# Week 09: State management in React, Auth

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## Outline

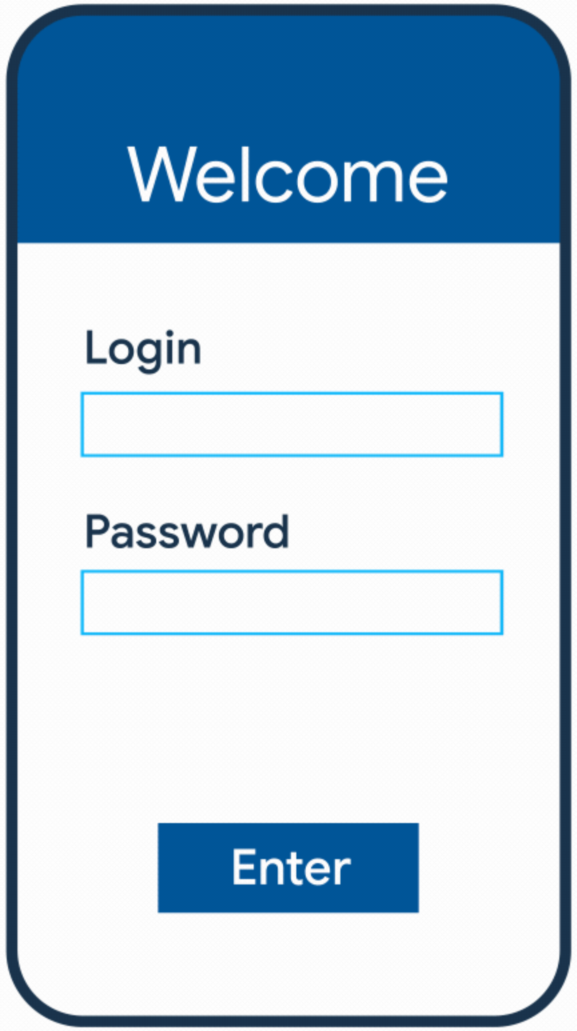
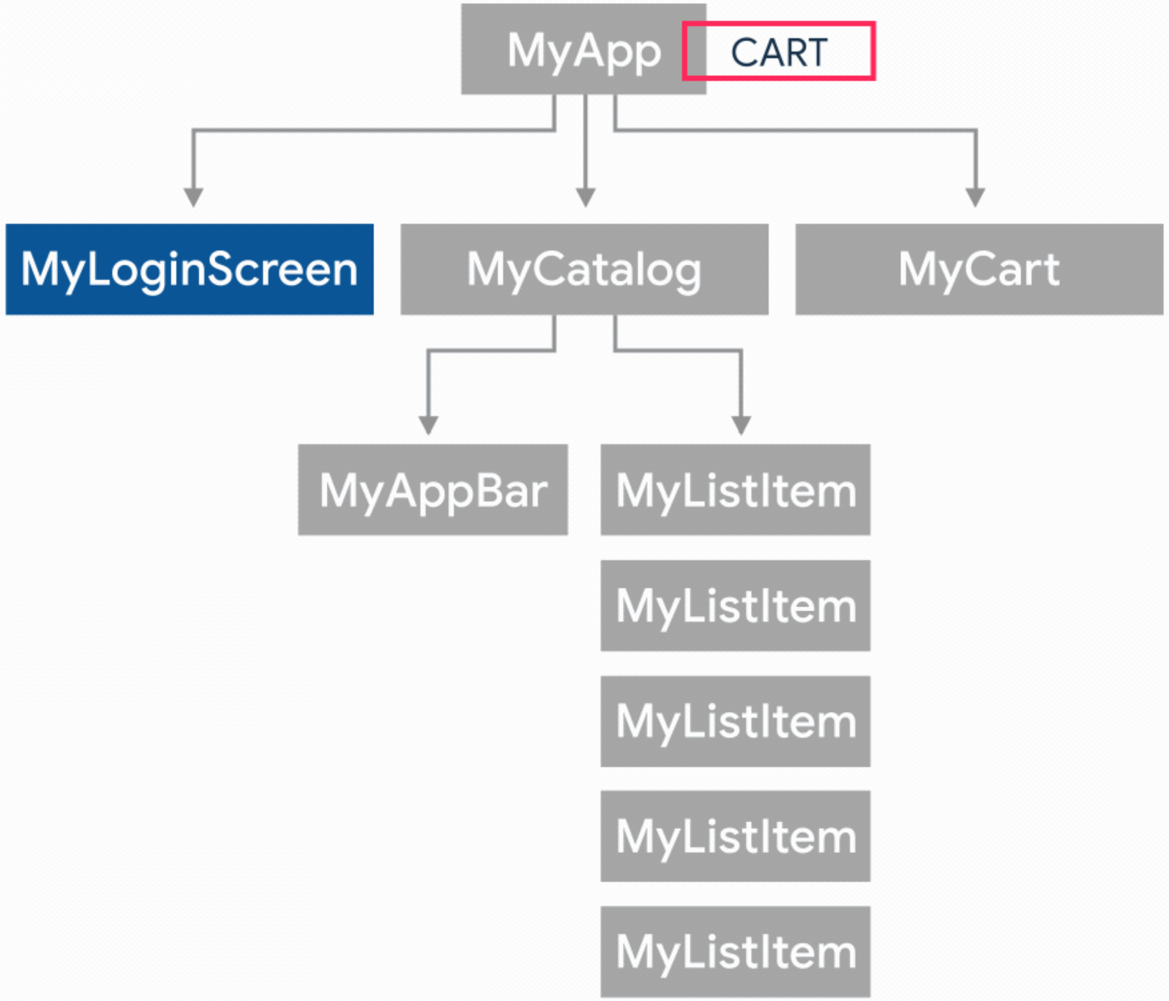
- What is state management? Why do we need it?
- History of state management in React
- State segregation
- Modern state management

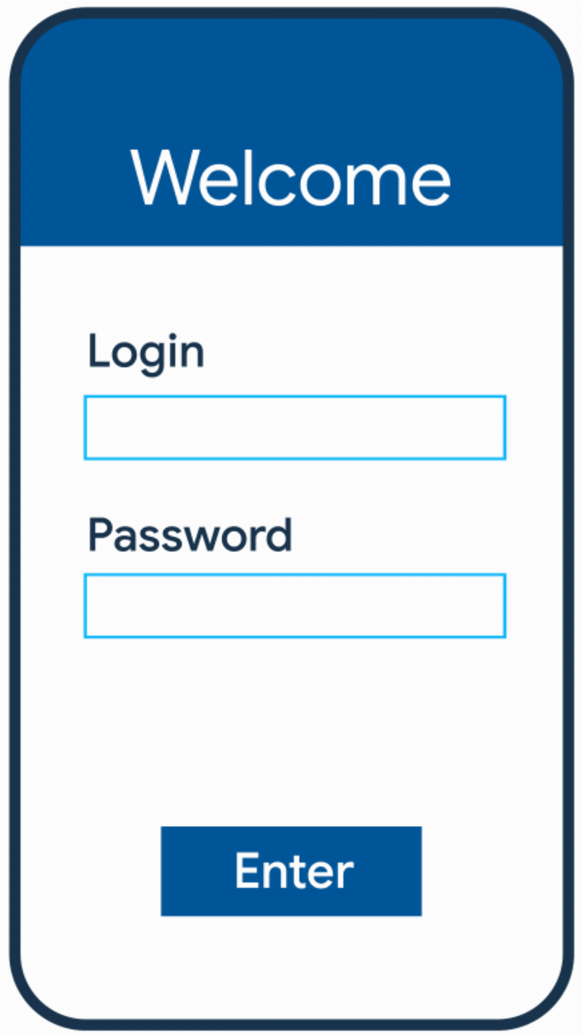
## What is state management? Why do we need it?

## We don't!*

## What is state management? Why do we need it?

- A way to manage the state of your application (duh)
- State is data that is used by your application
- State management is needed because:
    - State is shared between components
    - State is updated by multiple components
    - State is updated by external sources (API, user input)


Welcome
Login
Password
Enter

MyApp
CART
MyLoginScreen
MyCatalog
MyCart
MyAppBar
MyListItem
MyListItem
MyListItem
MyListItem
MyListItem


Welcome
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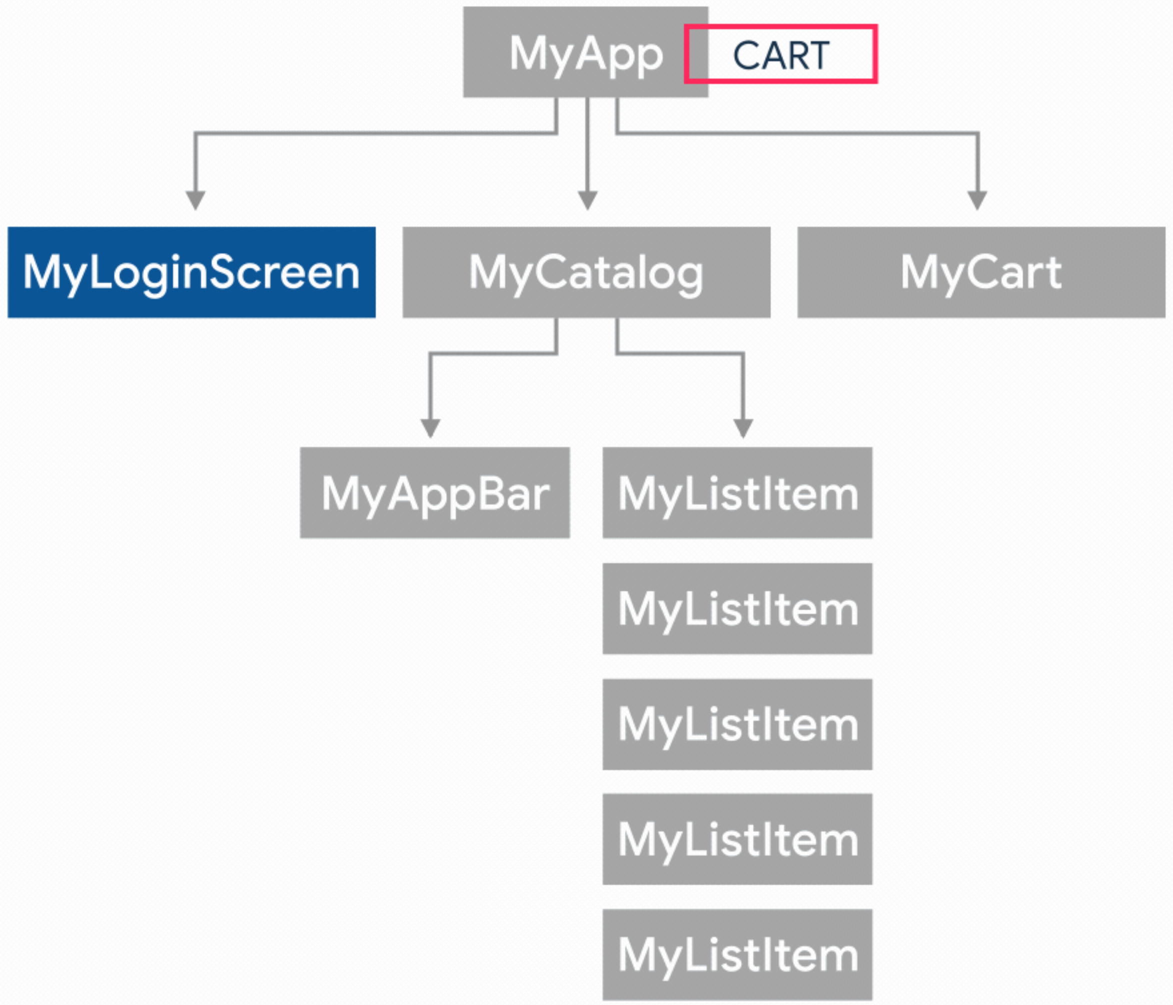
MyApp
CART
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MyListItem
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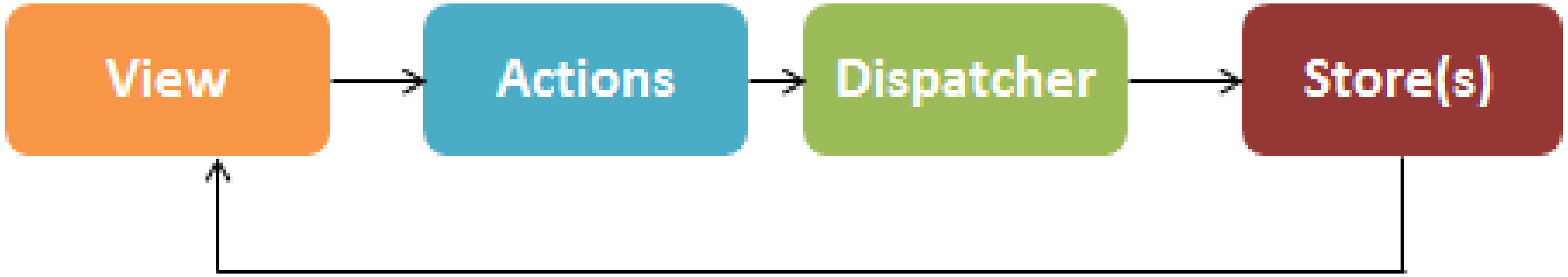
MyListItem
MyListItem

## History of state management in React

## Pre-redux era (< 2016)

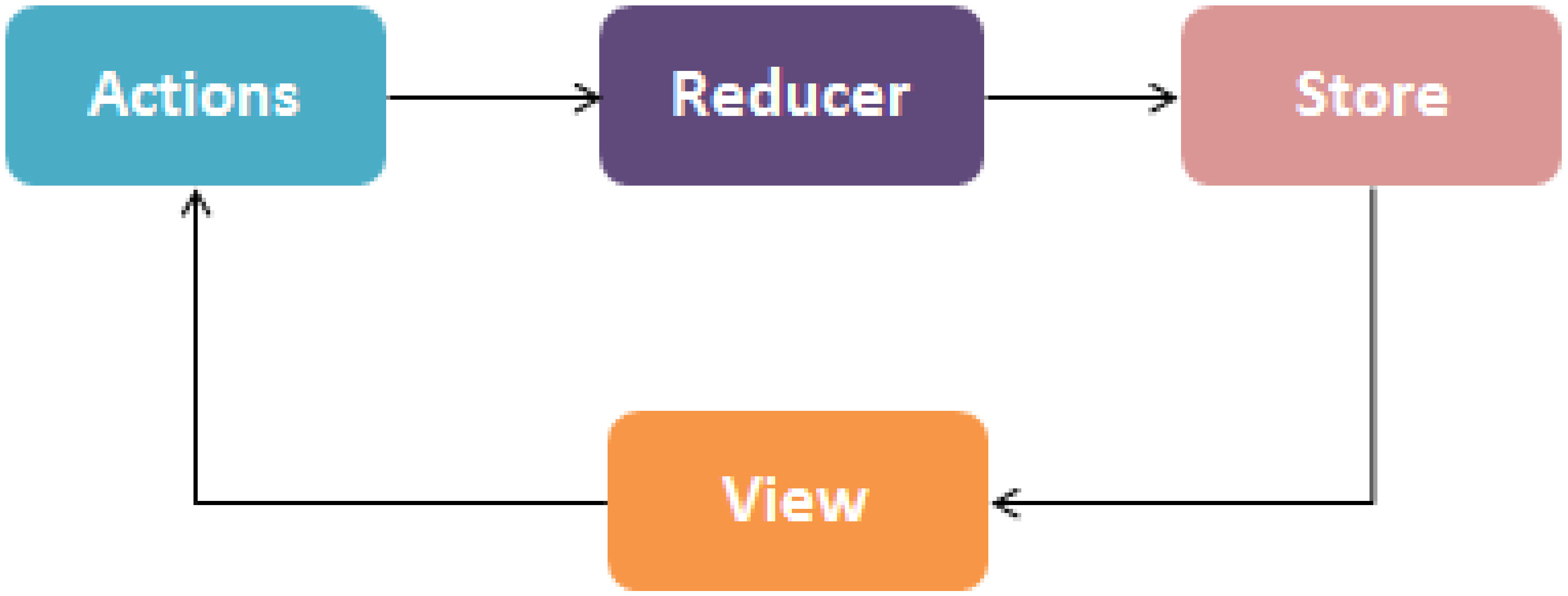
- React's self contained components were an unexplored concept
- Nobody knew what they were doing
- `Lifting state up` was a common way to share state between components
  - `God` components
  - Prop drilling
- Emerging patterns:
  - `Flux` architecture



Flux Architecture

## Redux (2016 - 2020)

- Created by Dan Abramov and Andrew Clark
- A simplification of the `Flux` architecture, Redux introduces a single store that is the source of truth for the entire application
- State is immutable and can only be updated by dispatching actions
- Actions are processed by reducers, which update the state



Redux Architecture

## Redux (2016 - 2020)

```
type Action =
  | { type: "increment" }
  | { type: "decrement" }
  | { type: "set"; payload: number };

type State = { count: number };

function counterReducer(state = State, action: Action) {
  switch (action.type) {
    case "increment":
      return { count: state.count + 1 };
    case "decrement":
      return { count: state.count - 1 };
    case "set":
      return { count: action.payload };
    default:
      return state;
  }
}
```

## Redux (2016 - 2020)

- Reducers cannot be async -> a new layer before reducers is introduced: redux middleware
  - in an era without async/await, async stuff was painful
  - `redux-thunk`, `redux-saga`, `redux-observable`
- A lot of boilerplate
- Everything is in one place (store)
- Immutable updates for nested objects
- Heavy!
- Fundamentally changes how you write your app
- Large ecosystem of libraries and tools for almost everything

## React Context API (> 2019)

- React's built-in state management solution
- Grew to popularity with hooks
- Declare a context and insert it into the component tree:

```
const MyContext = React.createContext(defaultValue);
```

```
<MyContext.Provider value={value}>
  <MyComponent />
</MyContext.Provider>
```

- Anything inside of `value` can be accessed via a `useContext(MyContext)` hook

## React Context API (> 2019)

- You can put `useState` values and functions in the context, sharing them between components

```
const [state, setState] = useState(initialState);
const value = useMemo(() => ({ state, setState }), [state]);
```

```
<MyContext.Provider value={value}>
  <MyComponent />
</MyContext.Provider>
```

> But, remember how `react` re-renders components?

> **The above is a very bad idea for global state management**

## Sidetrack: `useReducer`

- `useReducer` is a hook that is similar to `useState`, but it allows you to manage more complex state
- uses the same reducer pattern as `redux`

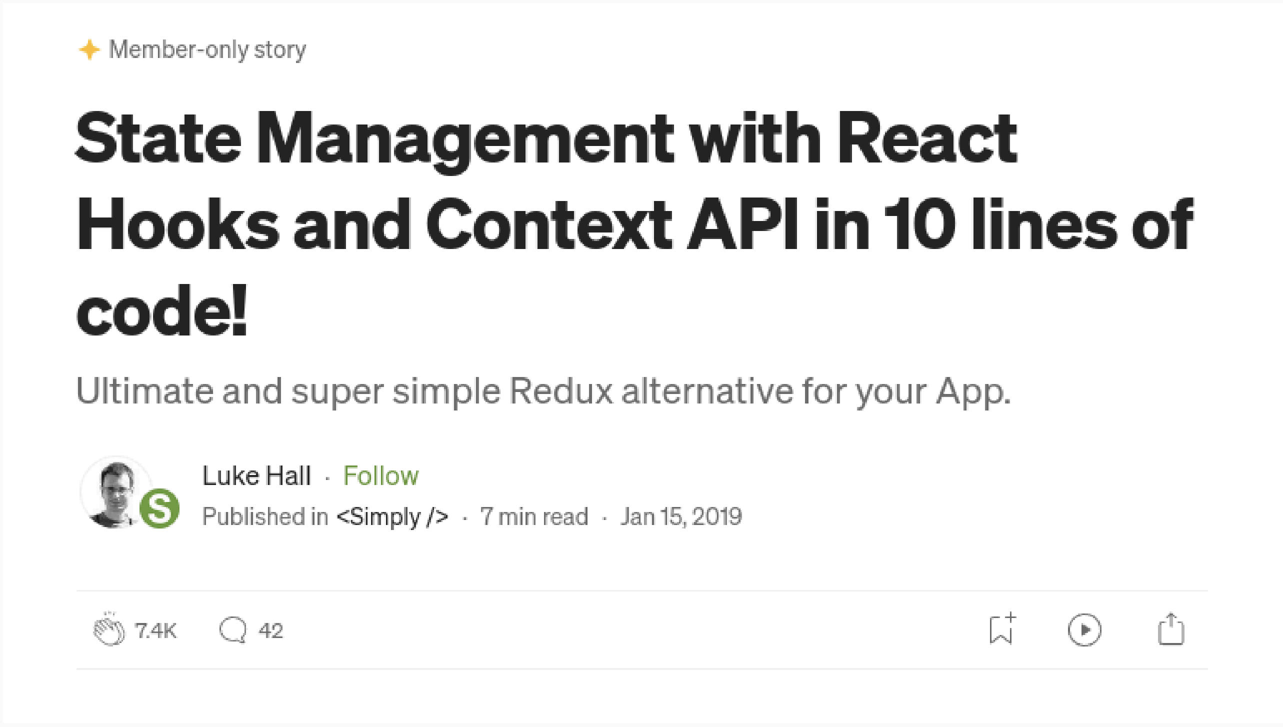
```
const [state, dispatch] = useReducer(reducer, initialState);
```

```
const reducer = (state: State, action: Action) => {
  switch (action.type) {
    case "increment":
      return { count: state.count + 1 };
    case "decrement":
      return { count: state.count - 1 };
    case "set":
      return { count: action.payload };
    default:
      return state;
  }
};
```

## Antipattern: Poor mans redux

- You can combine `useReducer` and `useContext` to create a poor mans redux in like 10 lines of code

> **DO not do this**, this is not a replacement for redux (or any other state management solution)



Member-only story

State Management with React Hooks and Context API in 10 lines of code!

Ultimate and super simple Redux alternative for your App.

Luke Hall · Follow

Published in <Simply /> · 7 min read · Jan 15, 2019

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## Change of perspective: State segregation

- Rather then treating all of our application state as `global` and one big pile of `data` handled by a generic manager, use specialized tools for specialized tasks
- There is no need to reinvent the wheel!
- Form data? Use `react-hook-form`
- API? Use `Tanstack Query`
- Routing? Use `react-router`
- Local state? Use `useState` / `useReducer`
- Local state across multiple components? Use `useContext`
- ???

> What else do we need to track of in an app?

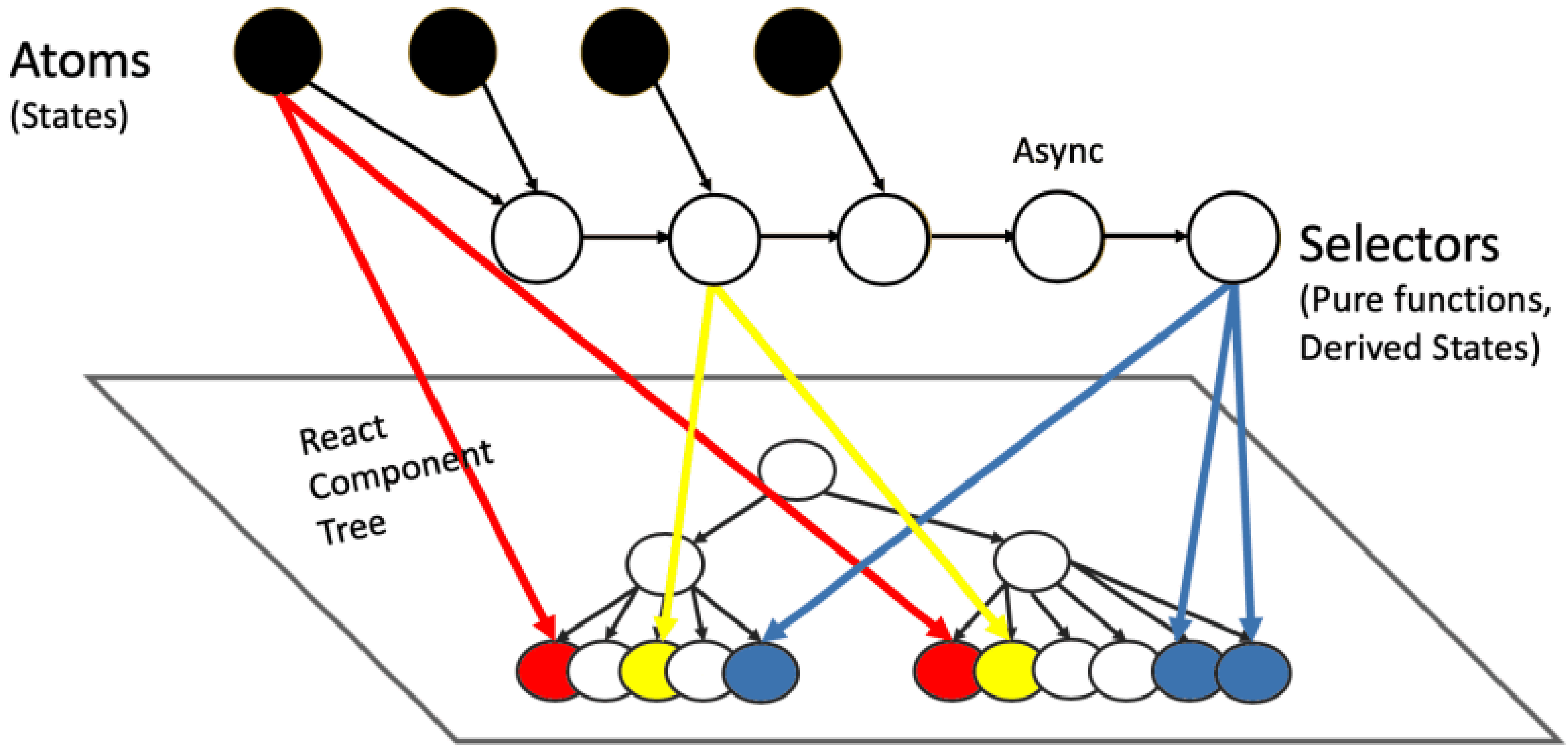
## State segregation

- There is nothing left! We have covered all of the state management needs of our application.
- Almost... (theme, current user, etc.)
- Most of the time, you will not need a global state management solution anymore

## Modern state management

- Ideal state is:
    - handle all state updates outside of React (it is bad at it, wants to re-render everything)
    - only notify and update components that are interested in the state change

## Composable state (atoms)


Atoms
(States)
Async
Selectors
(Pure functions,
Derived States)
React
Component
Tree

## Composable state (atoms)

- Originally a react core team's idea, now implemented as `Recoil`

```
const countState = atom({
  key: "countState",
  default: 0,
});

function Counter() {
  const [count, setCount] = useRecoilState(countState);
  return <div>{count}</div>;
}
```

- Recoil is a bloated library for what it provides, `jotai` is a much better implementation

## Signals

- Observer pattern for state management, introduced by `solid-js`
- By far the most performant solution for state management!
- Backported to react as `@preact/signals-react`

## Auth

## Outline

- Access control
- AuthN vs AuthZ
- Common auth patterns
- Auth in Express
- Auth on the frontend
- Security considerations

## Access control

- Only allow access to resources to authorized users
- Different users have different permissions

> User level access: only the resource owner can access the resource
> Role-based access control: users are assigned roles, roles have permissions
> Rules, policies, etc...

## AuthN vs AuthZ

- Authentication (AuthN) is the process of verifying the identity of a user
- Authorization (AuthZ) is the process of verifying that the user has the necessary permissions to access a resource
  - Easy to mix up, but they are different things
- AuthN and AuthZ are often handled together (Auth / AA) by an application

## Common auth patterns

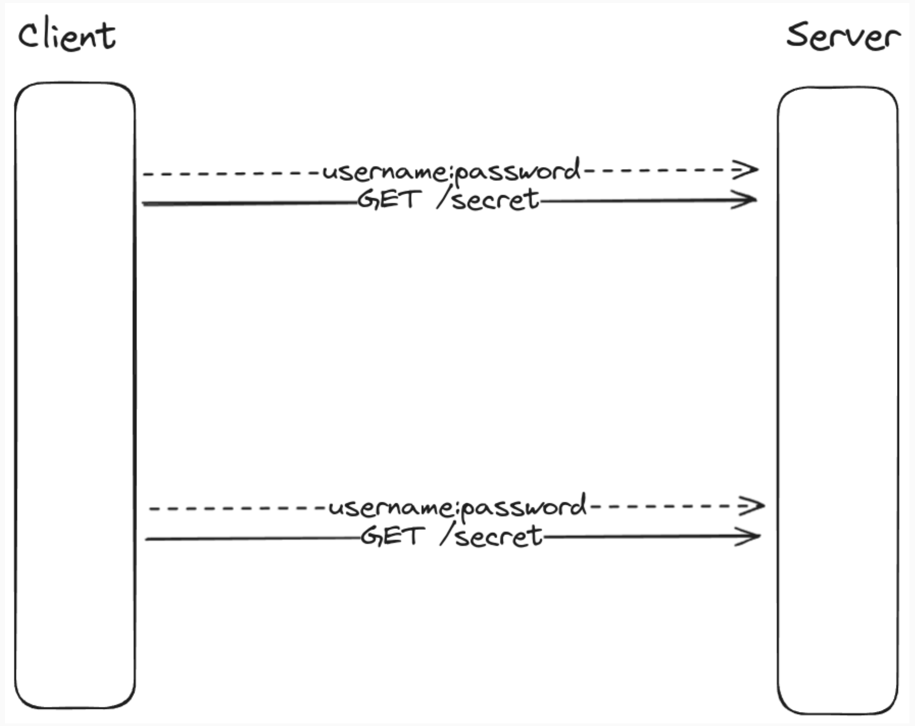
## Basic auth

- Username and password
- Sent in the `Authorization` header
- Base64 encoded

```
Authorization: Basic QWxhZGRpbjpvcGVuIHNlc2FtZQ==
```

- Not secure, use encrypted connections
- Some clients allow encoding the password in the URL

```
smtp://username:password@server:587
```



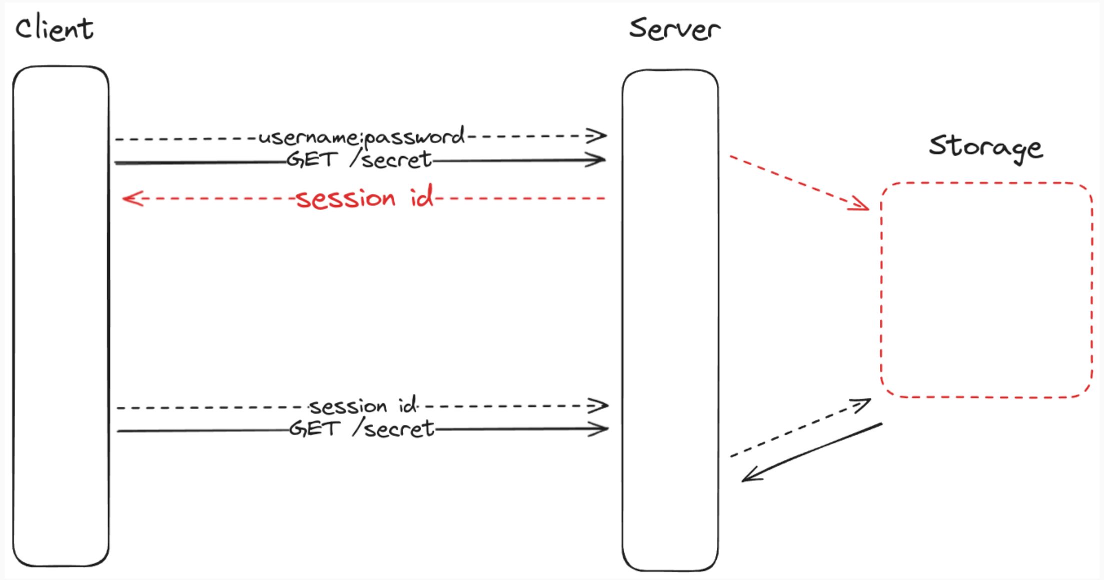
## Token based auth

- A client authenticates with a server and receives a token
- The token is then used for subsequent requests

## SessionID

- Create a unique session ID for each successful authentication
- Store it a database
- Send it to the client
- Client sends it back with each request

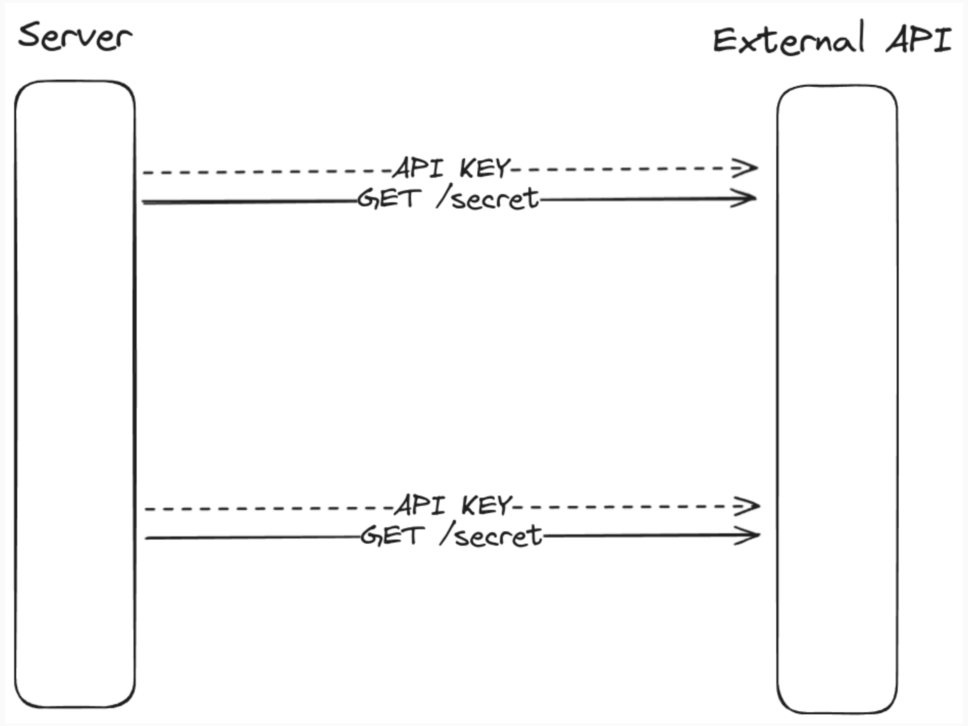
> Overhead of storing sessions 'somewhere', stateful



## API keys

- Used for authenticating against an external API
- Can be of any format

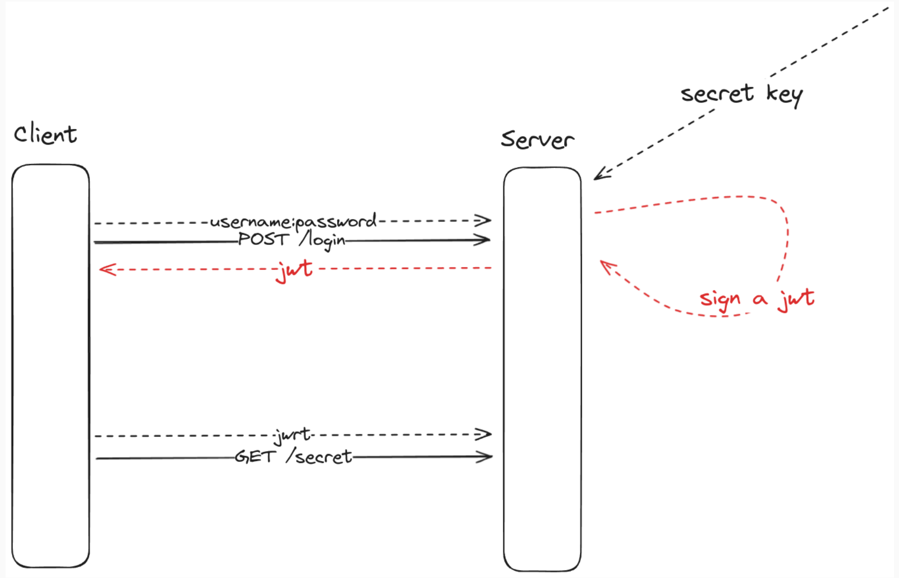
> Generally considered insecure
> ? Principle of least privilege
> Rotate keys often



## JWT

- JSON Web Token
- Self-contained, signed token
- Contains claims (data) about the user
- Cryptographically signed with a given expiry
- [jwt.io](jwt.io)

> Invalidation/revoking



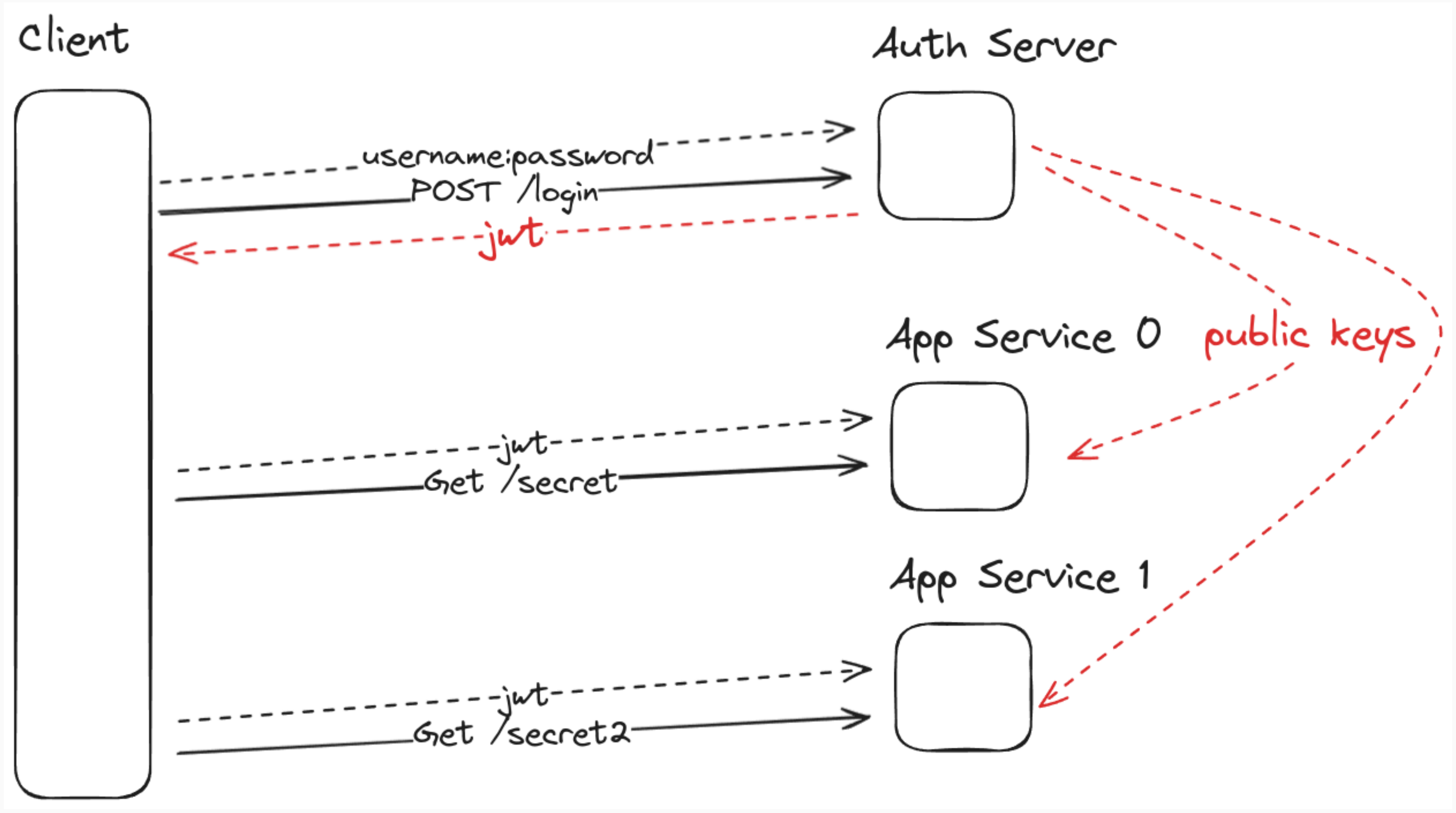
## OAuth2/OpenID Connect

- OAuth2 is an authorization framework
- OpenID Connect is an identity layer on top of OAuth2
- Used for single sign-on (SSO), "social login"
- Allows third-party applications to access resources on behalf of a user

> Requires multiple token exchanges for security
> Complex, but very powerful

## Pattern: Federated auth

- Dedicating a separate service for authentication and authorization
- Allows for more flexibility and scalability
- Allows multiple services to authenticate against the same service!
- In case of a breach, it is more difficult to access all the users' data
- Allows you to use an off the shelf solution, reducing the risk of introducing vulnerabilities


Client
Auth Server
username:password
POST /login
jwt
App Service 0
public keys
jwt
Get /secret
App Service 1
jwt
Get /secret2

## Auth in Express

`passport.js` is a middleware for Express that handles session management

```
app.post("/login/password", passport.authenticate("local"));
```

- `middleware`
- `strategies`
- `sessions`

## Strategies

- A strategy is a way to authenticate a user
- Over 500 strategies available!

For local username/password authentication:

```
npm install passport-local
```

OpenID Connect:

```
 npm install passport-openidconnect
```

## Sessions

Passport also contains connectors for session management

- `express-session`

```
app.use(
  session({
    secret,
  })
);
app.use(passport.session());
```

- internally uses cookies

## But wait? Where do I store the token for token-based auth?

## HTTP cookies

- both sides (client and server) are allowed to read and write them (most of the time)
- Usually the server sets a cookie with the token
- Logout can be done by deleting the cookie

> setting the cookie as `httpOnly` prevents client-side JS from reading it

## Headers

- The token can be sent in the `Authorization` header (just as with basic auth)

```
Authorization: Bearer <token>
```

- This header is then read by the server, but has to be sent by the client.
- Here, the client has to manage the token

> Local storage, session storage...

## Security considerations

## XSS

- Cross-Site Scripting
- Attacker injects malicious scripts into a website and can get access to cookies, session tokens, etc.

## CSRF

- Cross-Site Request Forgery
  - Forces authenticated users to submit a request to a Web application against which they are currently authenticated
- Mitigation: CSRF tokens

## Password storage and validation

- **Never store passwords in plaintext!**
- Always use a secure hashing algorithm (argon2, scrypt, bcrypt)
- Salting

Hashing:

```
const hash = await argon2.hash(..);
```

```
try {
  if (await argon2.verify("<big long hash>", "password")) {
    // password match
  } else {
    // password did not match
  }
} catch (err) {
  // internal failure
}
```

## Rate limiting

- Prevents brute force attacks
- Limits the number of requests a user can make in a given time frame
- Protects underlying infrastructure
- For sensitive endpoints, require the user to solve a challenge (captcha) to prevent automated attacks
- The above doesn't work well anymore (AI)

## Web Application Firewalls

Generally a paid service. Filters out malicious traffic.

WAF uses a set of heuristics and rules to determine if a request is malicious, can prompt the user to solve a challenge if the target is a website.

## OWASP

- Open Web Application Security Project
- A community that produces freely-available articles, methodologies, documentation, tools, and technologies in the field of web application security
- OWASP Top 10

## Thanks for listening!

- Questions?