STATE MANAGEMENT

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Assumptions

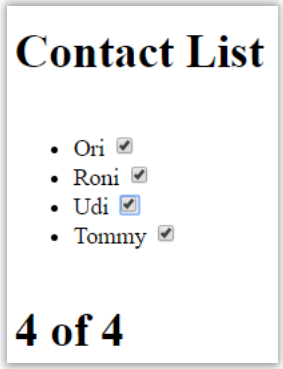
- Component based architecture
  - Component = tag+code+template+styles
  - Component is responsible for managing the view/DOM
- Application consists of multiple components
- We want isolated components
  - Allows for reusability
  - Easy of maintenance
- Components effect each other

The Challenge

- Keep all components synchronized
- Minimize DOM writes
- Minimize change detection
- Easily understand the flow of a change
- State modification is atomic
- State is valid even in the case of an error
- Restore state from server/client/routing
- Support undo ?

Scenario

- A component which displays a list of contacts
- Each contact can be selected
- Status component which displays the number of selected contacts and the total number
- Selecting/unselecting component effects the status
- The contact list component should be unaware of the status component



Solution 1 – Mediator

- Use the parent component to manage the interaction between siblings
- The contact-list component raises an event
- The parent handles the event and updates internal state which is bound to the status component

Solution 1 - Component Mediator


```
<h1>Contact List</h1>

<my-contact-list [contacts]="contacts"
                 (selectionChanged)="onSelectionChanged($event)">
</my-contact-list>

<my-status [all]="contacts"
           [selected]="selected">
</my-status>
```

```
export class AppComponent {
  contacts: Contact[];
  selected: Contact[];

  constructor() {
    this.contacts = [...];
    this.selected = [];
  }

  onSelectionChanged($event: SelectionChanged) {...}
}
```

Pros & Cons

- Straight forward solution
- Since parent manages the whole state it can be easily duplicated and reused
- Intermediate components must support inputs that are reflection of deep components state
- Intermediate components need to “bubble up” events

Solution 2 – Service Facade

- Remove all inputs & events
- All components talk to a single service façade
- The service holds the whole state for all components
- Each component is bound to the state directly
  - By holding a reference
- A component delegates user action to the service
- The service “fixes” all relevant state

Solution 2 – Service Facade


```
export class ContactService {
   contacts: Contact[];
   selected: Contact[];

   constructor() {
      this.contacts = […];
      this.selected = [];
   }

   changeSelection(contact, selected) {…}
}

export interface Contact {
   id: number;
   name: string;
   selected?: boolean;
}
```

```
export class ContactListComponent {
   constructor(private contactService: ContactService) {
   }

   get contacts() {
      return this.contactService.contacts;
   }
}
```

```
export class ContactListItemComponent {
   @Input() contact: Contact;

   constructor(private contactService: ContactService) {
   }

   changeSelection(contact, selected) {
      this.contactService.changeSelection(contact, selected);
   }
}
```

Pros & Cons

- No need to propagate event/inputs through intermediate components
- State is more accessible since it resides inside a service which can be injected everywhere
- Service is singleton → Cannot duplicate components with different state
  - Can be fixed by using Component's provider
- Components are stateless → Can remove/recreate component while keeping state
  - Router scenario

System wide solution ?

- Can we apply this technique to the whole application ?
  - No state inside component
  - Every component delegates the work to a service
  - The service is responsible for fixing all related state
  - Angular is responsible for updating components through data binding
- Yes we can. However …

System wide solution ?

- A component should not be aware of the scope of a change
- Therefore, most components delegate the work to a single root service
- The root service is responsible for “spreading the news”
- Can use
  - Broadcasting mechanism
  - Manual invocation

Unidirectional Data Flow

- State resides inside services
- Each service may use other service to handle part of the change
- It is important to control the change flow
  - We don't want cycles
- We can arrange services inside tree and prohibit access between
  - Sibling services
  - Child to parent

Reaction

- Two components/services might need the exact same data
- Who is the owner ? SRP again …
- Solution
  - One service is responsible for modifying the data
  - The other one only “reacts” to the change
- We need two phases
  - One for pushing data
  - Second for synchronizing it
- Both should be unidirectional

Reaction


```
export class RootService {
    state: AppState;

    constructor(private contactService: ContactService,
                private selectionService: SelectionService,
                private searchService: SearchService) {
    }

    refresh() {
        this.contactService.refresh();

        this.onContactsLoaded();
    }

    private onContactsLoaded() {
        const all = this.state.contacts.all;
        this.searchService.onContactsLoaded(all);
        this.selectionService.onContactsLoaded(all)
    }
}
```

Reaction

Modification

Can use broadcasting instead of manual invocation

Where are we ?

- End user clicks a button
- Component initiates an activity/action
- A service manages the scope of the activity
- Application state is changed
- Some effects/reactions may occur after state modification
- State is now stable
- Angular/React detects changes and modifies the DOM

Annotation

- Annotations are powerful way to describe code intents

```
export class SelectionService {
   state: SelectionState;

   @Activity()
   change(contact: Contact, selected: boolean) {
      if(selected) {
         this.state.selected.add(contact);
      }
      else {
         this.state.selected.delete(contact);
      }
   }

   @Query()
   isSelected(contact: Contact) {
      return this.state.selected.has(contact);
   }

   @Reaction()
   onContactsLoaded(all: Contact[]) {
      this.state.all = all;
   }
}
```

Not just description

- Decorator can intercept method invocation

```
export function Activity() {
   return function(target, prop) {
      const original = target[prop];

      return target[prop] = function() {
         const name = target.constructor.name + "." + prop;
         console.log("BEGIN", name);

         const before = performance.now();
         const retVal = original.apply(this, arguments);
         const after = performance.now();

         console.log("END", name, (after-before));

         return retVal;
      }
   }
}
```

Optimizing Change Detection

- The previous pattern offers no optimization
- A single action can change every thing
- There is no easy way for Angular to understand the scope of a change
- Therefore, Angular checks every component for each user/async event
  - Is it really a bad idea ?
  - Agular needs only a few milliseconds (<10) to check more than 10000 bindings

Hold your horses

- Assuming optimization is the art of compromising
- What is the price of optimizing change detection ?
  - Answer: A restricted state modification logic
- For applications that significantly hold more data than bindings
- The restrictions might incur higher price than the benefit of optimized change detection

Optimizing Change Detection

- Angular offer some ways to optimize change detection
- It assumes that data does not change inline
- But rather the whole object is cloned and updated
- Thus, Angular can just examine the reference/input

ChangeDetectionStrategy.OnPush

- Angular skip component's change detection unless one of its input changes
- An input is "shallow" checked
  - Only the reference is checked
  - Not nested fields
- Therefore we need to use immutable data and clone the data once it changes

Immutability - System wide solution ?

- Should we apply the immutability principle cross the whole application ?
- Going that direction means our code changes dramatically
  - No more inline editing ☹

```
const clone = this.state.all.concat([]);

for(let update of updates) {
   const index = clone.findIndex(c => c.id == update.id);
   if(index != -1) {
      clone[index] = Object.assign({}, clone[index], update);
   }
}
```

Immutability - Advantages

- Immutability offers many advantages
  - It is easy to detect a change
  - So even components without Input can be optimized
  - History data can be saved and restored → Undo is easy to implement
  - Data never changes → Data is atomic
- However
  - Cloning object is expensive
  - Must measure cloning vs. change detection

Where are we ?

- Externalizing components state
- Unidirectional data flow
- Single data store
- Immutability
- Modification has side effects/reaction

- Can someone help with that mess ?

Redux

- The most popular implementation of the Flux pattern
- Is not strictly Flux compatible
- Has no framework affinity
  - Although is most popular under the React eco-system
- More than 2M downloads per month

Redux - Ingredients

- Store – A single immutable data store
  - Everyone can subscribe to changes
- Action – Resembles a user action
- Reducer
  - Responsible for modification
  - Enforce immutability
  - Cannot handle asynchronous operations
- Action creator/Thunk
  - Business logic
  - Handles asynchronous activities

ngrx

- Same principles of Redux, but
- Store is observable
  - Thus, can react to change using reactive programming
- Effects can be installed
  - Same role as redux/thunk
  - But again … reactive programming

Mobx

- Adds observable capabilities to existing data
- You define a simple data model
- Using decorators Mobx monkey patches the properties and make them observable
  - Does it make you a bit nervous ?
- Mobx is aware of any data change and therefore can render component automatically
- Mobx is unopinionated about how user events should be handled

Summary

- The principles are important not the frameworks
  - Unidirectional data flow
  - Single store
  - Immutability
  - Externalize state & work out of components
- Functional/Reactive programming changes some of our patterns