Restful Web Services

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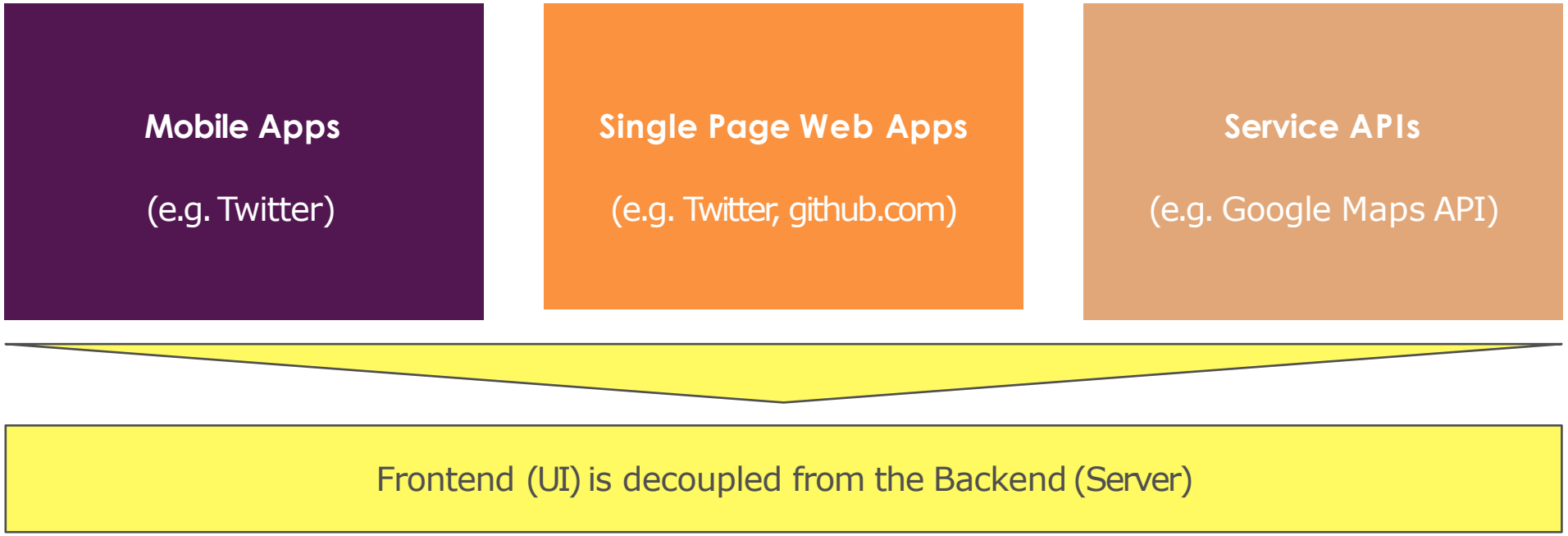
What is REST?

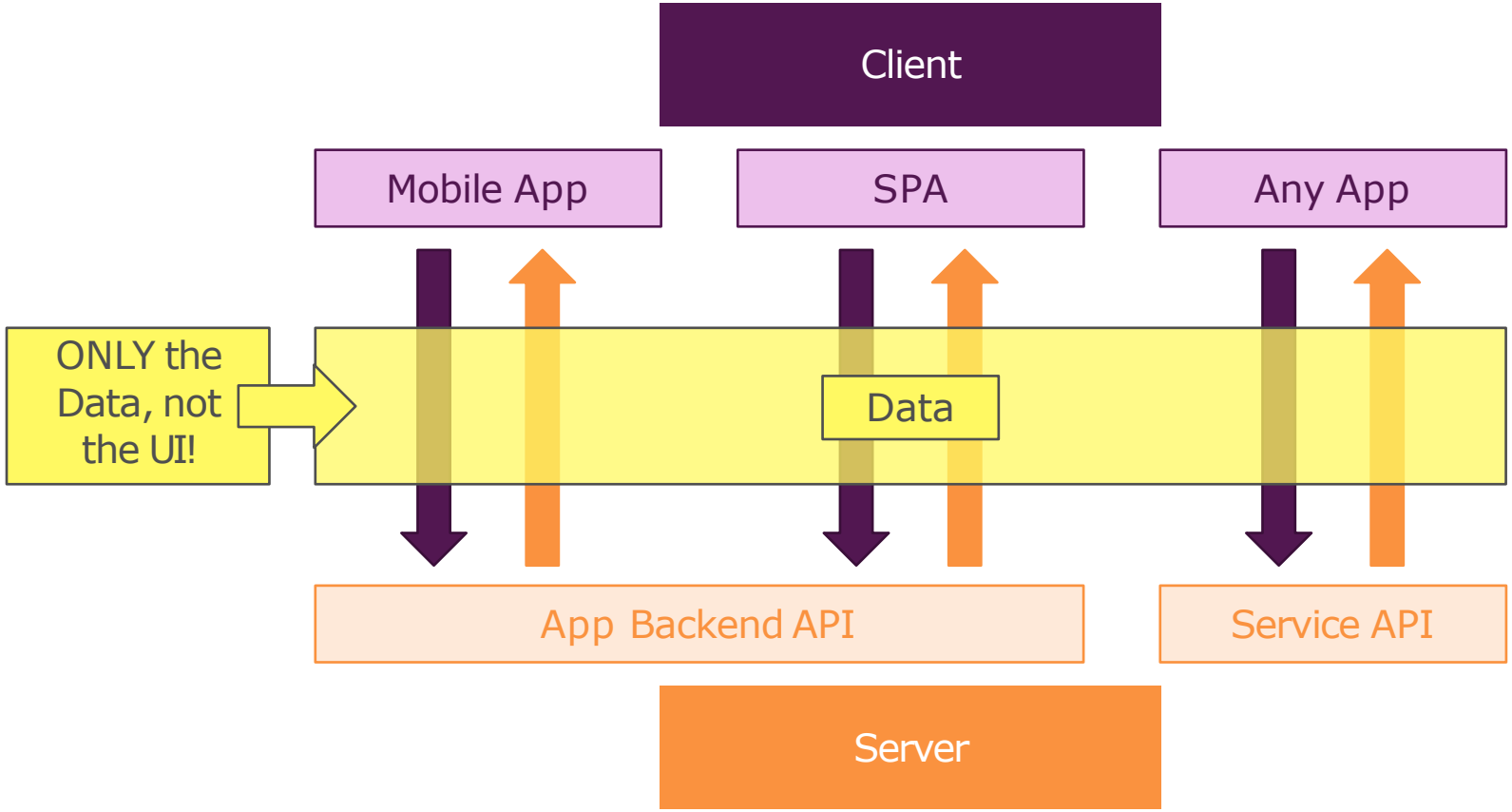
- REST = **RE**presentational **S**tate **T**ransfer
- REST is an architectural style consisting of a coordinated set of architectural constraints
- First described in 2000 by Roy Fielding in his doctoral dissertation at UC Irvine
- RESTful is typically used to refer to web services implementing a REST architecture
- Alternative to other distributed-computing specifications such as SOAP
- Simple HTTP client/server mechanism to exchange data
- Everything – the UNIVERSE is available through a URI
- Utilizes HTTP: GET/POST/PUT/DELETE operations

Why REST?

Not every Frontend (UI) requires HTML Pages!



REST API Big Picture



Data Formats

HTML	Plain Text	XML	JSON
`<p>Node.js</p>`	`Node.js`	`<name>Node.js</name>`	`{"title": "Node.js"}`
Data +Structure	Data	Data	Data
Contains User Interface	No UI Assumptions	No UI Assumptions	No UI Assumptions
Unnecessarily difficult to parse if you just need the data	Unnecessarily difficult to parse, no clear data structure	Machine-readable but relatively verbose; XML-parser needed	Machine-readable and concise; Can easily be converted to JavaScript

Architectural Constraints

Uniform interface

- Individual resources are identified in requests, i.e.,using URIs in web-based REST systems.

Client-server

- Separation of concerns. A uniform interface separates clients from servers.

Stateless

- The client-server communication is further constrained by no client context being stored on the server between requests.

Cacheable

- Basic WWW principle: clients can cache responses.

Layered system

- A client cannot necessarily tell whether it is connected directly to the end server, or to an intermediary along the way.

Code on demand (optional)

- REST allows client functionality to be extended by downloading and executing code in the form of applets or scripts. This simplifies clients by reducing the number of features required to be pre-implemented.

Resource

The key abstraction of information in REST is a **resource**.

- a document or image, a temporal service, a collection of other resources, a non-virtual object (e.g. a person), and so on.

Resource representation: consists of data, metadata describing the data and **hypermedia** links which can help the clients in transition to the next desired state.

Resource Naming Best Practices -Use nouns to represent resources

Document:

- a singular concept, like an object instance or db record.
- Use “singular” name to denote document resource archetype.
  - http://api.example.com/device-management/managed-devices/{device-id}
  - http://api.example.com/user-management/users/{id}
  - http://api.example.com/user-management/users/admin

Collection: sever-managed directory of resources.

- Use “plural” name to denote collection resource archetype
  - http://api.example.com/device-management/managed-devices
  - http://api.example.com/user-management/users
  - http://api.example.com/user-management/users/{id}/accounts

Resource Naming Best Practices -Use nouns to represent resources

store

- a client-managed resource repository.
- Use “plural” name to denote store resource archetype.
  - http://api.example.com/cart-management/users/{id}/carts
  - http://api.example.com/song-management/users/{id}/playlists

controller

- A controller resource models a procedural concept.
- Use “verb” to denote controller archetype.
  - http://api.example.com/cart-management/users/{id}/cart/checkout
  - http://api.example.com/song-management/users/{id}/playlist/play

Resource Naming Best Practices -Consistency is the key

Use forward slash (/) to indicate hierarchical relationships

- The forward slash (/) character is used in the path portion of the URI to indicate a hierarchical relationship between resources.
- http://api.example.com/device-management
- http://api.example.com/device-management/managed-devices
- http://api.example.com/device-management/managed-devices/{id}

Do not use trailing forward slash (/) in URIs

- http://api.example.com/device-management/managed-devices/
- http://api.example.com/device-management/managed-devices /*This is much better version*/

Use hyphens (-) to improve the readability of URIs

- http://api.example.com/inventory-management/managed-entities/{id}/install-script-location //More readable
- http://api.example.com/inventory-management/managedEntities/{id}/installScriptLocation //Less readable

Do not use underscores (_)

- http://api.example.com/inventory-management/managed-entities/{id}/install-script-location //More readable
- http://api.example.com/inventory_management/managed_entities/{id}/install_script_location //More error prone

Use lowercase letters in URIs

Do not use file extensions

- http://api.example.com/device-management/managed-devices.xml /*Do not use it*/
- http://api.example.com/device-management/managed-devices /*This is correct URI*/

Resource Naming Best Practices -Never use CRUD function names in URIs

HTTP request methods should be used to indicate which CRUD function is performed.

- HTTP GET http://api.example.com/device-management/managed-devices //Get all devices
- HTTP POST http://api.example.com/device-management/managed-devices //Create new Device

- HTTP GET http://api.example.com/device-management/managed-devices/{id} //Get device for given Id
- HTTP PUT http://api.example.com/device-management/managed-devices/{id} //Update device for given Id
- HTTP DELETE http://api.example.com/device-management/managed-devices/{id} //Delete device for given Id

Resource Naming Best Practices -Use query component to filter URI collection

Many times, you will come across requirements where you will need a collection of resources sorted, filtered or limited based on some certain resource attribute. For this, do not create new APIs – rather enable sorting, filtering and pagination capabilities in resource collection API and pass the input parameters as query parameters. e.g.

- http://api.example.com/device-management/managed-devices
- http://api.example.com/device-management/managed-devices?region=USA
- http://api.example.com/device-management/managed-devices?region=USA&brand=XYZ
- http://api.example.com/device-management/managed-devices?region=USA&brand=XYZ&sort=installation-date

HTTP Methods for RESTful APIs

HTTP METHOD	CRUD	ENTIRE COLLECTION (E.G. /USERS)	SPECIFIC ITEM (E.G. /USERS/123)
POST	Create	201 (Created), 'Location' header with link to /users/{id} containing new ID.	Avoid using POST on single resource
GET	Read	200 (OK), list of users. Use pagination, sorting and filtering to navigate big lists.	200 (OK), single user. 404 (Not Found), if ID not found or invalid.
PUT	Update/Replace	405 (Method not allowed), unless you want to update every resource in the entire collection of resource.	200 (OK) or 204 (No Content). Use 404 (Not Found), if ID not found or invalid.
DELETE	Delete	405 (Method not allowed), unless you want to delete the whole collection — use with caution.	200 (OK). 404 (Not Found), if ID not found or invalid.

JavaScript Object Notation (JSON)

JSON (JavaScript Object Notation) is a lightweight data-interchange format.

- Based on a subset of the JavaScript Programming Language Standard ECMA-262 3rd Edition - December 1999.
- A text format that is completely language independent.
- Easy for machines to parse and generate.
  - Can convert any JavaScript object into JSON, and send JSON to the server.
- Natively supported by all modern browsers
- Replaced XML (Extensible Markup Language)

JavaScript Object Notation (JSON)

JSON is a syntax similar to JS Objects for storing and exchanging data and an efficient alternative to XML.
A name/value pair consists of a field name **in double quotes**, followed by a colon, followed by a value. Values can be any JS valid type except functions.

```
{"students":[
    {"firstName":"Ashim", "lastName":"Ghimire"},
    {"firstName":"Mohamed", "lastName":"Hassan"},
    {"firstName":"Leul", "lastName":"Necha"},
    {"firstName":"Shawn", "lastName":"Daudi"},
]}
```

JSON values can be:

- A number (integer or floating point)
- A string (in double quotes)
- A Boolean (true or false)
- An array (in square brackets)
- An object (in curly braces)
- null

Spring MVC REST-Style Controller

Essentially means receive & send the content directly as the message body instead of structuring HTML pages.

- We are **NOT** using HTML
- We are using well-formed XML OR JSON

Spring support is based on the

- `@RequestBody` & `@ResponseBody` annotations
- `@ResponseStatus(value = HttpStatus.NO_CONTENT)`
  - ***For deletes, creates, updates…***
- `@RestController = @Controller + @ResponseBody`

RequestBody & ResponseBody

`@ResponseBody`

- Spring framework uses the "`Accept`" header of the request to decide the media type to send to the client.

`@RequestBody`

- Spring framework will use the " `Content-Type`" header to determine the media type of the Request body received.

To get XML, MIME media type = "`application/xml`"

To get JSON, MIME media type = "`application/json`"

Versioning

Media type versioning (a.k.a “content negotiation” or “accept header”)
- `@GetMapping(value = "/{id}", produces = "application/cs.miu.edu-v2+json")`
- Header: `Accept: application/cs.miu.edu-v1+json`
- Github

(Custom) header versioning
- `@GetMapping(value = "", headers = "X-API-VERSION=2")`
- Header: `X-API-VERSION: 2`
- Microsoft

URI versioning
- `http://localhost:8080/v1/products`
- Twitter

Request Parameter versioning
- `http://localhost:8080/products?version=1`
- Amazon

Factors
- URI Pollution
- Misuse of HTTP Headers
- Caching
- Execute the request on the browser
- API Documentation

Richardson Maturity Model

Level 0
- Expose SOAP Web Services in REST Style
  - http://server/getPosts
  - http://server/deletePosts
  - http://server/doThis

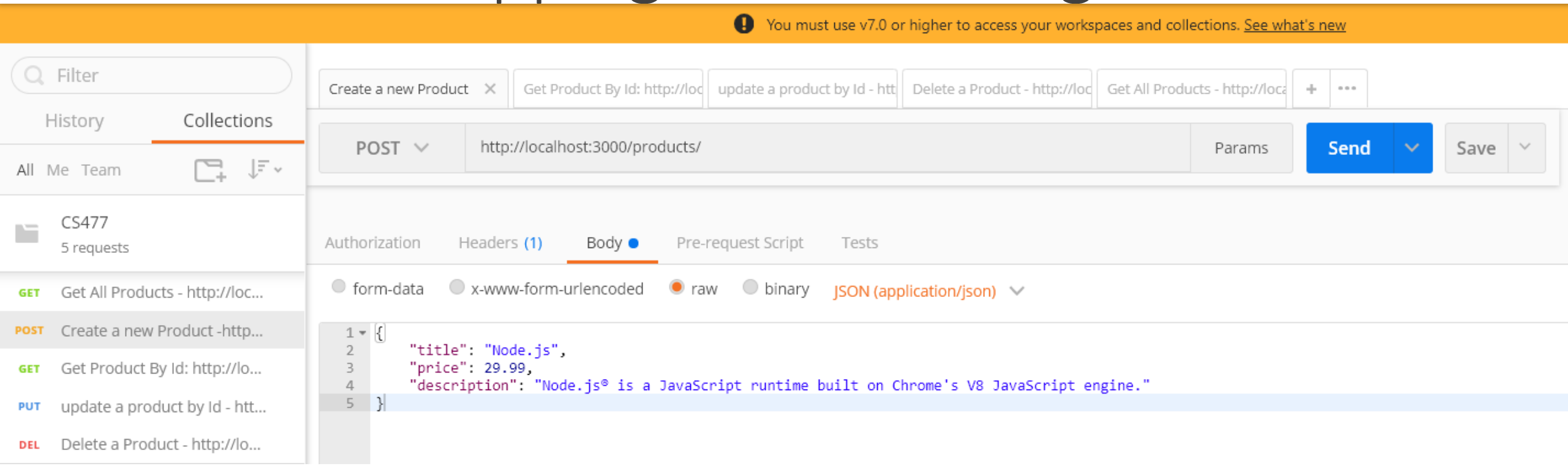
Level 1

Expose Resources with Proper URI
- Note: Improper use of HTTP Methods
  - http://server/accounts
  - http://server/accounts/10

Level 2
- Level 1 + HTTP Methods

Level 3
- Level 2 + HATEOAS
- Data + Next Possible Actions

Demo: Shopping Cart – Testing APIs



Main Point

REST is defined by architectural constraints. It is able to access information through the ubiquitous URI. Everything on the web is available through a URI.

Everything in creation is known through understanding and experience of the Unified Field of Consciousness.