RESTful services

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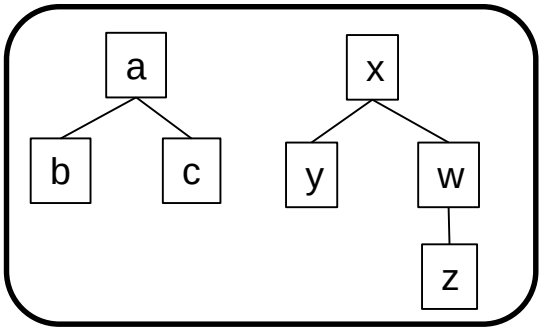
REpresentational State Transfer (REST)

Originally introduced as an *architectural style*, developed as an abstract model of the Web architecture to guide the redesign and definition of HTTP and URIs

Q: Why the name "*REpresentational State* Transfer"?

A: "[...] to evoke an image of how a well-designed Web application behaves: a network of Web pages forms a virtual state machine, allowing a user to progress through the application by selecting a link or submitting a short data-entry form, with each action resulting in a transition to the next state of the application by transferring a representation of that state to the user"

R.T. Fielding. Architectural styles and the design of network-based software architectures. *PhD Thesis, University of California, Irvine, 2000.*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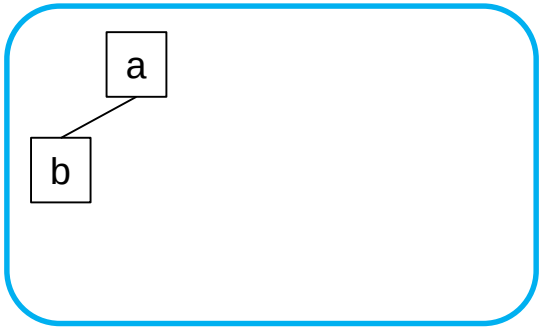
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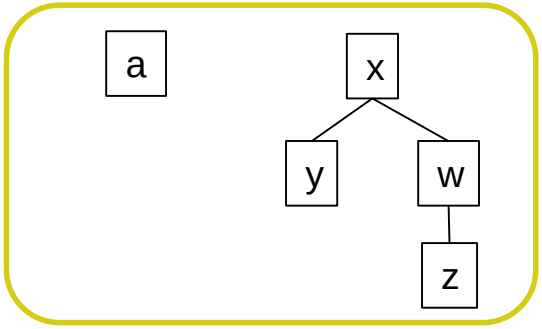
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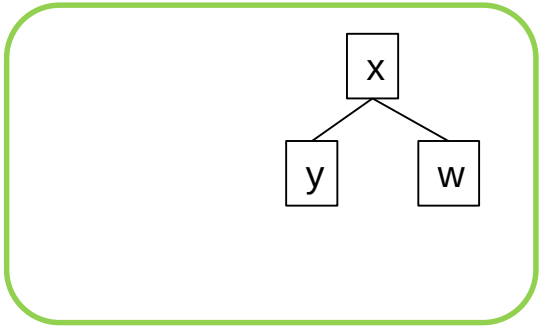
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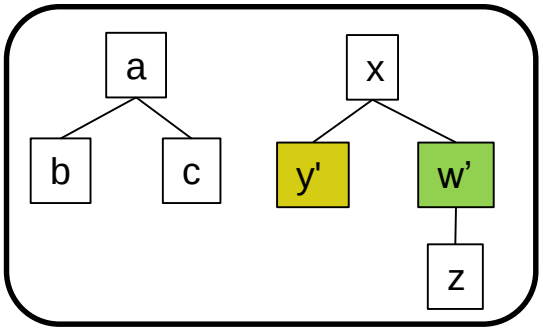
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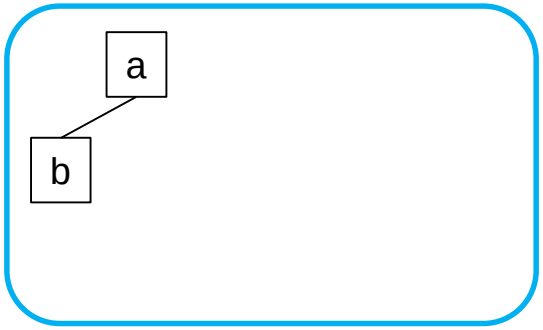
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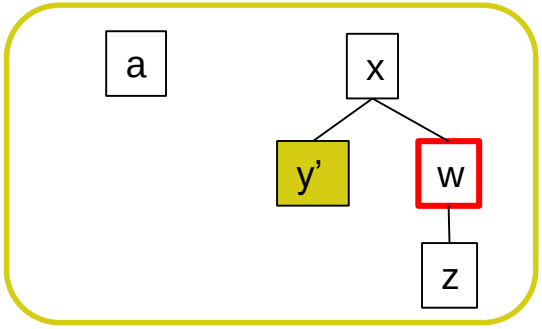
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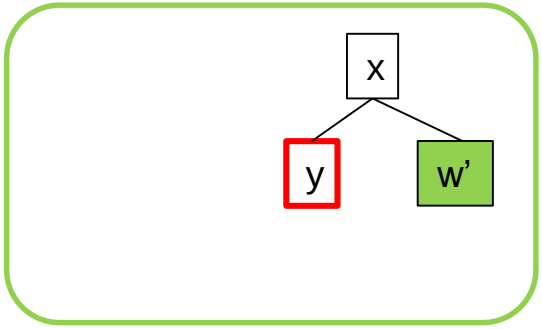
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RESTful services

- RESTful services:
  - **Services are viewed as *resources* that can be uniquely address by their URIs**
  - **Clients invoke HTTP methods to create/read/update/delete resources**
- REST "resource-centric" (SOAP "message-centric")
- Requests and responses to transfer representations of resources

REST motivations

- Simplicity

  rely on a few principles and a small set of well-defined operations

- Scalability

  stateless protocol and distributed state

- Layeredness

  allow (any number of) intermediaries (proxies, gateways, firewalls)

REST principles

REST principles

1. Resource identification through URIs
   - Service exposes a set of resources which identify the targets of the interaction with its clients
   - Resources identified by URIs, which define global addressing space for resource & service discovery
2. Uniform interface
   - Resources manipulated using a fixed set of operations:
     - PUT and POST to create and update state of resource
     - DELETE to delete a resource
     - GET to retrieve current state of a resource

```
PUT is idempotent
POST is not idempotent
                [RFC 2616]
```

3. Self-descriptive messages
   - Requests contain enough context information to process the message
   - Resources decoupled from their representation so that their content can be accessed in a variety of formats (e.g., HTML, XML, JSON, plain text, PDF, JPEG, etc.)
   - Metadata about the resource can be used to control caching or to negotiate representation format
4. Stateful interactions through hyperlinks
   - Every interaction with a resource is stateless
   - Serever contains no client state, any session state is held on the client
   - Stateful interactions rely on the concept of explicit state transfer

Example

Customer wants to update his last food order

GET /customers/fred

```
            200 OK
            <customer>
               <name>Fred Flinstone</name>
               <address> 45 Cave Stone Road, Bedrock</address>
               <orders>http://barbera.com/customers/fred/orders</orders>
            </customer>
```

GET /customers/fred/orders

```
            200 OK
            <orders>
               <customer>http://barbera.com/customers/fred</customer>
               <order id="1">
                  <orderURL>http://barbera.com/orders/1122</orderURL>
                  <status>open</status>
               </order>
               ...
            </orders>
```

GET /orders/1122

```
            200 OK
            <order>
               <customer>http://barbera.com/customers/fred</customer>
               <item quantity="1">brontoburger</item>
            </order>
```

PUT /orders/1122

```
<order>
   <customer>http://barbera.com/customers/fred</customer>
   <item quantity="50">brontoburger</item>
</order>
```

```
            200 OK
```

Example

Using a simple Doodle service to organize next Friday night

POST /polls
<title>Friday night</title>
<options>
<option>bowling</option>
<option>pool</option>
<option>poker</option>
</options>
...

201 Created
Content-Location: /polls/112233

GET /polls/112233

200 OK
<poll>
<title>Friday night</title>
...
<votes href="/vote">
</poll>

POST /polls/112233/vote
<name>Barnie>/name>
<choice>pool</choice>

GET /polls/112233

201 Created
Content-Location: /polls/112233/vote/1

200 OK
<title>Friday night</title>
...
<votes>
<vote id="1">
<name>Barnie</name>
<choice>pool>/choice>
</vote>
</votes>

DELETE /polls/112233

200 OK

GET /polls/112233

404 Not Found

Some other (real) examples

flickr http://api.flickr.com/services/search?...&text=pisa

twitter http://search.twitter.com/search.json?q=merkel

YouTube

facebook

Google maps

...

Strengths of REST

- Simplicity
  - low learning curve
    - REST leverages well-known standards (HTTP, XML, URI)
    - necessary infrastructure has already become pervasive
  - services can be built with minimal tooling
    - deploying a RESTful Web service very similar to building dynamic Web site
    - effort required to build a client to a RESTful service small
      - developers can begin testing service from ordinary Web browser
      - no need to develop custom client-side software
    - thanks to URIs and hyperlinks, it is possible to discover Web resources without compulsory registration to a repository
- Efficiency
  - lightweight protocol
  - lightweight message formats
- Scalability
  - stateless RESTful Web services can serve a very large number of clients

Weaknesses of REST

- Confusion on what are the best practices for building RESTfulWeb services, e.g.,
  - **Hi-REST** recommends the use of 4 verbs (GET, POST, PUT, DELETE)
  - Since proxies and firewalls may not always allow HTTP connections that use any other verb than GET and POST, **Lo-REST** uses only two verbs (GET for idempotent requests, and POST for everything else)
    - workarounds: "real" verb sent using a special HTTP header (`X-HTTP-Method-Override`) or – like with Ruby on Rails– a hidden form field
    - these workarounds may not be understood by all Web servers → additional development and testing effort required
- Encoding complex data structures into a URI can be challenging as there is no commonly accepted marshalling mechanism
- Idempotent requests having large amounts of input data cannot be encoded in a URI ("`414 - Request-URI too long`")

SOAP vs. REST

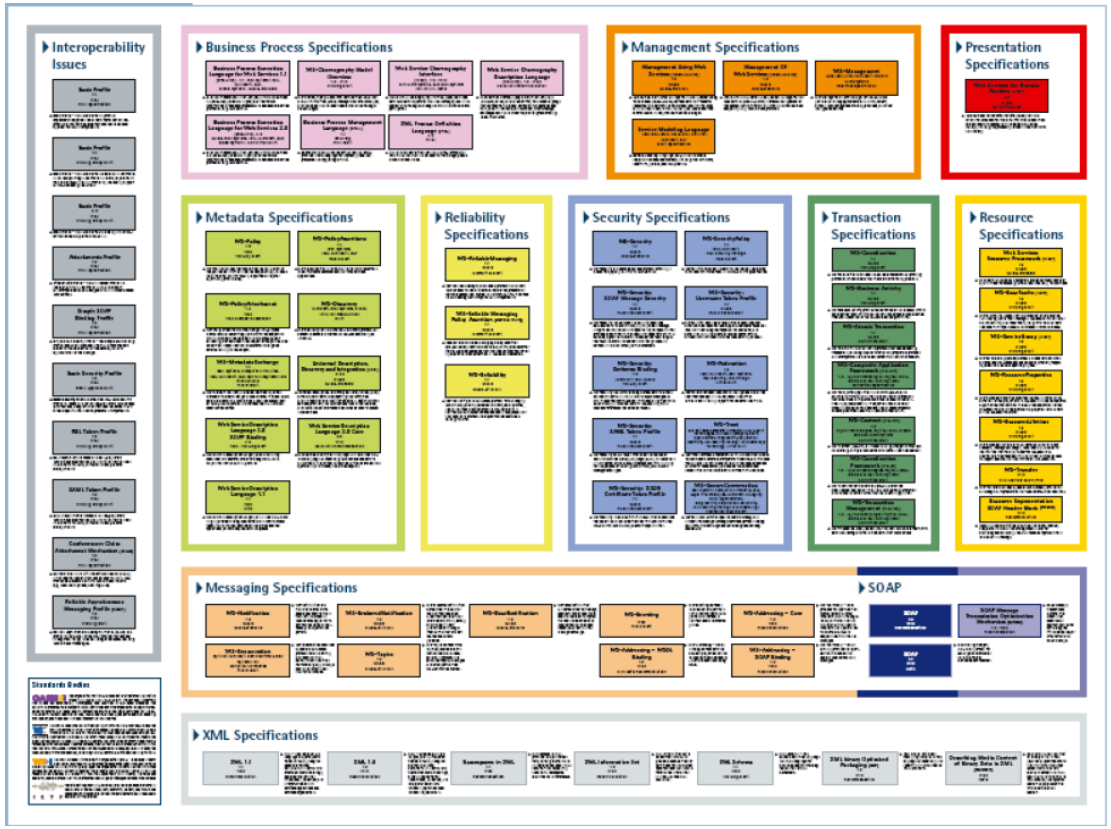
Example: Querying a phonebook application for the details of a given user (id)

```
<?xml version="1.0"?>
<soap:Envelope xmlns:soap="http://www.w3.org/2001/12/soap-envelope"
soap:encodingStyle="http://www.w3.org/2001/12/soap-encoding">
<soap:body pb="http://www.acme.com/phonebook">
<pb:GetUserDetails>
<pb:UserID>12345</pb:UserID>
</pb:GetUserDetails>
</soap:Body>
</soap:Envelope>
```

vs.

```
http://www.acme.com/phonebook/UserDetails/12345
```

WS-* vs. REST services



vs.

HTTP

XML | JSON

WS-* vs. REST services

- REST does not have the complexity of the layers of the WS-* stack
- Not easy to extend a RESTful Web service to support advanced functionalities in an interoperable manner
- Various decisions that are very easy to make for RESTful services may lead to significant development efforts and technical risks
  - e.g., the design of the exact specification of the resources and their URI addressing scheme
- If the enterprise-level features of WS-* (transactions, reliability, message-level security) are not required
  - REST can provide better flexibility and control, but requires a lot of low-level coding
  - WS-* provides better tool support and programming interface convenience

- REST convenient
  - to get (simple) services running
  - for tactical, ad hoc integration over the Web (e.g., mashups)
- WS-* preferable for professional enterprise application integration scenarios with longer lifespan and advanced QoS requirements

C. Pautasso, O. Zimmermann, F. Leymann. Restful web services vs. "big"' web services: making the right architectural decision.

https://nordicapis.com

https://nordicapis.com

https://www.youtube.com/watch?v=vhpjfAnqXlM

Mashup

[noun - Music, Slang.]: a recording that combines vocal and instrumental tracks from two or more recordings

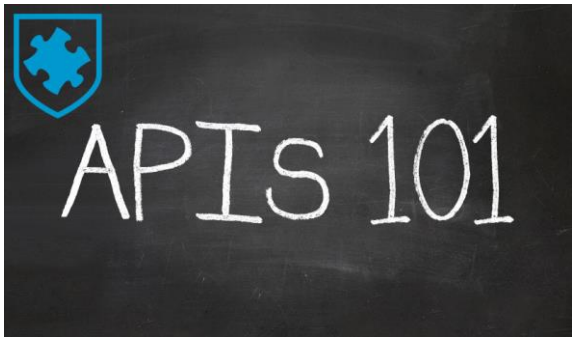
Mashup

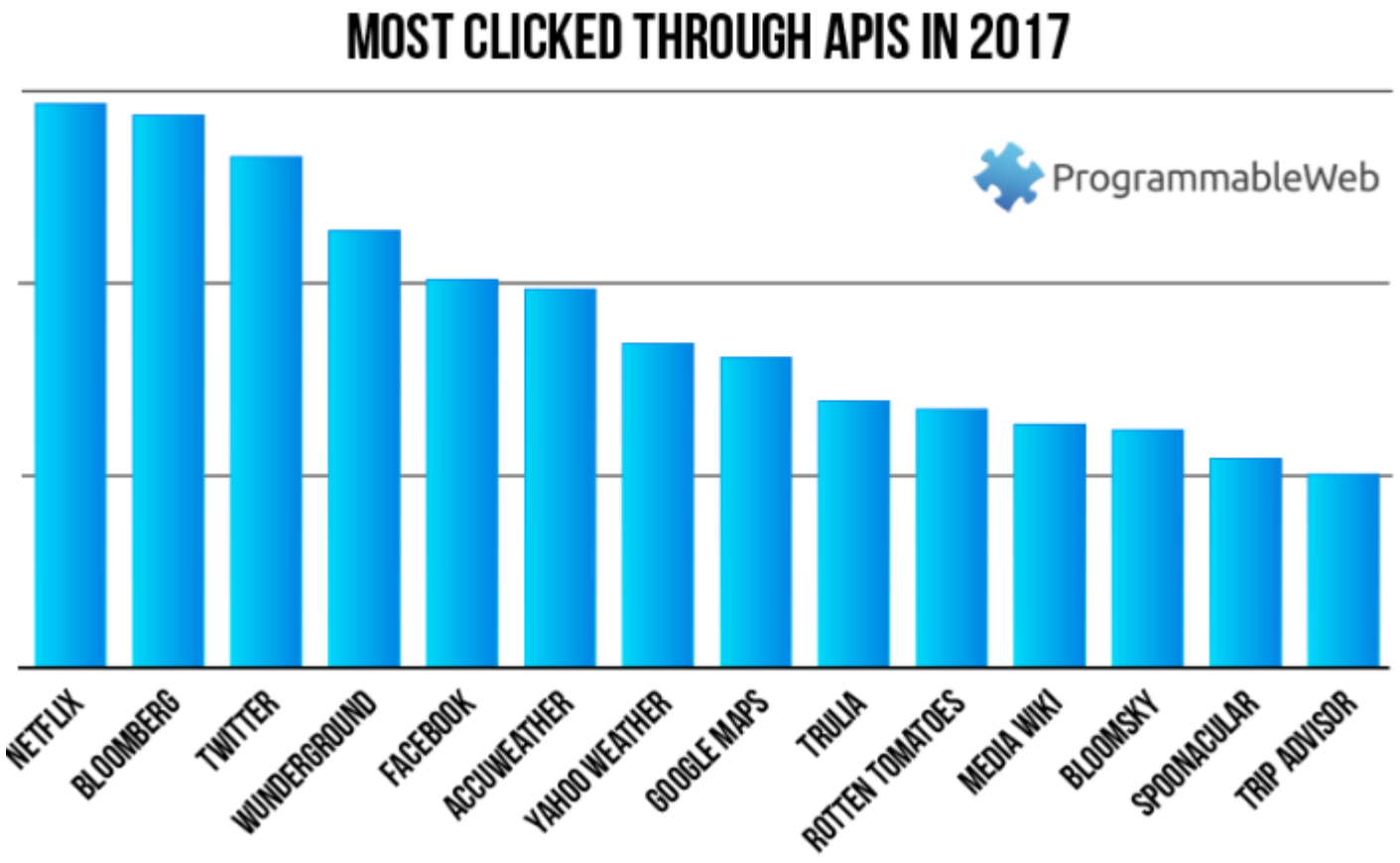
[noun - Music, Slang.]: a recording that combines vocal and instrumental tracks from two or more recordings

[noun – Computer Science]: **a light-weight Web application innovatively combining (data provided by) services available on the net**

A couple of random examples

- Given the title of a movie *m*, display map with cinemas featuring *m* and restaurants nearby
- BBC news map – places on a map (links to) BBC news reports





https://www.programmableweb.com

Kloudless

Kloudless helps aggregate multiple APIs and integrate these services into an application. The

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Healthcare Messenger – KPN

The Healthcare Messenger API is provided by KPN, allowing 1-1 chat communications for

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Live Objects

The Orange API connects with a platform for managing data from IoT sources. Using the API,

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Avalara AvaTax API

Avalara offers a suite of REST APIs to interface with AvaTax, an enterprise tax service. According

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NASA API

The NASA APIs open up NASA data and imagery for developers to create all sorts of spacey

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api.video

The api.video services provides a way to host and deliver videos using their content delivery

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RingCentral

The RingCentral API enables multi-faceted business communication abilities, including

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Home Connect API

Home Connect offers the possibility to control your Home Connect enabled kitchen appliances

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APItude by Hotelbeds

Described as "the world's bed bank," Hotelbeds is networking the world's travel trade. Through

Monzo API Docs

Monzo is an innovative, user-friendly mobile-first bank. Their web API provides an intuitive

https://nordicapis.com/best-public-api-of-2018/