful service is much more than just a set of nice URIs

http://map.search.ch/lugano



http://maps.google.com/lugano



http://maps.google.com/maps?f=q&hl=en&q=lugano,+switzerland&layer=&ie=UTF8&z=12&om=1&iwloc=addr

URI Design Guidelines

- Prefer Nouns to Verbs
- Keep your URIs short
- If possible follow a "positional" parameter-passing scheme for algorithmic resource query strings (instead of the key=value&p=v encoding)

GET /book?isbn=24&action=delete

DELETE /book/24

- **Note:** REST URIs are opaque identifiers that are meant to be discovered by following hyperlinks and *not constructed by the client*

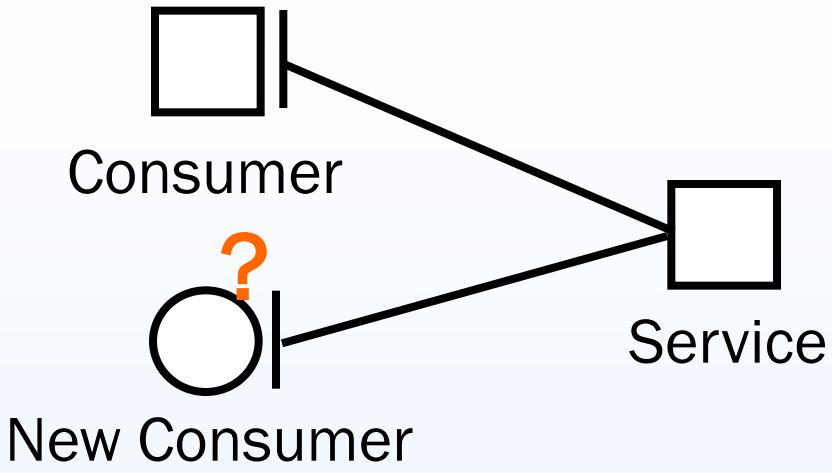
- Some use URI postfixes to specify the content type

- *This may break the abstraction*

- Do not change URIs
- Use redirection if you really need to change them

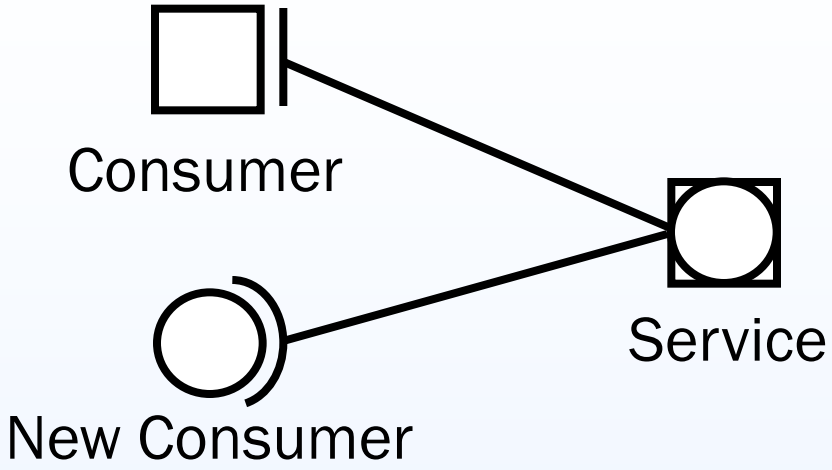
- **Warning:** URI Templates introduce coupling between client and server

Pattern: Content Negotiation



- How can services support different consumers without changing their contract?
- Problem: Service consumers may change their requirements in a way that is not backwards compatible. ***A service may have to support both old and new consumers*** without having to introduce a specific capability for each kind of consumer.

Pattern: Content Negotiation



- Solution: specific content and data representation formats to be accepted or returned by a service capability is negotiated at runtime as part of its invocation. The service contract refers to multiple standardized “media types”.
- Benefits: Loose Coupling, Increased Interoperability, Increased Organizational Agility

Content Negotiation in HTTP

Negotiating the message format does not require to send more messages (the added flexibility comes for free)

⇨ `GET /resource`

`Accept: text/html, application/xml, application/json`

1. The client lists the set of understood formats (MIME types)

⇦ `200 OK`

`Content-Type: application/json`

2. The server chooses the most appropriate one for the reply (status 406 if none can be found)

Advanced Content Negotiation

Quality factors allow the client to indicate the relative degree of preference for each representation (or media-range).

```
Media/Type; q=X
```

If a media type has a quality value q=0, then content with this parameter is not acceptable for the client.

```
Accept: text/html, text/*; q=0.1
```

The client prefers to receive HTML (but any other text format will do with lower priority)

```
Accept: application/xhtml+xml; q=0.9,
 text/html; q=0.5, text/plain; q=0.1
```

The client prefers to receive XHTML, or HTML if this is not available and will use Plain Text as a fall back

Forced Content Negotiation

The generic URI supports content negotiation

```
GET /resource
Accept: text/html, application/xml,
    application/json
```

The specific URI points to a specific representation format using the postfix (extension)

```
GET /resource.html
GET /resource.xml
GET /resource.json
```

Warning: This is a conventional practice, not a standard.

What happens if the resource cannot be represented in the requested format?

Multi-Dimensional Negotiation

Content Negotiation is very flexible and can be performed based on different dimensions (each with a specific pair of HTTP headers).

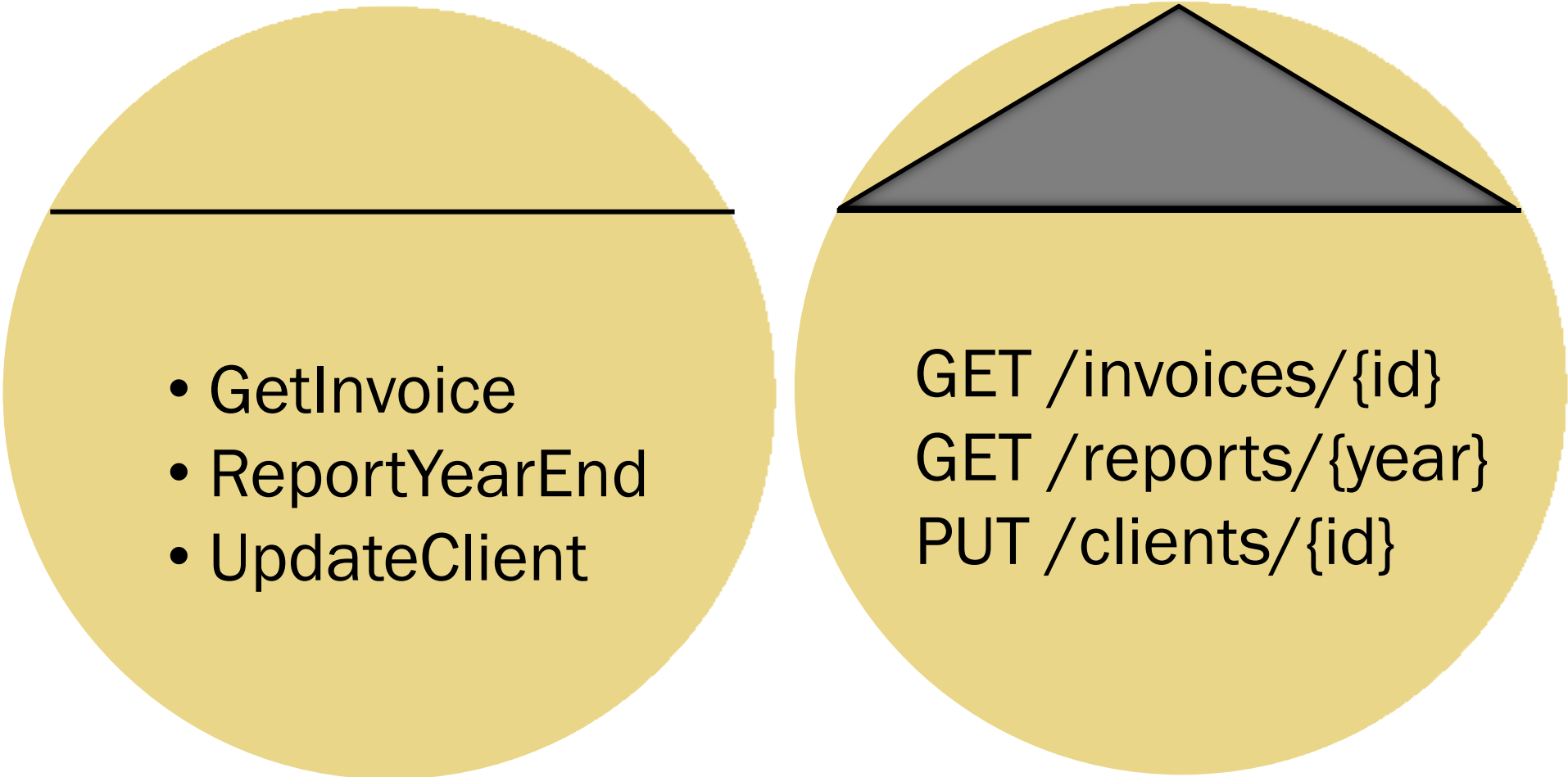
Request Header	Example Values	Response Header
`Accept:`	`application/xml, application/json`	`Content-Type:`
`Accept-Language:`	`en, fr, de, es`	`Content-Language:`
`Accept-Charset:`	`iso-8859-5, unicode-1-1`	`Charset` parameter fo the `Content-Type` header
`Accept-Encoding:`	`compress, gzip`	`Content-Encoding:`

More SOA with REST Patterns

1. Uniform Contract
2. Entity Endpoint
3. Entity Linking*
4. Content Negotiation
5. Distributed Response Caching*
6. Endpoint Redirection
7. Idempotent Capability*
8. Message-based State Deferral*
9. Message-based Logic Deferral*
10. Consumer-Processed Composition*

*Not Included in this talk

Conclusion


• GetInvoice
• ReportYearEnd
• UpdateClient
GET /invoices/{id}
GET /reports/{year}
PUT /clients/{id}

Conclusion

- SOA comes from the business IT domain, while REST comes from the World Wide Web.
- REST is more at home with HTTP and HTML, while SOA is more at home with SOAP and WSDL.
- Some REST advocates see the Web Services stack both as begin synonymous with SOA and as an invader in the architecture of the "real" Web. Some SOA advocates see REST as an unnecessary diversion from ensuring connectivity between enterprise service bus technologies supplied by different vendors.
- Despite their different histories, REST and SOA can learn a lot from each other.
- SOA with REST aims to forge an effective architectural model both for enterprise computing and for computing on the World Wide Web that brings the best of both worlds together

References

- R. Fielding, Architectural Styles and the Design of Network-based Software Architectures, PhD Thesis, University of California, Irvine, 2000
- C. Pautasso, O. Zimmermann, F. Leymann, RESTful Web Services vs. Big Web Services: Making the Right Architectural Decision, Proc. of the 17th International World Wide Web Conference (WWW2008), Bejing, China, April 2008
- C. Pautasso, BPEL for REST, Proc. of the 7th International Conference on Business Process Management (BPM 2008), Milano, Italy, September 2008
- C. Pautasso, Composing RESTful Services with JOpera, In: Proc. of the International Conference on Software Composition (SC2009), July 2009, Zurich, Switzerland.
- R. Balasubramanian, B. Carlyle, T. Erl, C. Pautasso, **SOA with REST**, Prentice Hall (to appear in 2010)
- Doodle RESTful API, http://doodle.com/xsd1/RESTfulDoodle.pdf