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Introduction to Angular

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Greenplum Architecture
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Machine Learning
Python
R Programming
Tableau
UiPath

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BusinessObjects
Crystal Reports
Excel Power Query
MongoDB
MySQL
NoSQL Databases
Oracle
Oracle APEX
Power BI
PivotTable and PowerPivot
PostgreSQL
SQL Server
Vertica Architecture & SQL

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Agile
Ansible
Chef
Docker
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Gradle Build System
Jenkins
Jira & Confluence
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Microservices
Red Hat
Software Design

Java
Apache Maven
Apache Tomcat
Groovy and Grails
Hibernate
Java & Web App Security
JavaFX
JBoss
Oracle WebLogic
Scala
Selenium & Cucumber
Spring Boot
Spring Framework

JS, HTML5, & Mobile
Angular
Apache Cordova
CSS
D3.js
HTML5
iOS/Swift Development
JavaScript
MEAN Stack
Mobile Web Development
Node.js & Express
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Swift
Vue

Microsoft & .NET
.NET Core
ASP.NET
Azure DevOps
C#
Design Patterns
Entity Framework Core
F#
IIS
Microsoft Dynamics CRM
Microsoft Exchange Server
Microsoft Office 365
Microsoft Power Platform
Microsoft Project
Microsoft SQL Server
Microsoft System Center
Microsoft Windows Server
PowerPivot
PowerShell
Team Foundation Server
VBA
Visual C++/CLI
Web API

Other
Blockchain
C++
Go Programming
IT Leadership
ITIL
Project Management
Regular Expressions
Ruby on Rails
Rust
Salesforce
XML

Security
.NET Web App Security
C and C++ Secure Coding
C# & Web App Security
Linux Security Admin
Python Security
Secure Coding for Web Dev
Spring Security

SharePoint
Power Automate & Flow
SharePoint Administrator
SharePoint Developer
SharePoint End User
SharePoint Online
SharePoint Site Owner

SQL Server
Azure SQL Data Warehouse
Business Intelligence
Performance Tuning
SQL Server Administration
SQL Server Development
SSAS, SSIS, SSRS
Transact-SQL

Teleconferencing Tools
Adobe Connect
GoToMeeting
Microsoft Teams
WebEx
Zoom

Web/Application Server
Apache Tomcat
Apache httpd
IIS
JBoss
Nginx
Oracle WebLogic

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Angular

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npm QuickStart

Node.js package manager

What is Node.js?

JavaScript runtime

Built on Chrome's V8 JavaScript engine

What is Java’s runtime?

JRE

What is .NET’s runtime?

CLR

Node.js package manager

Share/Reuse code

Update Code

Manage Versions of Code

Installing Dependencies

Package manager

Shared Code

- Authors
  - **Share code**
  - Created to solve particular problems
- Developers
  - **Reuse** shared **code** in their own applications
  - **Check** if author made **updates** to shared code
  - **Download** those updates
- Shared Code
  - Called **package**, **module**, or **dependency** (*library*)
  - Directory of one or more files (including package.json which lists shared code it depends on)
  - Packages often **small**
  - Follows Unix philosophy of small building blocks that **“do one thing well”**

Global Installs

```
$ npm install typescript --global
```

- This command installs a package and any packages that it depends on
- Replace --global with –g to save typing

Global Packages Location

$ npm get prefix

Mac:
/Users/[username]/.npm-packages/lib/node_modules

PC:
%USERPROFILE%\AppData\Roaming\npm\node_modules (Windows 7, 8, and 10)
%USERPROFILE%\Application Data\npm\node_modules (Windows XP)

The Problem with Global Installs?

- What could be the problem with installing all your packages globally?
- ProjectA and ProjectB need different versions of dependency (shared code)

Local Installs

```
$ npm init #creates package.json
$ npm install typescript --save-dev #saves in package.json
                                    #creates node_modules directory

$ tsc -v #fails because can't find package

$ node_modules/.bin/tsc -v #succeeds and outputs version info

$ npx tsc -v #succeeds, adds current directory’s node_modules to the path
so it picks up the locally installed version and outputs version info
```

package.json

dependencies and devDependencies

$ npm install rxjs --save

```
{
  "name": "npm-quickstart",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "scripts": {},
  "keywords": [],
  "author": "",
  "license": "ISC",
  "dependencies": {
     "rxjs": "^5.2.0"
  }
}
```

$ npm install typescript --save-dev

```
{
  "name": "npm-quickstart",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "scripts": {},
  "keywords": [],
  "author": "",
  "license": "ISC",
  "dependencies": {
       ”rxjs": ”5.2.0"
  },
  "devDependencies": {
    ”typescript": "^2.2.1"
  }
}
```

Semantic Versioning

- Major.Minor.Patch
- If you were starting with a package 1.0.4, this is how you would specify the ranges:
    - Patch releases: **~**1.0.**4** → 1.0.**5**
    - Minor releases: **^**1.**0**.4 → 1.**1**.0
    - Major releases: *** or x | 1**.0.4 → **2**.0.0
- Set prefix for npm installs (machine level)
  - npm set save-prefix="~"
  - Default: ""

Sharing Dependencies

```
$ npm install //installs dependencies and devDependencies
$ npm install --production //installs dependencies only
```

Updating Dependencies

```
//update a global dependency
$ npm uninstall @angular/cli -g
$ npm install @angular/cli -g
OR
$ npm update @angular/cli –g
OR
$ npx @angular/cli new my-app


//update a local dependency
$ npm update rxjs --save

//update all local dependencies
$ npm install npm-check -g
$ npm-check -u
```

Updating Angular Dependencies

```
$ ng update @angular/cli @angular/core
//updates all angular packages and dependencies (in an Angular CLI project)
```

Uninstalling Dependencies

```
$ npm uninstall lite-server -g //uninstall a global dependency
$ npm uninstall rxjs --save //uninstall a local dependency
```

Lab

Node Package Manager (npm)

Open **TypeScriptLabManual.pdf** and follow the directions to do the following sections:

Create Project

Install TypeScript

Understanding package-lock.json

- In an ideal world, the same **package.json** should produce the exact same **node_modules** tree, at any time
- In some cases, this is indeed true. But in many others, npm is unable to do this
- To **reliably** produce the **exact node_modules tree**, **package-lock.json** was created.

Broken package.json scenarios

- **A dependency of one of your dependencies may have published a new version, which will update even if you used pinned dependency specifiers (1.2.3 instead of ^1.2.3)**
- Different versions of npm (or other package managers) may have been used to install a package, each using slightly different installation algorithms.
- A new version of a direct semver-range package may have been published since the last time your packages were installed, and thus a newer version will be used.
- The registry you installed from is no longer available or allows mutation of versions (unlike the primary npm registry), and a different version of a package exists under the same version number now.

Using npm as a Build Tool

Build Automation | npm scripts

Your First Script

```
$ npm init -y //creates package.json
{
  "name": "npmscriptsdemo",
  "version": "1.0.0",
  "description": "",
  "main": "index.js",
  "scripts": {
    "test": "echo \"Error: no test specified\" && exit 1",
    "hi": "echo hello world "
  },
  "keywords": [],
  "author": "",
  "license": "ISC"
}

$ npm run-script hi //hello world
```

Custom npm script

Run the custom script

Shortcuts

Instead of:

```
$ npm run-script [script-name]
```

You could use the shorter:

```
$ npm run [script-name]
```

Or if it’s one of the npm supported scripts you can omit the run command:

```
$ npm [script-name]
```

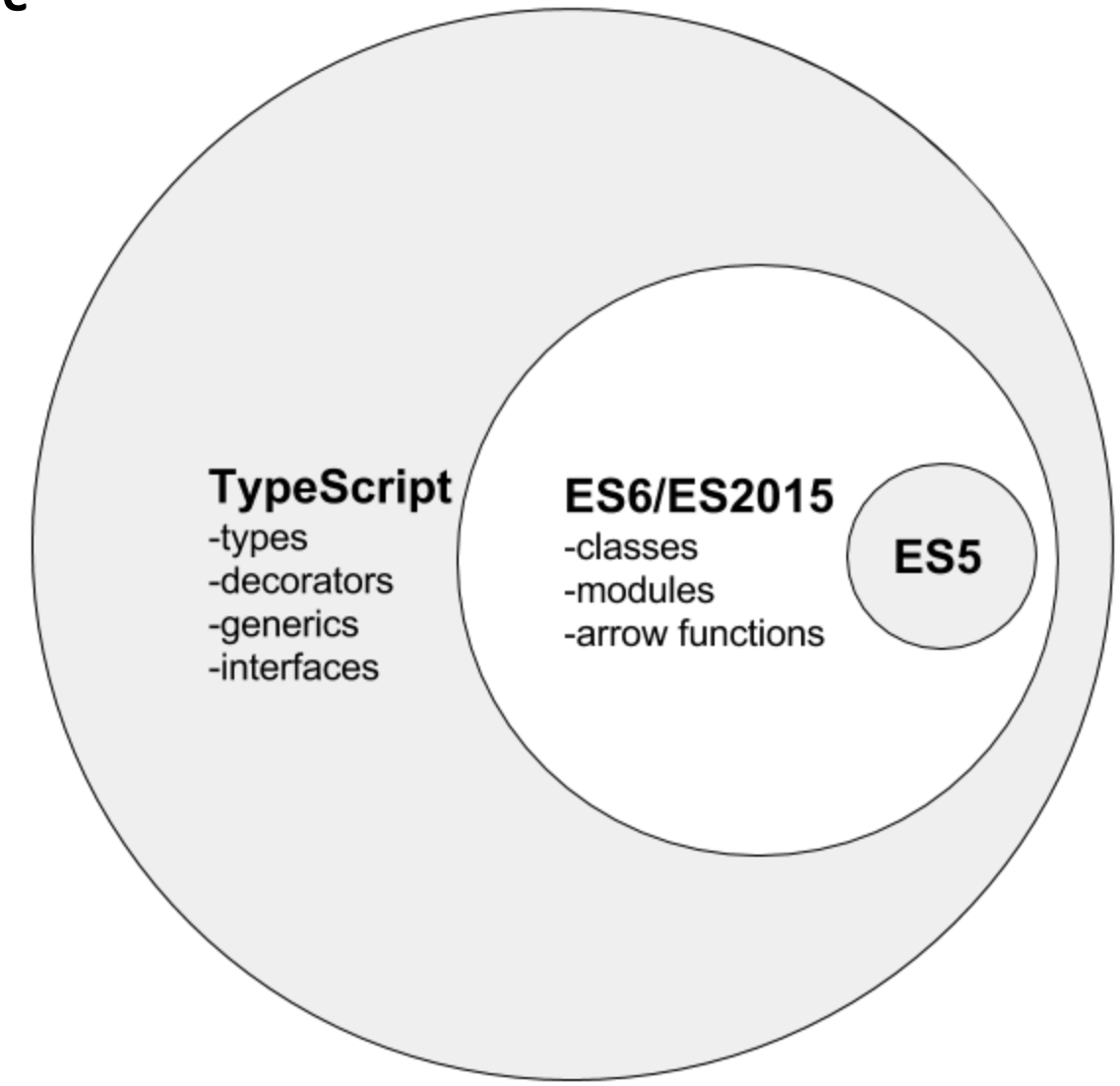
To see a list of Supported scripts: https://docs.npmjs.com/misc/scripts

Common supported scripts include: start, test

TypeScript/ES2015

Introduction

TypeScript


TypeScript
-types
-decorators
-generics
-interfaces
ES6/ES2015
-classes
-modules
-arrow functions
ES5

How TypeScript Works

https://www.typescriptlang.org/play/index.html

TypeScript | Documentation | Samples | Download | Connect | Playground | Fork me on GitHub

TypeScript 1.8 is now available. Download our latest version today!

Using Classes | TypeScript | Share | Run | JavaScript

```typescript
class Greeter {
    greeting: string;
    constructor(message: string) {
        this.greeting = message;
    }
    greet() {
        return "Hello, " + this.greeting;
    }
}

let greeter = new Greeter("world");

let button = document.createElement('button');
button.textContent = "Say Hello";
button.onclick = function() {
    alert(greeter.greet());
}

document.body.appendChild(button);
```

```javascript
var Greeter = (function () {
    function Greeter(message) {
        this.greeting = message;
    }
    Greeter.prototype.greet = function () {
        return "Hello, " + this.greeting;
    };
    return Greeter;
}());
var greeter = new Greeter("world");
var button = document.createElement('button');
button.textContent = "Say Hello";
button.onclick = function () {
    alert(greeter.greet());
};
document.body.appendChild(button);
```

Why TypeScript?

- TypeScript is a primary language for Angular application development
  - Angular is written in TypeScript.
- Recommended by Angular core team and Google
- Types enable better tooling including
  - Refactoring
  - Navigating code
  - Code completion
- Decorators (annotations) provide an easily understandable API

Who is Behind TypeScript?

Anders Hejlsberg

Core developer of TypeScript

Microsoft technical fellow

Lead architect C#

Original author Turbo Pascal: Delphi

Image from Wikimedia Commons

Installing TypeScript

Global

```
npm install -g typescript
```

Local

```
npm init //creates package.json
npm install typescript --save-dev //saves version to package.json
//To ensure you're getting local version run using npm scripts
```

Configuring TypeScript

```
tsc --init
message TS6071: Successfully created a tsconfig.json file.


//default tsconfig.json
{
    "compilerOptions": {
        "target": "es5",
         ...
    }
}
```

Compiling with TypeScript

```
tsc
//OR
tsc --watch
```

JavaScript is valid TypeScript

Q: What would be the output of the following JavaScript code run through the TypeScript compiler?

```
function greeter(name) {
    return "Hello " + name;
}

console.log(greeter("Anders"));
```

A: The same code.

Type Annotations

```
function greeter(name: string) {
    return "Hello " + name;
}

console.log(greeter("Anders"));
```

Lab

Node Package Manager (npm) & TypeScript

Open **TypeScriptLabManual.pdf** and follow the directions to do the following sections:

Run TypeScript

Type Annotations

Output on Error

ES2015 Classes

```
class Student{
    public firstName: string;
    middleInitial: string;
    lastName: string;

    constructor(firstName: string,
                middleInitial: string,
                lastName: string){

        this.firstName = firstName;
        this.middleInitial = middleInitial;
        this.lastName = lastName;
    }

    getFullName(){
        return this.firstName + " " + this.middleInitial + ". " + this.lastName;
    }
}
let student = new Student("John", "D", "Rockefeller");
console.log(student.getFullName());
```

Property: public is the default

Public keyword is not required

Constructor

Create instance and invoke method

TypeScript Automatic Property Assignment

```
class Student {
    firstName: string;
    middleInitial: string;
    lastName: string;

    constructor(firstName, middleInitial, lastName) {
        this.firstName = firstName;
        this.middleInitial = middleInitial;
        this.lastName = lastName;
    }
}
```

Equivalent

```
class Student {

    constructor(public firstName:string,
                public middleInitial:string,
                public  lastName:string) {}

}
```

Classes & Interfaces

```
interface Person {
    firstName: string;
    lastName: string;
}

class Student implements Person{
    fullName: string;
    constructor(public firstName, public middleInitial, public lastName) {
        this.fullName = firstName + " " + middleInitial + " " + lastName;
    }
}


function greeter(person : Person) {
    return "Hello, " + person.firstName + " " + person.lastName;
}

let student = new Student("Jon", "M.", "Turner");
console.log(greeter(student));
```

Interface

Class that implements interface

Function that takes parameter of the interface type

Create instance of class and invoke method

Scope: var, let, const

- var
  - Function scope
- let
  - Block scope
- const
  - Block scope
  - Cannot change or be redeclared

ES2015 Arrow Functions

```
let evens = [0,2,4,6,8];

//verbose
// let odds = evens.forEach(function(v){
//     return v+1;
// });

//terse
let odds = evens.forEach(v => v + 1);

odds.forEach(line=> console.log(line)); //1,3,5,7,9
```

Lab

Node Package Manager (npm) & TypeScript

Open **TypeScriptLabManual.pdf** and follow the directions to do the following sections:

Classes

Scope

Arrow Functions

ES2015 Arrow Functions (this)

without an arrow function

```
var organization={
    name: "Avengers",
    heroes: ["Hulk", "Iron Man", "Captain America"],
    printHeroes: function() {
        var self = this;

        this.heroes.forEach(function(hero) {
            console.log(hero + " is a member of the  " + self.name + ".");
        });
    }
};

organization.printHeroes()
```

Capture *this* into into *self* variable

this.name is undefined so we have to use self.name

ES2015 Arrow Functions (this)

with an arrow function

```
var organization={
    name: "Avengers",
    heroes: ["Hulk", "Iron Man", "Captain America"],
    printHeroes: function() {
      this.heroes

        .forEach(h => console.log(h + " is a member of the " + this.name + "."));
    }
};
```

- *this.name is "Avengers"*
- *Arrow functions don't create a new function context*

```
organization.printHeroes();
```

TypeScript Decorators

- With the introduction of Classes in ES2015, there now exist certain scenarios that require additional features to support metadata modifying classes and class members. Aspect-Oriented Programming (AOP).
- Decorators provide a way to add both annotations and a meta-programming syntax for class declarations and members
- Decorators are a stage 1 proposal for JavaScript and are available as an experimental feature of TypeScript
  - They may change in future releases

TypeScript Decorators: Configuring

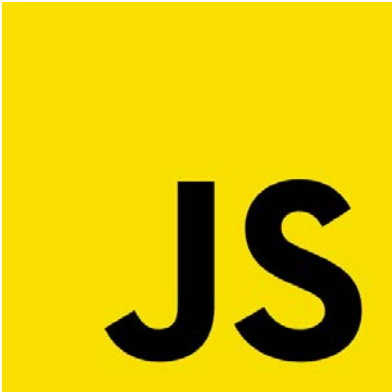
```
{
    "compilerOptions": {
        "module": "commonjs",
        "target": "es5",
        "noImplicitAny": false,
        "sourceMap": false,
        "experimentalDecorators": true
    }
}
```

Decorators

```
function ClassLogger(target: Function) {
    console.log("The function that created this class is: " + target);
}

@ClassLogger
class Customer {
}

var customer = new Customer();
```



ES Modules

ES Modules

ES Modules Explained

- An ES6 module is a file containing JS code.
  - There’s no special module keyword
  - A module reads like a script except:
    - ES modules are automatically strict-mode code
    - You can use import and export in modules
    - A JavaScript file is a module if it contains the import and/or export keyword
- Modules are executed within their own scope, not in the global scope
- Note: This feature is not implemented in any browsers natively at this time. It is implemented in by module loaders.

ES Modules Syntax

- The **export statement** is used to export functions, objects or primitives from a given file (or *module*)
- The **import statement** is used to import functions, objects or primitives that have been exported from an external module, another script, etc.

ES Module Example

```
//my-module.ts
export function myFunction(){
    return "myFunction was run.";
}
-----------------------------------------------------------------------------
//program.ts
import {myFunction} from "./my-module";
console.log(myFunction());
```

ES Module Privacy Example

```
//my-module.ts
export function myFunction(){
    return "myFunction was run.";
}


function myPrivateFunction(){
    return "myPrivateFunction was run.";
}
-----------------------------------------------------------------------------
//program.ts
import {myFunction, myPrivateFunction} from "./my-module";

//Module has no exported member myPrivateFunction.
```

ES Module Exporting

export function, object, primitive, and class

```
//my-module.ts

export function myFunction(){
    return "myFunction was run.";
}

var myObject = {
    name: 'I can access myObject\'s name',
    myMethod: function(){return 'myMethod'on myObject is running.';}
}
export {myObject}

export const myPrimitive = 55;

export class MyClass{
    myClassMethod(){
        return "myClassMethod on myClass is running."
    }
}
```

ES Module Importing

import function, object, primitive, and class

```
//program.ts

import {myFunction, myObject, myPrimitive, MyClass} from "./my-module";

console.log(myFunction());

console.log(myObject.name);

console.log(myObject.myMethod());

console.log(myPrimitive);

let myClass = new MyClass();
console.log(myClass.myClassMethod());
```

ES2015 Template literals

```
class Student{

    constructor(private firstName: string,
                private middleInitial: string,
                private lastName: string){}

    getFullName(){
      return `
            First: ${this.firstName}
            Middle: ${this.middleInitial}
            Last: ${this.lastName}`;
   }

}
```

Use backticks `` | NOT single quotes ''

Lab

TypeScript

Open **TypeScriptLabManual.pdf** and follow the directions to do the following sections:

Modules

Do the remaining sections in the manual if time permits

Angular Overview

Big Picture

Why Angular

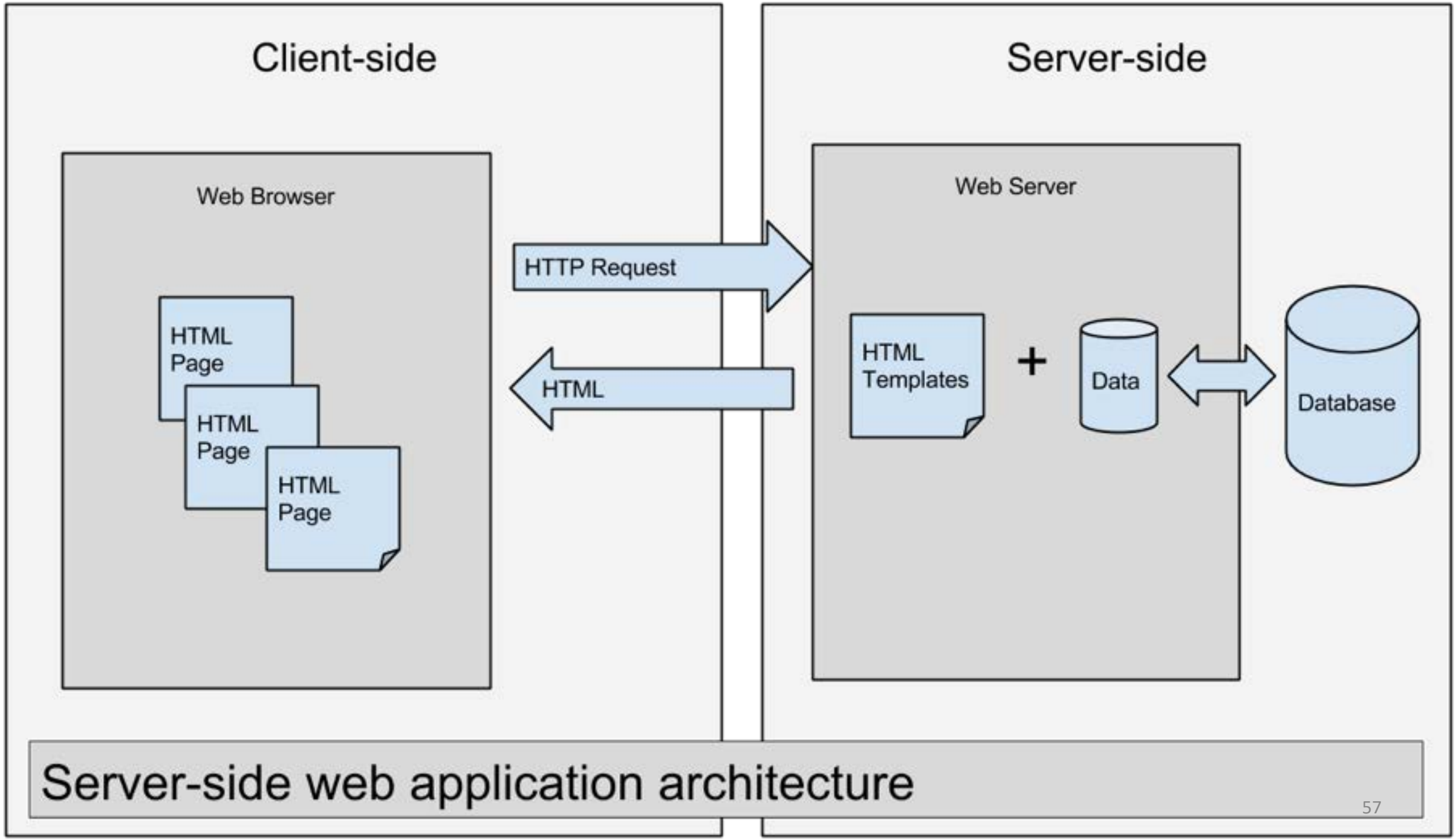
Why would we build our application front-end in JavaScript?

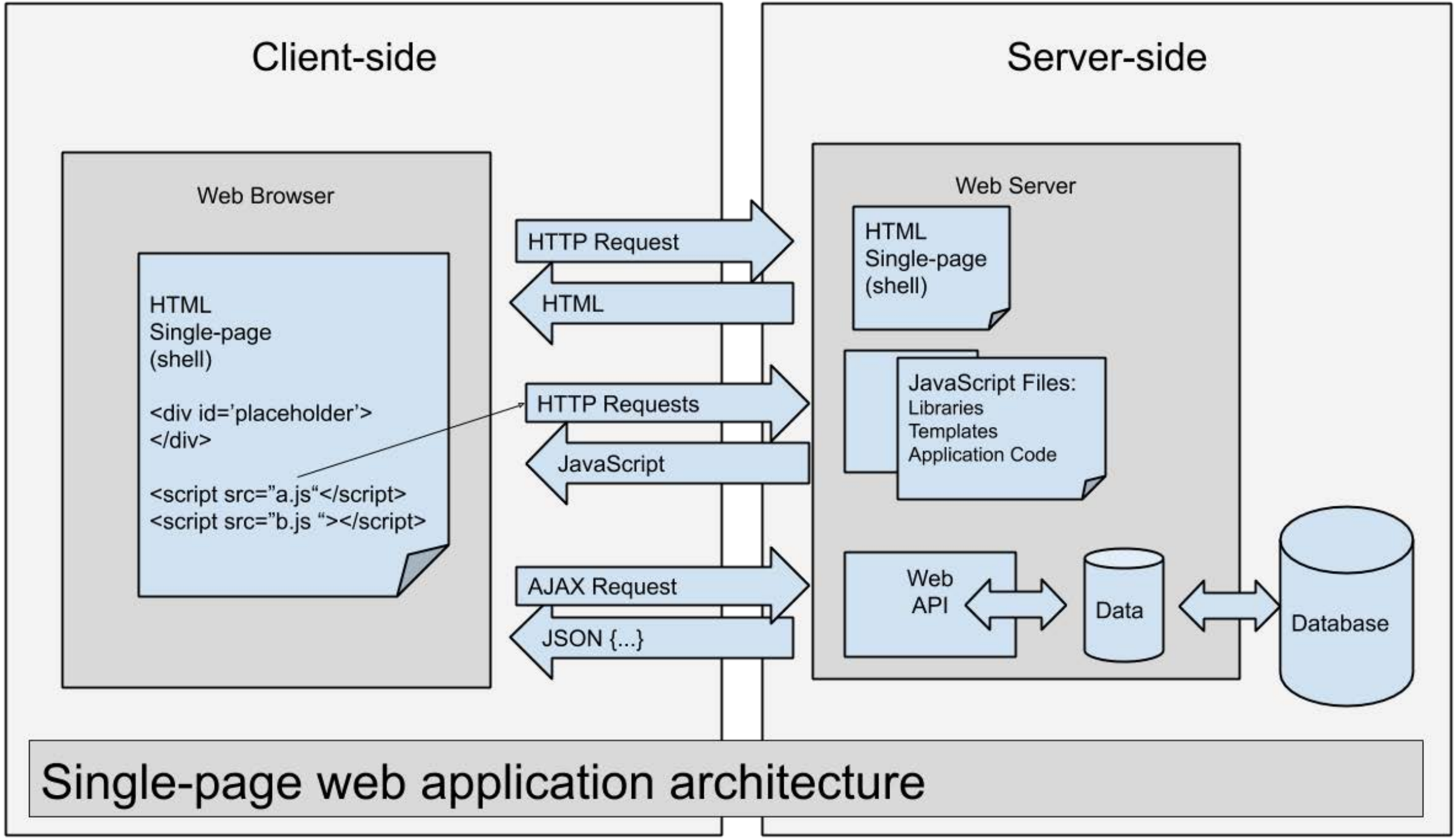
Why would we use a single-page application framework?

What is your current understanding?

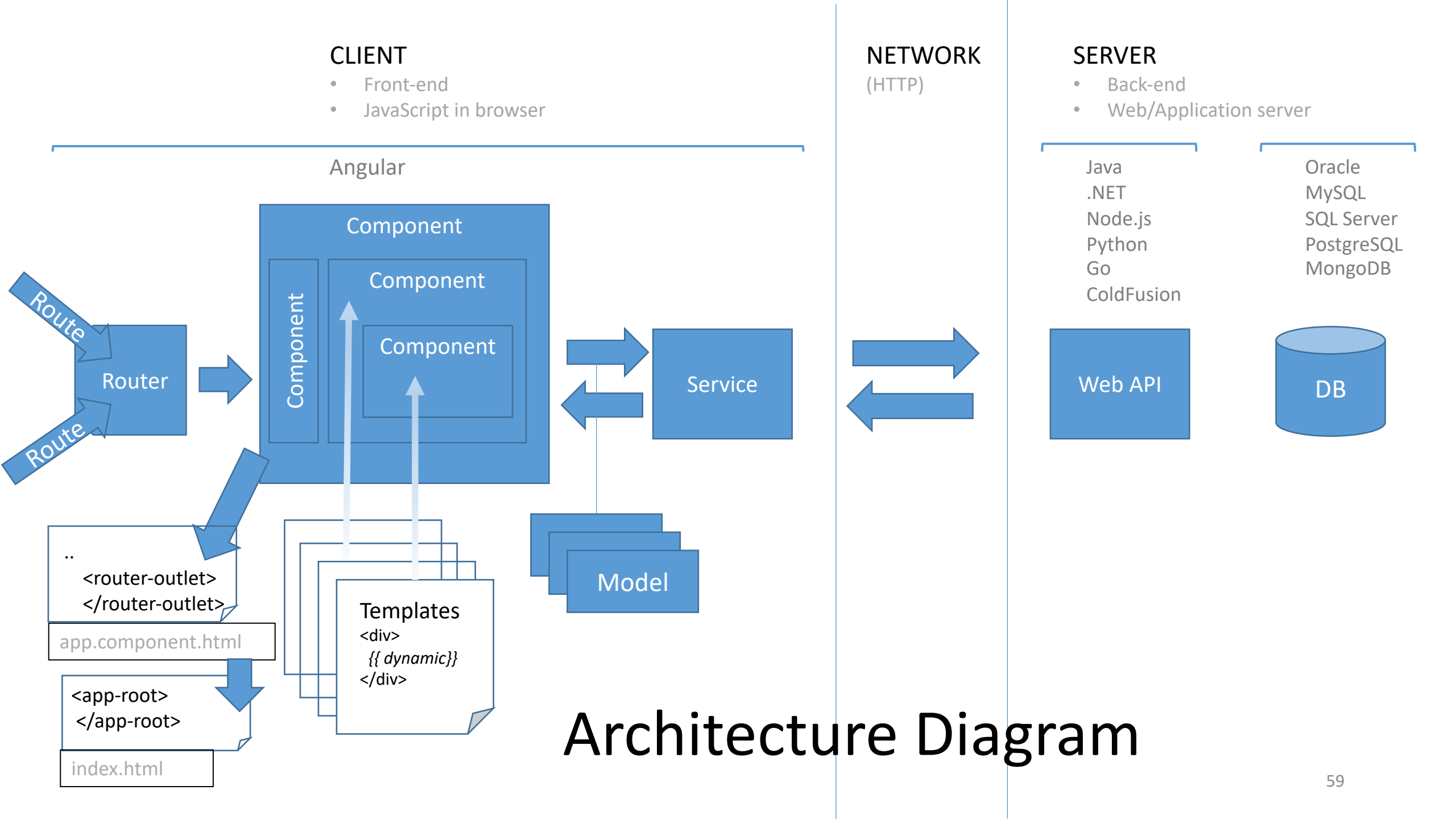
Why a single-page application?

- The user experience of a desktop or native application
- The deployment story of a web application


Client-side
Server-side
Web Browser
HTML Page
HTML Page
HTML Page
HTTP Request
HTML
Web Server
HTML Templates
+
Data
Database
Server-side web application architecture


Client-side
Server-side
Web Browser
HTML
Single-page
(shell)

<script src="a.js"></script>
<script src="b.js "></script>
HTTP Request
HTML
HTTP Requests
JavaScript
AJAX Request
JSON {...}
Web Server
HTML
Single-page
(shell)
JavaScript Files:
Libraries
Templates
Application Code
Web
API
Data
Database
Single-page web application architecture


CLIENT
Front-end
JavaScript in browser
NETWORK
(HTTP)
SERVER
Back-end
Web/Application server
Angular
Java
.NET
Node.js
Python
Go
ColdFusion
Oracle
MySQL
SQL Server
PostgreSQL
MongoDB
Component
Component
Component
Component
Route
Route
Router
Service
Web API
DB
..
<router-outlet>
</router-outlet>
app.component.html
<app-root>
</app-root>
index.html
Templates

{{ dynamic}}

Model
Architecture Diagram

Angular Versions

AngularJS

- 1.x
- angularjs.org

Angular

- >=2.x
- angular.io

Browser	Supported versions
Chrome	latest
Firefox	latest and extended support release (ESR)
Edge	2 most recent major versions
IE	11 **deprecated, see the deprecations guide*
Safari	2 most recent major versions
iOS	2 most recent major versions
Android	Q (10.0), Pie (9.0), Oreo (8.0), Nougat (7.0)

Style Guide

- Follow the official Angular Style Guide
  - https://angular.io/docs/ts/latest/guide/style-guide.html
- Opinionated guide to Angular
  - Naming
  - Syntax
  - Conventions
  - Application structure

Angular Big Picture Review

- With a partner, write down your answers to the following questions on sheet of paper in the next 5 minutes
  - What site should I visit to get the official documentation on AngularJS?
  - What site should I visit to get the official documentation on Angular?
  - In one sentence, why are so many people adopting Angular and other Single-page application frameworks (SPA) frameworks?
  - Draw a single-page application architecture diagram.
  - Draw an Angular architecture diagram.

Angular & React Compared

Angular

- Google
- Components
- Framework
  - Modular
    - Component Router
    - HttpClient
    - Forms
- Usually TypeScript (tsc compiler)
- Angular CLI
  - Uses Webpack
- Reactive Extensions for Angular (ngrx)

React

- Facebook
- Components
- Library
  - Just the View in MVC
  - Need to include other libraries
    - React Router (Routing)
    - Axios (AJAX)
- Usually ES6 (Babel compiler)
- Create React App
  - Uses Webpack
- Redux

React vs. Angular: Key Insights

- *Angular continues to put "JS" into HTML. React puts "HTML" into JS. – Cory House*
- Angular is a more comprehensive library while React is more of a targeted micro library.
- Because React is smaller it is:
  - Easier to understand
  - Easier to include in a project
- React is much more popular (but has existed longer)
- React is used more by design/digital/interactive agencies as well as in the Enterprise
- Angular is used more for Enterprise software particularly at larger organizations

Project Setup

using the Angular CLI (Command Line Interface)

Angular Style Guide: Naming Conventions

Symbol Name	File Name
@Component({ ... }) export class AppComponent { }	app.component.ts
@Component({ ... }) export class HeroesComponent { }	heroes.component.ts
@Component({ ... }) export class HeroListComponent { }	hero-list.component.ts
@Component({ ... }) export class HeroDetailComponent { }	hero-detail.component.ts
@NgModule({ ... }) export class AppModule	app.module.ts
@Pipe({ name: 'initCaps' }) export class InitCapsPipe implements PipeTransform { }	init-caps.pipe.ts
@Injectable() export class UserProfileService { }	user-profile.service.ts

Angular CLI: Features

- Create a new Angular application
- Run a development server with LiveReload support to preview your application during development
- Scaffolds Angular application code
- Run your application’s unit tests
- Run your application’s end-to-end (E2E) tests
- Build your application for deployment to production

Creating a New Project

- Install the Angular CLI

```
npm install –g @angular/cli
```

- Create a new project

```
ng new my-project --routing
cd my-project
```

Running Your Project

`ng serve --open //runs dev server at` http://localhost:4200/ and will automatically reload

or

```
ng serve -o
```

Angular CLI: Generating Code

- Generate a module

```
ng generate module projects --routing
```

- Generate a component

```
ng g component projects/project-list
```

g is short-hand for generate

- CLI generates files relative to the **app** folder
- Generated code follows the official **Angular Style Guide**

Demos

Instructor Demonstration

Lab 1: Creating a New Project

Lab 2: Running Your Project

Lab 3: Style: Using a CSS Framework

Labs

Lab 1: Creating a New Project

Lab 2: Running Your Project

Lab 3: Style: Using a CSS Framework

Attendees Hands-On

Bootstrapping an Angular Application

1. Create a root component
   a. By convention named AppComponent
   b. By convention the file is named app.component.ts
   c. Add selector (custom tag) to index.html
2. Create a root module
   a. By convention named AppModule
   b. By convention the file is named app.module.ts
   c. Declare and bootstrap the root component
   d. Import the BrowserModule from Angular
3. Bootstrap the root module
   a) By convention the file is named main.ts
   b) platformBrowserDynamic
      i. platformBrowser means it will run in a web browser (not a native mobile app etc…)
      ii. Dynamic means the template will be compiled in the browser (not on the server)

Components

Angular

CLIENT

- Front-end
- JavaScript in browser

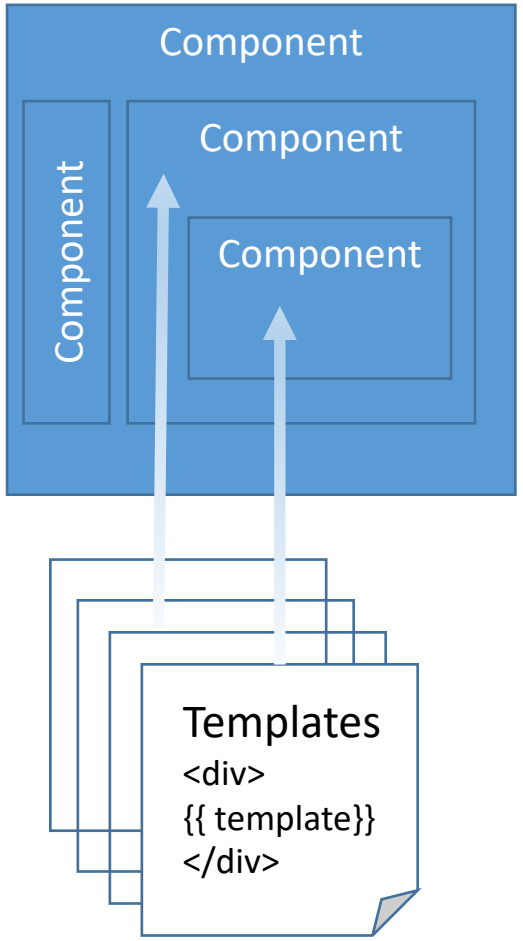
NETWORK

(HTTP)

SERVER

- Back-end
- Web/Application server

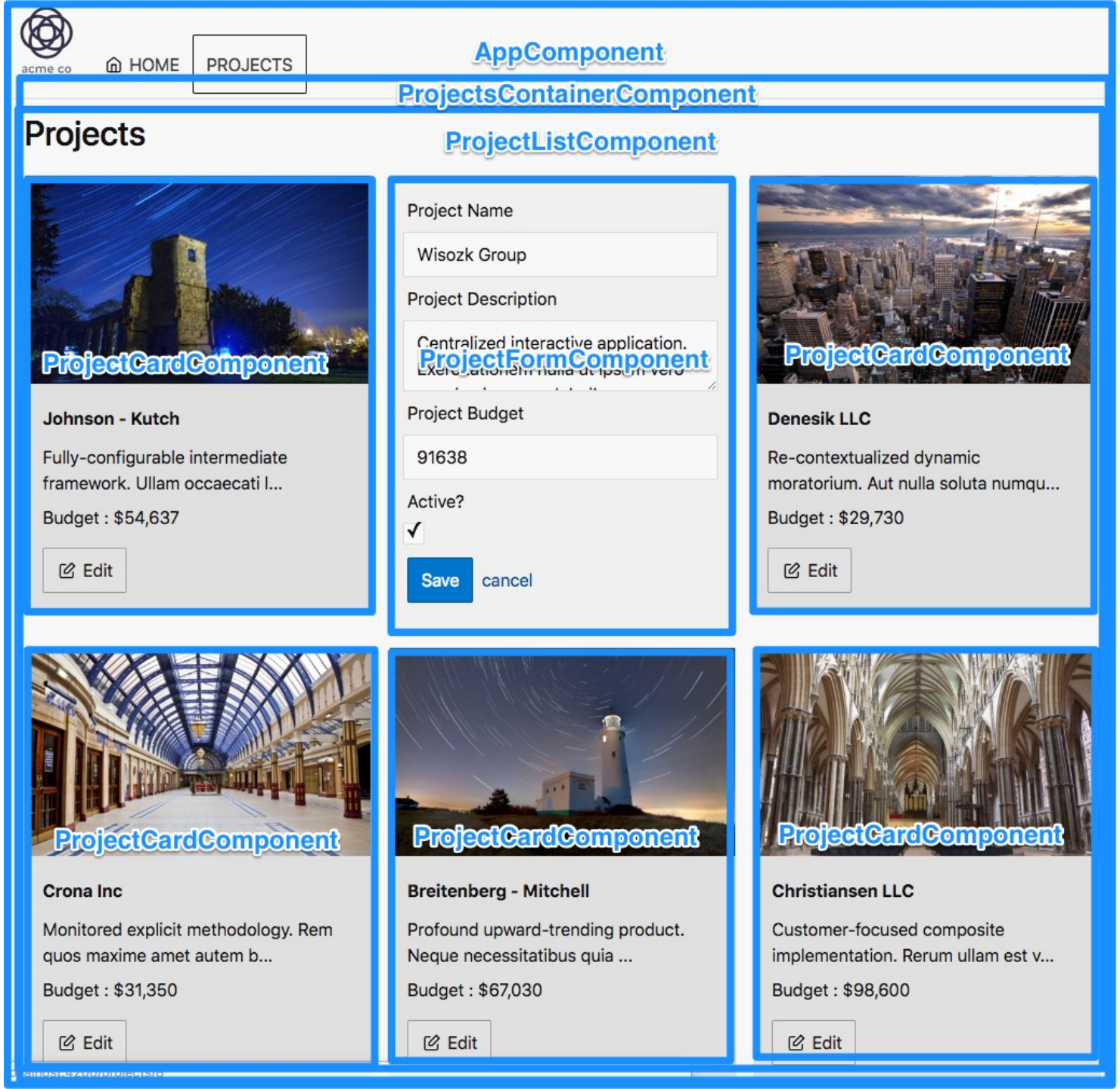
Angular

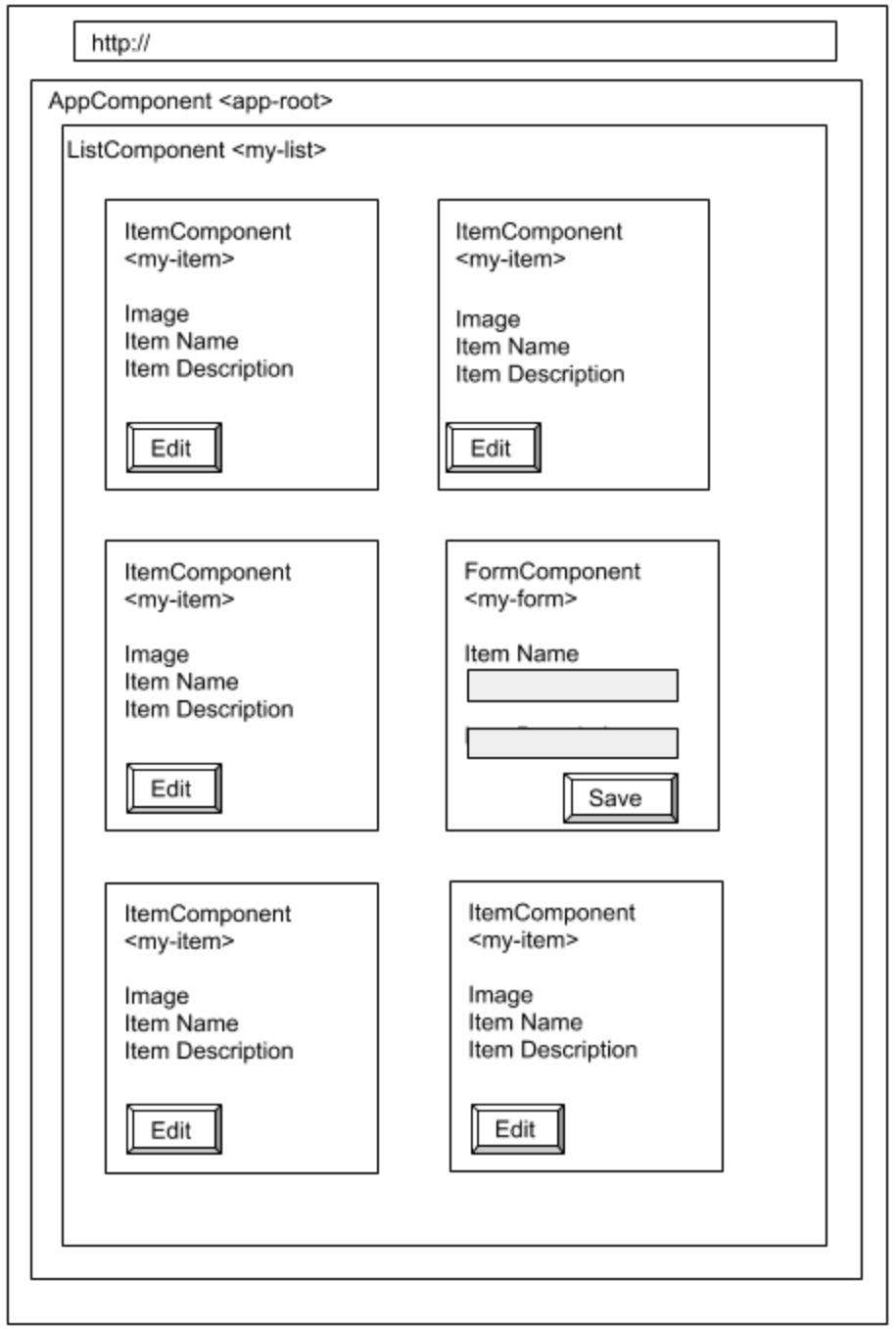


Architecture Diagram: Components

What is a Component?

- A **Component** controls a patch of screen real estate (view)
- Examples of views controlled by components
  - the shell at the application root with navigation links
  - the list of projects
  - the project form
- The view is defined using HTML in a template
- Component's application logic - what it does to support the view
  - defined in a class
  - the class interacts with the view through an API of properties and methods


acme co
HOME
PROJECTS
AppComponent
ProjectsContainerComponent
Projects
ProjectListComponent
ProjectCardComponent
Johnson - Kutch
Fully-configurable intermediate framework. Ullam occaecati l...
Budget : $54,637
Edit
Project Name
Wisozk Group
Project Description
Centralized interactive application.
ProjectFormComponent
Project Budget
91638
Active?
Save
cancel
ProjectCardComponent
Denesik LLC
Re-contextualized dynamic moratorium. Aut nulla soluta numqu...
Budget : $29,730
Edit
ProjectCardComponent
Crona Inc
Monitored explicit methodology. Rem quos maxime amet autem b...
Budget : $31,350
Edit
ProjectCardComponent
Breitenberg - Mitchell
Profound upward-trending product. Neque necessitatibus quia ...
Budget : $67,030
Edit
ProjectCardComponent
Christiansen LLC
Customer-focused composite implementation. Rerum ullam est v...
Budget : $98,600
Edit



index.html

```
<html>
<body>
 <app-root>
   <my-list>
     <div *ngFor="let item of items">
       <my-item>
         <div class="list-item">
           <img src="..." alt="item name">
           <h3>Item Name</h3>
           <p>Item Description</p>
         </div>
       </my-item>
       <my-form>
         <div class="form">
           <form>
             <label>Item Name</label>
             <input type="text" name="item-name">
             <label>Item Description</label>
             <input type="text" name="item-description">
             <button>Save</button>
           </form>
         </div>
       </my-form>
     </div>
   </my-list>
 </app-root>
</body>
</html>
```

app.component.html

list.component.html

item.component.html

form.component.html

Demo: Component Basics

Instructor Only Demonstration

code\demos\component-first

code\demos\component-nesting

Modules

Angular

NgModule

ES Modules vs Angular Modules

JavaScript (ES) Modules

- ES6 modules represent a single file
- JavaScript modules are needed to:
  - to structure our applications (we cannot use a single file)
  - to avoid leaking code to the global namespace and thus to avoid naming collisions
  - to encapsulate code; to hide implementation details and control what gets exposed to the “outside”
  - to manage dependencies
  - to reuse code

Angular Modules

- Angular Modules are an Angular specific construct used to
- Logically group different Angular artifacts such as components, services, pipes, and directive
- Provide metadata to the Angular compiler which in turn can better “reason about our application” structure and thus introduce optimizations
- Lazy load code

Angular Module (NgModule)

- Organizes Angular code
- Logically groups different Angular framework artifacts such as components, services, pipes, and directive
- Similar to packages in Java
- Similar to namespaces in .NET
- Except Angular Modules are not organizing language constructs, but instead framework constructs

Declarations

```
@NgModule({
    declarations: [
     ProjectsContainerComponent,
     ProjectListComponent,
     ProjectCardComponent,
     ProjectFormComponent,
     ValidationErrorsComponent,
     TruncateStringPipe
    ]
})
export class ProjectsModule {}
```

If **used** in the **template** of any component listed in this module then they must be listed in **declarations**.

Angular has it's own HTML compiler. It turns Angular HTML templates into JavaScript code that generates dynamic HTML.

The compiler looks for Angular components, directives, and pipes in a template and associates them with your code.

Demo: Module Declarations

Instructor Only Demonstration

code\demos\module-declarations

Feature

- Chunk of functionality that delivers business value
- Realized by some number of user stories
- Often the same as a:
  - Table in the database
  - Entity in your domain model

Feature Modules

- Feature modules are NgModules for the purpose of organizing code
- You can organize code relevant for a specific feature
- Helps with collaboration between developers and teams, separating directives, and managing the size of the root module
- A feature module is an organizational best practice, as opposed to a concept of the core Angular API
- A feature module delivers a cohesive set of functionality focused on a specific application need such as a user workflow, routing, or forms
- Collaborates with the root module and with other modules through the services it provides and the components, directives, and pipes that it share

Feature Module Example

```
@NgModule({
    imports: [
     ReactiveFormsModule,
     CommonModule,
     SharedModule,
     ProjectsRoutingModule
    ],
    declarations: [
     ProjectsContainerComponent,
     ProjectListComponent,
     ProjectCardComponent,
     ProjectFormComponent,
     ValidationErrorsComponent
    ]
})
export class ProjectsModule {}
```

Imports are always modules and are always named with a Module suffix.

These modules can be parts of the Angular framework, your app's reusable code, or your app's other features or routing modules.

If used in the template of any component listed in this module then they must be listed in declarations.

Application Structure

- LIFT
  - **L**ocate code quickly
  - **I**dentify the code at a glance
  - Keep the **F**lattest structure you can
  - **T**ry to be DRY
    - Avoid being so DRY that you sacrifice readability
- *Folders-by-feature*
  - Do create folders named for the feature area they represent.

```
<project root>
  src
    app
      core
        core.module.ts
        exception.service.ts|spec.ts
        user-profile.service.ts|spec.ts
      heroes
        hero
          hero.component.ts|html|css|spec.ts
        hero-list
          hero-list.component.ts|html|css|spec.ts
        shared
          hero-button.component.ts|html|css|spec.ts
          hero.model.ts
          hero.service.ts|spec.ts
        heroes.component.ts|html|css|spec.ts
        heroes.module.ts
        heroes-routing.module.ts
      shared
        shared.module.ts
        init-caps.pipe.ts|spec.ts
        text-filter.component.ts|spec.ts
        text-filter.service.ts|spec.ts
      villains
        villain
          ...
        villain-list
          ...
        shared
          ...
        villains.component.ts|html|css|spec.ts
        villains.module.ts
        villains-routing.module.ts
      app.component.ts|html|css|spec.ts
      app.module.ts
      app-routing.module.ts
    main.ts
    index.html
    ...
  node_modules/...
  ...
```

Demo: Module Imports & Exports

Instructor Only Demonstration

code\demos\module-imports-exports

Root Module vs Feature Modules

- Every Angular app has at least one module, the *root module*, conventionally named AppModule.
- While the *root module* may be the only module in a small application, most apps have many more *feature modules*.
  - A feature module is a cohesive block of code dedicated to an application domain, a workflow, or a closely related set of capabilities.
- An Angular module, whether a *root* or *feature*, is a class with an @NgModule decorator.

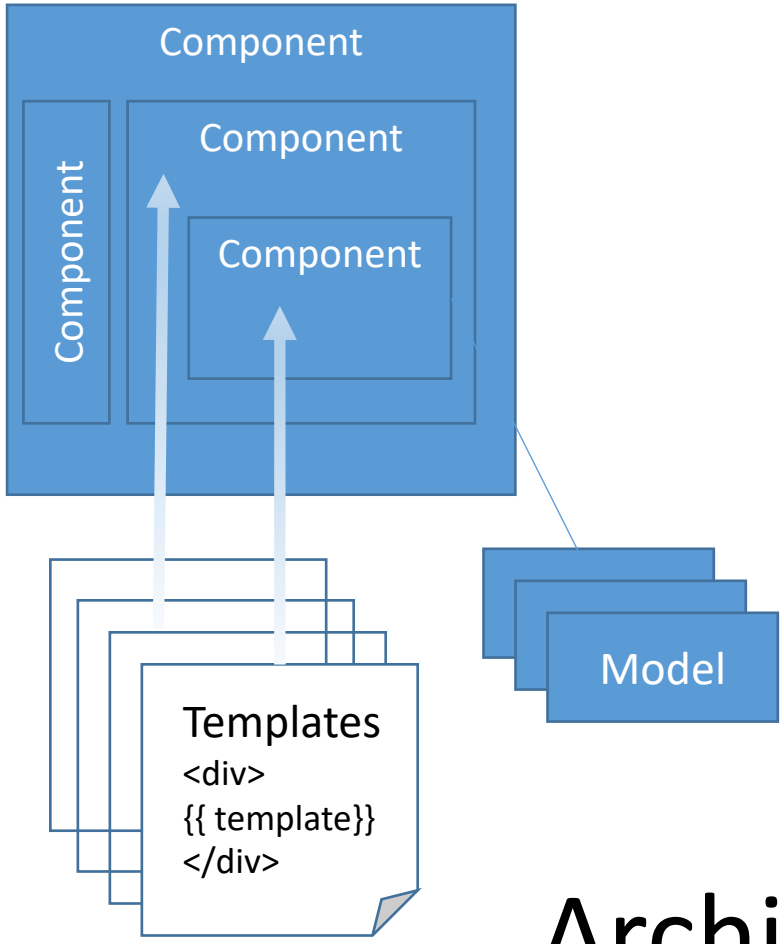
Models

CLIENT
- Front-end
- JavaScript in browser

NETWORK
(HTTP)

SERVER
- Back-end
- Web/Application server

Angular



Architecture Diagram: Models

Models

are just classes

```
export class Project {
    constructor(
    public id: number,
    public name: string,
    public description: string,
    public imageUrl: string,
    public contractTypeId: number,
    public contractSignedOn: Date,
    public budget: number,
    public isActive: boolean,
    ) {}
}
```

Models

constructor overloads

```
export class Project {
    id: number;
    name: string;
    description: string;
    isActive: boolean;
    contractSignedOn: Date;
    budget: number;

    constructor(obj?: any) {
        this.id = (obj && obj.id) || null;
        this.name = (obj && obj.name) || null;
        this.description = (obj && obj.description) || null;
        this.contractTypeId = (obj && obj.contractTypId) || null;
        this.isActive = (obj && obj.isActive) || false;
        this.contractSignedOn = (obj && obj.contractSignedOn) || new Date();
        this.budget = (obj && obj.budget) || 0;
    }
}

let project = new Project({ name: 'Acme Website Redesign', budget: 30000 });
```

Angular CLI: Generate Class

```
ng g class projects/shared/project --type=model
```

JSON Pipe

```
@Component({
    selector: 'json-pipe',
    template: `<div>

    <p>Without JSON pipe:</p>
    <pre>{{object}}</pre>

    <p>With JSON pipe (no pre tag):</p>
    <p>{{object | json}}</p>

    <p>With JSON pipe (and pre tag):</p>
    <pre>{{object | json}}</pre>

    </div>`,
})
export class JsonPipeComponent {
...
}
```

ngFor

```
@Component({
    selector: 'app-ng-for-demo',
    template: `
        <ul>
            <li *ngFor="let fruit of fruits">
                {{fruit}}
            </li>
        </ul>
    `,
})
export class NgForComponent {
        fruits : string[] = ['Apple', 'Orange', 'Plum'];
}
```

Start with *

of
not
in

Demo: ngFor

Instructor Only Demonstration

code\demos\ngFor

Lab

Lab 4: Your First Component

Lab 5: Creating Data Structures (Models)

Attendees Hands-On

Data Binding

Angular

Data Binding

Four forms (types)

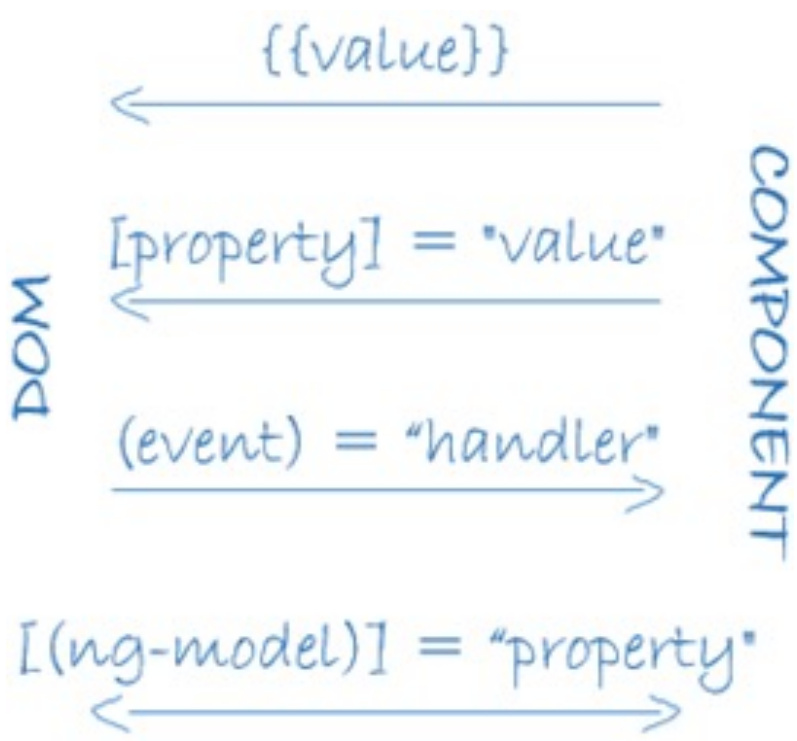


Image from angular.io

- **Interpolation**
- Property binding
- Event binding
- Two-way data binding

Interpolation

```
@Component({
    selector: 'app-root',
    template: `
    <h2>{{image.name}}</h2>
    <p>{{image.path}} </p>
    `,
    styles: []
})
export class AppComponent {
    image = {
        path: '../assets/angular_solidBlack.png',
        name: 'Angular Logo'
    };
}
```

Data Binding

Four forms (types)

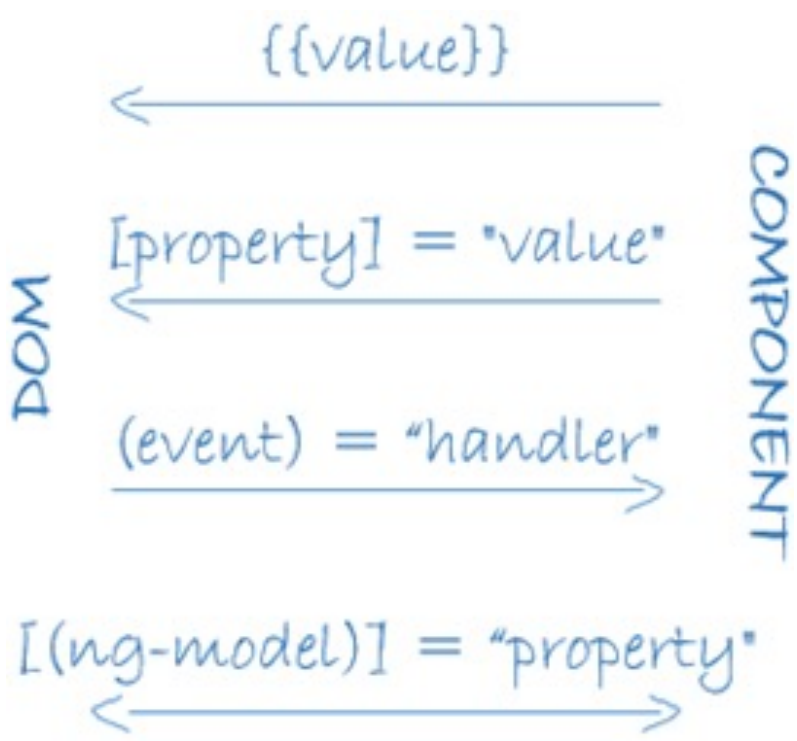


Image from angular.io

- Interpolation
- **Property binding**
- Event binding
- Two-way data binding

Property Binding

```
import { Component } from '@angular/core';

@Component({
    selector: 'app-root',
    template: `
    <img [src]="image.path" [title]="image.name"
        [alt]="image.name">
    `,
})
export class AppComponent {
    image = {
        path: '../../assets/angularlogo.png',
        name: 'Angular Logo',
    };
}
```

Demo: Data Binding

Interpolation & Property Binding

Instructor Only Demonstration

code\demos\interpolation

code\demos\property-binding

Input Property

- @Input
  - Decorator that marks a class field as an input property
- Property Binding to a Component Property

```
@Component({
    selector: 'app-root',
    template: `
    <app-fruit-list [fruits]="data"></app-fruit-list>
    `,
    styles: []
})
export class AppComponent {
  data: string[] = ['Apple', 'Orange', 'Plum'];
}
```

Demo: Input Property

Instructor Only Demonstration

code\demos\input-property

Labs

Lab 6: Passing Data into a Component

Lab 7: Looping Over Data

Attendees Hands-On

Data Binding

Four forms (types)

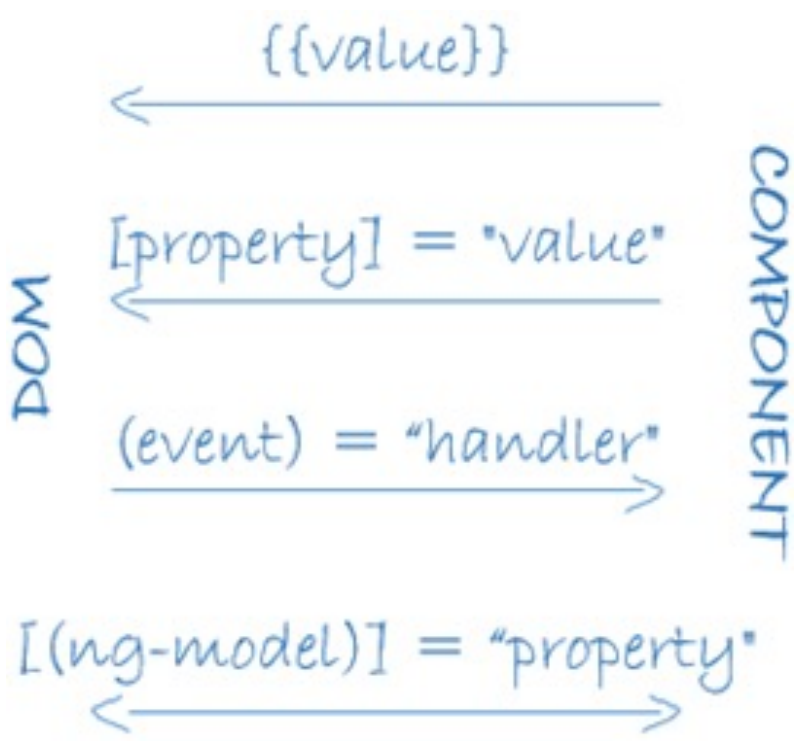


Image from angular.io

- Interpolation
- Property binding
- **Event binding**
- Two-way data binding

Event Binding

```
@Component({
    selector: 'app-event-binding-demo',
    template: `
    <a href="/event-binding" (click)="onClick($event)">Click Me!</a>
    <p [innerText]="message"></p>
    `,
})
export class EventBindingComponent {
    message = '';

    onClick(event) {
        event.preventDefault();
        this.message = 'clicked';
    }
}
```

$event is template variable available in Angular

Can use any standard browser event.

https://developer.mozilla.org/en-US/docs/Web/Events#Standard_events

Prevents the default browser behavior for that element.

https://developer.mozilla.org/en-US/docs/Web/API/Event/preventDefault

Demo: Event Binding

Instructor Only Demonstration

code\demos\event-binding

Pipes

Angular

CLIENT

- Front-end
- JavaScript in browser

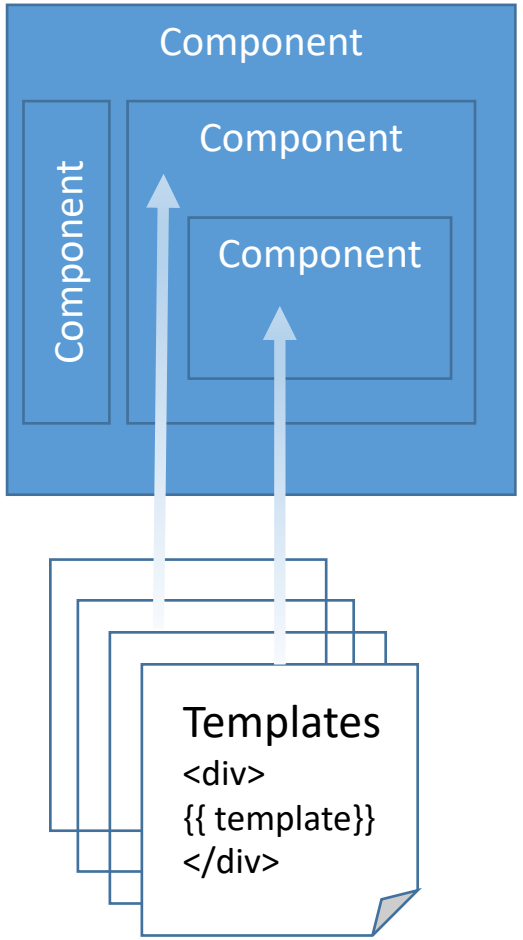
NETWORK

(HTTP)

SERVER

- Back-end
- Web/Application server

Angular



Architecture Diagram: Templates

What are Pipes?

- A pipe takes in data as input and transforms it to a desired output
- Commonly used to format data
- Get their name from the pipe operator “|”
- Can format various types: String, Number, Data, Array

Using Pipes

- Pipes can be used
  - In HTML templates
  - In JavaScript (often in components)
- Pipes can be
  - Built-in to Angular
  - Custom pipes created by application developers
    - Custom pipes can be used to implement any type of formatting

Changes from AngularJS

- Filters in AngularJS are Pipes in Angular
- The “filter” filter is not built-in Angular
  - Was used to filter out arrays based on a search term
- The “orderBy” filter is not built-in to Angular
  - Was used to sort array elements for display
- ”filter” and “orderBy”
  - Prone to breaking if code was minified
  - Could lead to performance issues
  - Replacements can be implemented as a custom filter

Using a Built-in Pipe

```
<h4>{{project.name | uppercase}}</h4>
```

Common Built-In Pipes

Class	Name
PercentPipe	percent
UpperCasePipe	uppercase
LowerCasePipe	lowercase
TitleCasePipe	titlecase
DatePipe	date
DecimalPipe	decimal
CurrencyPipe	currency

Pipe Syntax

- Syntax

{{data-expression | pipe-name [:pipe-parameter: pipe-parameter-2…]}}

- Example

releaseDate: Date(1977, 5, 25);

{{releaseDate| date: ”M-dd-yyyy”}}

Chaining Pipes

- Chained pipes are executed from left to right

  {{ releaseDate| date | uppercase}}
- The *releaseDate* property is converted to a date string
- The date string is then converted to uppercase

Decimal Pipe

- Takes a number as input
- And a *digitInfo* string defining the number format {minIntegerDigits}.{minFractionDigits}-{maxFractionDigits}
- Example
  - Usage: {{47.243 | number: “3.2-4”}}
  - Output: 047.243

CurrencyPipe

- Use currency to format a number as currency.
- Takes a number and up to three parameters
  - *currencyCode* is the ISO 4217 currency code, such as USD for the US dollar and EUR for the euro.
  - *display* indicates whether to use the currency symbol or code.
    - code: use code (e.g. USD).
    - symbol(default): use symbol (e.g. $).
    - symbol-narrow: some countries have two symbols for their currency, one regular and one narrow (e.g. the canadian dollar CAD has the symbol CA$ and the symbol-narrow $).
    - boolean (deprecated from v5): true for symbol and false for code If there is no narrow symbol for the chosen currency, the regular symbol will be used.
  - *digitInfo* defining the number format:
    - ”{minIntegerDigits}.{minFractionDigits}-{maxFractionDigits}”
  - Example:
    - Usage: {{47.341| currency: 'USD': '2.1-2'}}
    - Output: $47.34

Demo: Pipes

Instructor Only Demonstration

code\demos\pipes

How to Structure an Application

1. Components
   - If a component gets too complex split it into smaller components
2. After you create more components, more questions arise
   - What types of components are there?
   - How should components interact?
   - Should I inject services into any component?
   - How do I make my components reusable across views?

Component Architecture

Smart/Container Components

- Are concerned with *how things work*
- *Sets data* into child component input properties
- *Receives events* by subscribing to children
- *Loads and modifies data* via calls to an API
- Also know as *container* components or *controller* components

Presentation Components

- Are concerned with *how things look*
- *Receive data* via input properties from parent
- *Send events* with information to their parent
- Don’t specify how the data is loaded or changed
- Also know as *pure* components or *dumb* components

When to Create Another Component

- Is it possible for your code chunk to be reused?
  - If yes, construction of a new component seems like a great idea.
  - Even if the reuse is within a single component.
- Is your code quite complex?
  - If yes maybe its good idea to split in separate components in order to make your code more readable and maintainable.

Custom Events in a Component

- @Output
  - Decorator that marks a class property as sending a custom output event
- EventEmitter
  - Class used in directives and components to emit custom events synchronously or asynchronously, and register handlers for those events by subscribing to an instance

Demo: Output Events

Instructor Only Demonstration

code\demos\output-events

Component Styles

- Angular applications are styled with regular CSS
- Angular has the ability to bundle *component styles* with our components
  - enables a more modular design than regular stylesheets

Component Styles

demos/components/styling-external.ts

External Styles

```
@Component({
    selector: 'styling-external',
    template: '<h1>Styling Components: External</h1>',
    styleUrls: ['./styling-external.css'],
})
export class StylingExternalComponent {}
```

Reference external style sheet.

demos/components/styling-external.css

```
h1 {
color: rgb(255, 165, 0);
}
```

Use CSS to style your template.

By default these styles will be local to this component and not affect the rest of the page (ViewEncapsulation.Emulated).

Component Styles

View Encapsulation

- Component CSS styles are *encapsulated* into the component's own view and do not affect the rest of the application (when using the default)
- We can control how this encapsulation happens on a *per component* basis by setting the *view encapsulation mode* in the component metadata
- There are three modes to choose from
  - Emulated (default)
  - ShadowDom (uses Shadow DOM)
  - None

Component Styles

Emulated View Encapsulation

```
▼<app-project-card _ngcontent-c2 _nghost-c3 ng-reflect-project="[object Object]">
  ▼<div _ngcontent-c3 class="card">
     <img _ngcontent-c3 src="assets/placeimg_500_300_arch4.jpg" alt="Dusty Epsilon">
   ▼<section _ngcontent-c3 class="section dark">
     ▼<h5 _ngcontent-c3 class="strong"> == $0
        <strong _ngcontent-c3>Dusty Epsilon</strong>
      </h5>
     ▶<p _ngcontent-c3>…</p>
      <p _ngcontent-c3>Budget : $42,400</p>
     ▶<button _ngcontent-c3 class=" bordered">…</button>
     </section>
   </div>
 </app-project-card>
```

```
Filter
element.style {
}
h5[_ngcontent-c3] {
   color: #2552b5;
}
h5 {
   font-size: 1rem;
}
h1, h2, h3, h4, h5, h6 {
☑ line-height: 1.2;
☑ margin: calc(1.5 * var
```

Demo: Component Styles

Instructor Only Demonstration

code\demos\component-styles

Labs

Lab 8: Formatting Data for Display

Lab 9: More Reusable Components

Lab 10: Responding to an Event

Lab 11: Create a Form to Edit Your Data

Lab 12: Communicating from Child to Parent Component

Attendees Hands-On Together

Directives

Built-In to Angular

CLIENT

- Front-end
- JavaScript in browser

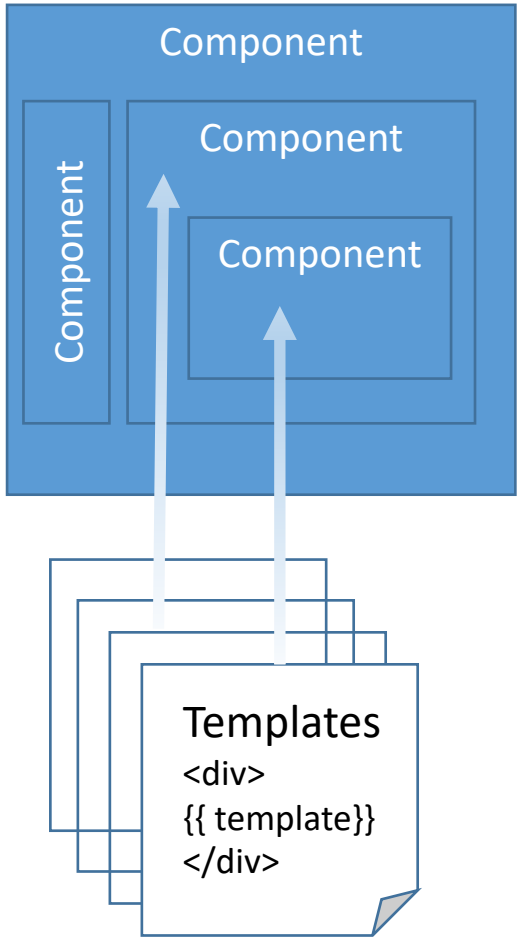
NETWORK

(HTTP)

SERVER

- Back-end
- Web/Application server

Angular



Architecture Diagram: Templates

What is a Directive?

- Angular transforms the DOM according to the instructions given by **directives**
- A directive is a class with directive metadata.
  - In TypeScript, we apply the @Directive decorator to attach metadata to the class

Kinds of Directives

- Component
  - A **component** is a *directive-with-a-template*
- Structural
  - **Structural** directives alter layout by adding, removing, and replacing elements in DOM
- Attribute
  - **Attribute** directives alter the appearance or behavior of an existing element

Structural Directives

- **Structural** directives alter layout by adding, removing, and replacing elements in DOM
  - ngIf
  - ngFor
  - ngSwitch

ngIf

- Takes a boolean and makes an entire chunk of DOM appear or disappear

```
<p *ngIf="condition">
    condition is true and ngIf is true.
</p>

<p *ngIf="!condition">
    condition is false and ngIf is false.
</p>
```

Demo: ngIf

Instructor Only Demonstration

code\demos\ngIf

Labs

Lab 13: Hiding and Showing Components

Lab 14: Preventing a Page Refresh

Lab 15: More Component Communication *(**optional**, do only if you are finishing labs early and want extra practice, similar to Lab 12)*

Attendees Hands-On Together

Understand How Structural Directives Work

```
<!-- Examples (A) and (B) are the same -->

<!-- (A) *ngIf paragraph -->
<p *ngIf="condition">
    Our heroes are true!
</p>
```

```
<!-- (B) [ngIf] with template -->
<ng-template [ngIf]="condition">
    <p>
        Our heroes are true!
    </p>
</ng-template>
```

NgSwitch

```
@Component({
  selector: 'my-app',
  template: `
  <div class="container">
  <button (click)="value=1">select - 1</button>
  <button (click)="value=2">select - 2</button>
  <button (click)="value=3">select - 3</button>
  <h5>You selected : {{value}}</h5>

  <hr>
  <div [ngSwitch]="value">

     <div *ngSwitchCase="1">1. Template - <b>{{value}}</b> </div>
     <div *ngSwitchCase="2">2. Template - <b>{{value}}</b> </div>
     <div *ngSwitchCase="3">3. Template - <b>{{value}}</b> </div>
     <div *ngSwitchDefault>Default Template</div>

  </div>
  </div>
   `
})
export class AppComponent {
        value: number;
}
```

Demo: ngSwitch

Instructor Only Demonstration

code\demos\ngSwitch

Forms

Reactive Forms

Benefits of Forms

- Forms are the mainstay of business applications
  - Login
  - Place an Order
  - Book a Flight
  - Schedule a Meeting

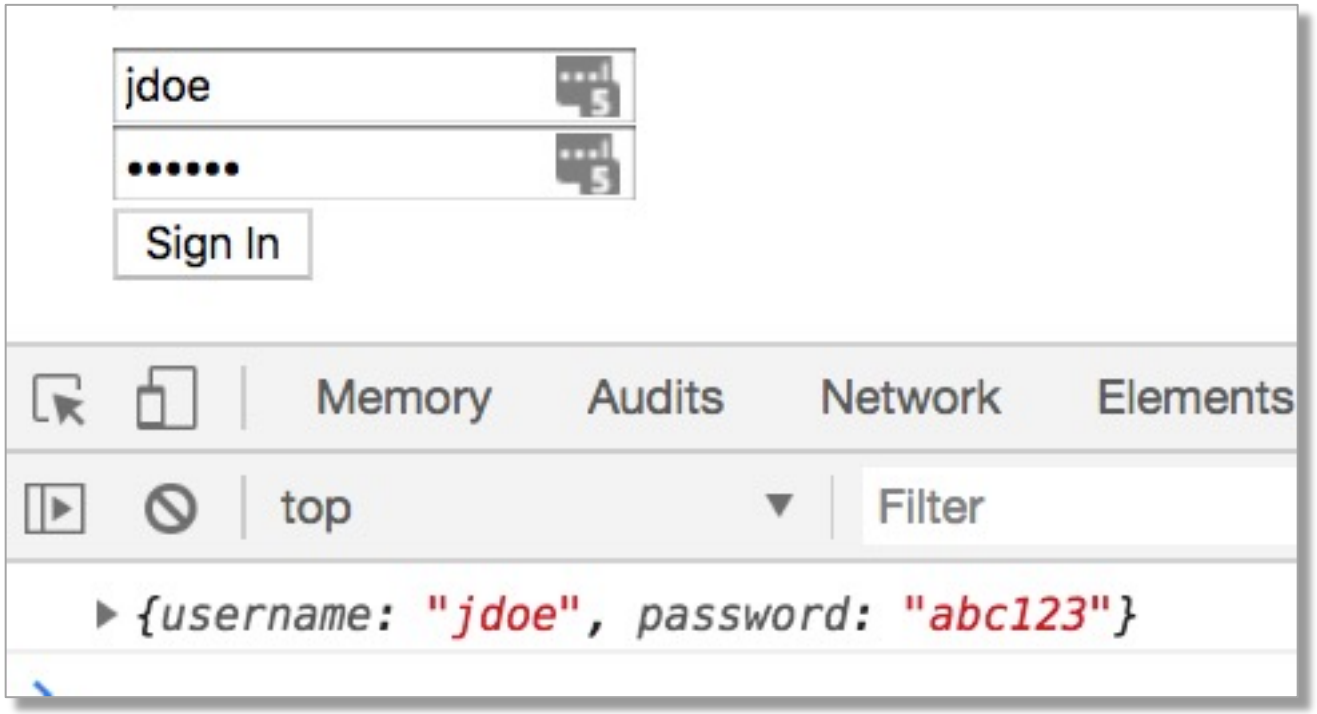
Form Strategies

Template-driven

- AngularJS style
- FormsModule
- Use the core ng prefix
- Declarative in the template

Model-driven (new)

- Reactive programming
- ReactiveFormsModule
- Use the form prefix
- Configured in component code
- Enables dynamic forms
- Facilitates unit testing



Demo: Reactive Forms Binding

Instructor Only Demonstration

code\demos\reactive-forms-binding

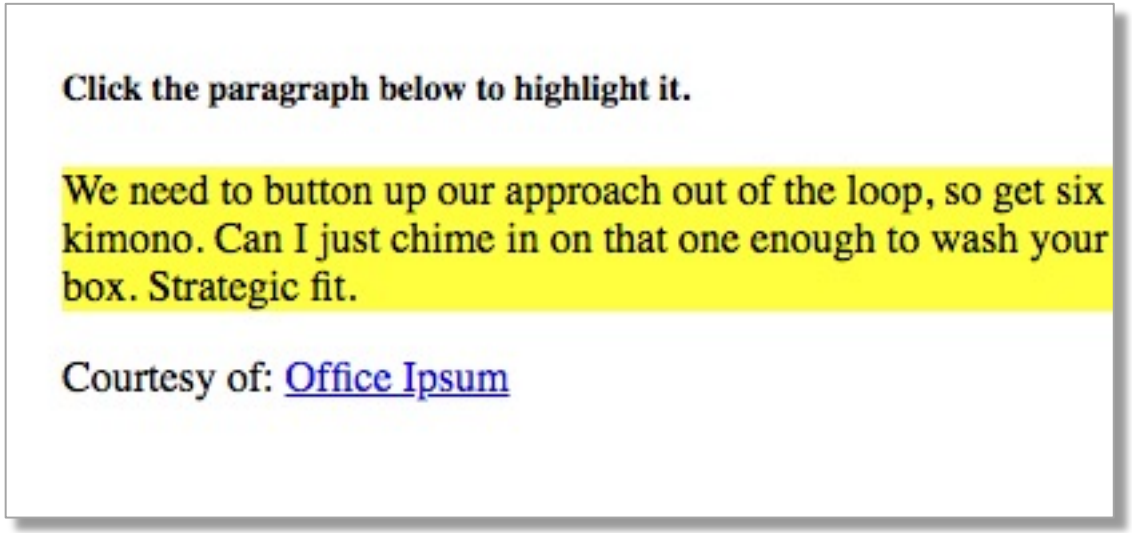
Labs

Lab 16: Forms | Binding

Demo: Reactive Forms Validation

Instructor Only Demonstration

code\demos\reactive-forms-validation



Dynamically adds or removes CSS classes.

Demo: ngClass

Instructor Only Demonstration

code\demos\ngClass

Labs

Lab 16: Forms | Binding

Lab 17: Forms | Saving

Lab 18: Forms | Validation

Attendees Hands-On

Lab 19: Forms | Refactor (Instructor Walkthrough)

Services

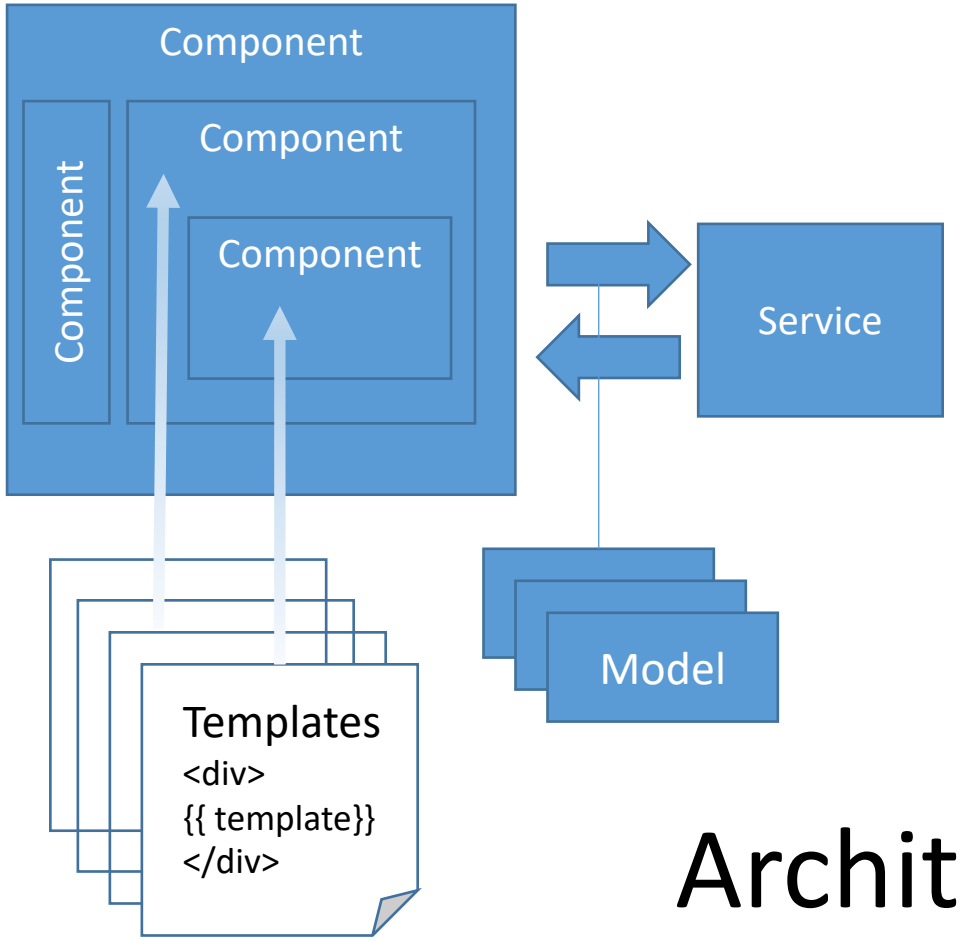
Angular

CLIENT
- Front-end
- JavaScript in browser

NETWORK
(HTTP)

SERVER
- Back-end
- Web/Application server

Angular



Architecture Diagram: Services

What is a Service?

- *Service* is a broad category, almost anything can be a service
- A service is typically a class with a narrow, well-defined purpose
- It should do something specific and do it well

Service Compared to Component

- By separating a component's view-related functionality from other kinds of processing, you can make your component classes lean and efficient.
- Ideally, a component's job is to enable the user experience and nothing more.
- A component can delegate certain tasks to services, such as fetching data from the server, validating user input, or logging directly to the console. By defining such processing tasks in an *injectable service class*, you make those tasks available to any component.

Data Service

project.service.ts

```
import { Injectable } from '@angular/core';
import { Observable, of } from 'rxjs';
import { Project } from './project.model';
import { PROJECTS } from './mock-projects';

@Injectable({
  providedIn: 'root'
})
export class ProjectService {

  constructor() { }

  list(): Observable<Project[]>
     return of(PROJECTS);
  }
}
```

Provides this service in the root module's injector.
We cover dependency injection and injectors in the next section.

The RxJS **of** method creates an **Observable** which (like a Promise) allows us to easily work with Asynchronous operations like AJAX calls

Using a Data Service in a Component

projects-conainter.component.ts

```
export class ProjectsContainerComponent implements OnInit {
    projects: Project[] = [];

    constructor(private projectService: ProjectService) {}

    ngOnInit() {
        this.projectService.list()
            .subscribe(data => {
                this.projects = data;
            });
    }

}
```

OnInit is an **interface** that has one method **ngOnInit** which is a component lifecyle event

Tell Angular you need an instance of the service and the framework will **Inject** it into the constructor.

The **list** method returns an RxJS **Observable.** We **subscribe** to the **Observable** and when it has data it will call the arrow function we passed as an argument.

Demo: Services

Instructor Only Demonstration

code\demos\services

Labs

Lab 20: Services

Attendees Hands-On

Start from Lab 18 or 19 solution

Dependency Injection

Angular

Dependency Injection

explained

- Imagine you are not allowed to use the new keyword and create instances of other objects (dependencies) you need when writing code
- Dependency Injection is a practice where objects are designed in a manner where they receive instances of the objects from other pieces of code, instead of constructing them internally
- This means that any object implementing the interface which is required by the object can be substituted in without changing the code, which simplifies testing, and improves decoupling

Dependency Injection

example

```
//no DI
class CustomersComponent{
    private customerService = new CustomerDataAccessService ();
}
```

```
//using DI
class CustomersComponent{
 private customerService : CustomerDataAccessService;

    constructor(customerService : CustomerDataAccessService){
        this.customerService = customerService;
    }
}
```

Dependency Injection Frameworks

- Java
  - Spring, Guice
- .NET
  - Ninject, Structure Map, Unity, Spring.NET, .NET Core (built-in)
- Angular
  - Dependency Injection is built-in

Providing Services in the Root Module Injector

project.service.ts

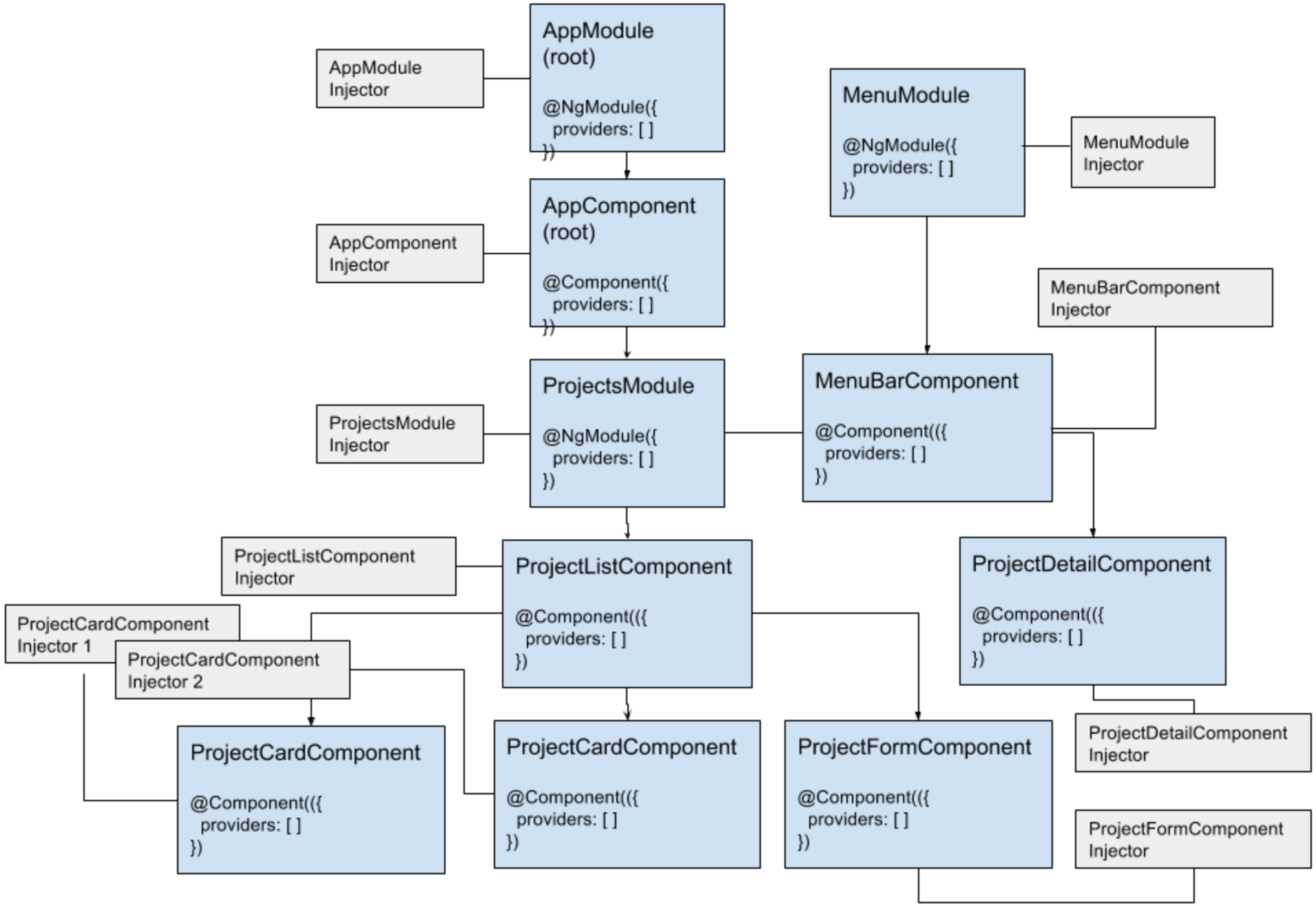
```
import { Injectable } from '@angular/core';
import { Observable, of } from 'rxjs';

import { Project } from './project.model';
import { PROJECTS } from './mock-projects';


@Injectable({
  providedIn: 'root'
})
export class ProjectService {
  list(): Observable<Project[]> {
    return of(PROJECTS);
  }
}
```

Provides this service in the **root** injector (**Singleton**)

RxJS **of** method creates an Observable



Hierarchical Dependency Injectors

Providing Services in a Feature Module Injector

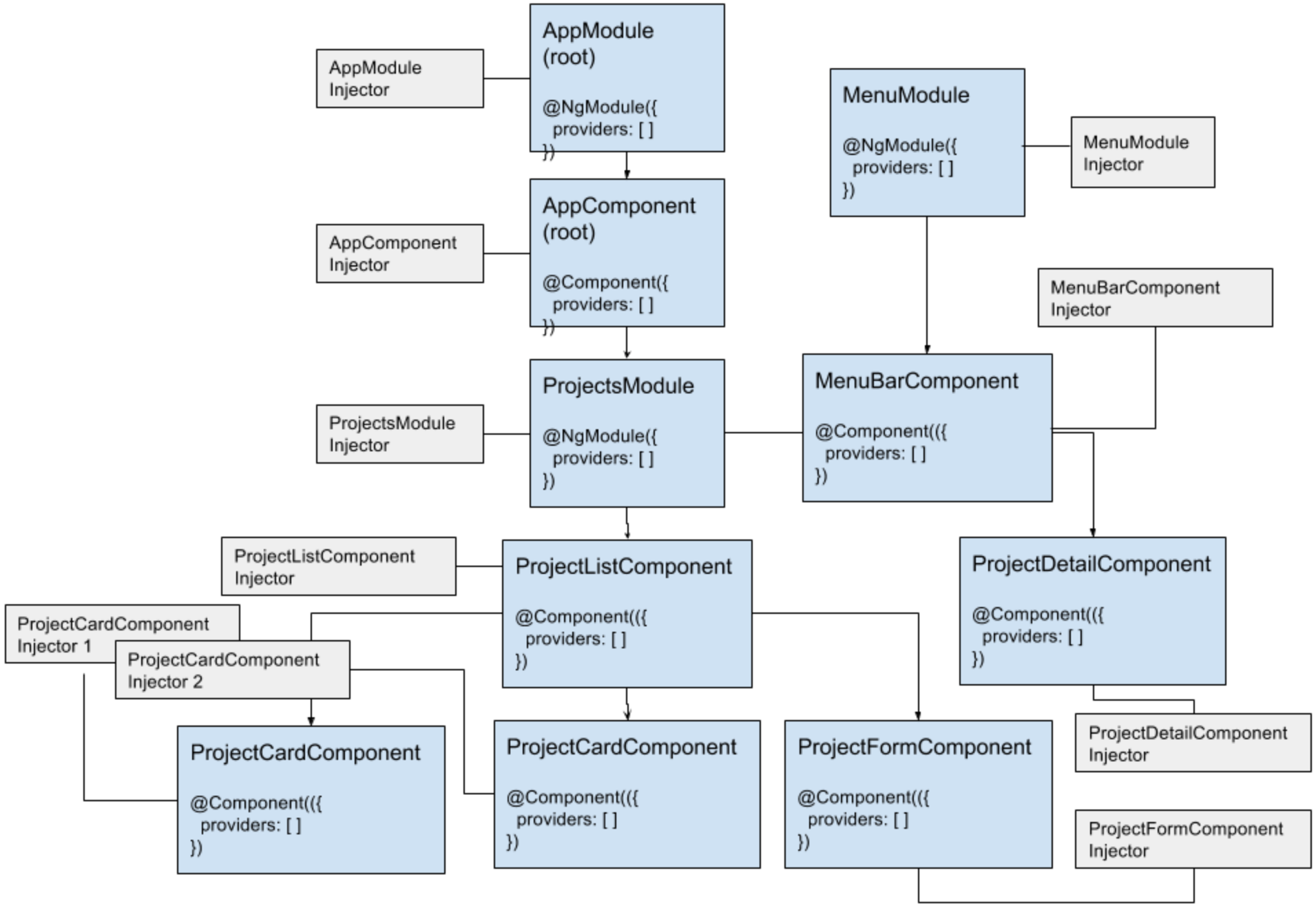
project.service.ts

```
import { Injectable } from '@angular/core';
import { Observable, of } from 'rxjs';

import { Project } from './project.model';
import { PROJECTS } from './mock-projects';


@Injectable({
  providedIn: ProjectsModule
})
export class ProjectService {
  list(): Observable<Project[]> {
    return of(PROJECTS);
  }
}
```

Provides this service in the **ProjectsModule** injector



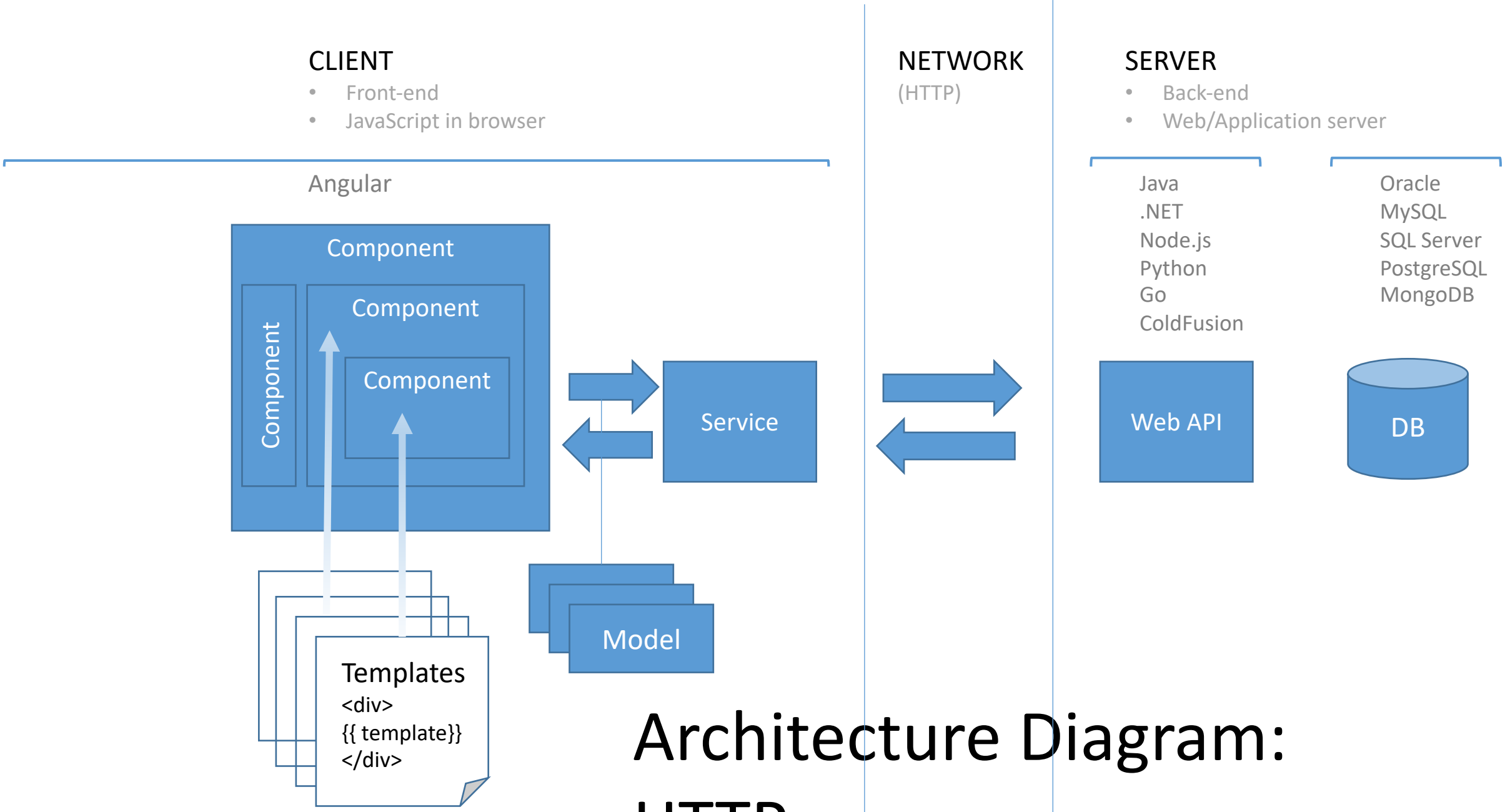
Hierarchical Dependency Injectors

Service Registration Best Practices

- Provide services in the Service itself (providedIn)
- Set **providedIn** to
  - **root** if you want the service to be a **Singleton**
  - **Feature Module** (*ProjectsModule*) if you want the service to be **lazy-loaded**
    - **Lazy Loading** requires additional steps which are covered in the Routing section of the course

Http

Angular



Architecture Diagram: HTTP

Labs

Lab 21: Setup Backend REST API (attendees with instructor)

Appendix B: Rest Review (instructor only demonstration) (optional)

HttpClient Overview

- Import HttpClientModule
- HttpClient in Services
- Observables in Components

Import HttpClientModule

```
import { HttpClientModule } from '@angular/common/http';

@NgModule({
    declarations: [AppComponent],
    imports: [BrowserModule, AppRoutingModule,
              ProjectsModule, HttpClientModule],
    providers: [],
    bootstrap: [AppComponent]
})
export class AppModule {}
```

HttpClient in Services

```
import { HttpClient } from '@angular/common/http';
import { environment } from '../../../environments/environment';


...
export class ProjectService {
  private projectsUrl = environment.backendUrl + '/projects/';

  constructor(private http: HttpClient) {}

  list(): Observable<Project[]> {
    return this.http.get<Project[]>(this.projectsUrl);
  }
}
```

Observables in Components

```
...
export class ProjectsContainerComponent implements OnInit {
  projects: Project[] = [];
  errorMessage: string = '';

  constructor(private projectService: ProjectService) {}
  ngOnInit() {
    this.projectService.list().subscribe(
      data ⇒ {
        this.projects = data;
      }
    );
  }
   ...
}
```

Demos: Http Get

Instructor Only Demonstration

code\demos\http-get

Error Handling in Services

```
import { Observable, of, throwError } from 'rxjs';
import { catchError } from 'rxjs/operators';
import { HttpClient, HttpErrorResponse } from '@angular/common/http';

...
export class ProjectService {
...
  list(): Observable<Project[]> {

    return this.http.get<Project[]>(this.projectsUrl).pipe(
      catchError((error: HttpErrorResponse) => {
        console.log(error);
        return throwError('An error occurred loading the projects.');
      })
    );

  }
}
```

Error Handling in Components

```
...
export class ProjectsContainerComponent implements OnInit {
  projects: Project[] = [];
  errorMessage: string = '';

  constructor(private projectService: ProjectService) {}
  ngOnInit() {
    this.projectService.list().subscribe(
      data ⇒ {
        this.projects = data;
      },
      error ⇒ {
        this.errorMessage = error;
      }
    );
  }
   ...
}
```

Demos: Http Error Handling

Instructor Only Demonstration

code\demos\http-error-handling

Labs

Lab 22: HTTP GET

Lab 23: HTTP Error Handling

HttpClient PUT

```
...
import { HttpClient, HttpErrorResponse, HttpHeaders } from '@angular/common/http';

const httpOptions = {
  headers: new HttpHeaders({ 'Content-Type': 'application/json' })
};

export class ProjectService {
...
  put(project: Project): Observable<Project> {
    const url = this.projectsUrl + project.id;
    return this.http.put<Project>(url, project, httpOptions).pipe(
      catchError((error: HttpErrorResponse) => {
        console.log(error);
        return throwError('An error occurred updating the projects.');
      })
    );
  }
}
```

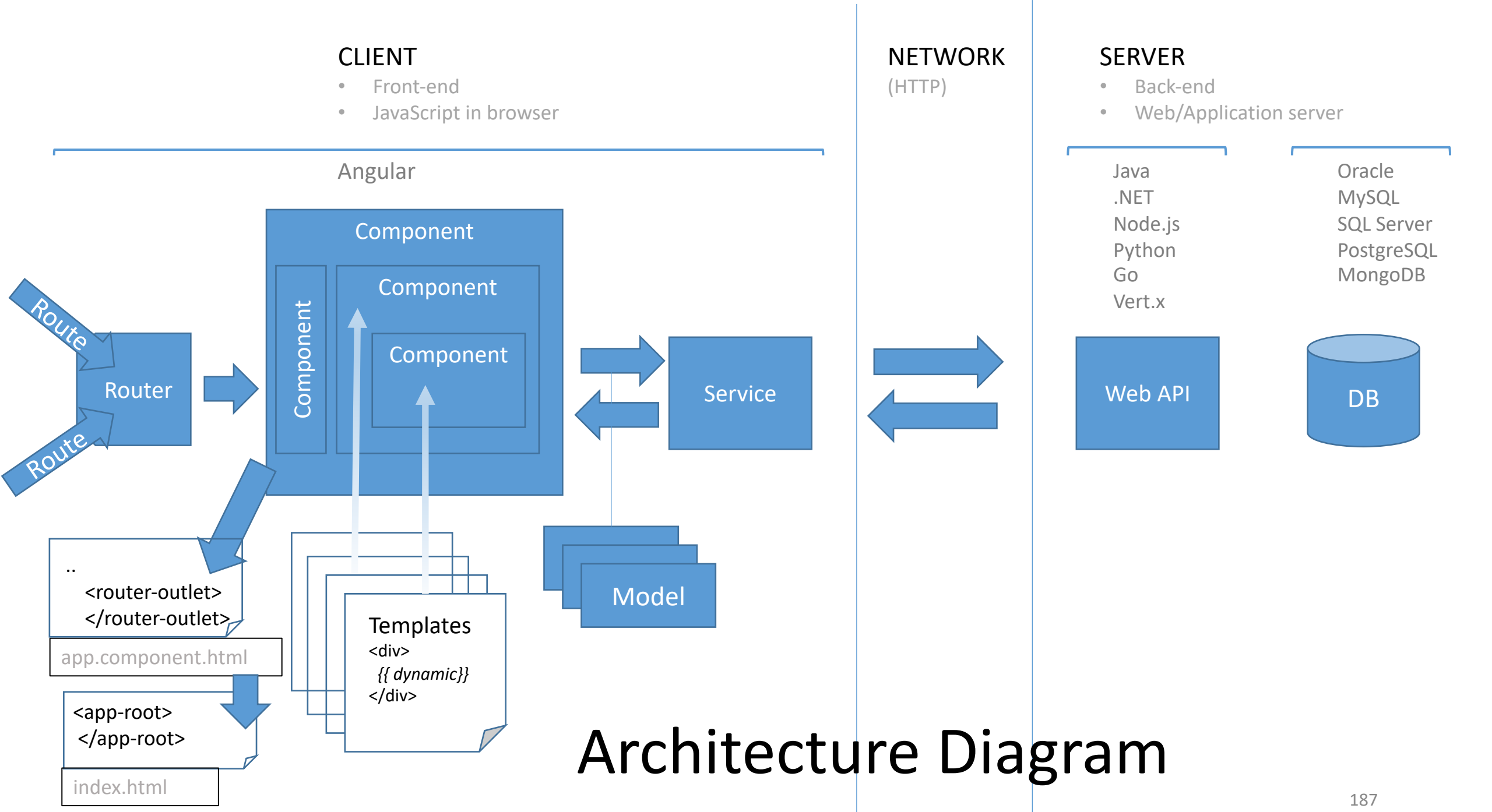
Labs

Lab 24: HTTP PUT

Lab 25: Showing a Loading Indicator (optional)

Routing & Navigation

Angular

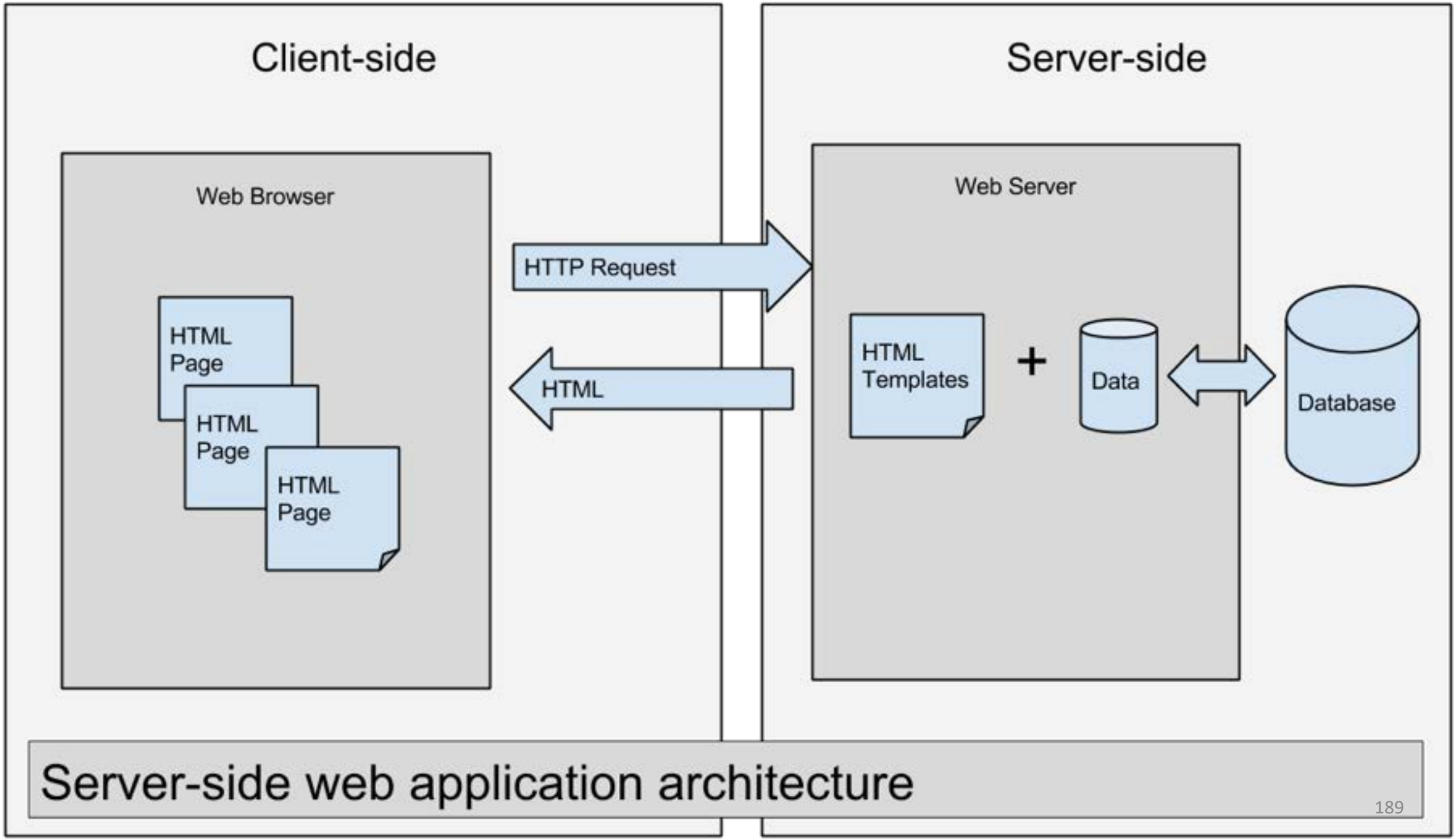

CLIENT
Front-end
JavaScript in browser
NETWORK
(HTTP)
SERVER
Back-end
Web/Application server
Angular
Java
.NET
Node.js
Python
Go
Vert.x
Oracle
MySQL
SQL Server
PostgreSQL
MongoDB
Route
Route
Router
Component
Component
Component
Component
Service
Web API
DB
Model
..
<router-outlet>
</router-outlet>
app.component.html
Templates

{{ dynamic}}

<app-root>
</app-root>
index.html
Architecture Diagram

Router Overview

- A router watches the browser's url for changes and runs the corresponding code for that url (route).
- JavaScript applications commonly break the back button in the browser. A router can fix this problem.
- Before HTML5 there was no way to write to the browser's history via JavaScript
- The HTML5 history API (also know as pushState/replaceState) enables JavaScript code to add or modify history entries
- Before HTML5 history, JavaScript applications used the **fragment** identifier introduced by a hash mark # and is the optional last part of a **URL** for a document. It is typically used to identify a portion of that document (hyperlink bookmarks).

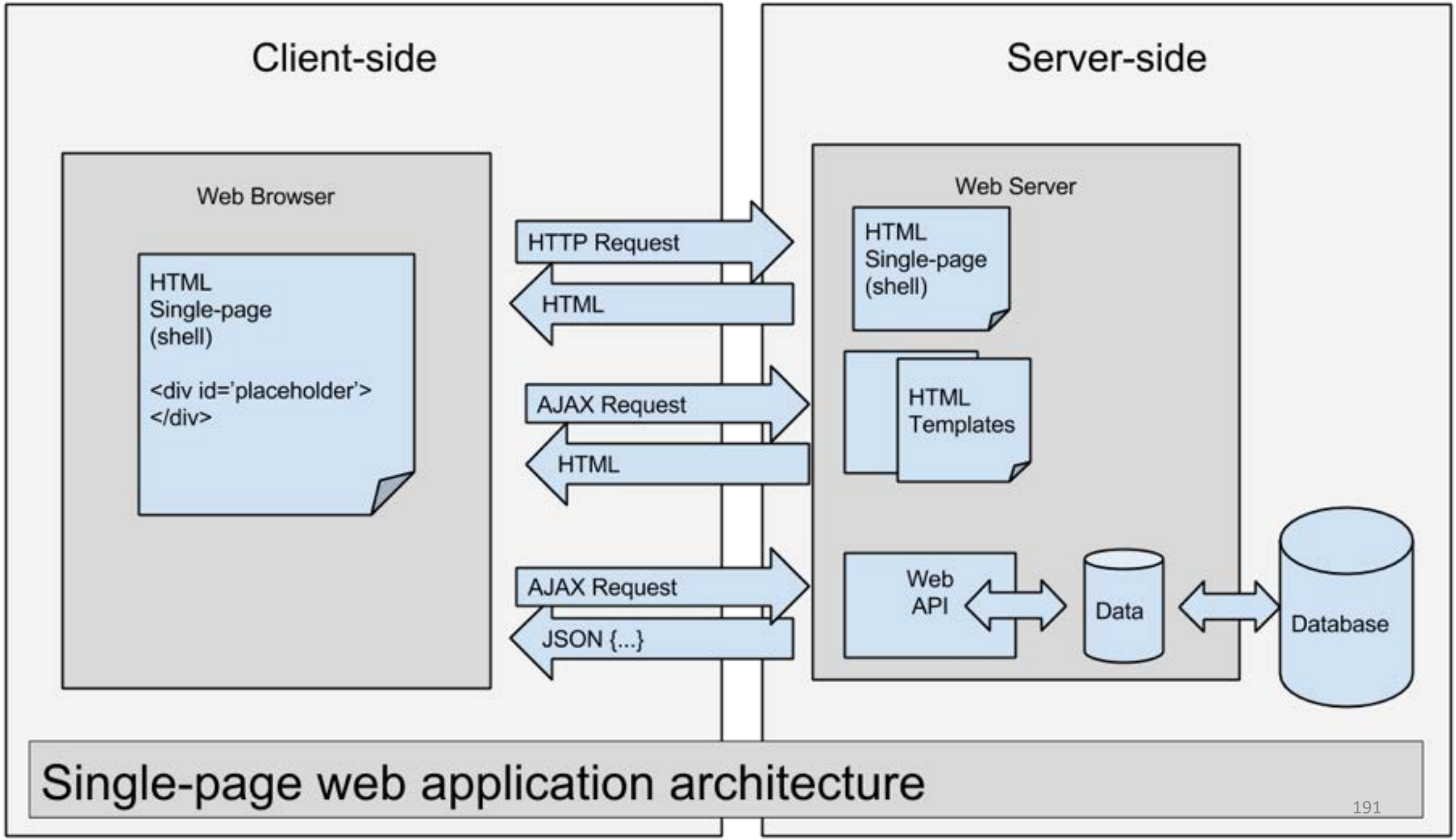


Server-side web application architecture

Component Router

Angular

- Navigates you through components and their corresponding client-side views without a page reload
- Bind the router to links on a page and it navigates to the appropriate application view when they are clicked
- Also, can navigate imperatively when the user clicks a button, selects from a drop box, or in response to some other stimulus
- Logs activity in the browser's history journal so the back and forward buttons work as expected



Single-page web application architecture

Routing Summary

- The application is provided with a configured router.
- The component has a RouterOutlet where it can display views produced by the router.
- It has RouterLinks that users can click to navigate via the router.

Router Configuration

```
import { NgModule } from '@angular/core';
import { Routes, RouterModule } from '@angular/router';
import { HomeComponent } from './home/home.component.ts'

const routes: Routes = [
  { path: 'home', component: HomeComponent }
];

@NgModule({
  imports: [RouterModule.forRoot(routes)],
  exports: [RouterModule]
})
export class AppRoutingModule { }
```

Create an array of **Route** objects. Configure the **routes** in the app.

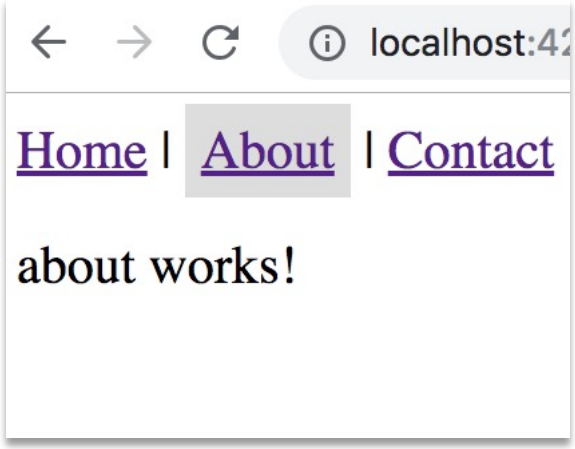
Create a **RouterModule** configured with the application routes.

The Angular CLI generates all this code except the Route objects.

Router Outlet

```
<div class="container">
  <router-outlet>
  </router-outlet>
</div>
```

Placeholder where the component configured in the **Route** object gets rendered



Demo: Routing Basics

Instructor Only Demonstration

code\demos\routing-basics

Labs

Lab 26: Router Navigation

Navigating

- Using a routerLink directive
  - Route parameters
  - Query parameters
- Navigating with Code
  - Router
  - Route parameters
  - Query parameters
- Retrieving Parameters
  - ActivatedRoute
  - Synchronous
  - Asynchronous

Route Parameters or Query Parameters?

- There is no hard-and-fast rule. In general,
  - *prefer a route parameter when*
    - the value is required.
    - the value is necessary to distinguish one route path from another.
  - *prefer a query parameter when*
    - the value is optional.
    - the value is complex and/or multi-variate.

Matrix URL Notation

- The query string parameters are not separated by "?" and "&". They are **separated by semicolons (;)**
- This is *matrix URL* notation — something we may not have seen before.
- *Matrix URL* notation is an idea first floated in a 1996 proposal by the founder of the web, Tim Berners-Lee.

Demo: Routing Navigation

Instructor Only Demonstration

code\demos\routing-navigation

Labs

Lab 27: Router Parameters

Build & Deploy

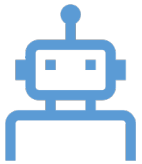
Using Angular CLI (Command-Line Interface)

Angular CLI: Builds

- Builds your application for deployment to production
  - Combining, minifying
  - Tree-shaking, dead code elimination
  - Ahead-of-time compilation
  - Remove Decorators

Ahead-of-Time (AOT) Compiler

- Angular offers two ways to compile your application:
  - *Just-in-Time* (JIT), which compiles your app in the browser at runtime
  - *Ahead-of-Time* (AOT), which compiles your app at build time.
- Converts your Angular HTML and TypeScript code into efficient JavaScript code during the build phase *before* the browser downloads and runs that code.
- The size of the Angular framework downloaded in the browser decreases in size by over 50%. Angular's template compiler code does not need to be sent to the browser because the template compilation has been done ahead-of-time.



Build Optimizer

- Build-Optimizer (PurifyPlugin) is a Webpack plugin created by the Angular team, specifically to optimize Webpack builds beyond what Webpack can do on its own.
- Optimizations
  - Removal of Angular decorators from AoT builds
  - adding /*@__PURE__*/ annotations to transpiled/downleveled TypeScript classes. The point of this is to make it easier for minfiers like Uglify to remove unused code.
  - Full list of optimizations is available here:
    - https://www.npmjs.com/package/@angular-devkit/build-optimizer

CLI: Builds

- The **build** command sends output to the **dist** directory
- **Copy** the contents of the **dist** directory to your web server to deploy
- Run a production build

  ng build

- Shorthand for "--configuration=production”
- In previous Angular CLI versions you need to pass --prod flag

Production Builds

angular.json | configurations:production

```
"optimization": true,  //Enables optimization of the build output. (bundling, limited tree-shaking, limited dead code elimination)
"outputHashing": "all", // Define the output filename cache-busting hashing mode.
"sourceMap": false,  // Output sourcemaps.
"extractCss": true, // Extract css from global styles into css files instead of js ones.
"namedChunks": false, // Use file name for lazy loaded chunks.
"aot": true, // Build using Ahead of Time compilation.
"extractLicenses": true, // Extract all licenses in a separate file.
"vendorChunk": false, // Use a separate bundle containing only vendor libraries.
"buildOptimizer": true, // Enables '@angular-devkit/build-optimizer' optimizations when using the 'aot' option.
"fileReplacements": [{
        "replace": "src/environments/environment.ts",
        "with": "src/environments/environment.prod.ts"
 }],
```

Bundles

- runtime.js is webpack
- polyfills.js includes core-js and zone.js
- main.js includes all your application code
- styles.css includes all the CSS component styles as well as global styles in styles.css combined into one file

Demo

Angular CLI: Production Builds

Instructor: completes Lab 29 as a demonstration (steps 1-15)

Labs

Lab 29: Build & Deploy

Appendices

The remainder of the topics in this manual are not always able to be covered during the introductory course. Instructors can choose to include them as time allows or questions arise. Students can use them as additional information to go deeper on topics particularly around the setup, build, and deployment of an Angular project.

Custom Pipe Example

```
import {Pipe, PipeTransform} from '@angular/core';

@Pipe({
    name: 'characterLength'
})
export class CharacterLengthPipe implements PipeTransform{

    transform(value:string, length:number){
        return value.substring(0, length);
    }
}
```

Use:

```
<p>description | characterLength </p>
```

```
src
  app
    core
      exception.service.ts|spec.ts
      user-profile.service.ts|spec.ts
    heroes
      hero
        hero.component.ts|html|css|spec.ts
      hero-list
        hero-list.component.ts|html|css|spec.ts
      shared
        hero-button.component.ts|html|css|spec.ts
        hero.model.ts
        hero.service.ts|spec.ts
      heroes.component.ts|html|css|spec.ts
      heroes.module.ts
      heroes-routing.module.ts
    shared
      shared.module.ts
      init-caps.pipe.ts|spec.ts
      filter-text.component.ts|spec.ts
      filter-text.service.ts|spec.ts
```

Shared Feature Module

Do create a feature module named SharedModule

app/shared/shared.module.ts de fines SharedModule

Do declare *components*, *directives*, and *pipes*

When those items will be **re-used**

Consider *not* providing services in shared modules.

Services are usually singletons that are provided once for the entire application or in a particular feature module

Core Feature Module

Do create a feature module named **CoreModule**

- **app/core/core.module.ts** defines CoreModule

Do **declare** *common Services*

- When those items will be **re-used**
  - **Exception/Logging Service**
  - **User Profile Service**

Labs

Lab 28: Custom Pipe

Pure Pipe

```
import {Pipe, PipeTransform} from '@angular/core';

@Pipe({
    name: 'charlength',
    pure: true // default
})
export class CharacterLengthPipe implements PipeTransform{

    transform(value:string, length:number){
        return value.substring(0, length);
    }
}
```

pure: When true, the pipe is pure, meaning that the **transform()** method is **invoked only when** its **input arguments change**. Pipes are pure by default.

Impure Pipe

- If the pipe has internal state (that is, the result depends on state other than its arguments), set pure to false.
  - In this case, the pipe is invoked on each change-detection cycle, even if the arguments have not changed.

Updating Angular

Features in Different Angular Versions & How-To

Updating Angular

- Run the command
  - **ng update @angular/cli @angular/core**
- If using Angular Material also run
  - **ng update @angular/material**
- For more details see the update guide:
  - https://update.angular.io/
- Tip: Don't go from Angular 10 to Angular 12 with one **ng update** command
  - Instead: **ng update @angular/cli@11 @angular/core@11**
  - Then: **ng update @angular/cli@12 @angular/core@12**
  - …

Patching Dependencies

- To see dependencies with know security issues:

  npm audit

- To fix those issues:

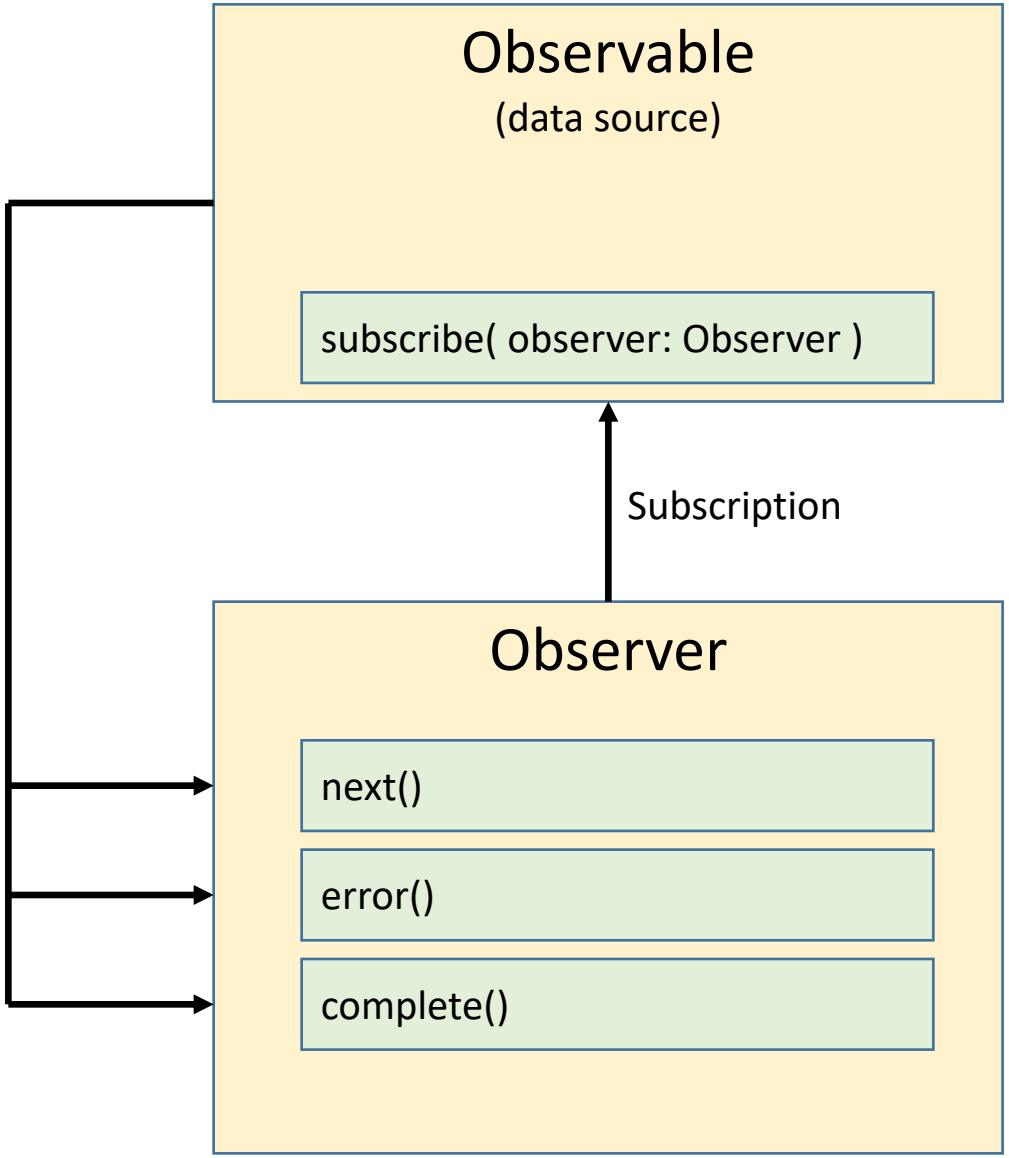
  npm audit fix

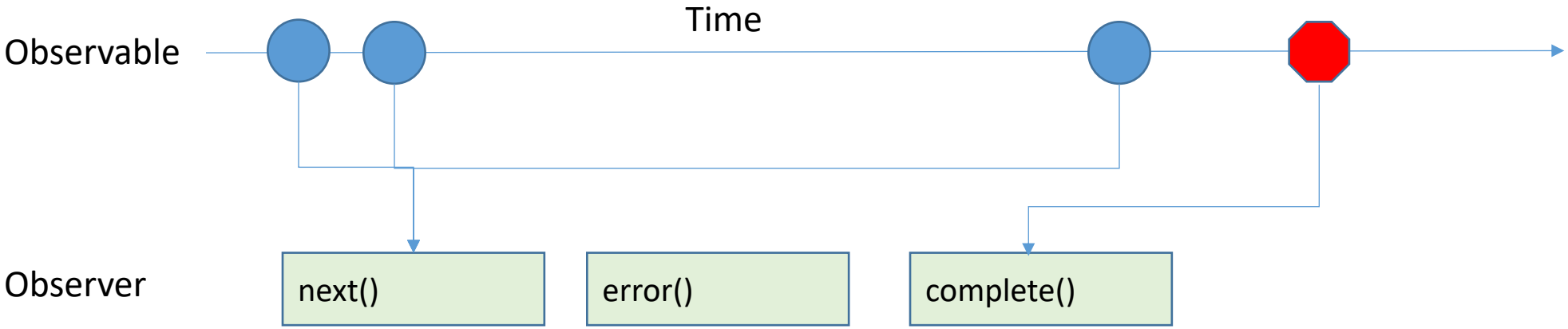
  - Then, test your application
  - If broken by packages (won't build)
    - Revert to old package-lock.json
    - Try again in a week
    - If waiting is not an option, then apply specific npm update commands for critical packages. The commands are provided as part of the npm audit output.

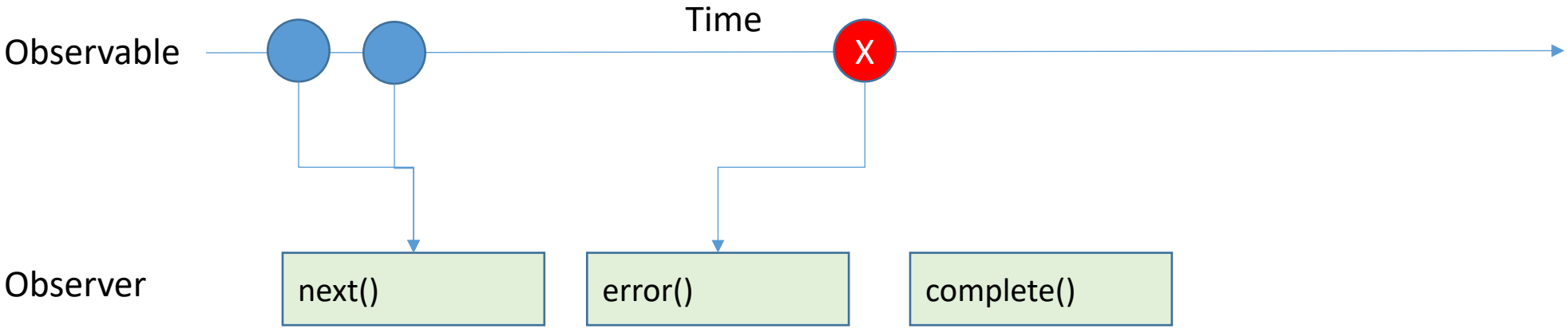
RxJS

RxJS

- **Reactive Extensions for JavaScript**
- RxJS is a library for composing asynchronous and event-based programs by using observable sequences
- It provides one core type, the Observable, satellite types (Observer, Schedulers, Subjects) and operators inspired by Array#extras(map, filter, reduce, every, etc) to allow handling asynchronous events as collections
- Using RxJS, developers represent asynchronous data streams with Observables and query asynchronous data streams using the many operators (functions) provided


Observable
(data source)
subscribe(observer: Observer)
Subscription
Observer
next()
error()
complete()


Time
Observable
Observer
next()
error()
complete()


Time
Observable
X
Observer
next()
error()
complete()

RxJS Imports

- rxjs: Contains creation methods, types, schedulers, and utilities

```
import {
  Observable,
  Subject,
  pipe,
  of,
  from,
  interval,
  merge,
  fromEvent,
} from 'rxjs';
```

- rxjs/operators: Contains all pipeable operators

```
import { map, filter, scan } from 'rxjs/operators';
```

Observable

- A representation of any set of values over any amount of time
- The most basic building block of RxJS
- Represents a data source that streams values over time
- Observables are lazy push collections of multiple values

	Single	Multiple
Pull	Function	Iterator
Push	Promise	**Observable**

Observable Creation Functions

- Used to create Observables from scratch
- Stand-alone functions
  - import { of } from 'rxjs';

Creating Observables

```
of(1,2,3)
.subscribe(x=> console.log(x)); // 1, 2, 3
```

```
let button = document.querySelector("button");
fromEvent(button, "click")
.subscribe(x => console.log(x));
```

```
let input = document.querySelector("input");
fromEvent(input, "keyup")
.subscribe((x: Event) => console.log(x.target.value));
```

Demo: Obervables

Instructor Only

code/demos/rxjs-observables

Observer

- A collection of callbacks that knows how to listen to values delivered by the Observable
- An Observer is a consumer of values delivered by an Observable
- Observers are simply a set of callbacks, one for each type of notification delivered by the Observable:
  - next
  - error
  - complete

Observer Example

```
//Observer
let observer: Observer<any> = {
    next: x => console.log(x),
    complete: () => console.log('completed'),
    error: x => console.log(x)
}

of(1,2,3)
.subscribe(observer); // 1, 2, 3, completed
```

Demo: Observers

Instructor Only

code/demos/rxjs-observers

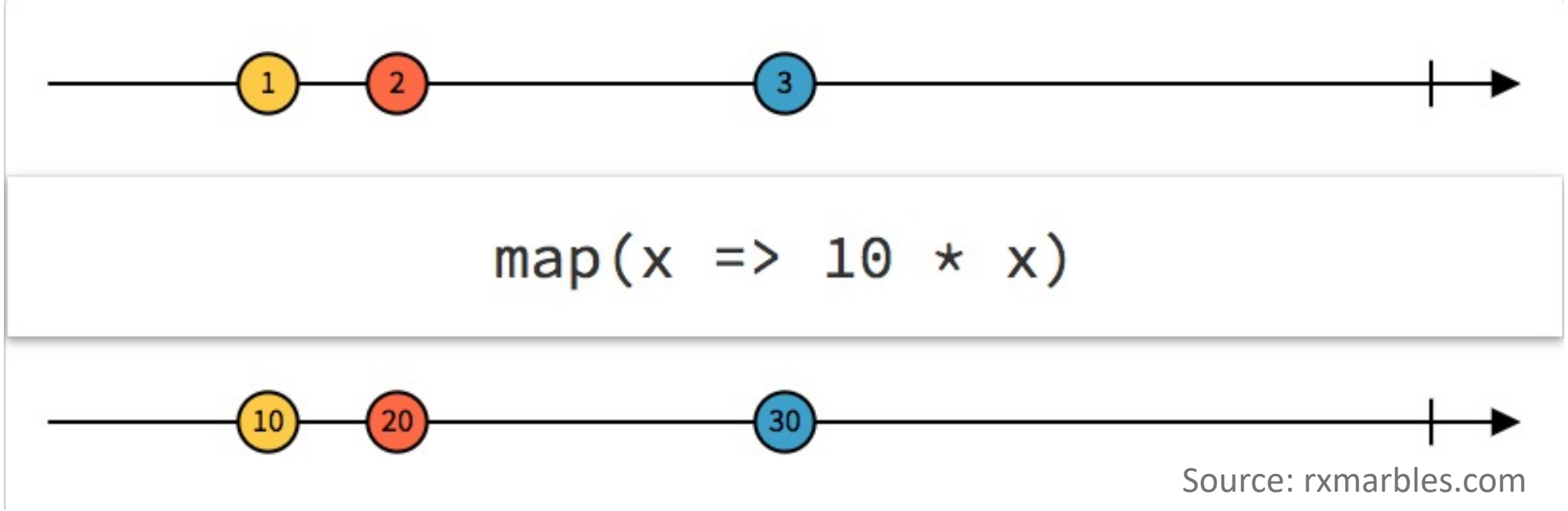
code/demos/rxjs-subscriptions

Operators

- Methods on Observable instances in RxJS <=5.4
- Stand-alone functions in RxJS >=5.5
  - import { map, filter } from 'rxjs/operators';
  - Use the this keyword to infer what is the input Observable

map Operator

```
//map returns same number of items as source
of(1, 2, 3)
  .pipe(map(x => x * 10))
  .subscribe(x => console.log(x));  //10, 20, 30
```



Source: rxmarbles.com

switchMap Operator

```
let obs1$ = of(1, 2, 3);
let obs2$ = of('a', 'b');

obs1$.pipe(switchMap(() => obs2$)).subscribe(observer);
// a, b, a, b, a, b, completed
```

```
let obs1$ = of(1, 2, 3);
let obs2$ = of('a', 'b');

obs1$.pipe(switchMap(() => obs2$, (n, l) => n + l)).subscribe(observer);
//1a, 1b, 2a, 2b, 3a, 3b
```

Demo: Operators

Instructor Only

code/demos/rxjs-operators

Subject

- A Subject is like an Observable, but can multicast to many Observers
- Subjects are like EventEmitters: they maintain a registry of many listeners
- Plain Observables are unicast (each subscribed Observer owns an independent execution of the Observable)
- Subjects are read (Observable) and write (Observer)
  - Read/Write makes them useful for creating a stream of user generated events that can also be filtered for noise and then read

Subject Example

```
var subject = new Subject();


subject.subscribe({
  next: (v) => console.log('observerA: ' + v)
});

subject.subscribe({
  next: (v) => console.log('observerB: ' + v)
});


subject.next(1);
subject.next(2);


// observerA: 1
// observerB: 1
// observerA: 2
// observerB: 2
```

Practical Application of RxJS

```
this.items = this.searchTermStream.pipe(
  debounceTime(300),
  distinctUntilChanged(),
  switchMap((term: string) => this.searchService.search(term))
);
```

- searchTermStream is a Subject
  - We create (write) an observable stream of text input's change events
  - We read the stream and decide what we are interested in consuming
- debounceTime waits for the user to stop typing for at least 300 milliseconds
- distinctUntilChanged ensures that the service is called only when the new search term is different from the previous search term
- switchMap calls the WikipediaService with a fresh, debounced search term and coordinates the stream(s) of service response

Demo: Practical Application of RxJS

Instructor Only

code/demos/rxjs-practical

EventEmitter or Observable

- Summary
  - Use EventEmitter in Components
  - Use some form of an Observable (Observable, Subject, BehaviorSubject) in Services

- Explanation
  - Do NOT count on EventEmitter continuing to be an Observable
  - Do NOT count on those Observable operators being there in the future
  - Only call event.emit()… Don't defeat angular's abstraction

Observables and Reactive Programming

In Angular

- We can structure our application to use Observables as the backbone of our data architecture
- Using Observables to structure our data is called Reactive Programming
- Reactive programming is programming with asynchronous data streams
- Observables are the main data structure we use to implement Reactive Programming.

Promises vs. Observables

Promises

- Returns single value
- Not cancellable
- Standard as of ES 2015

Observables

- Returns multiple values over time
- Cancellable
- Retry
- Supports map, filter, reduce and similar operators
- Proposed feature for ES 2016
  - Angular uses Reactive Extensions (RxJS)

Data Binding

Four forms (types)

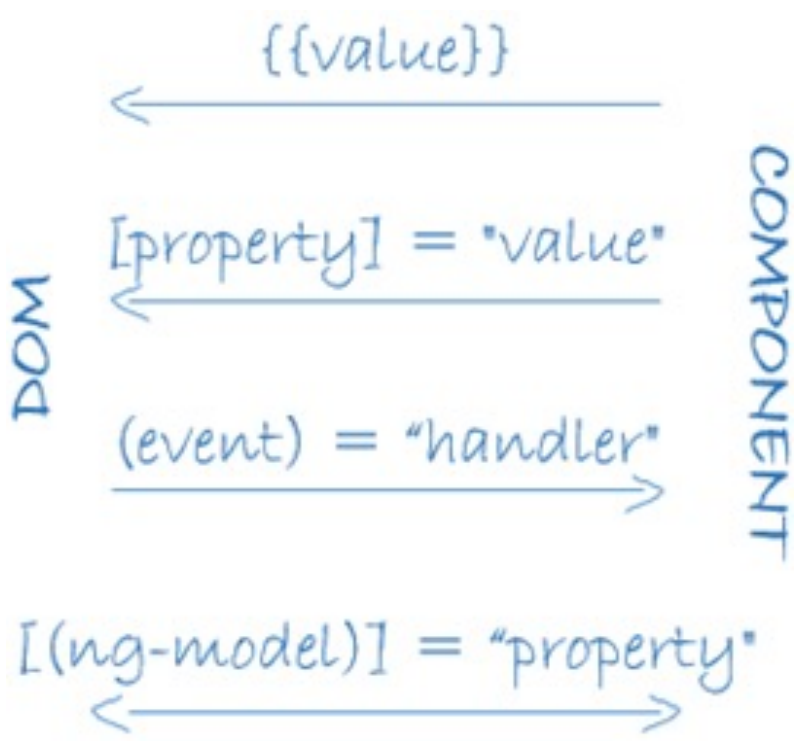


Image from angular.io

- Interpolation
- Property binding
- Event binding
- **Two-way data binding**

Two-way Binding

```
@Component({
  selector: 'app-root',
  template: `
    <input [(ngModel)]="message" type="text">
    <p>{{message}}</p>
  `,
  styles: []
})
export class AppComponent {
  message = '';
}
```

It accepts a domain model as an optional Input. If you have a one-way binding to ngModel with [] syntax, changing the value of the domain model in the component class sets the value in the view. If you have a two-way binding with [()] syntax (also known as 'banana-box syntax'), the value in the UI always syncs back to the domain model in your class.

Demo: Two-way Binding

Instructor Only Demonstration

code\demos\data-binding

Forms

Template-driven Forms

Form Strategies Revisted

Template-driven

- AngularJS style
- FormsModule
- Use the core ng prefix
- Declarative in the template

Model-driven (new)

- Reactive programming
- ReactiveFormsModule
- Use the form prefix
- Configured in component code
- Enables dynamic forms
- Facilitates unit testing

Pros and Cons of Template Driven Forms

- Pro
  - Simplicity
- Cons
  - The template as the source of all form validation truth is something that can become pretty hard to read.
  - Form validation logic cannot be unit tested. Must use end to end tests.
  - Bi-directional binding directly to the model can create rendering performance issues.

Form Directives

Template-driven

- ngForm
- ngModel
- ngModelGroup
- ngSubmit

NgForm

- We don’t need to add the NgForm directive explicitly. Angular does this for us.
- Supplements the form element with additional features
  - holds the controls we created for the elements with ngModel directive and name attribute
  - monitors their properties including their validity
  - has its own valid property which is true only if every contained control is valid
- Add ngNoForm attribute to form element if we don’t want to use Angular with a given form

NgModel

- Used for
  - Tracking change state of form controls and whether they have been touched
    - <input name="first" ngModel>
  - Validity of form controls
    - <input name="first" ngModel>
  - Binding the form control to the model (one or two-ways)
    - One-way
      - <input name="first" [ngModel]="person.first">
    - Two-way
      - <input name="first" [(ngModel)]="person.first">

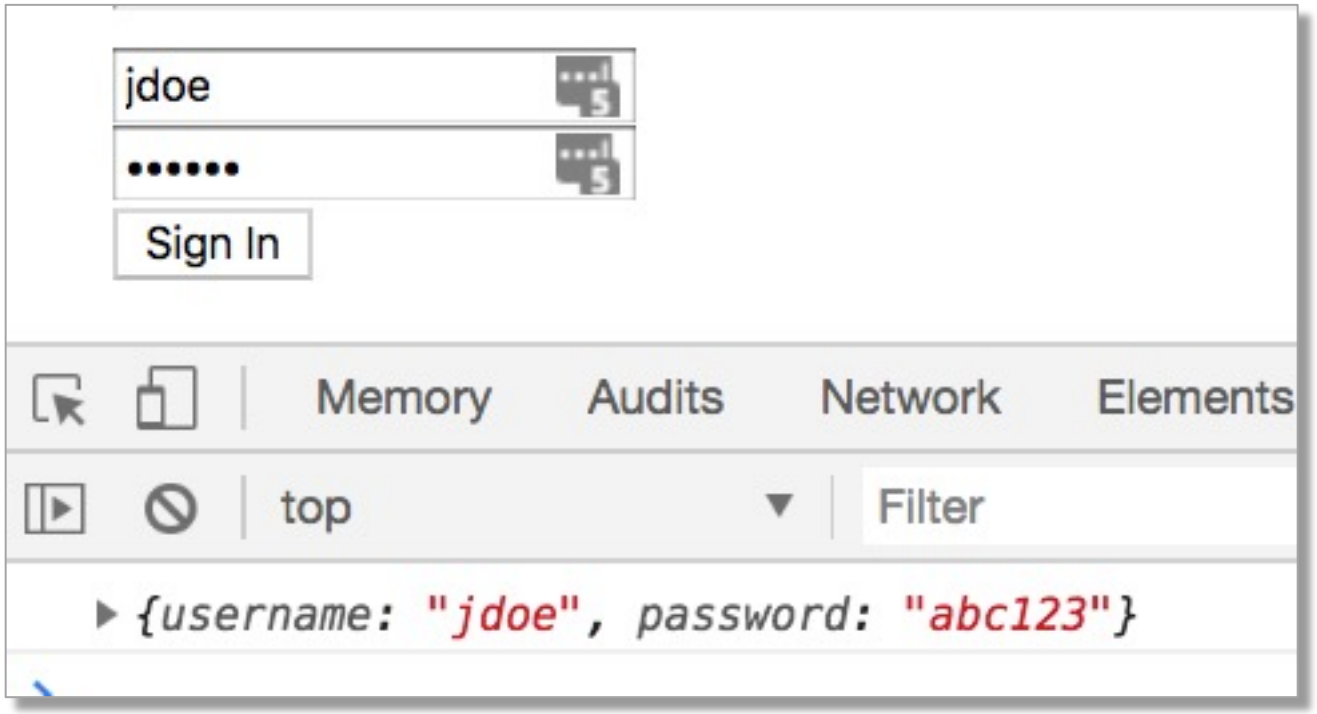
CSS Classes

- The *NgModel* directive doesn't just track state. It updates the control with three classes that reflect the state.

State	Class if true	Class if false
Control has been visited	ng-touched	ng-untouched
Control's value has changed	ng-dirty	ng-pristine
Control's value is valid	ng-valid	ng-invalid

NgModelGroup

- Semantically groups our form controls
- Tracks validity state of inner form controls
  - Allows us to check the validity state of a subset of the form
- An NgForm is an NgModelGroup



Demo: Template Forms Binding

Instructor Only Demonstration

code\demos\template-forms-binding

Validation Directives

- **required**
  - Requires a form control to have a non-empty value
- **minlength**
  - Requires a form control to have a value of a minimum length
- **maxlength**
  - Requires a form control to have a value of a maximum length
- **pattern**
  - Requires a form control’s value to match a given regex
- **email**
  - Requires a form control’s value pass an email validation test
- Reference to all built-in validators
  - https://angular.io/api/forms/Validators

Demo: Template Forms Validation

Instructor Only Demonstration

code\demos\template-forms-validation

code\demos\template-forms-validation-messages

UI Components

Suites & Kits

Reference

- List of all options in the Angular documentation
  - https://angular.io/resources?category=development
  - Scroll down to UI Components

Popular UI Component Suites for Angular

- Material: https://material.angular.io/ (open source/free)
- Clarity: https://vmware.github.io/clarity/ (open source/free)
- Kendo: https://www.telerik.com/kendo-angular-ui (open source/paid)
- Bootstrap: https://ng-bootstrap.github.io/#/home (open source/free)

Notes

- Material Design
  - Most used with Angular
  - Backed by Google
  - Mobile-friendly
    - Good if you have mobile requirements
    - Can be challenging if your UI is dense
- Clarity
  - Backed by VMWare which is now owned by Dell
  - Includes Figma design assets to assist with design and prototyping
  - Bootstrap like but not Bootstrap
  - Often preferred for line of business applications with dense UIs

Notes

- NgBootstrap
  - There are two competing Bootstrap/Angular projects
  - Same team behind AngularJS Bootstrap component library
  - If you use Bootstrap directly you need to integrate bootstrap.js which in older versions requires jQuery which can create unnecessary bundle sizes for your application and impact performance (particularly on initial load) as well require additional coding
  - NgBoostrap replaces bootstrap.js and jQuery with Angular components that use Angular data binding etc…
  - Components are made for Angular using Angular