Introduction SPA

Browser-based Applications

Benefits
- Work from anywhere, anytime
- Platform independent, including mobile
- No software update, no application, easy maintenance
- Software can be provided as a service (SaaS - pay as you go)
- Code separation

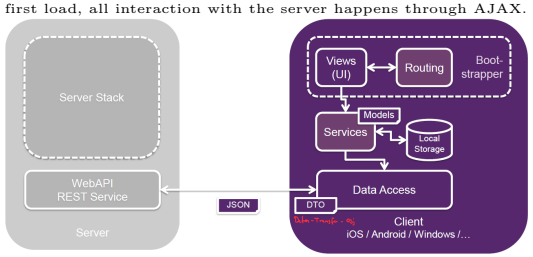
Liabilities
- No data sovereignty (Datenhoheit)
- Limited/restricted hardware access
- SEO - Search engines must execute JavaScript
- More complex deployment strategies

SPA

A website that fits on a single web page with a user experience similar to that of a desktop application. All code is retrieved with a single page load or resources are dynamically loaded. SPAs use AJAX and HTML5 to create responsive Web apps, without constant page reloads.

Architecture

Website interacts with user by rewriting parts of the DOM. After first load, all interaction with the server happens through AJAX.



Bundling

All JS code must be delivered to the client over potentially slow networks. Bundling and minifying the source leads to smaller SPA footprint. Larger SPAs with many modules need a reliable dependency management. Initial Footprint can be reduced by loading dependent modules on-demand.

WebPack as Bundler

Entry: Start, follows the graph of dependencies to know what to bundle.
Output: Tell webpack where to bundle your application.
Loaders: Transforms these files into modules as they are added to your dependency graph.
Plugins: Perform tasks like bundle optimization, asset management and injection of env variables.
Mode: Enable built-in optimization mechanisms.

Routing

- Completely on client-side by JS
- Navigation behaves as usual
- Browser needs to fake the URL to change and store page state
- *window.history.pushState*

Dependency Injection

Benefits
- Reduces coupling between consumer and implementation
- Contracts between classes are based on interfaces
- Supports the open/closed principle
- Allows flexible replacement of an implementation

Decorators

- Provide a way to add annotations / meta-programming syntax
- Can be attached to a class declaration, method, accessor, property or parameter
- Widely used in Angular

React

- Library, kein Framework
- Um User Interfaces zu bauen
- View in MVC
- Minimales Featureset
- Entwickelt von Facebook
- Verwendet für: WhatsApp, Insta, AirBnb, etc.

Prinzipien

- Komplexes Problem aufteilen in einfachere Komponenten
- Für eine bessere: Wiederverwendbarkeit, Erweiterbarkeit, Wartbarkeit, Testbarkeit, Aufgabenverteilung

Entwicklung von UIs

- Beschreibung des UIs
- Event-Handling
- Aktualisieren der Views

Komponenten und Elemente

- Funktionen die HTML zurückgeben
- Beliebige Komposition von React-Elementen und DOM-Elementen

```
function App() {
 return (                          Parameterübergabe an Funktion
   <div>
     <HelloMessage name="HSR" />
     <img src="/logo.png" />
   </div>                          Äquivalent zu Attribut für DOM-Element
 )
}
```

JavaScript XML

React verwendet JSX (blau), eine Erweiterung von JavaScript (gelb). Überall wo JSX verwendet wird, muss *react* importiert werden.

```
const menu = entries.map(entry =>
  <ListItem as="a" to={`/${entry.path}`}>
    <h1>{entry.title.toUpperCase()}</h1>
    <p>{entry.subtitle}</p>
  </ListItem>
)
```

Styles: werden nicht als Strings sondern als Object angegeben.

Conditionals

```
<Container>
 { error &&
   <Message>
     Fehler: {error}
   </Message>
 }
</Container>
```

oder

```
<Container>
 { error
   ? <span>
       Fehler: {error}
     </span>
   : <span>OK!</span>
 }
</Container>
```

Props

Komponenten erhalten alle Parameter/Properties als **props** Objekt.
- *this.props* bei Klassen
- Bei Funktionen als Parameter
- Immer **read-only**

Rendering und Mounting

Mounting: nötig um Komponenten auf Webseite anzuzeigen. *ReactDOM.render*

```
ReactDOM.render(
    <App/>
    document.getElementById('root')
)
```

React State

React-Klassenkomponenten können einen veränderbaren Zustand haben. Der **state** einer Komponente ist immer privat. Ändert der State, wird auch die Komponente aktualisiert.

```
class Counter extends React.Component {
    state = { counter: 0 }
    // ...
}
```

Event Handler

```
const increment = () => {
    this.setState({counter: this.state.counter +
        1})
} // ...
<button onClick={this.increment}>
```

Reconciliation

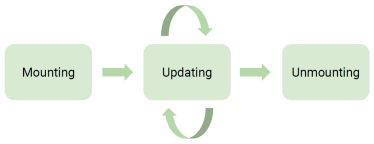
1. React Komponenten werden als virtueller DOM gerendert
2. Wird der **state** geändert, erstellt React einen virtuellen DOM
3. Alter und neuer DOM werden verglichen
4. Erst dann werden geänderte DOM-Knoten im Browser erstellt

Formulare

Input Handling

```
<form onSubmit={this.handleSubmit}>
<input value={this.state.username}
       onChange={this.handleUsernameChange} //...
</form>
handleUsernameChange = (event) => {
    this.setState({username: event.target.value});
};
handleSubmit = (event) => {
    event.preventDefault();
    //...
}
```

Komponenten Lifecycle



Mounting

1. **constructor(props)**
   - State initialisieren, sonst weglassen
2. static getDerivedStateFromProps(props, state)
   - Von State abhängige Props initialisieren
3. **render()**
4. **componentDidMount()**
   - DOM ist aufgebaut
   - Guter Punkt um zum Beispiel Async-Daten zu laden
   - setState Aufruf führt zu re-rendering

Updating

1. static getDerivedStateFromProps(props, state)
   - Von State abhängige Props aktualisieren
2. shouldComponentUpdate(nextProps, nextState)
   - wird false zurückgegeben wird render übersprungen
3. **render()**
4. getSnapshotBeforeUpdate(prevProps, prevState)
5. **componentDidUpdate(prevProps, prevState, snaspshot)**
   - Analog zu componentDidMount, DOM ist aktualisiert

Unmounting

1. **componentWillUnmount()**
   - Aufräumen

Error Handling

1. static getDerivedStateFromError(error)
   - Error im State abbilden
2. componentDidCatch(error, info)
   - Logging
   - Verhindern, dass Error propagiert wird, analog zu catch-Block in try-catch

React Router

- Komponentenbibliothek
- Komponenten anzeigen oder verstecken abhängig von der URL
- Für React Web und React Native

Router Komponenten

```
<Router>
```

Alle Routen müssen Teil des Routers sein, typischerweise nahe der Root-Komponente

```
<Route exact path="/" component={Home} />
```

Home-Komponente wird nur gerendert, wenn der path (exakt) matcht. Mehrere Route Elemente können gleichzeitig aktiv sein.

```
<Link to="/">Home</Link>
```

App-interne Links, welche nicht wie <a >die Seite neu laden.

```
<Redirect to="/somewhere/else">
```

Wird ausgeführt, sobald gerendert.

Hooks

Problem von Lifecycle Methoden Zusammengehörender Code ist auf mehrere Methoden verteilt (Mount/Unmount).
Problem von Klassen-State State ist über verschiedene Methoden verteilt
Fazit:
- Lifecycle und State ohne Klassen machen react verständlicher
- Klassen sind weiterhin unterstützt
- Hooks erlauben, Logik mit Zustand einfacher wiederzuverwenden

State Hook

```
function Counter() {
    const [count, setCount] = useState(0);
    // button => setCount(count + 1)
    return( <p>{count}</p> );
}
```

Mehrere State-Variablen: useState Aufrufe müssen immer in derselben Reihenfolge gemacht werden.

Effect Hook

```
useEffect(() => {
    // Mount stuff
    return () => {
        // Unmount stuff
    }
}, [] /* <= Dependencies */);
```

Flow

- Erweitert JavaScript um Typenannotationen
- Typ-Annotation im Code Typ-Inferenz für lokale Definitionen
- Generics, Maybe-Types, Union and Intersection-Types

TypeScript und React

- Mehr Typensicherheit in React-Komponenten
- Props und State lassen sich typisieren

Vorteil gegenüber Flow:
- Vollwertige Programmiersprache
- Besser unterstützt von Libraries und IDEs
- TypeScript Fehler müssen korrigiert werden

React Context

Ermöglicht es, Props für alle Unterkomponenten zur Verfügung zu stellen. (Theme Variablen)

```
// provider
const c = React.createContext(themes.light);
const theme = useContext(c); // consumer
```

Redux

Library für Statemanagement (Repräsentation / Veränderung / Benachrichtigung). State wird als Tree (immutable) von Objekten dargestellt. Veränderung am Tree führt durch den Reducer zu einem neuen Tree t+1 (funktionale Programmierung). State wird im **Store** verwaltet.

Actions

Benötigt um Stateänderungen zu machen. Wird an den Store gesendet / dispatched. Action ist eine reine Beschreibung der Action.

```
{type: 'TRANSFER', amount: 100 }
```

Reducer

Pure Funktionen, haben keine Seiteneffekte.

```
function balance(state = 0, action) {
    switch (action.type) {
        case 'TRANSFER':
            return (state + action.amount);
        default:
            return state;
    }
}
```

Reducer kombinieren: Jeder Reducer erhält einen Teil des States, für den er zuständig ist. Resultat wird in einem neuen State-Objekt kombiniert.

```
function rootReducer(state = {}, action) {
    return {
        balance: balance(state.balance, action),
        transactions: transactions(state.
            transactions, action)
    }
}
// Hilfsfunktion combineReducers:
const rootReducer = combineReducers({
    balance, transactions
});
```

Store erstellen

```
const store = createStore(rootReducer);
```

Mit dem root-Reducer kann der Store erstellt werden. In Kombination mit React führt das zu einem re-rendering der Komponenten.

React <3 Redux

Redux mit React verbinden:

```
const mapStateToProps = (state) => {
    return {
        transactions: state.transactions
    }
}
const mapDispatchToProps = {
    fetchTransactions
}
export default connect(mapStateToProps,
    mapDispatchToProps)(Component);

// Root Komponente
const store = createStore(
    rootReducer, applyMiddleware(thunkMiddleware));
render(
    <Provider store={store}>
        <App />
    </Provider>
    document.getElementById('root')
)
```

mapStateToProps: erhält State und kann daraus Props ableiten. Die Komponente bekommt auch die *dispatch* Methode des Stores als Prop. Das Resultat von *connect* ist eine React-Komponente die mit dem Store verbunden ist.
Store muss der Root-Komponente mitgegeben werden.
thunkMiddleware: Erlaubt es, anstelle eines Objektes eine Funktion zu dispatchen (benötigt für asynchrone Actions).

Thunk Actions

```
function fetchTransactions(token) {
    return (dispatch, getState) => {
        dispatch({type: "FETCH_TRANSACTIONS_STARTED
            "});
        api.getTransactions(token)
            .then(({result: transactions}) => {
                dispatch({type: "
                    FETCH_TRANSACTIONS_SUCCEEDED",
                    transactions});
            })
    };
```

}

Selectors

Getter bei den Reducern, die einen Subtree des Stores zurückgeben. Wissen über den Aufbau des State-Trees bleibt bei den Reducern.

Firebase

Läuft in der Google Cloud Platform. Hauptfokus von Firebase sind Mobile- und Web-Apps.

Firebase Authentication

Backend Services für Authentifizierung und einfache Userverwaltung. SDKs für diverse Plattformen. Vorgefertigte UI Libraries

Firebase Hosting

Einfaches Hosting für statischen Content.

- Immer per HTTPS ausgeliefert
- Automatisches Caching in CDNs

Dynamischer Content nur über **Cloud Function**, wenn das nicht reicht:

- PaaS: Google App Engine
- Docker: Google Container oder Kubernetes Engine

Serverless Computing

Cloud Provider verwaltet Functions:

- Deployment geschieht on-demand
- Plattform bestimmt die Parallelisierung
- Entwickler hat keine Kontrolle über laufende Instanzen
- Funktionen sind Stateless
- Abgerechnet werden Aufrufe und Laufzeit der Funktion

Limitationen: Ausführungszeit / Memory begrenzt. Teilweise hohe Latenz.

Firebase Cloud Functions

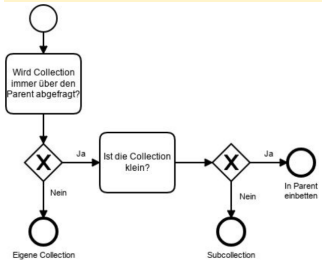
Anwendungszenarien: Code als Reaktion auf einen Event ausführen, Administration (Cron Jobs), REST API für Mobile und SPAs zur Verfügung stellen.

Cloud Firestore

- NoSQL, document-oriented database
- DB besteht aus mehreren Collections mit Documents
- Document ist ein JSON-Objekt
- Document kann Collections beinhalten
- Vergleichbar mit MongoDB
- Stark eingeschränkte Queries (keine Volltextsuche)

```
// Auf Collections / Documents zugreifen
const colRef = db.collection("todos");
const docRef = db.collection("todos").doc("...");
// Dokumente erstellen
db.collection("todos").add({text: "..."});
// Dokument bearbeiten
.doc("...").update({text: "..."});
// Daten Abfragen
db.collection("todos").doc("...").get().then(d => {
    if(!doc.exists) { /* ... */ }
    else { console.log(d.data()); }
}).catch(err => { /* ... */ });
// Daten abfragen mit Filter
db.collection("todos").where("checked", "==", true)
    .orderBy("createdAt").get().then(snapshot => {
// ...
});
```

NoSQL One-To-Many



NoSQL Many-To-Many

- Wie in relationaler Datenbank mit Assoziationstabelle
  - Kein kopieren von Daten
  - Komplexere Abfragen, keine Joins im Firestore
- Oder Daten kopieren und einbetten

Kopieren der Daten: muss kein Nachteil sein. Preisänderung eines Produktes hat keinen Einfluss auf vergangene Bestellungen. Adressänderung eines Kunden verändert keine alten Bestellungen. Kopierte Daten können mittels Trigger und Cloud Function wieder synchronisiert werden.

Angular

Flexible SPA Framework for CRUD applications

- Typescript 4.1 based
- Reduces boilerplate Code
- Dependency Injection Mechanism
- JS-optimized 2-way binding
- Clearly structured, information hiding
- Increases testability / maintainability of client-side code

Architecture

ngModules: Cohesive block of code dedicated to closely related set of capabilities. (*module*) **Directives:** Provides instructions to transform the DOM. (*class*) **Components:** Directive-with-a-template; it controls a section of the view. (*class*) **Templates:** Form of HTML defining how to render the component. (*HTML / CSS*) **Metadata:** Describes a class and defines how to process it. (*decorator*) **Services:** Provides logic of any value, function or feature that the app needs. (*class*)

Angular Modules (ngModule)

Base for Angular modularity system. Every app has at least one Module, the root Module (a.k.a app). Root Module ist launched to bootstrap the app. Modules export features (directives, services) required by other modules.

TypeScript Module vs. ngModule:
ngModule is a logical block of multipe TypeScript modules linked together. The ngModule declaration itself is placed into a TypeScript module. Modules can accommodate submodules. All public TS members are exported as an overall *barrel*

```
@NgModule({
  imports: [
    CommonModule
  ],
  declarations: []
})
export class CoreModule { }
```

NgModule with metadata object whose properties describe the module.

other modules whose exported classes are needed by components in *this* module.

the view classes that belong to this module.

declarations: View Classes that belong to this module (Components, Directives, Pipes).
exports: Subset of declarations that should be visible and usable by other modules.
imports: Specifies the modules which exports/providers should be imported.

- forChild-Import: returns an object with a **providers** and **ngModule** property
  - allows you to configure services for the current Module level
  - Use if you need to configure the foreign module
- forRoot-Import: returns an object with a **providers** and **ngModule** property
  - It provides and condigures services at the same time
  - Will instantiate the required services exactly once, globally
  - If no configuration is required, use tree shakable providers { *providedIn: 'root'*}

providers: Creators of services that this module contributes to the global collection of services (DI Container). They become accessible in all parts of the app.
bootstrap: Main application view, root component. Only the root module should set this property.

Module Types

Root / App Module: Provides the entry point (bootstrap component) for the app. Has no reason to export anything. **Feature Modules:** Specifies boundaries between app features.

- Domain Modules: Deliver a UI dedicated to a app domain
- Routing Modules: Specifies routing configurations
- Service Modules: Provides utility services
- Widget Modules: Makes components, directives and pipes available to external modules
- Lazy Modules: Lazily loaded feature modules

Shared Modules: Provides globally used components/directives/pipes. Is a global UI component module. Do not specify app-wide singleton providers in a shared module. **Core Module:** Keeps your Root Module clean. Contains components/directives/pipes used by the Root Module. Globally used services can be declared here. Only imported by the Root Module

Components

Manages the view and binds data from the model. Consists of:

- Controller (App logic), TS Class with *@Component* decorator
- HTML file, visual interface (HTML / template expression)
- (S)CSS file, styles behind HTML

Can be nested, results in Component tree.
Provide **Information Hiding:**

- Each Component declares part of the UI
- Should be implemented as small coherent piece to support:
  - Testability, Maintainability, Reusability

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

@Component({
  selector: 'wed-navigation',
  templateUrl: './navigation.component.html',
  styleUrls: ['./navigation.component.css']
})
export class NavigationComponent {
  Logic (TypeScript)
}
```

...
navigation.component.html
.css { }
navigation.component.css

Components must be declared within the containing module so its **selector** is registered for all sub-components of that module. They can be exported, so other modules can import and use then.

Component Lifecycle

Most important events are **ngOnInit** (Creation / Hydration) and **ngOnDestroy** (Destruction / Dehydration).
ngAfter... events are mainly for control

constructor
ngOnChanges
ngOnInit
ngDoCheck
ngAfterContentInit

developers to handle sub-components and their DOM. To hook into the lifecycle, interfaces of the Angular core can be implemented. Each interface has a single hook method, prefixed with *ng*. (**OnInit** contains method *ngOnInit*).

```
export class CounterComponent implements OnInit, OnDestroy {

  ngOnInit() {
    console.log("OnInit");
  }
  ngOnDestroy() {
    console.log("OnDestroy");
  }
}
```

Content Projection

```
<!-- component usage -->
<section>
  <wed-navigation>
    <h1 wed-title>WED3 Lecture</h1>
    <menu><!-- … --></menu>
  </wed-navigation>
</section>

<!-- resulting DOM -->
<section>
  <wed-navigation>
    <header>
      <h1 wed-title>WED3 Lecture</h1>
    </header>
    <nav>
      <menu><!-- … --></menu>
    </nav>
  </wed-navigation>
</section>
```

```
<header>
  <ng-content select='[wed-title]'>
  </ng-content>
</header>
<nav>
  <ng-content select='menu'>
  </ng-content>
</nav>
```

navigation.component.html

Templates

View in MVC. Written in HTML annotated with Angular **template syntax**:

- HTML5 except script-Tag
- Angular extends the HTML with
  - Interpolation (...)
  - Template Expression/Statements
  - Binding Syntax
  - Directives
  - Template Reference Variables
  - Template Expression Operators

Binding

Two Way Binding / *Banana in a box* [(...)]

```
<input type="text" [(ngModel)]="counter.team">
```

One Way (from View to Model / *Event Binding*) (...)

```
<button (click)="counter.eventHandler($event)">
```

One Way (from Model to View / *Property Binding*) [...] or {{ ... }}

```
<p>... {{counter.team}} ...</p>
<img [attr.alt]="counter.team" src="team.jpg">
```

```
@Component({…})
export class CounterComponent
{
  public counter: any = {
    get team() { return …; },
    set team(val) { },
    eventHandler: ()=>{ }
  }
}
```

Model Object

Binding targets must be declared as **Inputs or Outputs:** Targets stand on the left side of the binding declaration. e.g. the click / title property: `<wed-navigation (click)="..." [title]="...">`

```
@Component({…})
export class NavigationComponent {
  @Output() click =
          new EventEmitter<any>();
  @Input() title: string;
}
```

Directives

Similar to a component, but without a template. TypeScript class with an *@Directive()* function decorator.

Attribute Directives

Changes the appearance or behaviour of an element, component or another directive. Applied to a host element as an attribute.

NgStyle Directive
Sets the inline styles dynamically, based on the state of the component.

```
<div [style.font-size]="isSpecial ? 'x-large' : 'smaller'">
    <!-- render element -->
</div>
```

NgClass Directive
Bind to the ngClass directive to add or remove several classes simultaneously.

```
<div [class.special]="isSpecial">
    <!-- render element -->
</div>
```

Structural Directives

Responsible for HTML layout. Reshape the DOM's structure by adding, removing or manipulating elements. Applied to a host element as an attribute. Asterisk (*) precedes the directive attribute name.

NgIf Directive
Takes a boolean value and makes an entire chunk of the DOM appear or disappear.

```
<div *ngIf="hasTitle"><!-- shown if title available --></div>
```

NgFor Directive
Represents a way to present a list of items.

```
<li *ngFor="let element of elements"><!-- render element --></li>
```

NgTemplates:

```
<ng-template #toReference><!-- content --></ng-template>
```

Aren't rendered directly. They need a directive or component which takes over this part. Can be referenced by their *#id*:

```
<div *ngIf="hasTitle; else toReference"><!-- conditional content --></div>
```

Template Reference Variables

References a DOM element within a template. Can also be a reference to an component or directive. A hash (#) declares a reference variable.

```
<input placeholder="phone number" #phone>

<!-- lots of other elements -->

<!-- phone refers to the input element; pass its
`value` to an event handler -->
<button (click)="callPhone(phone.value)">Call</button>
```

Services

Provides any value, function or feature. Typical Services: logging service, data service, message bus, tax calculator, etc.
Strongly related to DI: Angular uses DI to provide components with needed services. Therefore, services must be registered within the DI container.

```
@Injectable ({ providedIn: 'root' })
export class CounterService { /* ... */ }
```

providedIn: 'root': The service is registered for the whole application.

Decorator function to mark class as an injectable instance

```
@Injectable({ providedIn: 'root' })
export class CounterService {
  private model: CounterModel
    = new CounterModel();

  public load():CounterModel {…}
  public up():CounterModel {…}
}
```

```
@Component(…)
export class CounterComponent {
  counter?: CounterModel;

  constructor(private counterService:
              CounterService) {
    this.counter = counterService.load();
  } …
}
```

Required services (dependencies) are automatically injected by Angulars injector.

Forms

Angular Forms is an external, optional ngModule called FormsModule. It's a combination of multiple provided services and multiple directives (ngModel, ngForm, ngSubmit).
Template-driven forms: Angular Template syntax with the form-specific directives and techniques. Less code but places validation logic into HTML. (Useful for small forms)
Reactive / model driven forms: Import ReactiveFormsModule. Form is built within the Controller (FormBuilder). Validation logic is also part of the controller (easier to test).

Template-driven

```
<input type="text" class="form-control" id="name"
       required
       [(ngModel)]="model.name" name="name"
       #nameField="ngModel">
<div [hidden]="nameField.valid || nameField.pristine" class="alert alert-danger">
  Name is required
</div>
```

Two-Way-Binding: [(ngModel)] directive to bind values. Reads out the value of the model for the first time. Updates are automatically written back into the bound model.
Validation: Reference the [ngModel] directive and check its valid property.
Submitting the form:

ngForm can also be referenced
- This is useful to bind validation state on the submit button
- or pass the form to the submit method

```
@Component({ ... })
export class SampleComponent {
  public doLogin(f?: NgForm): boolean {
    if (f?.form.valid) { // store data
    }
    return false; // avoid postback
  }
}
```

```
<form (ngSubmit)="doLogin(sampleForm)" #sampleForm="ngForm">
    <button type="submit"
            class="btn btn-success"
            [disabled]="!sampleForm.form.valid">Submit</button>
</form>
```

Asynchronous Services

Event Emitter example:

```
@Injectable({providedIn: 'root'})
export class SampleService {
  private samples: SampleModel[] = []; // simple cache
  public samplesChanged: EventEmitter<SampleModel[]> =
    new EventEmitter<SampleModel[]>();

  constructor( /* inject data resource service */ ) {
  }

  load(): void {
    /* in real word app, invoke data resource service here */
    this.samples = [ new SampleModel() ];
    this.samplesChanged.emit(this.samples);
  }
}

export class SampleModel { }
```

Create emitter instance. The type argument specifies the kind of object to be passed to the subscriber.

Logic to execute when data ready. Emit changed event to notify the registrars (e.g. UI components).

```
@Component({ ... })
export class SampleComponent implements OnInit, OnDestroy {

  private samples: SampleModel[];
  private samplesSubscription: Subscription;
  constructor(private sampleService: SampleService) {
  }

  ngOnInit() {
    this.samplesSubscription = this.sampleService.samplesChanged.subscribe(
      (data: SampleModel[]) => { this.samples = data; });
  }

  ngOnDestroy() {
    this.sampleSubscription.unsubscribe();
  }
}
```

Subscription is used to unsubscribe the update event when the component is de-hydrated.

Register samplesChanged event on underlying business service when component is hydrated. Subscribe() returns a Subscription which is used for deregistration.

Update procedure; refresh data on the UI level.

Unsubscribe the update event when the component is de-hydrated.

Data Access

HTTP Client API

Implements asynchronisms by using the RxJS library. RxJS is a third-party library that implements the Observable pattern. An Observable can be turned into a promise.
Hot Observables: Sequences of events (mouse moves / stock tickers). Shared amoung all subscribers. Postfix hot-observables with a $
Cold Observables: Start running on subscriptions (such as async web requests). Not shared amoung subscribers. Are automatically closed after Task is finished.

```
var subscription = this.http.get('api/samples').subscribe(
  function (x) { /* onNext -> data received (in x) */ },
  function (e) { /* onError -> the error (e) has been thrown */ },
  function () { /* onCompleted -> the stream is closing down */ }
);
```

Routing

External, optional NgModule called RouterModule. Combination of multiple provided services and directives: *RouterOutlet, RouterLink, RouterLinkActive.*
Defining Routes: The router must be configured with a list of route definitions. Each definition maps a route to a component.

- *.forRoot():* use exactly once to declare routes on root level
  - contains all the directives, the given routes and the router service itself
  - Every app has one singleton instance of the router
- *.forChild():* When declaring sub-routings
  - contains all directives and the given routes

Each ngModule defines its own routes. Load modules on-demand (lazy load) with the *import*-Syntax.

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

```
@NgModule({
  imports: [ RouterModule.forChild(welcomeRoutes) ],
  exports: [ RouterModule ]
})
export class WelcomeRoutingModule {}
```

Router Outlet: Directive from the Router module. Defines where the Router should display the views.

```
<router-outlet></router-outlet>
```

Route Configuration:

```
const appRoutes: Routes = [
    // matches /hero/42, 42 saved in param
    {path: 'hero/:id', component: 'Hero'},
    // redirect
    {path: '', redirectTo: '/heroes', pathMatch: '
        full'},
    // Wildcard route
    {path: '**', component: PageNotFound}
];
```

The router uses a first-match-wins strategy.
Lazy Loading Configuration

```
{ path: 'config',
  loadChildren: () => import('./cfg/cfg.module').then(m => m.CfgModule),
  canLoad: [ AuthGuard ] }
```

Angular Architectures

MVC+S

Observable Business Data Service: Provides data to multiple parts of the app in a stream-like manner. An *Observable* is provided. Stores/Caches business objects.
RxJS Subject: Heart of an observable data service. *EventEmitter*; derives from Subject. Hot Observable and does not provide the latest value.
Behaviour Subject: Emits the initial state. Can be called some kind of warm. Stores the data and emits *next()* events on change. Do not expose to the Service API.
Data Resources: Return cold Observables. Must be converted into a hot Observable (*share()*).
Observable Business Data Service Example:

```
@Injectable(providedIn: 'root'))
export class SampleService {

  private samples: BehaviorSubject<SampleModel[]> = new BehaviorSubject([ ]);
  public samples$: Observable<SampleModel[]> = this.samples.asObservable();

  constructor(
    private resourceService: SampleResourceService) {
  }
```

Event bus which is used to store the last state and to notify subscribers about updates.

Postfix hot-observables (streams) with a $.

Convert event bus into an observable, which can be provided to the UI or other services.

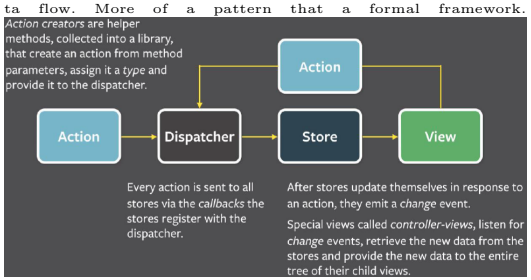
```
public addSample(newSample: SampleModel): Observable<any> {
  return this.resourceService
    .post(newSample)
    .pipe(
      tap(res => {
        this.samples.next([...this.samples.getValue(), newSample]);
      }),
      catchError((err) => this.han     or(err)) );
}

private handleError(err: Ht
  return new ErrorObservabl
}
```

Call data resource service to store the data into the underlying backend-server.

Store the retrieved data into the **BehaviorSubject** and emit the data changed event. It is important to create a new array with the new data; otherwise, the async pipe won't track the change.

Flux Architecture

Invented by Facebook. Enforces a unidirectional data flow. More of a pattern that a formal framework.



Redux Architecture

ngrx: implements the Redux pattern using RxJS. **Benefits:**

- Enhanced debugging, testability and maintainability
- Undo/redo can be implemented easily
- Reduced code in Angular Components

Liabilities:

- Additional 3rd party library required
- More complex architecture
- Lower cohesion, global state may contain UI / business data
- Data logic may be fragmented into multiple effects/reducers

UI Advanced

Pipes

Can be applied within a template expression to make small transformations.

```
<p>{{counter.team | uppercase}}</p>
<p>{{counter.team | uppercase | lowercase}}</p>
<p>{{counter.date | date:'longDate'}}</p>
```

Pure-Pipes: Executed when it detects a pure change to the input expression. Implemented as pure functions. Restricted but fast.
Impure-Pipes: Executed on every component change detection cycle (every keystroke etc.). To reduce processing time, caching is often used.
Predefined-Pipes: *date, number, currency, async* etc.
Angular does not provide Filter- / OrderBy-Pipes because of poor performance.
Custom-Pipes: A class decorated with *@Pipe()*. It implements the PipeTransform interface's *transform()* method. Needs to be added to the declarations of the current Module.

```
<img src="{{counter?.team | logo:'toImage'}}">
```

Specifies arguments to be passed to the transform() method.

```
@Pipe({name: 'logo', pure: true})
export class LogoPipe implements PipeTransform {
  private logos = { /*...*/ };
  transform(value?: string, transformSettings?: string): string {
    if (value && transformSettings && this.logos[value]) {
      return (this.logos[value][transformSettings] || this.logos[value].unspec);
    }
    return value;
  }
}
```

Async Pipes: Binds Observables directly to the UI. Changes are automatically tracked. Automatically subscribes and unsubscribes from the bound Observable.

```
<h1>WE3 - Sample Component</h1>
<section>
  <li *ngFor="let s of sampleService.samples$ | async">
    <ul>{{s.name}}</ul>
  </li>
</section>
```

```
@Component({...})
export class CounterComponent {
  constructor(
    public sampleService:SampleService) {
  }
}
```

View Encapsulation

Component Styles: Apps are styled with standart CSS. The CLI transpiles SCSS to CSS. The selectors of a component's styles apply only within this own template.
Special Selectors:

- *:host* - Target styles in the element that hosts the component
- *:host-context* - Looks for a CSS class in any ancestor of the host element

Link Styles to Component - Options:

- Add a styles array property to the @Component decorator

```
@Component({ /*...*/
  styles: ['h1 { font-weight: normal; }']
})
export class WedNavComponent { }
```

- Add styleUrls attribute into a components @Component decorator

```
@Component({ /*...*/
  styleUrls: ['app/nav.component.css']
})
export class WedNavComponent { }
```

- Template inline tags/styles

```
@Component({ /*...*/
  template: `<style>…</style> … <link rel="stylesheet" href="app/nav.component.css">`
})
export class WedNavComponent { }
```

Controlling View Encapsulation:

- *Native:* Uses the browsers native shadow DOM
- *Emulated:* Emulates the behaviour of shadow DOM by preprocessing (and renaming) the CSS
- *None:* No view encapsulation (scope rules) applied. All CSS added to the global styles.

PWA & Angular & Firebase

Angularfire

- Observable based - Use of RxJS, Angular and Firebase
- Realtime bindings, synchronized data
- Authentication providers
- Offline Data
- Server-side Render

PWA

Progressive Web Apps: Use modern web APIs along with traditional progressive enhancement strategy to create **cross-platform web apps.** Work everywhere and have the same user experience advantages as native apps. **Advantages:** Discoverable, installable, linkable, network independent, progressive, responsive, safe.

React - MobX

Straighforward: write minimalistic, boilerplate free code. The reactivity system will detect all changes and propagate them out to where they are being used.

Redux	MobX
Single Store	Multiple Store
Plain Objects	Business Objekte
Immutable Store	Mutable Store
Normalized Data	Denormalized data
Unidirectional data flow,	Unidirectional data flow (empfohlen)

ASP.NET CORE

Weshalb: Enterprise Framework, Kompilierbare Sprache (C#), Komplett neue Entwicklung, Lauf auf allen Betriebssystemen.
Convention over Configuration.

C#

style=sharpc]

```
// Anonyme Typen
var v =  new { Amount = 100, Message = "Arsch" }
// keine Typechecks / IntelliSense
dynamic person = new ExpandoObject();
// Extesion Methods
public static class MyExtensions {
    public static int WordCount(this string str) {
        return str.Split(new char[] {' ', '.'}).
            length;
    }
}
```

Middleware

```
// Register Middleware
app.Use(async (context, next) => {
    System.Diagnostics.Debug.WriteLine("go req");
    await next.Invoke();
    System.Diagnostics.Debug.WriteLine("end");
});
// Verzweigung für Pfad erzeugen
app.Map("/logging", builder => {
    builder.Run(async (context) => {
        await context.ResponseWriteAsync("Arsch");
    });
});
// Request terminieren, keine neue Middleware
app.Run(async (context) => {
    await context.Response.WriteAsync("Yo");
});
```

Dependency Injection

ASP.NET kommt mit einem primitiven DI Container.
Idee: Klasse erwähnt welche Interfaces benötigt werden. Ein Resolver sucht im Container nach einer geeigneten Klasse und übergibt diese.
DI - Registrierung

```
public class Startup {
    // called by runtime, Used to add services
    public void ConfigureServices(
          IserviceCollection services) {
        services.AddTransient<IUserService,
              UserService>();
    }
    // Called by runtime, Configure HTTP req pipeline
    public void Configure(IApplicationBuilder app,
          IHostingEnvironment env, ILoggerFactory
          loggerFactory) {
        app.UseMiddleware<UserMiddleware>();
    }
}
```

DI - Nutzen

```
public class UserMiddleware {
    private readonly RequestDelegate _next;
    // Captive Dependency*
    public UserMiddleware(RequestDelegate next,
          IUserService userService) {
        _next = next;
    }
    // No Captive Dependency
    public async Task Invoke(HttpContext context,
          IUserService userService) {
        await context.Response.WriteAsync(string.
              Join(", ", userService.Users));
    }
}
    //
```

Lifetime

Transient: Created each time they are requested. Works best for lightweight, stateless services.
Scoped: Created once per request.
Singleton: Created the first time they are requested. Every subsequent request will use the same instance.

Captive Dependency

Komponenten dürfen sich nur Komponenten mit gleicher oder längerer Lebensdauer Injecten lassen.

Projekt-Struktur

wwwroot: Statische Inhalte der Webseite (CSS / JS / HTML). **appsettings.json:** Einstellungen der Webseite (Connection-String für DB). **Programm.cs:** Einstiegspunkt der WebApp. **Startup.cs:** Konfiguriert die WebApp.

Razor

```
@{  var name = "John Doe";
    var weekDay = DateTime.Now.DayOfWeek; }
<p>Hello @name, today is @weekDay</p>
```

Wichtige Dateien

Shared/_layout.cshtml: Generelles layout der App. Definiert Sections (Placeholders), welche von der Page gefüllt werden.
_Layout.cshtml: Struktur der Webseite, identisch für jede Seite.

```
@RenderBody() // Platz für Content
@RenderSection("Nav", false); // Platz für Section
@section Nav{ /* ... */ }
```

_ViewStart.cshtml: Hierarchisch, Code welcher vor den Razor-Files ausgeführt wird. Definiert z.B. das Layout für alle Pages

```
@{ Layout = "_Layout"; }
```

_ViewImports.cshtml: Hierarchisch, Namespaces / Tag-Helpers können in diesem File registriert werden.

Tag Helpers

Ermöglichen C# Code an HTML Tags zu binden. Bsp: Email-Tag durch Link Tag ersetzen.

```
public class EmailTagHelper : TagHelper {
    public string MailFor { get; set; }
    public override void Process(TagHelperContext
          context, TagHelperOutput output) {
        output.TagName= "a";
        output.Attributes.SetAttribute("href", "
              mailto:" + MailFor);
        output.Content.SetContent(MailFor);
    }
}
// Helper im ViewImports-file registrieren
@addTagHelper *, Microsoft.AspNetCore.Mvc.
    TagHelpers
@addTagHelper *, DataBinding
```

Partials

Markup Files, verwendet innerhalb von anderen Markup Files. Bessere Aufteilbarkeit und Wiederverwendbarkeit.

```
<partial name="_Card" for="Card1" />
<partial name="_Card" model="..." />
```

View Components

Mächtigere Variante von Partials. Beinhalten Logik, können Daten laden / auf bearbeiten. Rendert ein Teil der Webseite.
Unterschied zu Pages: Rendern nur ein Teil der Seite.
Location: */ViewComponents*
Razor-File: *Pages/Shared/Components/[ComponentName]/[ViewName]*

```
public class ToDoList: ViewComponent {
    public string[] Todos { get; set; }
    public ToDoList() { /* ... */ }
    public IViewComponentResult Invoke() {
        // /Pages/Shared/Components/TodoList/Default
        return View(Todos);
    }
}
// Razor File
@Page
@{ ViewData["Title"] = "ViewComponent"; }
```

```
<vc:to-do-list></vc:to-do-list>
@await Component.InvokeAsync("ToDoList")
```

ViewData / TempData

Mit Attribut Gekennzeichnete Daten werden allen Razor-Files im Render-Baum übergeben.
ViewData / ViewBag: Daten an das _Layout übergeben
TempData: Überlebt ein redirect, Cookie-Middleware nötig (default aktiv)

Pages

Alternative und vereinfachte Variante vom MVC. Router muss nicht konfiguriert werden. Best-Practices für Serverseitiges-Rendering.
Kombination mit MVC: Statische Seiten mit Pages, REST-API mit MVC.

Routing

WebApp generiert anhand der URL eine Antwort. Bei einem Aufruf wird im Folder */pages/* nach einer Page gesucht und ausgeführt (**case insensitive**):
/add → */pages/add.cshtml*

MVVM

***.cshtml:** View mit Razor

```
@page
@model HelloWorldModel
@{ ViewData["Title"] = "HelloWorld"; }
<h1>@Model.HelloWorld</h1>
```

***.cshtml.cs:** View Model

```
public class HelloWorldModel : PageModel {
    public string HelloWorld { get; set; }
    public void OnGet() {
        HelloWorld = "Hi World!";
    }
}
    //
```

Model

Pro HTTP-Verb kann im VM eine Funktion definiert werden, die davor aufgerufen wird (OnGet / OnPost etc.).
Body und Query werden automatisch gemappt: Parameter werden als Argumente übergeben.

```
public void OnPost(string echoText, long times) {
    EchoText = echoText;
    Times = times;
}
// Param können als Klasse übernommen werden
public void OnPost(EchoModel data) {
    Data = data;
}
// Ohne kopieren der Properties
public class PostModel : PageModel {
    [BindProperty]
    public string EchoText { get; set; }
}
```

View

@page: Definiert das Razor-File als Page
@page /test/{id?}": Überschreibt die Default-Routing-Informationen
Zugriff auf Routing Parameter:

```
// Im Razor-File
@page "/test/{id:int?}"
<p>ID: @RouteData.Values["id"]</p>
// Im Model
public int Id { get; set; }
[BindProperty(SupportsGet = true, Name = "Id")]
public int Id2 { get; set; }
public void OnGet(int id) { Id = id; }
```

AJAX

Handlers

Pages können Actions als handler anbieten.
Namenskonvention: *On[Method][Name]*

```
public IActionResult OnPostEcho(strong echoText) {
    return this.Content(echoText);
}
```

Zugriff: */[Page]?handler=[HandlerName]*
Bsp: POST auf */Ajax?handler=echo*
Rückgabewerte (IActionResult)

- ContentResult: StringResult, JsonResult, EmptyResult
- Status: NotFoundResult, StatusCodeResult
- Redirects: RedirectToPage, RedirectToPagePermanent
- Hilfsmethoden: Page(), Partial(), Content()

Entity Framework

Code First benötigt: Type Discovery (Welche Klassen in die DB), Connection String, DbContext (Entry Point)
Migration: EF Core erlauft keine automatische Migrationen von Model Änderungen mehr. Aktuell nur über Konsole: *dotnet ef database update*

Entity Konventionen

public [long/string] Id: wird automatisch zum PK
public virtual ApplicationUser Customer: Als Navigation Property erkannt
public [long/string] CustomerId: Als FK für Customer Property erkannt

Wichtige Attribute

[Required]: NotNull in DB, **[NotMapped]:** Nicht in DB geschrieben, **[Key]:** Definiert den PK, **[MaxLength(10)]:** Allokationsgrösse in DB

Validierung

Schritt 1: Annotieren der Klassen

Mögliche Attribute: [StringLength(60, MinimumLength = 3)], [RegularExpression(@"...")], [Required], [DataType(DataType.Date)]. Attribute sind kombinierbar.

Schritt 2: Razor anpassen

Validation ins DOM einfügen:

```
<div asp-validation-summary="ModelOnly"></div>
<span asp-validation-for="Item.Name"></span>
```

JQuery Validation einbinden:

```
@section Scripts {
    <script src=".../jquery.validate.js"></script>
    <script src=".../...unobtrusive.js"></script>
}
```

Schritt 3: Serverseitige Validierung

```
[HttpPost]
public ActionResult Index(Order order) {
    if(ModelState.IsValid) {
        order.CustomerId = User.Identity.GetUserId
            ();
        _db.Orders.Add(order);
        _db.SaveChanges();
        return View("OrderOk", order);
    } return BadRequest();
}
```

Authentifizierung

ASP.NET Identity Features: PW Stärke, User Validator, Lockout Mechanismus, 2Faktor Auth, Reset PW, OAuth
ASP.NET Identity Klassen:

- UserManager<ApplicationUser>
- RoleManager<IdentityRole>
- IAuthorizationService: Validation von Policies
- SingInManager

Aktivierung & Konfiguration

Startup.cs:

```
services.AddDefaultIdentity<IdentityUser>() // DI
    .AddEntityFrameworkStores<ApplicationDbContext
        >()
    .AddDefaultTokenProviders();
app.UseIdentity(); // Middleware
// Einstellungen
services.AddDefaultIdentity<IdentityUser>( options
    => {
    options.Password.RequireDigit = false;
    options.Password.RequiredLength = 8;
}).AddRoles<IdentityRole>()
.AddEntityFrameworkStores<ApplicationDbContext>()
```

Anwenden

Attribute:
[Authorize]: User muss authentifiziert sein (Controller/Actions)
[AllowAnonymous]: Ausnahme für spezifische Action

```
this.User // Eingeloggter User Typ: ClaimsPrincipal
// CRUD Operationen über ApplicationUsers von DI
var user = await _userManager.GetUserAsync(User);
var id = _userManager.GetUserId(User);
```

Claim: Statement über einen User, ausgestellt von einem Identity Provider.

Authentifizierung Prüfen

```
// Automatisch
[Authorize]
public ActionResult Create() { return View(order);
    }
// Manuell
public ActionResult Create() {
    if(User.Identity.IsAuthenticated) { /* ... */ }
    else { return new StatusCodeResult(401); }
}
```

Authorisierung

```
// Lösung 1: Attribute:
[Authorize(Roles = "Admin, PowerUser")]
[Authorize(Policy = "OlderThan18")]
// Lösung 2: Services:
var isInRole =
    await _userManager.IsInRoleAsync(user,"Admin");
// Lösung 3: Claims
User.HasClaim(ClaimTypes.Role, "Admin")
```

Policy

Ermöglichen es, komplexere Regeln zu definieren.

```
options.AddPolicy("Founders", policy => {
    policy.RequireAuthenticatedUser();
    policy.RequireClaim(ClaimTypes.Name, "joe", "")
        ;
});
```

Authorizierung mit Razor

```
@inject UserManager<ApplicationUser> manager;
@inject ApplicationDbContext context;
@{
    var user = await manager.GetUserAsync(User);
    if(user != null &&
        await manager.IsInRoleAsync(user, "Admin"))
        { /* ... */ }
}
```

Testing

Unit Test mit ASP.NET

```
public class UnitTest {
    [Fact]
    public void TestName() { /* ... */ }
}
```

App Secrets

Ermöglicht es, Secrets in einem separaten File zu persistieren.

```
// Wert setzen:
dotnet user-secrets set "admin-pwd" "123456"
// Wert nutzen:
if(env.IsDevelopment()) {
    builder.AddUserSecrets<Startup>(); }
app.ApplicationServices.GetService<DataService>()
    .EnsureData(Configuration["admin-pwd"]);
```

API Routing

Startup

Nur die nötigen Services und Endpoints registrieren.

```
public void ConfigureServices(IServiceCollection
     services) {
    services.AddRazorPages();
    services.AddControllersWithViews();
    services.AddControllers();
    services.AddMvc();
}
public void Configure(IApplicationBuilder app,
                      IWebHostEnvironment evn) {
    app.UseRouting();
    app.UseEndpoints(endpoints => {
        endpoints.MapControllers();
        endpoints.MapRazorPages();
        endpoints.MapBlazorHub();
    });
}
```

Verwendung

Funktioniert über Attribute. *[Route]* definiert einen neuen Eintrag im Router. *[HttpMethod]* bei Actions ist required.

```
[HttpPost]
[Route("/foo")]
oder
[HttpPost("/foo")]
```

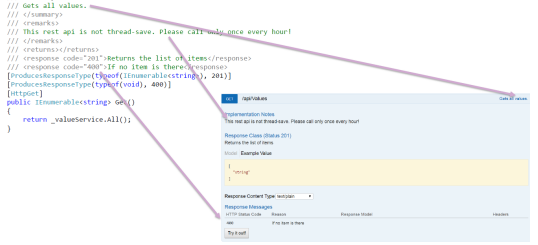
POST /foo

```
[HttpPost]
[Route("foo")]
oder
[HttpPost("foo")]
```

POST /api/Values/foo

Swagger

Eine Spezifikation für die Dokumentation von REST APIs. Programmiersprachen unabhängig. Wird im *Startup.cs* eingetragen. Defaultmässig unter *http://[server-name]/swagger* erreichbar. C# ermöglicht es Kommentare als XML zu exportieren. Dieses XML-File kann von Swagger genutzt werden um die API zu beschreiben.



REST HATEOAS

Idee: Verlinkte Daten als Links zu Verfügung stellen.

Exception Handling

Error Handling soll generisch funktionieren.
Vorgehen: Es gibt eine Exception, welche die notwendigen Daten sammelt. Es gibt einen globalen Errorhandler, welcher diese Exception für Client aufbereitet. Bei einem ungültigen Zustand wird Custom-Exception ausgelöst.