Chapter 5

Web API

CT313H –WEB TECHNOLOGIES

Objective

Introduction to the Web API

and REST API architecture

Content

- Introduction to Web API
- REST basics
- REST API user authentication
- Implementation and using REST API

Web API Introduction

API (Application Programming Interface)

- "A set of functions and procedures allowing the creation of applications that access the features or data of an operating system, application, or other service"

(Oxford English Dictionary)

- "A set of programming code that queries data, parses responses, and sends instructions between one software platform and another"

(Investopedia)

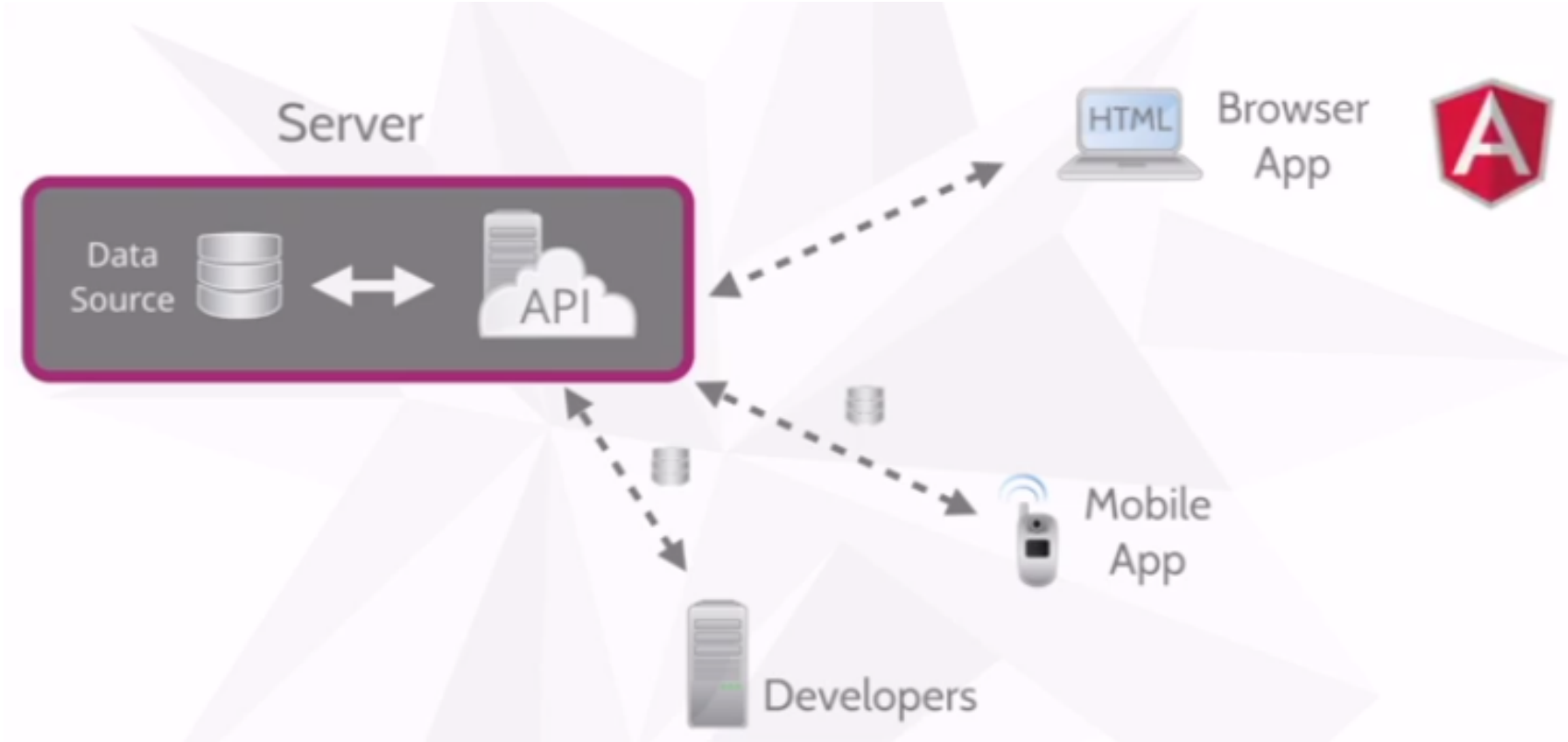
Web API

- APIs that work based on the WWW infrastructure:
  - Request/Response is established using HTTP protocol
  - They can be implemented by various technologies: Java, .NET, PHP,…
- Suited to the machine – machine communications
  (vs. the websites: human – machine communication)
- Request/Response are plain text with JSON or XML syntax that are easy for parsing and analyzing
  (vs. HTML that is used for formatting data – presentation)
  - **Input**: URI [+JSON/XML/…], **Output**: JSON/XML/…

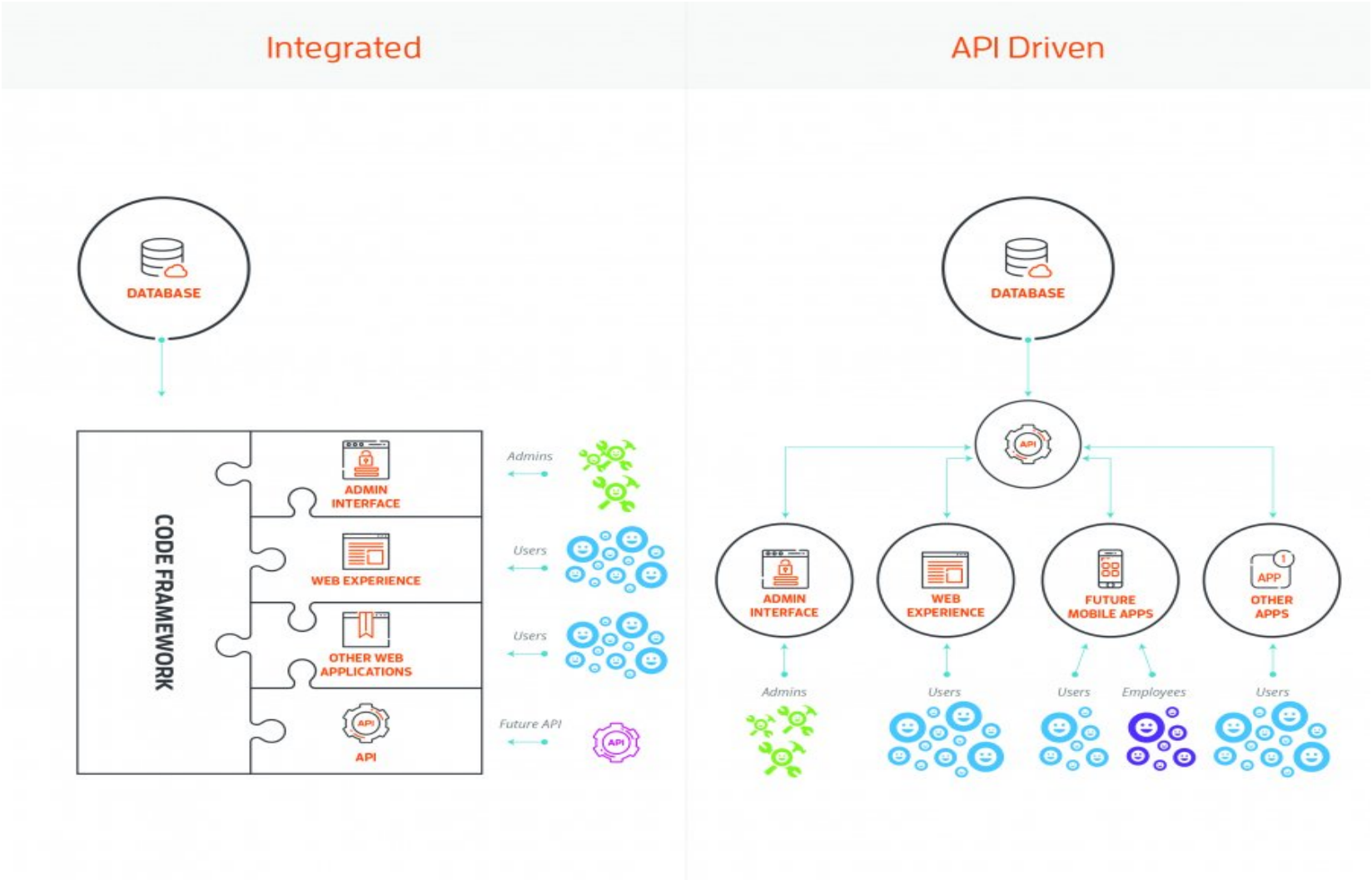
Web API

- Demo Facebook REST API

API-Driven web applications



API-Driven vs. Integrated web applications



REST Basics

What is REST?

- REST = Representational State Transfer
  - A software architecture style that defines a set of constraints for creating web services
- REST constraints:
  - Client/Server, stateless, cache, uniform interface (between components), layered system, code-on-demand (optional)
- Basic concepts: resource, representation state and manipulation of resources

Resource

- An object with a type, associated data, relationships to other resources and a set of methods that operate on it (any information: document, image,…)
- Identified by an URI (Uniform Resource Identifier)
  - Several URIs may refer to the same resource
- Type of resources:
  - collection resource:
    - Example: /lectures
  - instance resource:
    - Example: /lectures/001533

Representation

- The state of a resource at any particular timestamp
  - consists of data, metadata describing the data and hypermedia links which can help the clients in transition to next desired state
  - is the information exchanged between client and server
- Typically in JSON or XML syntax
- Example:
  - Resouce: person
  - Representation: {

```
"name": "Perter Jackson",
"address": "123 Ada Street, PN",
"phone": "(+64) 123456" }
```

Resource methods

- Used to perform the desired transitions
  - GET (idempotent): read
  - DELETE (idempotent): delete
  - POST: create (or update)
  - PUT (idempotent): update (or create)

- All above methods should be implemented for every resource to reduce the error (use response state as an indication if the method is not supported)

Create a new resource with PUT

- Provide ID and information of new resource
  - PUT <new resource URI>
    {
      . . . //properties of the new resource
    }
- Example, to create a new lecturer:
  - PUT /lectures/clientSpecifiedID
    {
      //properties of the new lecturer
    }

Update a resource with PUT

- Updating data and status of a resource:
  - PUT <existing resource URI>
    {
      . . . //new properties of the resource
    }
- Example, update lecturer's information
  - PUT /lecturers/existingID
    {
      "name": "Bùi Võ Quốc Bảo",
      "dept": "IT"
    }

Creata a new resource with POST

- Create a new resource:
  - POST <new resource ID>
    {
      . . . //properties of the new resource
    }
- Example, create a new lecturer (auto ID):
  - POST /lecturers
    {
       "name": "Bùi Võ Quốc Bảo"
    }

Update a resource with POST

- Update an existing resource:
  - POST <existing resource ID>
    {
      . . . //properties of the existing resource
    }
- Example, update information of a lecturer:
  - POST /lecturers/003025
    {
       "name": "Nguyen Van A"
    }

REST API – Best practices

- Use nouns to represent resources (may be singular or plural)
- A resource should provide all methods GET, PUT, POST, DELETE (unsupported methods are indicated by resp. status)
- Status information must be hold at the client side (e.g. if the client need to perform several steps, it must hold the current step)
- Clients are not required to know all URI of all resources but the API will provide links to other related resouces instead (**HATEOAS**: Hypermedia As The Engine Of Application State)

HATEOAS

- HATEOAS: Hypermedia as the Engine of Application State

```
Request: GET /api/v1/cars/711
Response:
{
  "id": 711,
  "manufacturer": "bmw",
  "model": "X5",
  "seats": 5,
  "drivers": [{
  "id": "23",
  "name": "Stefan Jauker",
  "links": [{"rel": "self",
             "href": "/api/v1/drivers/23"}]}]
}
```

REST API Authentication

Token-based authentication

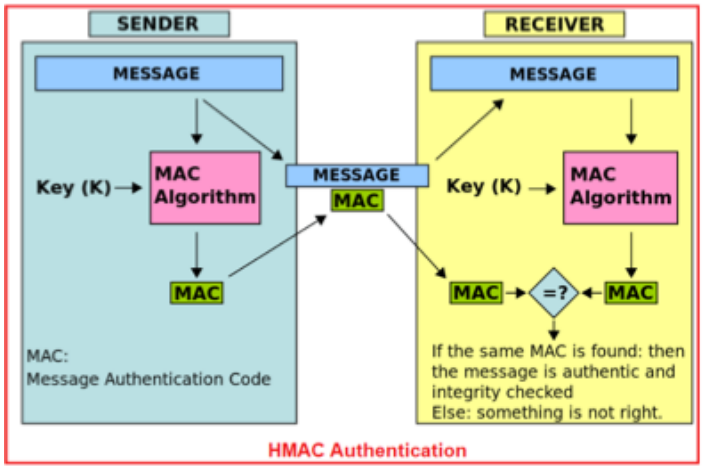
- Server generates a token for the user (based on credentials)
  - Token: một chuỗi được sinh ra ngẫu nhiên
- Every request sent to server will include the token in the HTTP header, e.g.:
  - curl -X GET https://127.0.0.1/api/example
    -H 'X-Api-Key: 9944b09199c62bcf9418ad846dd0e4bety89eff'
- Server will validate the token to check whether the token is valid or not

HMAC-based authentication

- HMAC: Hash-based message authentication code
- Use a pair of hashes: private hash and public hash
  - Public hash: used to identify the user, can be public
  - Private hash: kept secret (only the user and server know)
- Client:
  - Private hash is combined with the request content to create content hash
  - Content hash + public hash + request are sent to the server

HMAC-based authentication

- Server:
  - uses public hash to identify the user and the corresponding private hash
  - hashes the request content + private hash
  - compare the computed hash with the hash value in the request to perform the authentication



HMAC-based authentication

- Private hash and public hash:
  - Shouldn’t contain any user information in generating the hash code
- Example:

```
$hash = hash('sha256', openssl_random_pseudo_bytes(32));
```

or:

```
$hash = hash('sha256', mt_rand());
```

HMAC-based authentication – Client

```php
//Client
<?php
$publicHash = '3441df0babc2a2dda551d7cd39fb235bc4e09cd1e4556bf261bb...';
$privateHash = 'e249c439ed7697df2a4b045d97d4b9b7e1854c3ff8dd668c779...';
$content = json_encode(array('test' => 'content'));

$hash = hash_hmac('sha256', $content, $privateHash);
$headers = array('X-Public: '.$publicHash,
                 'X-Hash: '.$hash);

$ch = curl_init('http://test.localhost:8080/api-test/');
curl_setopt($ch,CURLOPT_HTTPHEADER, $headers);
curl_setopt($ch,CURLOPT_RETURNTRANSFER, true);
curl_setopt($ch,CURLOPT_POSTFIELDS, $content);

$result = curl_exec($ch);
curl_close($ch);
echo "RESULT\n======\n".print_r($result, true)."\n\n";
?>
```

HMAC-based authentication – Server

```php
<?php
require_once 'vendor/autoload.php';
$app = new \Slim\App();
$app->post('/', function($request, $response) {
  $publicHash = $request->getHeaderLine('X-Public');
  $contentHash = $request->getHeaderLine('X-Hash');
  $privateHash = 'e249c439ed7697df2a4b045d97d4b9b7e1854c3ff8dd668c779...';

  $content = $request->getBody();
  $hash = hash_hmac('sha256', $content, $privateHash);

  if ($hash == $contentHash){
    echo "match!\n";
  }
});
?>
```

Creating and Comsuming REST API

Creating REST API

- Set the appropriate response header “Content-Type”:
  - header('Content-Type: application/json');
- PHP array/object → Json string: json_encode($var)
  - $arr = ['a' => 1, 'b' => 2, 'c' => 3, 'd' => 4, 'e' => 5];
  - echo json_encode($arr); *// {"a":1,"b":2,"c":3,"d":4,"e":5}*
- Json string → PHP array/object: json_decode($var)
  - $json = '{"a":1,"b":2,"c":3,"d":4,"e":5}';
  - $obj = json_decode($json); *// $obj is a stdClass object*
  - $arr = json_decode($json, true); *// $arr is an associative array*

Jsend-based response format

- Success (2xx): yêu cầu được xử lý thành công

```
{
    "status" : "success",
    "data" : {
        "post" : { "id" : 1,
            "title" : "A blog post",
            "body" : "Some useful content"
        }
    }
}

{
  "status" : "success",
  "data" : null
}
```

Jsend-based reponse format

- Thất bại (4xx): yêu cầu không hợp lệ (lỗi client)

```
{
  "status" : "failed",
  "data" : {"title" : "A title is required"}
}
```

- Thất bại (5xx): lỗi trong quá trình xử lý y/c (lỗi server)

```
{
  "status" : "error",
  "message" : "Unable to communicate with database"
}
```

JSON in Javascript

- JS object → Json string: JSON.stringify(obj)
  - `var j = {"name" : "binchen"};`
  - `JSON.stringify(j);  //'{"name":"binchen"}'`

- Json string → JS object: JSON.parse(json)
  - `var json = '{"result":true,"count":1}';`
  - `var obj = JSON.parse(json);`

Consume JSON data with AJAX (jQuery)

- Receive JSON data from server:

```
$.ajax({
  type: 'GET',
  url: '/api/contacts',
  data: {name:'Bao'},
  dataType: 'json',
  success: function (res) {
    // data is converted from JSON to JS object
    // automatically by jQuery
    // res: JS object
  }
});
```

Consume JSON data with AJAX (jQuery)

- Send JSON data to server:

```
var contact = {name:'Bao',phone:'1234567890'};
$.ajax({
  type: 'POST',
  url: '/api/contacts',
  data: JSON.stringify(contact),
  contentType:'application/json',
  success: function (res) {
    alert(res)
  }
});
```

Question?

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