CS 326
REST Web Services

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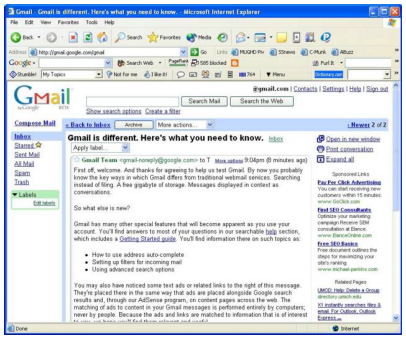
Old School (90's)

- Server makes full static web page. Client renders page

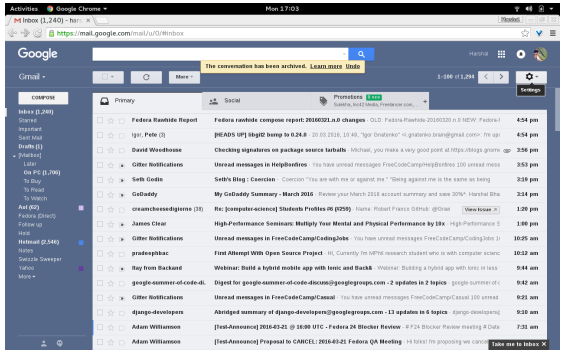
The 00's

- Server makes full web page
  - includes some JavaScript for callbacks to server for dynamic update of portions of pages.



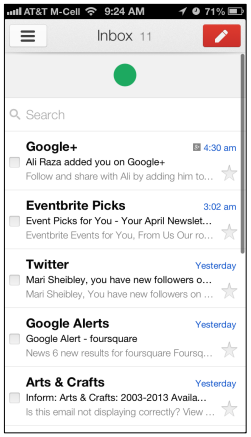
The 10's

- Single-page applications. No reloads.
  - JavaScript in browser rewrites web page (DOM)

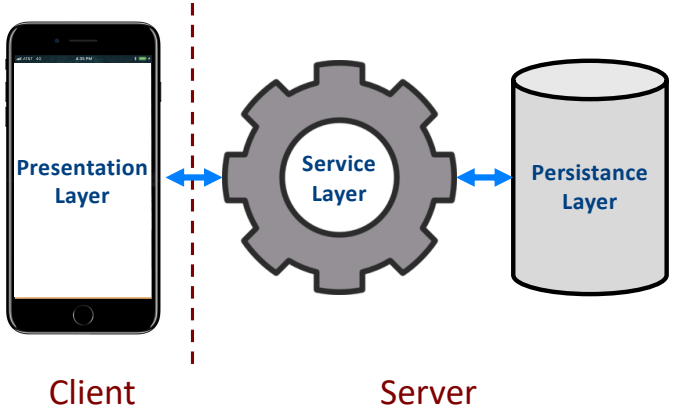


REST Mobile Apps

- Same protocol to talk to server
- App written for native platform
  - iOS, Android
  - not JavaScript in browser



Implementing a REST "MicroService"



Client/Server Interface

- The (http) web server performs all the necessarily central actions
- The JavaScript in the browser or the iOS app:
  - presents the data pulled from the server
  - accepts user input, which may prompt it to make a request to server
- REST: Precise spec of communication

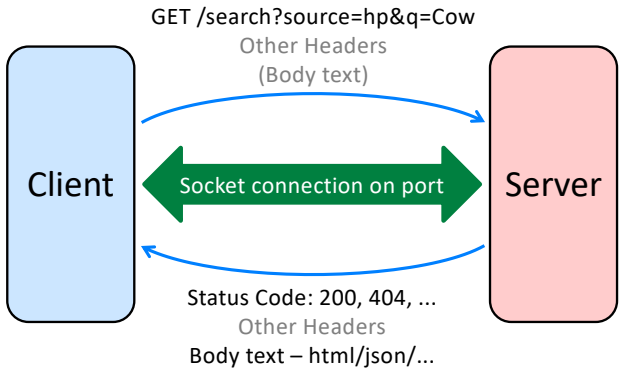
REST

- REST == Representational State Transfer
- REST is a convention on top of good old HTTP.
- Basic properties of REST
  - Request/response *data format*: JSON, xml, etc.
  - *Stateless*: Don't assume the server knows anything about client state.

Basic REST Requests

- Type (Method)
  - GET get some data
  - POST put up new data
  - PUT update or overwrite data
  - DELETE delete data
- URL
  - protocol://host:port/path?query
  - http://www.google.com:80/search?source=hp&q=Cow

Basic REST Requests



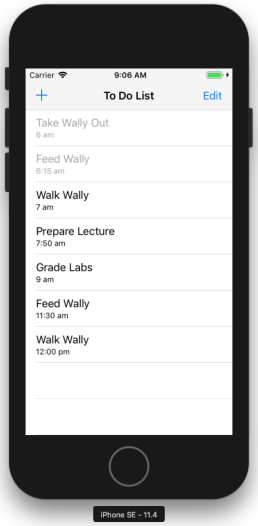
RESTful Interface Endpoints

- Resource: a particular data item on server
  - ex: a "to do" item
- Route: is a URL suffix to address a resource
  - All items: /todos
  - Single item: /todos/5
  - Items matching query: /todos?id=5
- **Endpoint**: route plus an HTTP method (POST/GET/UPDATE/DELETE/...)
  - eg: GET /todos?id=5

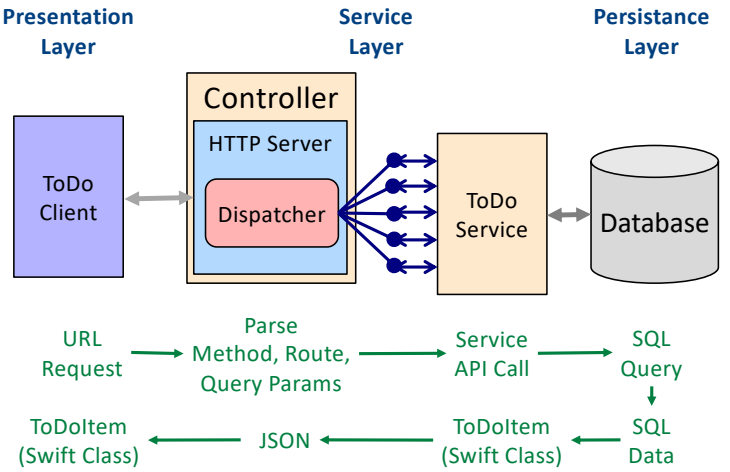
Good REST API Example

- https://developer.spotify.com/documentation/web-api/reference/

To Do List App



Implementing a REST "MicroService"



Data Representations


```
{
 "id": 5,
 "task: "Feed Wally",
 "done": false,
 "created": "11/18/18"
}
```

item

5
Feed Wally
false
11/18/18

id	task	done	created
...	...	...	...
5	Feed Wally	false	11/18/18
...	...	...	...

ToDoItem Model and Enpoints

```
// Data Model for To Do Items.
class ToDoItem {
  public let id : Int
  public let task : String
  public let done : Bool
  public let created : String
}
```

ToDoList Endpoints

Data Representations : Manual

- Slightly painful to encode

```
// convert item to JSON string
let str = """
  { "id":\(item.id),
    "task": "\(item.task)"
    ...
  }
"""
```

Data Representations : Manual

- Slightly painful to decode

```
// convert from JSON Data object for one item
let data = Data(contentsOf: url)
let json = try?
   JSONSerialization.jsonObject(with: data,
                                options: [])
let map = json as! [String:Any]
let item = Item(id : map["id"] as! Int,
                task : map["task"] as! String,
                ...)
```

Data Representations : Codeable Objects


```
class ToDoItem : Codeable { ... }

// convert to JSON Data object
let encoder = JSONEncoder()
let data = try? encoder.encode(item)

// convert Data object to String
let json = String(data: data!, encoding: .utf8)
```

Data Representations : Codable Objects


```
// convert from JSON Data object for one item
let data = Data(contentsOf: url)
let decoder = JSONDecoder()
let item = try? decoder.decode(ToDoItem.self,
                               from: data)

// convert from JSON Data object for array
...
let items = try? decoder.decode([ToDoItem].self,
                                from: data)
```

Data Representations

id	task	done	created
...	...	...	...
5	Feed Wally	false	6/10/18
...	...	...	...

- Service's job

ToDoItem Object ⟷ SQL Data

- Create SQLite database table
- Each row represents one to do item
  - Object relational mapping (ORM)
  - Manual mapping (write SQL queries, translate results)
- Use manual mapping until it becomes painful

Data Representations

id	task	done	created
...	...	...	...
5	Feed Wally	false	6/10/18
...	...	...	...

- Service's job

ToDoItem Object ⟷ SQL Data

- Sneak Preview:

```
let row = db.pluck(todos.filter(id == toDoId))

let item = ToDoItem(id: row[id],
                    task: row[task],
                    done: row[done],
                    created: row[created])
```

ToDo Controller


```
private let server = HttpServer()
private let todos = ToDoService()

func launchService() {

    server.POST["/todos"]   = { self.add($0) }
    server.GET["/todos"]    = { self.items($0) }
    server.PUT["/todos"]    = { self.update($0) }
    server.DELETE["/todos"] = { self.delete($0) }

    server.start(port)
}

func add(request : HttpRequest) -> HttpResponse {
  ...  todos.add(...) ...
}
```

ToDoItem Model and Service

```
// Data Model for To Do Items.
class ToDoItem {
  public let id : Int
  public let task : String
  public let done : Bool
  public let created : String
}

// To Do Service API.
class ToDoService {
  var items : [ToDoItem]?
  func insert(task: String, done: Bool, created: String) -> Bool
  func update(id: Int, task: String,
              done: Bool, created: String) -> Bool
  func delete(id: Int) -> Bool
}
```

SQL Database

- Benefits
  - DB manages data
  - Provides robust, efficient access in uniform way
  - persistent, fault-tolerant, scalable, multi-user, …
  - Standard Query Language
- Data Definition Language (DDL)
  - Create/alter/delete tables
- Data Manipulation Language (DML)
  - Query one or more tables
  - Insert/delete/modify tuples in tables

Creating a Table

```
CREATE TABLE "todos" (
  "id"      INTEGER PRIMARY KEY AUTOINCREMENT NOT NULL,
  "task"    TEXT NOT NULL,
  "created" TEXT NOT NULL,
  "done"    BOOLEAN NOT NULL
)
```

Primary Key!
Unique for each row

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18

Attributes

Rows

Adding a Row to a Table

```
INSERT INTO "todos" ("task", "done", "created")
  VALUES ("Prepare Lecture", false, "11/18/18")
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	**Prepare Lec**	**false**	**11/18/18**

SQL Query

```
SELECT *
FROM "todos"
WHERE NOT done
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

id	task	done	created
5	Feed Wally	false	11/17/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

SQL Query

```
SELECT *
FROM "todos"
WHERE NOT done
  AND created = '11/18/18'
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

id	task	done	created
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

SQL Query

```
SELECT id, task
FROM "todos"
WHERE NOT done
  AND created = '11/18/18'
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

id	task
8	Walk Wally
9	Prepare Lec

SQL Query

```
SELECT *
FROM "todos"
WHERE id = 8
LIMIT 1
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

id	task	done	created
8	Walk Wally	false	11/18/18

Update a Row

```
UPDATE "todos"
SET done = true
WHERE id = 5
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	true	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

Delete a Row

```
DELETE FROM "todos"
WHERE id = 5
```

id	task	done	created
1	Walk Wally	true	11/17/18
5	Feed Wally	false	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

id	task	done	created
1	Walk Wally	true	11/17/18
6	Grade Labs	true	11/18/18
8	Walk Wally	false	11/18/18
9	Prepare Lec	false	11/18/18

SQL Bindings

- Can write directly in SQL
  - hard to integrate in to control logic of code
- Use wrapper around Database engine
  - write directly in target language (eg: Swift)
- We'll use SQLite bindings:

```
// SELECT * FROM "todos"
// WHERE id = n
// LIMIT 1
if let row = db.pluck(todos.filter(id == n)) {
   return ToDoItem(id: row[id],
                   task: row[task],
                   done: row[done],
                   created: row[created])
}
```