<WA1/>

2020

REST API

The glue between clients and servers

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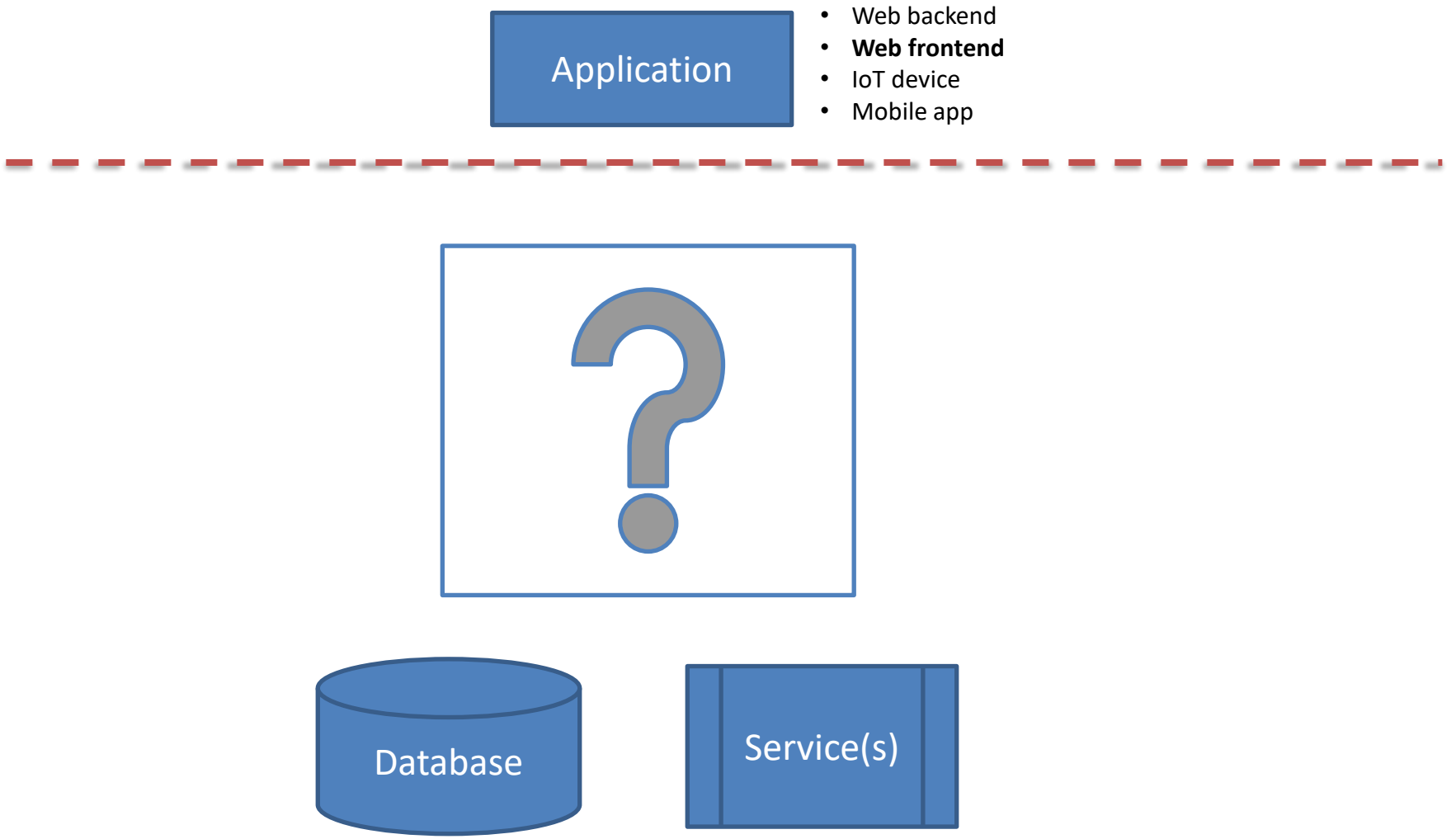
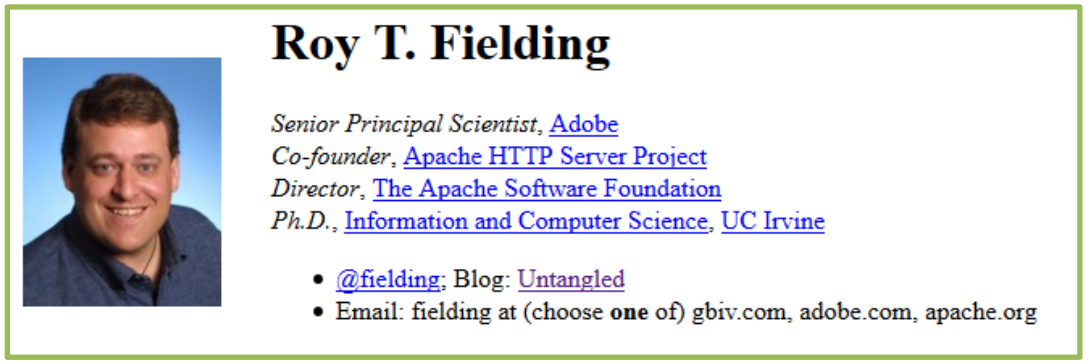
Goal


Application
Web backend
Web frontend
IoT device
Mobile app
Database
Service(s)

REST



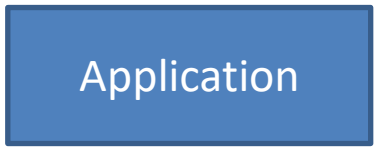
- **Representational State Transfer**
- A style of software architecture for distributed systems
- Platform-independent
  - you don't care if the server is Unix, the client is a Mac, or anything else
- Language-independent
  - C# can talk to Java, etc.
- Standards-based
  - runs on top of HTTP
- Can easily be used in the presence of firewalls

What is a Resource?

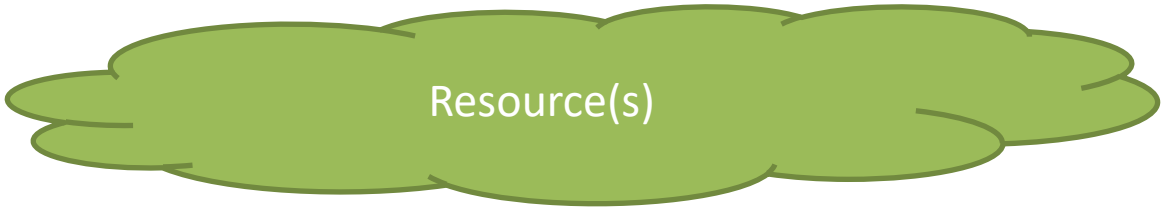
{REST}

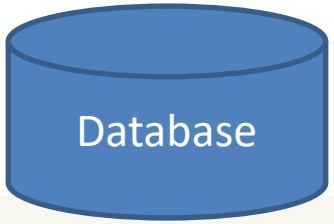
- A resource can be anything that has identity
  - a document or image
  - a service, e.g., "today's weather in New York"
  - a collection of other resources
  - non-networked objects (e.g., people)
- The resource is the **conceptual mapping** to an entity or set of entities, not necessarily the entity that corresponds to that mapping at any particular point in time!

REST Architecture



- Web backend
- **Web frontend**
- IoT device
- Mobile app





Main Principles

{REST}

- Resource: source of specific information
- Mapping: Resources ⇔ URIs
- Client and server exchange *representations* of the resource
  - the same resource *may* have different representations
  - e.g., XML, JSON, HTML, RDF, …

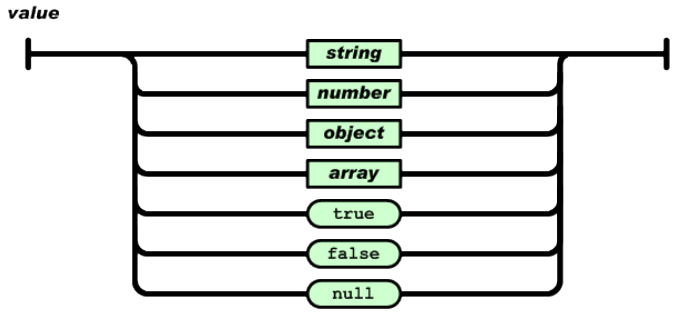
JSON - JavaScript Object Notation

/ˈdʒeɪ·sən/

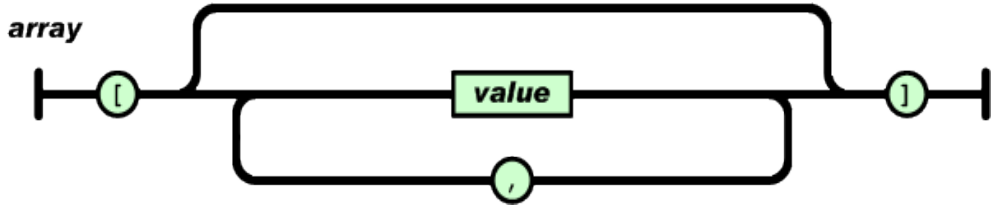
- Lightweight Data Interchange Format
  - Subset of JavaScript syntax for object literals
  - Easy for humans to read and write
  - Easy for machines to parse and generate
  - https://www.json.org/
  - ECMA 404 Standard: http://www.ecma-international.org/publications/files/ECMA-ST/ECMA-404.pdf
  - RFC 8259: https://tools.ietf.org/html/rfc8259
- Media type: `application/json`

JSON Logical Structure

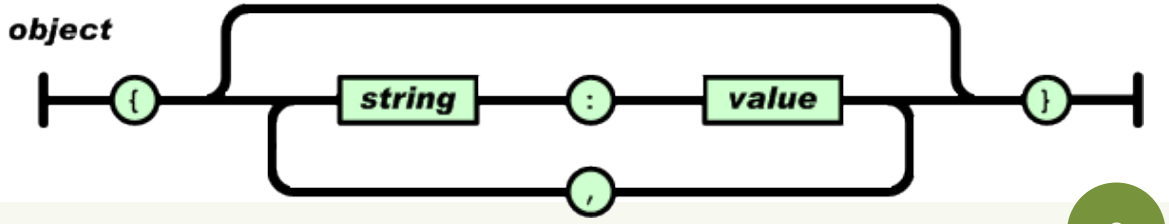
- Primitive types: string, number, true/false/null
  - Strings MUST use "double" quotes, not 'single'



- Composite type – Array: ordered lists of values



- Composite type – Objects: list of key-value pairs
  - Keys are strings (not identifiers)
  - MUST be "quoted"



JSON Example


```
{
    "firstName": "John",
    "lastName": "Smith",
    "address": {
        "streetAddress": "21 2nd Street",
        "city": "New York",
        "state": "NY",
        "postalCode": 10021
    },
    "phoneNumbers": [
        "212 555-1234",
        "646 555-4567"
    ]
}
```

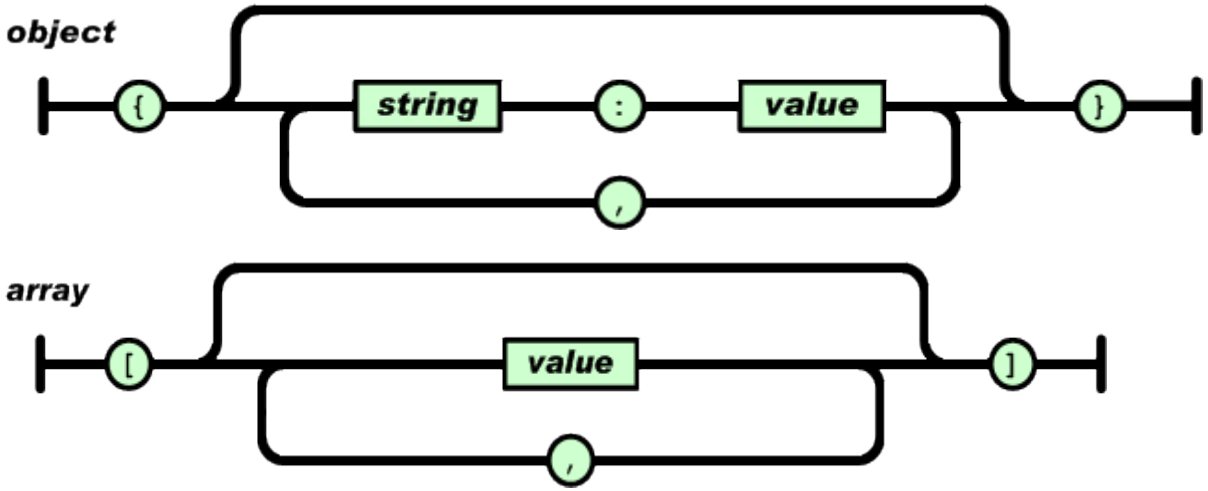
Name/Value Pairs

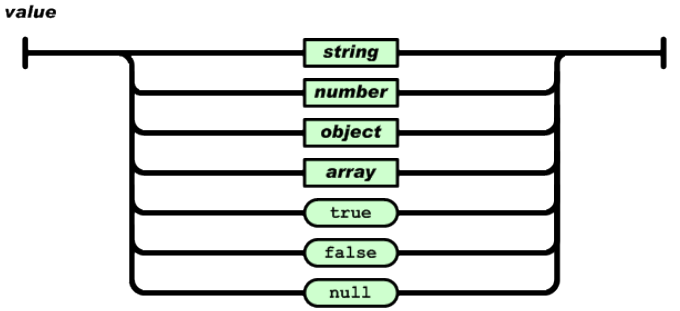
Child properties

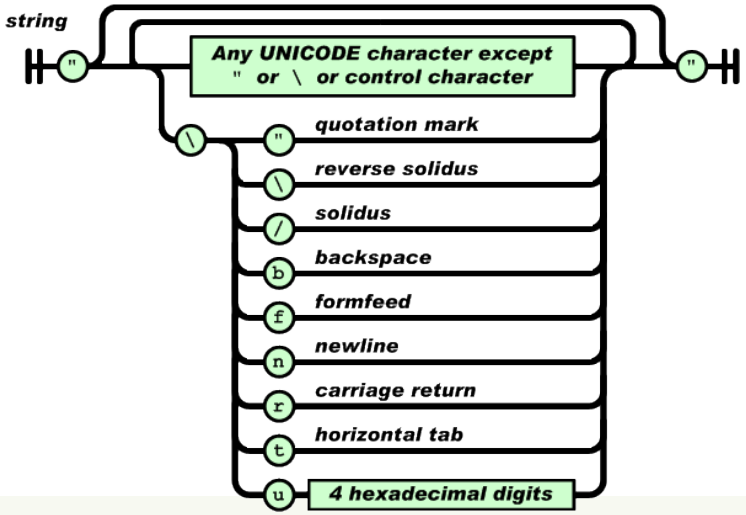
String Array

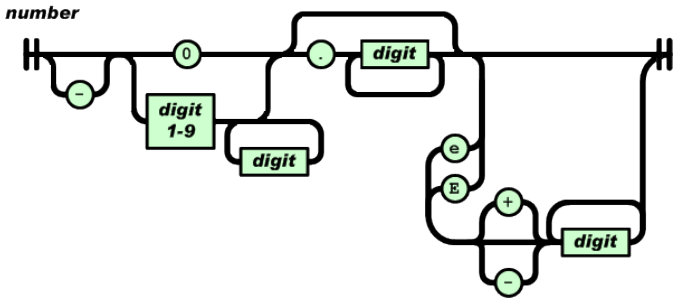
Number data type

JSON Full Syntax







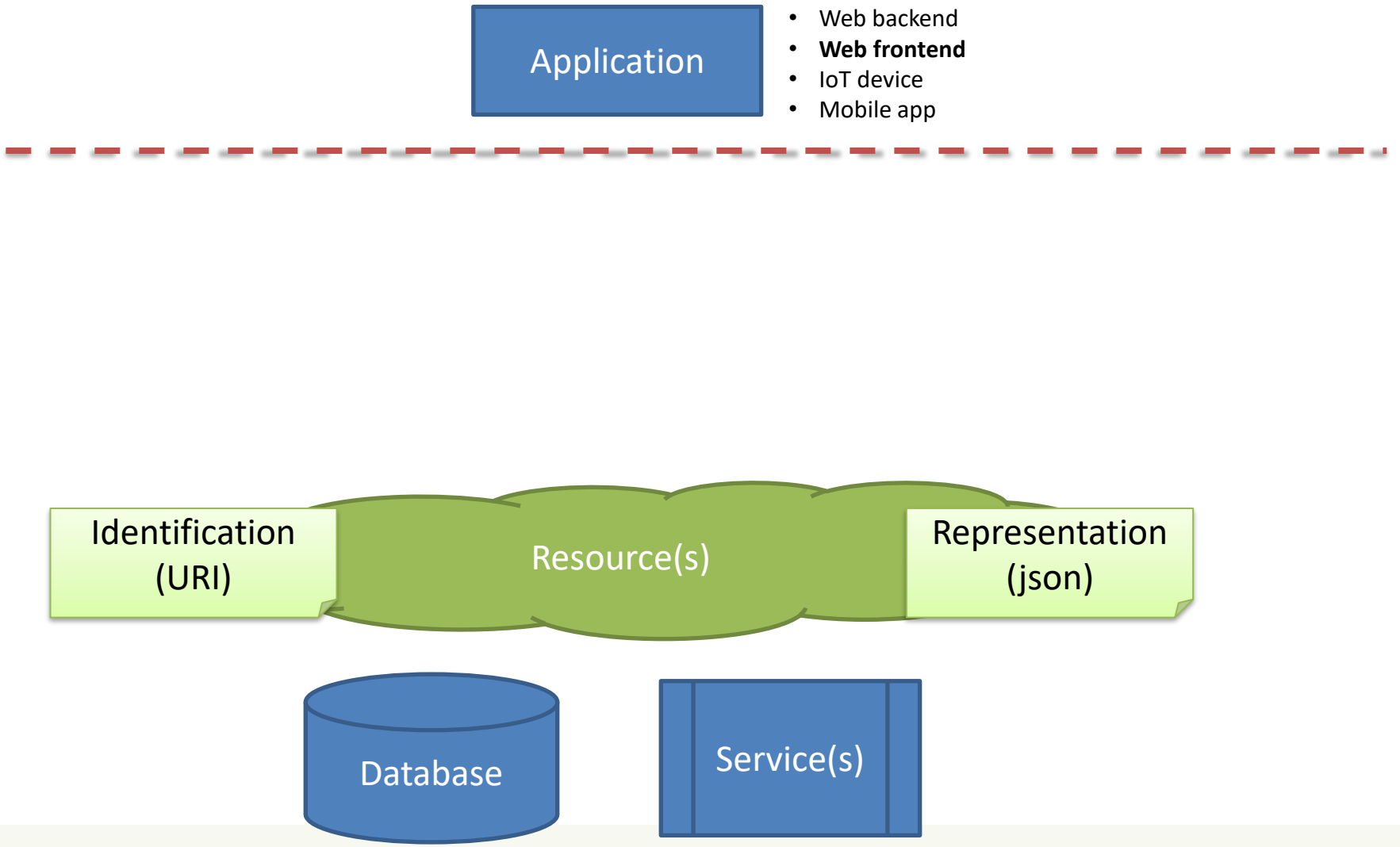


Using JSON in JavaScript

- `JSON.stringify` to convert objects into JSON
  - `const aString = JSON.stringify(myObj)`
  - Works recursively also on nested objects/arrays
  - Excludes function properties (methods) and undefined-valued properties
- `JSON.parse` to convert JSON back into an object
  - `const myObj = JSON.parse(aString)`
  - All created objects have the default `{}` Object prototype
    - Can fix with a *reviver* callback

https://javascript.info/json

REST Architecture



Main Types of Resources

{REST}

- **Collection** resource
  - Represents a set (or list) of resources of the same type
  - Format: /resource
    - `http://api.polito.it/students`
    - `http://api.polito.it/courses`

- **Element** (Item, Simple) resource
  - Represents a single item, and its properties
  - Has some state and zero or more sub-resources
    - Sub-resources can be simple resources or collection resources
  - Format: /resource/identifier
    - `http://api.polito.it/students/s123456`
    - `http://api.polito.it/courses/01zqp`

Best Practice

{REST}

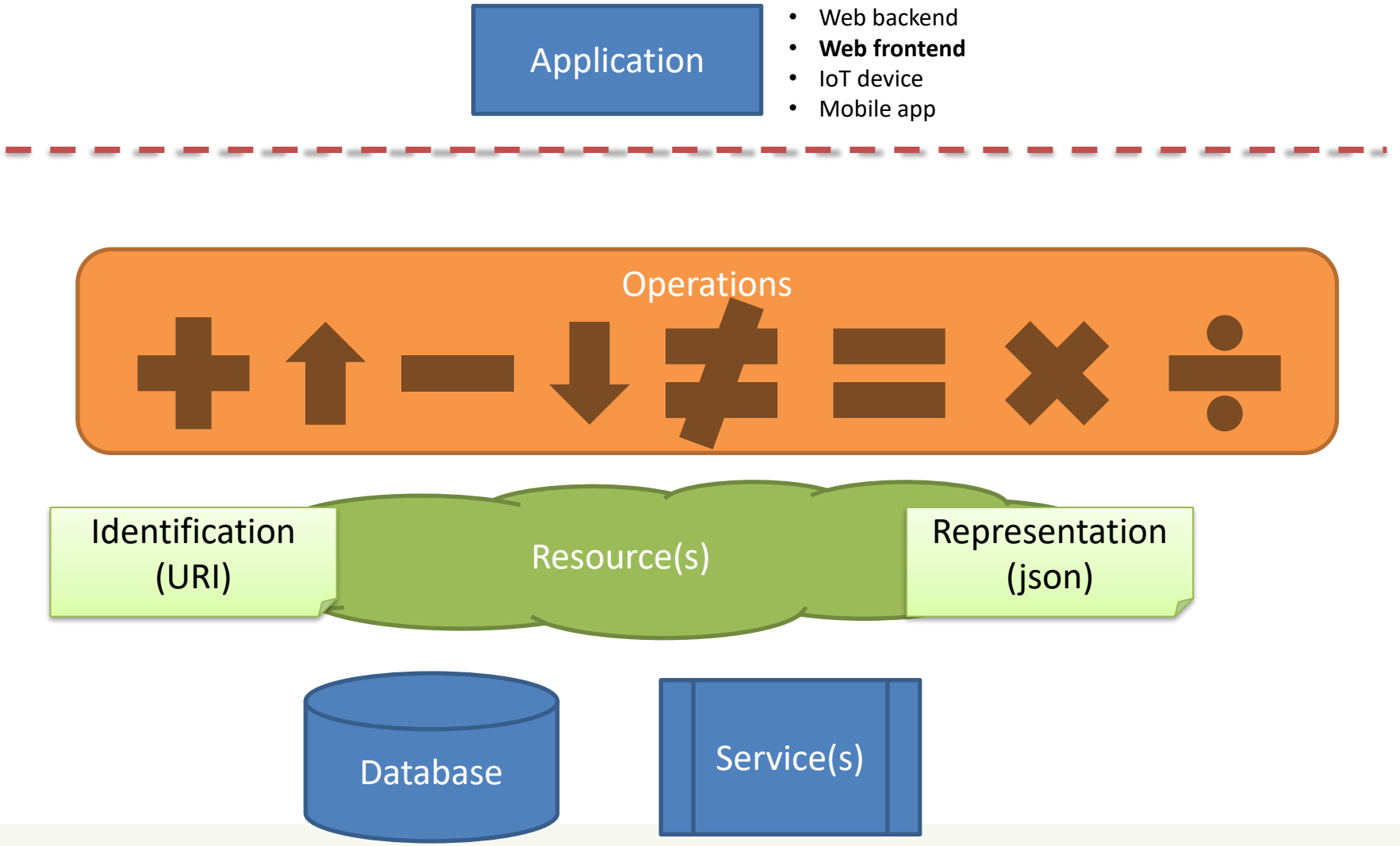
- Nouns (not verbs)
- Plural nouns
- Concrete names (not abstract)
  - /courses, not /items

Main Principles

{REST}

- **Resources** support **Operations** (Actions)
  - Add
  - Delete
  - Update
  - Find
  - Search
  - …

REST Architecture

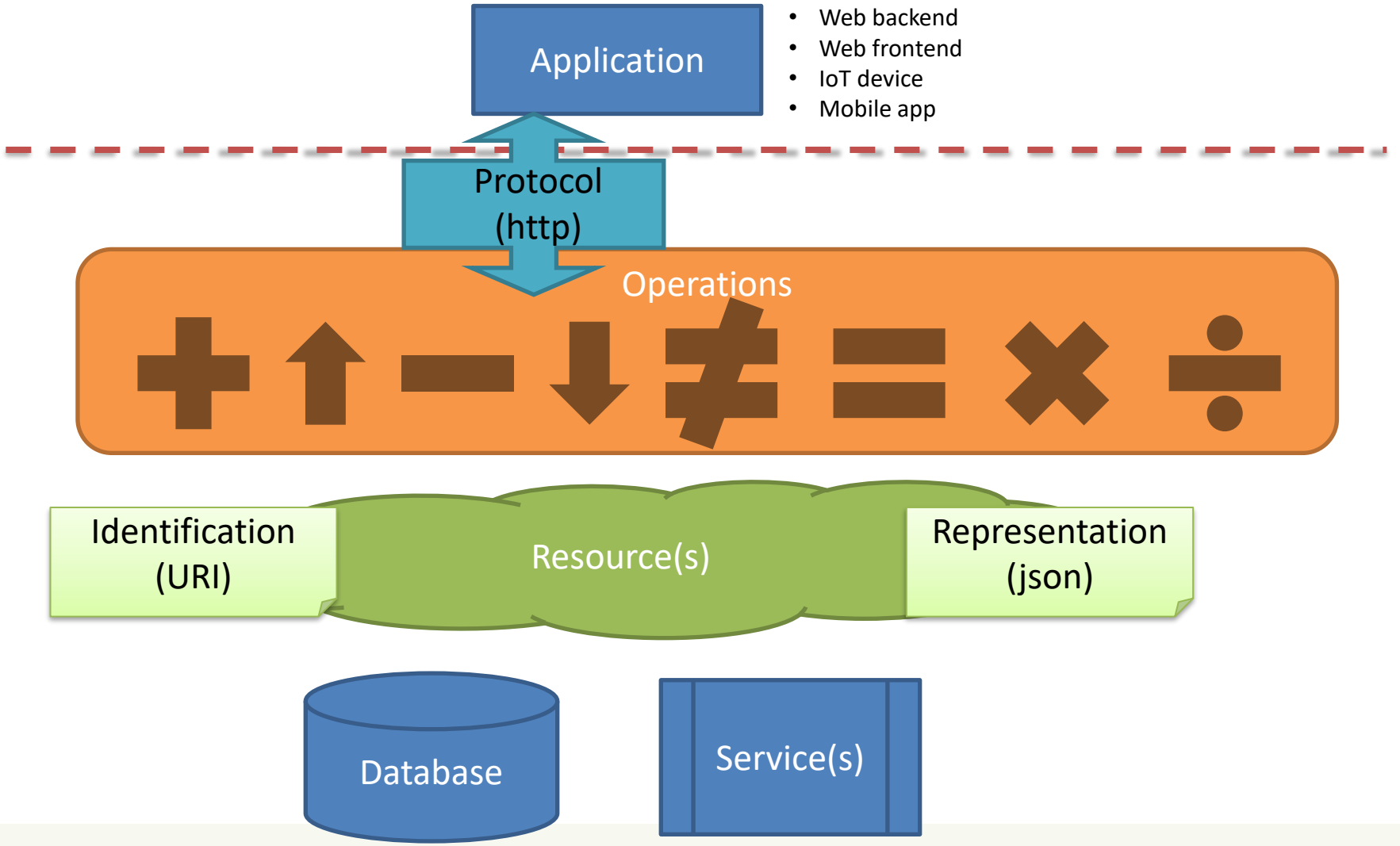


Actions use HTTP Methods

{REST}

- GET
  - Retrieve the representation of the resource (in the HTTP response body)
  - Collection: the list of items
  - Element: the properties of the element
- POST
  - Create a new resource (data in the HTTP request body)
  - Use a URI for a Collection
- PUT
  - Update an existing element (data in the HTTP request body)
  - Mainly for elements' properties
- DELETE

REST Architecture



Actions on Resources: Example

Resource	GET	POST	PUT	DELETE
/dogs	List dogs	Create a new dog	Bulk update dogs (avoid)	Delete all dogs (avoid)
/dogs/1234	Show info about the dog with id 1234	ERROR	If exists, update the info about dog #1234	Delete the dog #1234

Relationships

{REST}

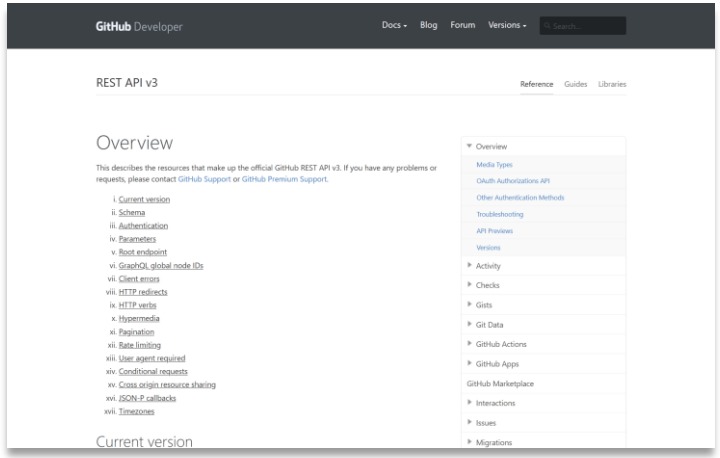
- A given Element may have a (1:1 or 1:N) relationship with other Element(s)
- Represent with: /resource/identifier/resource
- `http://api.polito.it/students/s123456`/courses (list of courses followed by student `s123456`)
- `http://api.polito.it/courses/01qzp/students` (list of students enrolled in course `01qzp`)

Representations

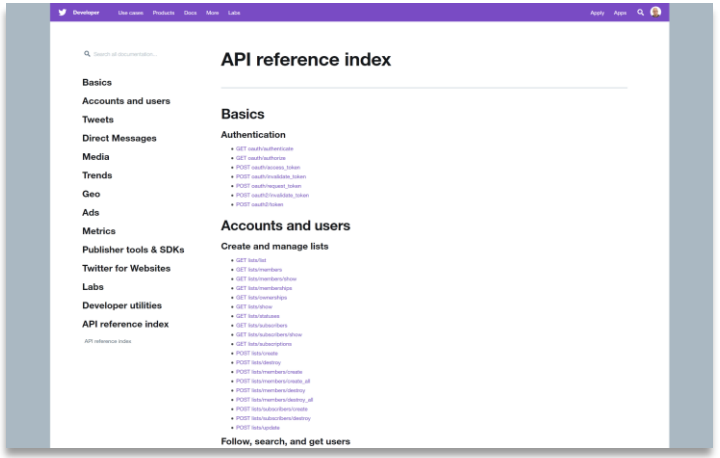
{REST}

- Returned in GET, sent in PUT/POST
- Different formats are possible
- Mainly: XML, JSON
  - But also: SVG, JPEG, TXT, …
  - In POST: URL-encoding
- Format may be specified in
  - Request headers
    - **`Accept: application/json`**
  - URI extension
    - `http://api.polito.it/students/s123456.json`
  - Request parameter
    - `http://api.polito.it/students/s123456?format=json`

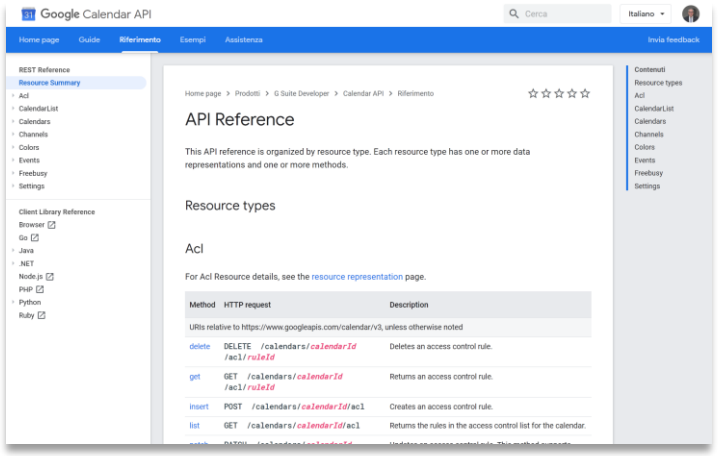
Real World Examples



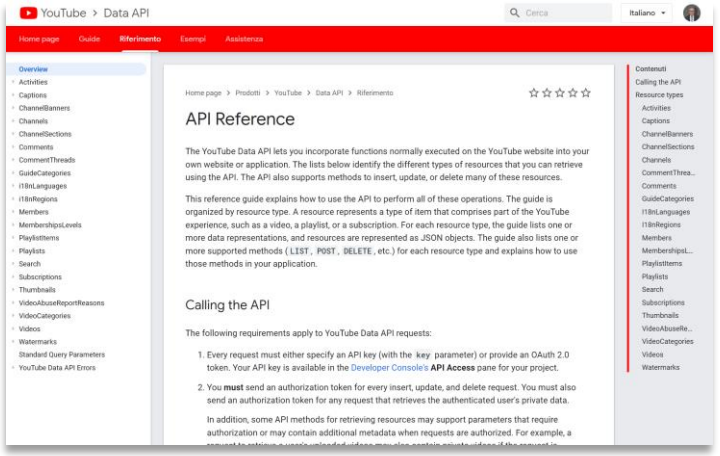
https://developer.github.com/v3/



https://developer.twitter.com/en/docs/api-reference-index



https://developers.google.com/calendar/v3/reference/



https://developers.google.com/youtube/v3/docs

Complex resource search

{REST}

- Use `?`*`parameter`*`=`*`value`* for more advanced resource filtering (or search)
  - E.g., `https://api.twitter.com/1.1/statuses/user_timeline.json`**`?screen_name=twitterapi&count=2`**

Errors

{REST}

- When errors or exceptions are encountered, use meaningful HTTP Status Codes
  - The Response Body may contain additional information (e.g., informational error messages)

```
{
   "developerMessage" : "Verbose, plain language description of
the problem for the app developer with hints about how to fix
it.",
   "userMessage":"Pass this message on to the app user if
needed.",
   "errorCode" : 12345,
   "more info": "http://dev.teachdogrest.com/errors/12345"
}
```

Authentication

Twitter Streaming API

```
Authorization: OAuth
oauth_consumer_key="xvz1evFS4wEEPTGEFPHBog", …
```

Amazon Web Services API

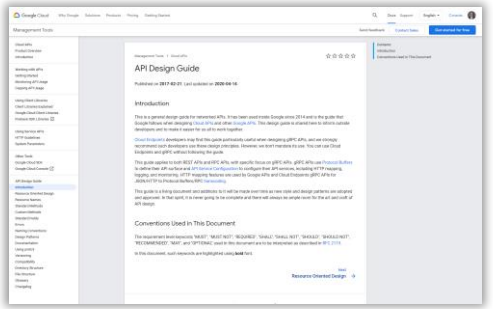
```
Authorization: AWS
AKIAIOSFODNN7EXAMPLE:frJIUNo//yllqDzg=
```

Google API

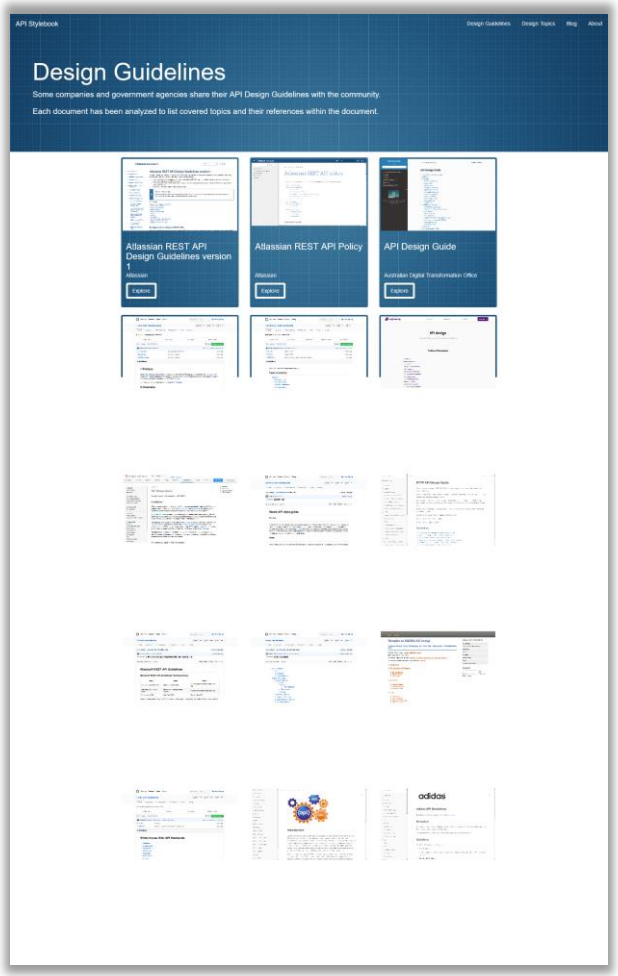
```
Authorization: Bearer 1/fFBGRNJru1FQd44AzqT3Zg
```

API Design

- How to design a set of APIs for your application?
- Practical guidelines, with applied standard practices
- Suggestion: Google API Design Guide
  - https://cloud.google.com/apis/design/



http://apistylebook.com/design/guidelines/



API Design Flow

1. Determine what types of **resources** an API provides.
2. Determine the **relationships** between resources.
3. Decide the resource **name schemes** based on types and relationships.
4. Decide the **resource schemas**.
5. Attach minimum set of **methods** to resources.

API Service Name	Collection ID	Resource ID	Resource ID	Resource ID
//mail.googleapis.com	/users	/name@example.com	/settings	/customFrom

Example (Gmail API)

- API service: `gmail.googleapis.com`
- A collection of users: `users/*`. Each user has the following resources.
  - A collection of messages: `users/*/messages/*`.
  - A collection of threads: `users/*/threads/*`.
  - A collection of labels: `users/*/labels/*`.
  - A collection of change history: `users/*/history/*`.
  - A resource representing the user profile: `users/*/profile`.
  - A resource representing user settings: `users/*/settings`.

Standard Methods

Standard Method	HTTP Mapping	HTTP Request Body	HTTP Response Body
List	GET <collection URL>	N/A	Resource* list
Get	GET <resource URL>	N/A	Resource*
Create	POST <collection URL>	Resource	Resource*
Update	PUT or PATCH <resource URL>	Resource	Resource*
Delete	DELETE <resource URL>	N/A	google.protobuf.Empty**

Let's read:
https://cloud.google.com/apis/design/standard_methods

Guidelines (1/2)

URL Design	
Plural nouns for collections	/dogs
ID for entity	/dogs/1234
Associations	/owners/5678/dogs
HTTP Methods	POST GET PUT DELETE
Bias toward concrete names	/dogs (not animals)
Multiple formats in URL	/dogs.json /dogs.xml
Paginate with limit and offset	?limit=10&offset=0
Query params	?color=red&state=running
Partial selection	?fields=name,state
Use medial capitalization	"createdAt": 1320296464 myObject.createdAt;
Use verbs for non-resource requests	/convert?from=EUR&to=CNY&amount=100
Search	/search?q=happy%2Blabrador
DNS	api.foo.com developers.foo.com

Guidelines (2/2)

Versioning	
Include version in URL	/v1/dogs
Keep one previous version long enough for developers to migrate	/v1/dogs /v2/dogs

Errors	
Status Codes	200 201 304 400 401 403 404 500
Verbose messages	{"msg": "verbose, plain language hints"}

Client Considerations	
Client does not support HTTP status codes	?suppress_response_codes=true
Client does not support HTTP methods	GET /dogs?method=post GET /dogs GET /dogs?method=put GET /dogs?method=delete
Complement API with SDK and code libraries	1. JavaScript 2. … 3. …

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