

Web 2.0

Lecture 3: Uniform Interface

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REST Core Principles

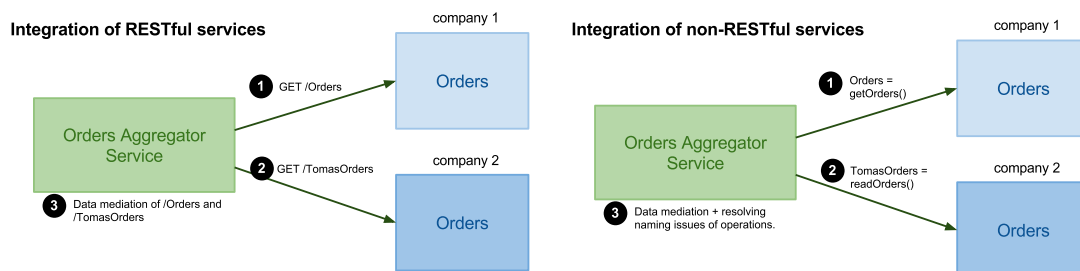
- REST architectural style defines constraints
 - *if you follow them, they help you to achieve a good design, interoperability and scalability.*
- Constraints
 - *Client/Server*
 - *Statelessness*
 - *Cacheability*
 - *Layered system*
 - ***Uniform interface***
- Guiding principles
 - *Identification of resources*
 - *Representations of resources and self-descriptive messages*
 - *Hypermedia as the engine of application state (HATEOAS)*

Overview

- **Uniform Interface**
 - *Basic operations*
 - *Handling Errors*
- Asynchronous Communication
- Implementing a RESTful Service
- Advanced Design Issues

Uniform Interface

- Uniform interface = finite set of operations
 - *Resource manipulation*
 - *CRUD – Create (POST/PUT), Read (GET), Update (PUT/PATCH), Delete (DELETE)*
 - *operations are not domain-specific*
 - *For example, **GET /orders** and not **getOrders()***
 - *This reduces complexity when solving interoperability*
- Integration issues examples



Safe and Unsafe Operations

- Safe operations
 - *Do not change the resource state*
 - *Usually "read-only" or "lookup" operation*
 - *Clients can cache the results and refresh the cache freely*
- Unsafe operations
 - *May change the state of the resource*
 - *Transactions such as buy a ticket, post a message*
 - *Unsafe does not mean dangerous!*
- Unsafe interactions and transaction results
 - **POST** response may include transaction results
 - *you buy a ticket and submit a purchase data*
 - *you get transaction results*
 - *and you cannot bookmark this..., why?*
 - *Should be referable with a persistent URI*

Idempotence

- Idempotent operation
 - *Invoking a method on the same resource always has the same effect*
 - *Operations GET, PUT, DELETE*
- Non-idempotent operation
 - *Invoking a method on the same resource may have different effects*
 - *Operation POST*
- Effect = a state change
 - *recall the effect definition in MDW*

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GET

- Reading
 - **GET** *retrieves a representation of a state of a resource*
 - *It is read-only operation*
 - *It is **safe***
 - *It is **idempotent***
 - **GET** *retrieves different states over time but the effect is always the same, cf. **resource state** hence it is idempotent.*
 - *Invocation of **GET** involves content negotiation*

PUT

- Updating or Inserting
 - **PUT** updates a representation of a state of a resource or inserts a new resource
 - where *CODE* is:
 - **200 OK** or **204 No Content** for updating: A resource with id **4456** **exists**, the client sends an updated resource
 - **201 Created** for inserting: A resource **does not exist**, the client generates the id **4456** and sends a representation of it.
 - It is **not safe** and it is **idempotent**

POST

- Inserting
 - **POST** inserts a new resource
 - A server generates a new resource ID, client only supplies a content and a resource URI where the new resource will be inserted.
 - It is **not safe** and it is **not idempotent**
 - A client may "suggest" a resource's id using the **Slug** header
 - Defined in AtomPub protocol [🔗](#)

DELETE

- Deleting
 - **DELETE** deletes a resource with specified URI
 - where *CODE* is:
 - **200 OK**: the response body contains an entity describing a result of the operation.
 - **204 No Content**: there is no response body.
 - It is **not safe** and it is **idempotent**
 - Multiple invocation of **DELETE /orders/4456** has always the same effect – the resource **/orders/4456** does not exist.

Other

- HEAD
 - same as **GET** but only retrieves HTTP headers
 - It is **safe** and **idempotent**
- OPTIONS
 - queries the resource for resource configuration
 - It is **safe** and **idempotent**

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Types of Errors

- Client-side – status code **4xx**
 - **400 Bad Request**
 - *generic client-side error*
 - *invalid format, such as syntax or validation error*
 - **404 Not Found**
 - *server can't map URI to a resource*
 - **401 Unauthorized**
 - *wrong credentials (such as user/pass, or API key)*
 - *the response contains **WWW-Authenticate** indicating what kind of authentication the service accepts*
 - **405 Method Not Allowed**
 - *the resource does not support the HTTP method the client used*
 - *the response contains **Allow** header to indicate methods it supports*
 - **406 Not Acceptable**
 - *so many restrictions on acceptable content types (using **Accept-***)*
 - *server cannot serialize the resource to requested content types*

Types of Errors (Cont.)

- Server-side – status code **5xx**
 - **500 Internal Server Error**
 - *generic server-side error*
 - *usually not expressive, logs a message for system admins*
 - **503 Service Not Available**
 - *server is overloaded or is under maintenance*
 - *the response contains **Retry-After** header*

Use of Status Codes

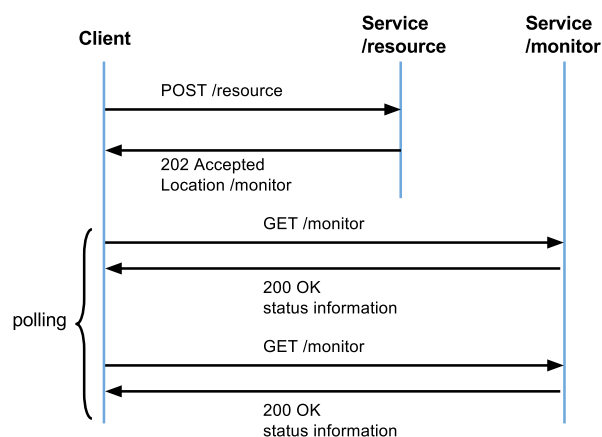
- Service should respect semantics of status codes!
 - *Client must understand the semantics of the response.*
 - *This breaks loose coupling and reusability service principles*
 - *The response should be:*

Overview

- Uniform Interface
- **Asynchronous Communication**
- Implementing a RESTful Service
- Advanced Design Issues

Asynchronous Communication

- Recall asynchronous communication from MDW
- Asynchronous communication in HTTP
 - *Server cannot establish a connection, always clients need to*
→ *clients are browsers behind firewalls*



Asynchronous and Polling/Pushing

- Submit request for processing
 - Always through HTTP request and **202 Accepted** response and **Location** header with a monitor resource
 - Methods: **PUT, POST, DELETE**
- Getting the status from the monitor resource
 - **polling** – a client periodically checks for changes via **GET**
 - Most natural solution, not a real-time solution
 - **pushing** – a server pushes changes back to the client
 - Part of real-time Web efforts
 - More details in *Lecture 8: Protocols for the Realtime Web*

Overview

- Uniform Interface
- Asynchronous Communication
- **Implementing a RESTful Service**
 - *Basic Implementation*
- Advanced Design Issues

Service Description

- Example service: Oder processing
<https://github.com/tomvit/w20/tree/master/examples/restful-service>
- Basic steps to define a RESTful service
 1. *identify resources and URIs*
 2. *specify resources' representations*
 3. ***define service operations*** (methods and status codes)

Overview

- Uniform Interface
- Asynchronous Communication
- Implementing a RESTful Service
 - *Basic Implementation*
- Advanced Design Issues

Resources, URIs and Representations

- There are three resources
 - Resource `/orders` is a container of all orders
 - Resource `/orders/{order-id}` is an order with resource id `order-id`.
 - Resource `/orders/{order-id}/{item-id}` is an item that belongs to the order `order-id` and that has a resource id `item-id`.
- Structure
 - `/orders`
 - list of all orders
 - `/orders/{order-id}`
 - status, order id, list of all items in the order
 - `/orders/{order-id}/{item-id}`
 - item id, name, price
- Resource representations
 - We define representations in JSON

Open Order

- To open an order
 - Insert a new order to `/orders` using `POST`
 - Set the new order's status to "open"
 - `storage.getOrderSeqId()` returns the order ID
 - `storage.orders` (line 37) is an array of all orders in a storage

Add Item to Order

- To add an item to the order
 - *Insert a new item to the order* `/orders/{order-id}` using **POST**

Close Order

- To close an order
 - *Update the status of the order* `/orders/{order-id}` using **PUT**

Other Operations

- To get, delete an order and get, delete and update an item
 - Delete an order `/orders/{order-id}` using **DELETE**
 - Get an order's item `/orders/{order-id}/{item-id}` using **GET**
 - Update an order's item `/orders/{order-id}/{item-id}` using **PUT**
 - Delete an order's item `/orders/{order-id}/{item-id}` using **DELETE**
- Other methods are not allowed
 - Send **405 Not Allowed** status with **Allow** header to indicate which methods are allowed on a resource



Task

- Implement the remaining methods listed above

Testing

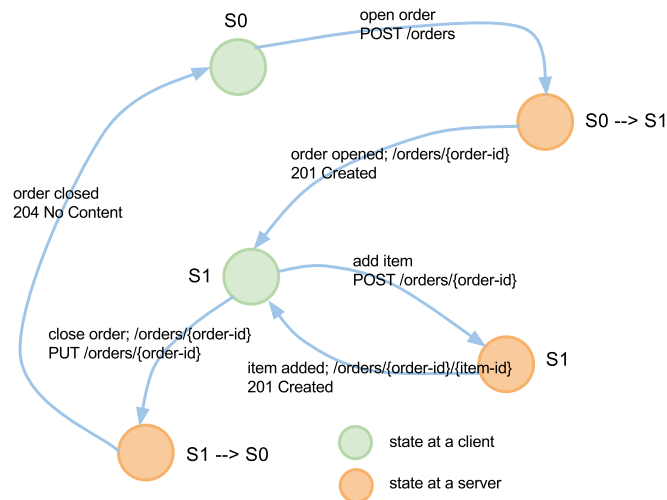
- Test the service using a bash script **test.sh**



Task

- Run service and test it using the **test.sh** script.

RESTful Public Process



- Note

- client, service communicate through metadata and representations
- There is no need for a stateful server

Overview

- Uniform Interface
- Asynchronous Communication
- Implementing a RESTful Service
- **Advanced Design Issues**

Respect HTTP Semantics

- Do not overload semantics of HTTP methods
 - For example, **GET** is read-only method and idempotent
 - REST Anti-pattern:
GET /orders/?add=new_order
 - This is not REST!
 - This breaks both safe and idempotent principles
- Consequences
 - Result of **GET** can be cached by proxy servers
 - They can revalidate their caches freely
 - You can end up with new entries in your storage without you knowing!
- The same is true for other methods

Change Order Status

- **status** property of **/orders/{order-id}** resource
 - reflects a state of the process
 - No need to use a stateful service, state is communicated through the order representation
- How do you implement a canceling an order?
 - You can delete it using **DELETE**
 - But you may want to cancel it in order to:
 - maintain a list of canceled orders
 - have a possibility to "roll-back" canceled orders

DELETE to cancel

- A bad solution to cancel the order
 - *to cancel with DELETE*
`DELETE /orders/3454/?cancel=true`
 - *you overload the meaning of DELETE*
 - *you violate the uniform interface principle*
- Always ask a question:
 - *Is the operation a state of the resource?*
 - *if yes, the operation should be:*
 - *modeled within the data format*
 - *or as a separated resource (sub-resource)*
- No verbs in **path** and **query** components!
 - `/cancelOrder`, `/orders/{order-id}/?action=delete`, etc.
 - *Verbs in URIs indicate that a resource is actually an operation!*

PUT to cancel

- A RESTful solution to cancel an order
 1. *first, have an order's status*
 - *as part of the Order representation format*
 - *we extend "open" and "close" with "cancel"*
 2. *Use PUT to cancel an order*
- Clean-up all cancelled orders
 - *you can have a resource "all valid orders": `/orders/valid` (~ all orders that are not canceled)*
 - `GET /orders/valid` will return all non-canceled orders
 - `POST /orders/valid` will purge all cancelled orders

Evaluation

- How "good" is our Order Book service?
 - Analysis of the service by service characteristics (see MDW for details) and HTTP principles.

Principle	+/-	Comment
Loose Coupling	+	Uses standard response codes.
	+	Uses representation of resources and HTTP Location header to implement the public process.
	–	Does not use hypermedia; client needs to construct links for some resources.
	+	Properly models resource URIs and resource IDs; they have hierarchical nature; does not use verbs.
	+	Respects semantics of HTTP methods and extensively uses them.
Reusability	+	Unforeseen clients will likely use the service as the application state is communicated through HTTP.
	–	Only offers one representation format (JSON).
Contracting and Discoverability	–	Does not describe content type nor public process such as by using Internet Media Types.
Composability	+	Does not obstruct composition.
Abstraction	+	Service description can be implemented by various implementation technologies.
Encapsulation	+	Distinguishes interface from implementation, processing logic is not exposed to clients through the interface.