Blazor State Management

Managing User Data Across Client and Server

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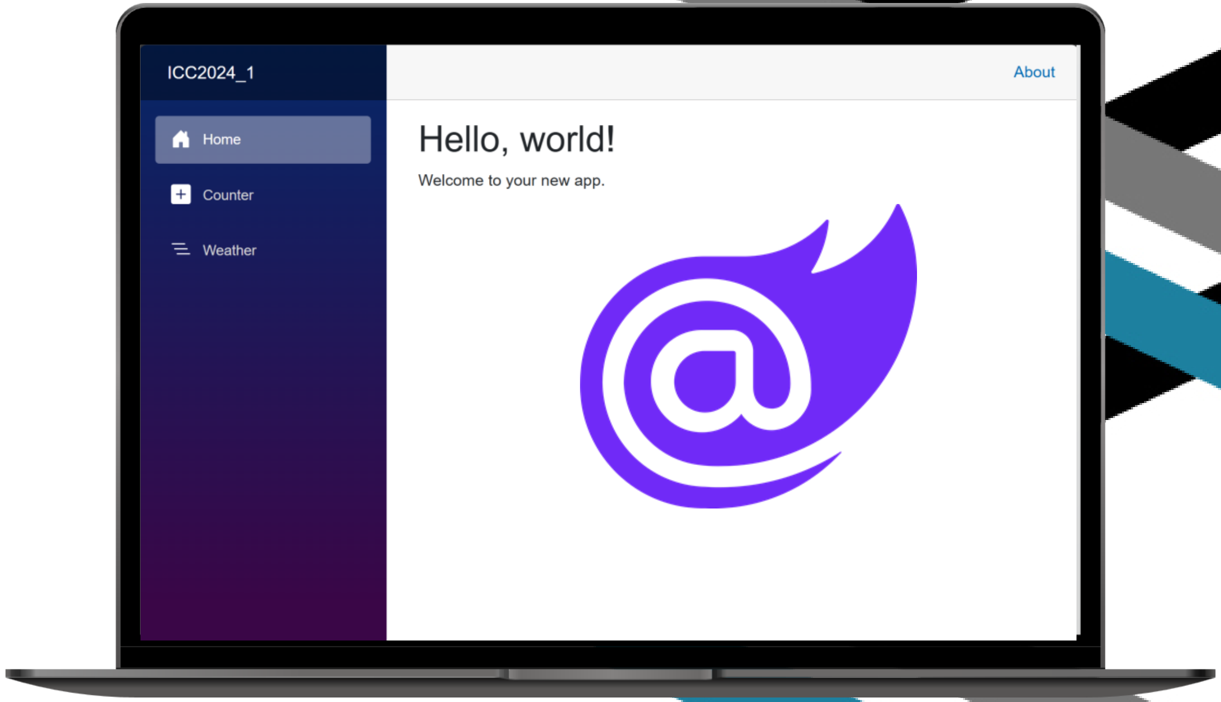
Goals of the Session

- Identify the major elements and framework features that make up state in Blazor
- Briefly touch on state storage and retrieval
- Learn about how the Blazor rendering modes impact state management
- Identify larger architectural patterns for managing state in a Blazor application

What is Blazor?

- Modern full-stack web framework
- Built on Asp.NET Core and Modern .NET
- Robust, production-ready solution since .NET Core 3.1 in 2018
- Static and dynamic Server-Side rendering
- Client WebAssembly SPA applications or individual components
- High productivity with a single unifying language and framework
- Hot-reload == rapid development with robust dev tools



Hello, world!

Welcome to your new app.

dev up

Bl@zing Shipments

As we look at this web app, consider the following questions:

- Where is the page being rendered?
- How does it know what data to load?
- Is the page comprised of a single component, or many?
- How does the site respond to user interaction?
- If we needed to store data, where would we store it?

What is State Management?

- “State management refers to the management of the state of one or more user interface controls such as text fields, submit buttons, radio buttons, etc. in a graphical user interface.”
  - *from Wikipedia (based on redux.js.org)*

Types of State in Web Development

- **Component State**
- **Application State**
- **User/Session State**

Component State

- Stored in component fields/properties or a model object
- Bound to HTML input and display elements
- Unsaved changes are lost on navigation/refresh

```
<p role="status">Current count: @currentCount</p>
<button class="btn btn-primary"
        @onclick="IncrementCount">Click me</button>
@code {
    private int currentCount = 0;
    private void IncrementCount() => currentCount++;
}
```

Component State

- /

```
<input type="text" @bind="fieldOrProp" />
```

- fires with the event
- Change the event with `@bind:event="oninput"`
- Add a change handler method with `@bind:after="HandlerMethod"`
- C w /

```
<TestComponent @bind-ParameterName="fieldOrProp" />
```

Application State

- State shared across components using
  - Parameters
  - CascadingValues
  - EventCallbacks
  - Service Classes

Application State: Parameters

- C# public properties with [Parameter] attribute on a child component

```
MapView.razor

[Parameter]
public double? Latitude { get; set; }

[Parameter]
public double? Longitude { get; set; }
```

- In consuming (parent) class markup, parameters display like HTML attributes with capital letters

```
<MapView Latitude="@shipment.Latitude" Longitude="@shipment.Longitude">
  <Map>
    <Basemap>
      <BasemapStyle Name="BasemapStyleName.ArcgisStreets"/>
    </Basemap>
  </Map>
</MapView>
```

Application State: Cascading Values

- Wrap child components with markup tags

```
<CascadingValue Value=" @User" Name="CurrentUser">
  <ProfileSelector />
</CascadingValue>
```

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```
[CascadingParameter(Name="CurrentUser")]
public ApplicationUser? CurrentUser { get; set; }
```

Application State: EventCallbacks

- A type of Parameter
- Async-supporting Event triggers

```
[Parameter]
public EventCallback<LayerViewCreateEvent> OnLayerViewCreate { get; set; }
```

- Bind to a parent component method instead of field or property

```
<MapView  OnLayerViewCreate="OnLayerViewCreate">
   <Map>
      <FeatureLayer OutFields="@(["*"])">
         <PortalItem PortalItemId="234d2e3f6f554e0e84757662469c26d3" />
      </FeatureLayer>
   </Map>
   </Extent>
</ MapView>
```

```
private async Task OnLayerViewCreate(LayerViewCreateEvent createEvent)
{
   if (createEvent.Layer is FeatureLayer)
   {
      // query the feature service
   }
}
```

Application State: Service Classes

- Any C# Class can be injected via Property Injection
  - In Razor Markup

```
@page "/order"
@inject StateManagementService StateManagementService
```

  - Or in C#

```
@code {
      [Inject]
      private StateManagementService? StateManager { get; set; }
}
```

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User/Session State

- Authentication
- Authorization
- Profile
- Records
- Work Progress

User/Session State

- Browser Persistence
  - Query String https://blazingshipments.com?id=12345
  - Tokens
  - Cookies
  - localStorage
  - sessionStorage
  - indexedDb
- Server Persistence
  - Persistent Cache (e.g., Redis)
  - Database

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Persistent State: Browser Storage

- **localStorage**
  - persists when tab/browser is closed, across multiple tabs
- **sessionStorage**
  - isolates data between tabs to prevent issues, data also is lost when tab is closed
- **IndexedDb**
  - Object-store structured database
  - Create an object store with a key path (aka ID) or a key generator
  - Also supports indexes
  - Transaction-scoped access: add, put (update), get, delete
- All require JavaScript or NuGet JS wrappers to interact.
- Available in “Interactive Render Modes”

Persistent State: Server Storage

- Too many options to enumerate, but here's a few
  - Redis cache
  - Database
- Only available from "Interactive Server" or via web API calls.

Blazor Render Modes

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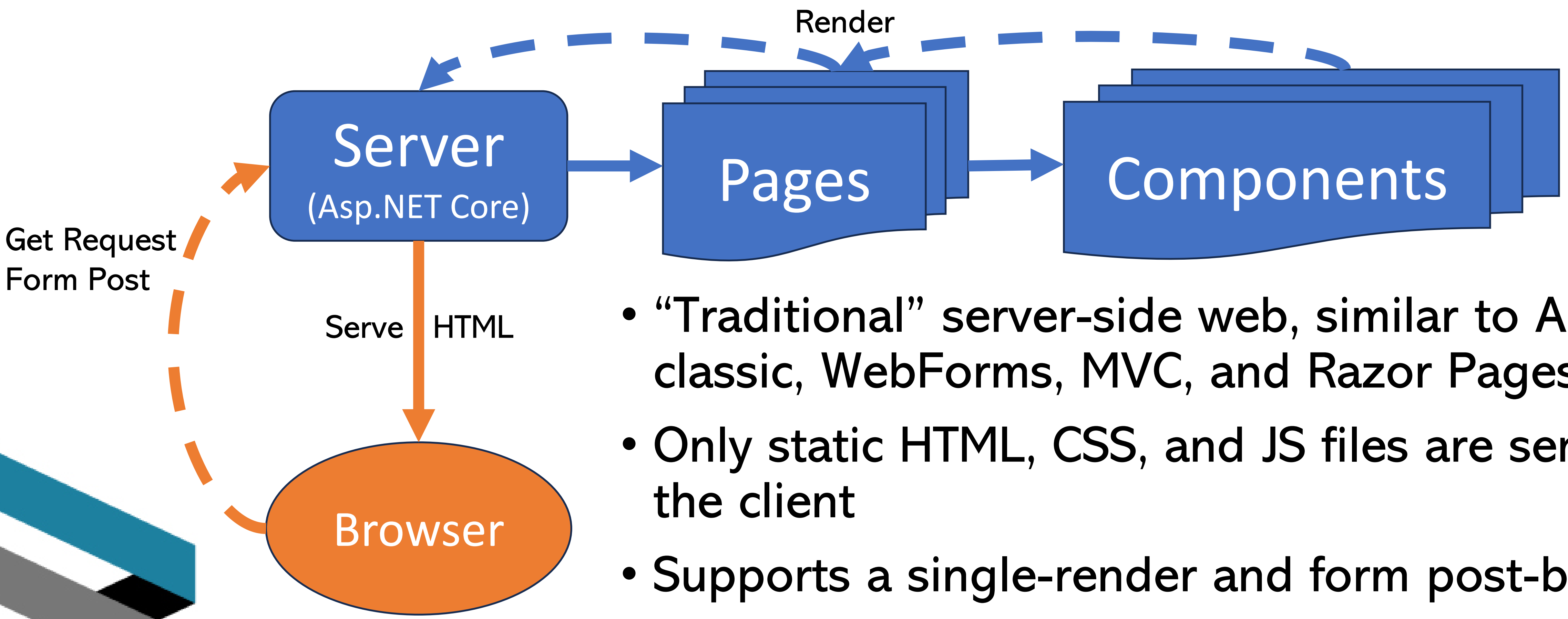
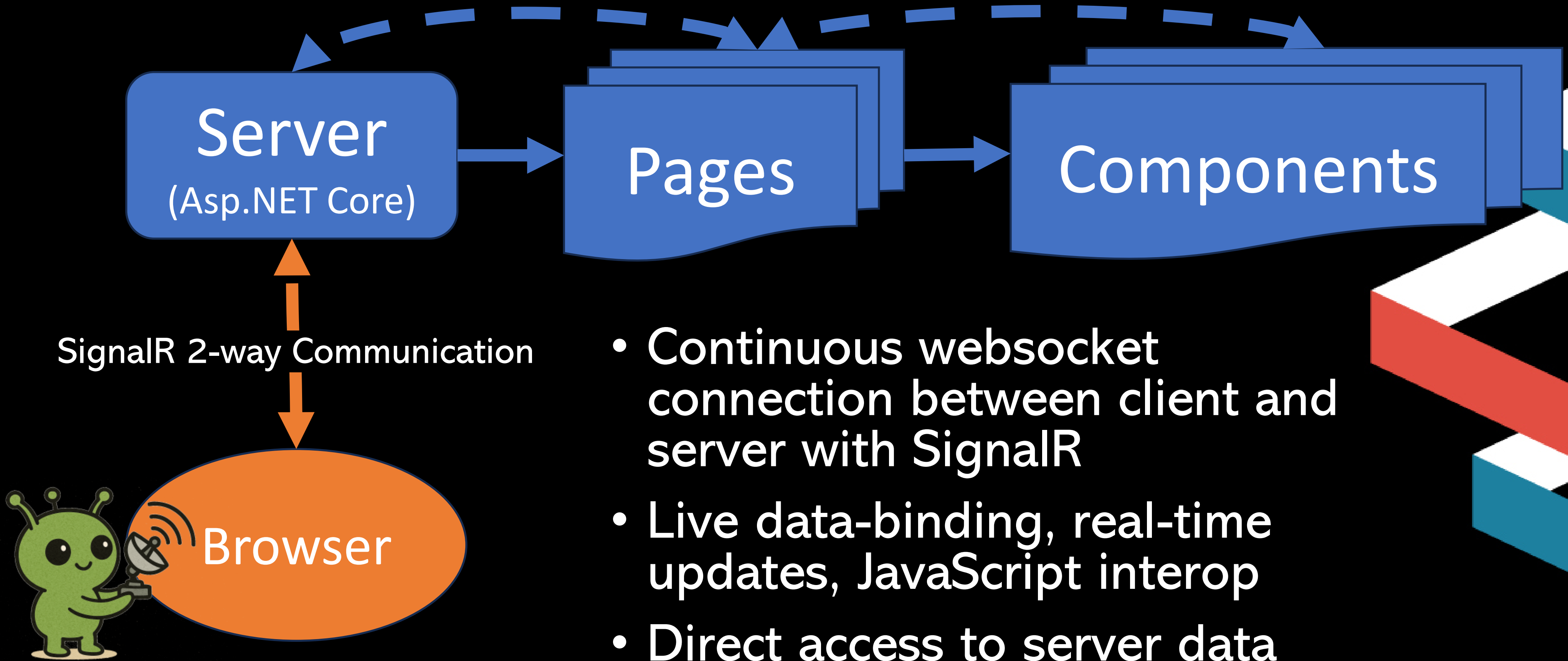
Blazor Render Modes: Static Server



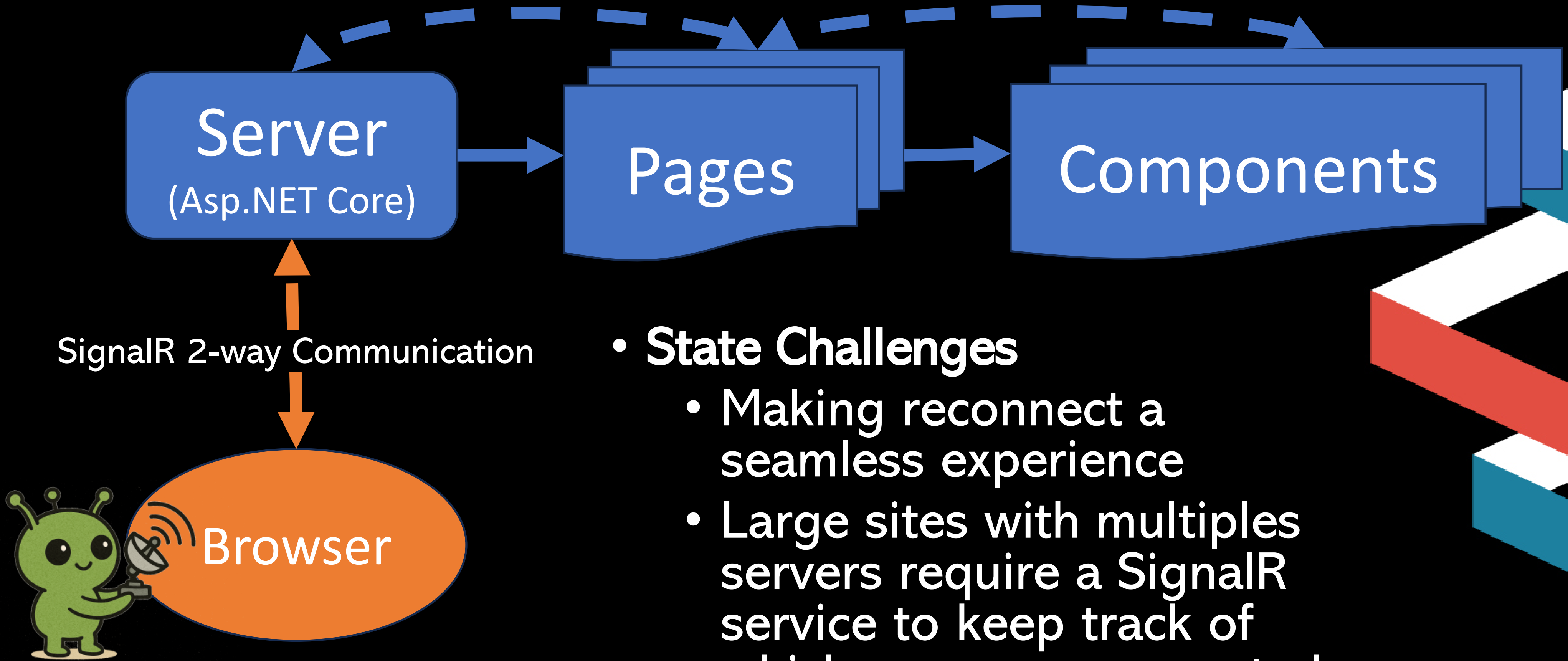
- "Traditional" server-side web, similar to ASP classic, WebForms, MVC, and Razor Pages
- Only static HTML, CSS, and JS files are sent to the client
- Supports a single-render and form post-backs
- No interactive updates via C# (can still use JS)
- Great for blog posts or other readonly content and simple forms

Blazor Render Modes: Interactive Server



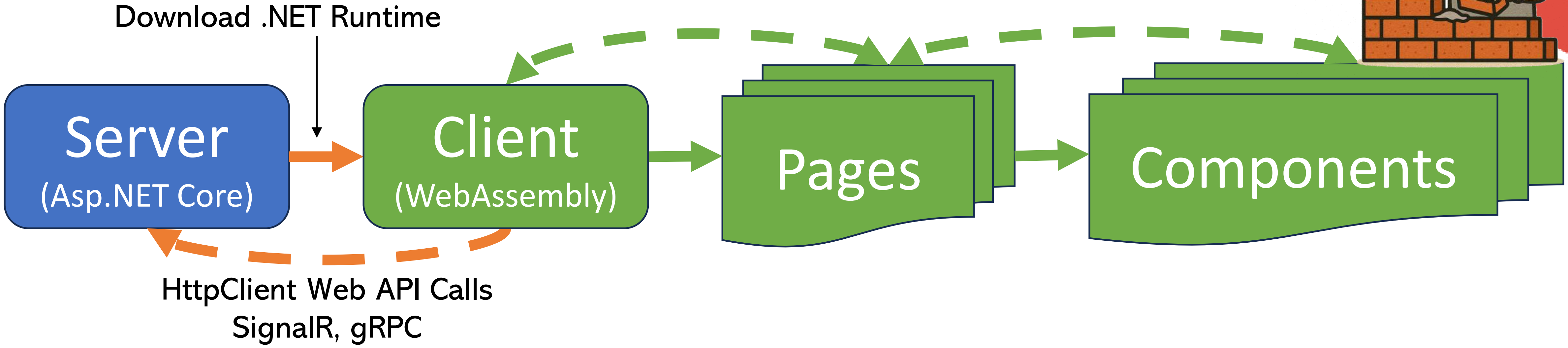
- Continuous websocket connection between client and server with SignalR
- Live data-binding, real-time updates, JavaScript interop
- Direct access to server data store
- Fast on first load
- Leaving browser tabs open can cause disconnection issues

Blazor Render Modes: Interactive Server



- **State Challenges**
  - Making reconnect a seamless experience
  - Large sites with multiples servers require a SignalR service to keep track of which users are connected to each server
  - Data size limits and lag can impact usability of some features

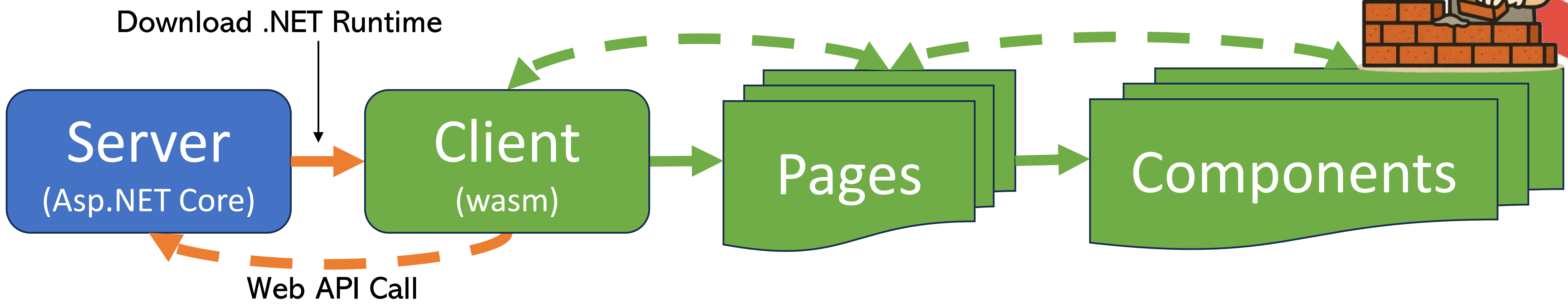
Blazor Render Modes: Interactive WebAssembly



- Runs in the client browser
- Live data-binding, real-time updates, JavaScript interop
- HttpClient calls to communicate with server web API

- Single-threaded
- Large/slow first load
- Fast interactions after load
- Closest in approach to most JS SPA frameworks

Blazor Render Modes: Interactive WebAssembly



- **State Challenges**
  - Easy for state to get out of sync with server, when tracking changes locally
  - Creating new data objects before syncing requires an ID strategy

Blazor Render Modes: Interactive Auto

- On first load, runs from server, creating SignalR connection
- In the background, downloads .NET runtime and client code
- On next load, switches to running from WebAssembly
- “Best of both worlds”
  - Fast start on first load (server)
  - More responsive and robust interactions (client)
- Requires flexible data handling/abstraction to handle both client and server modes

Architectural Patterns for State Management

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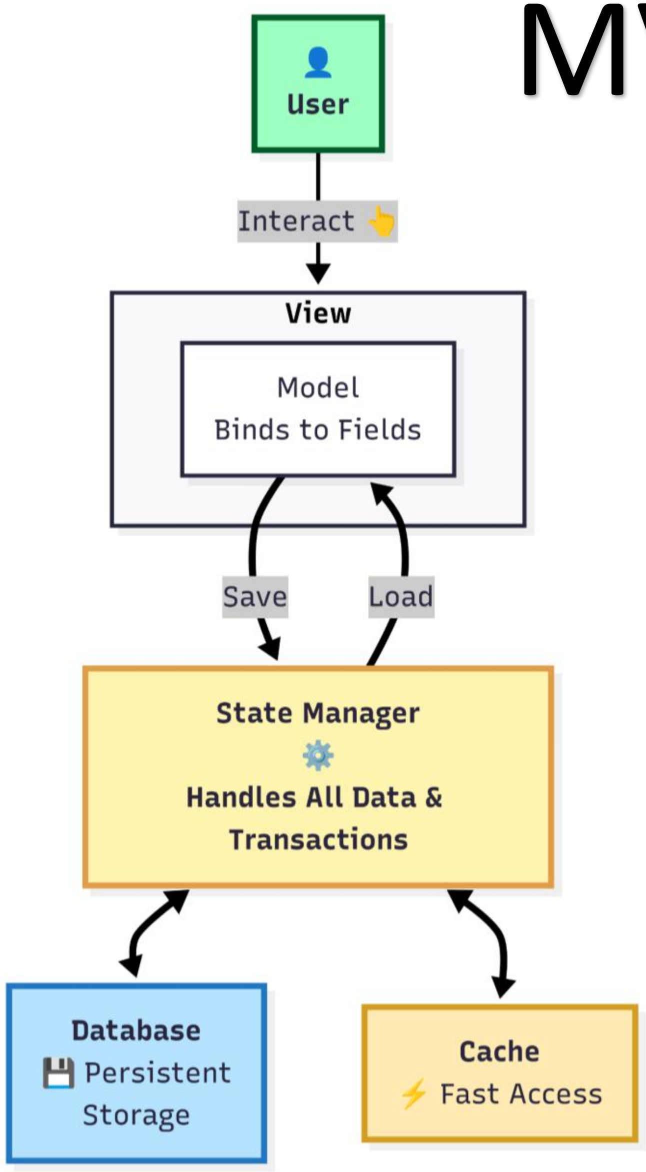
Architectural Patterns for State Management

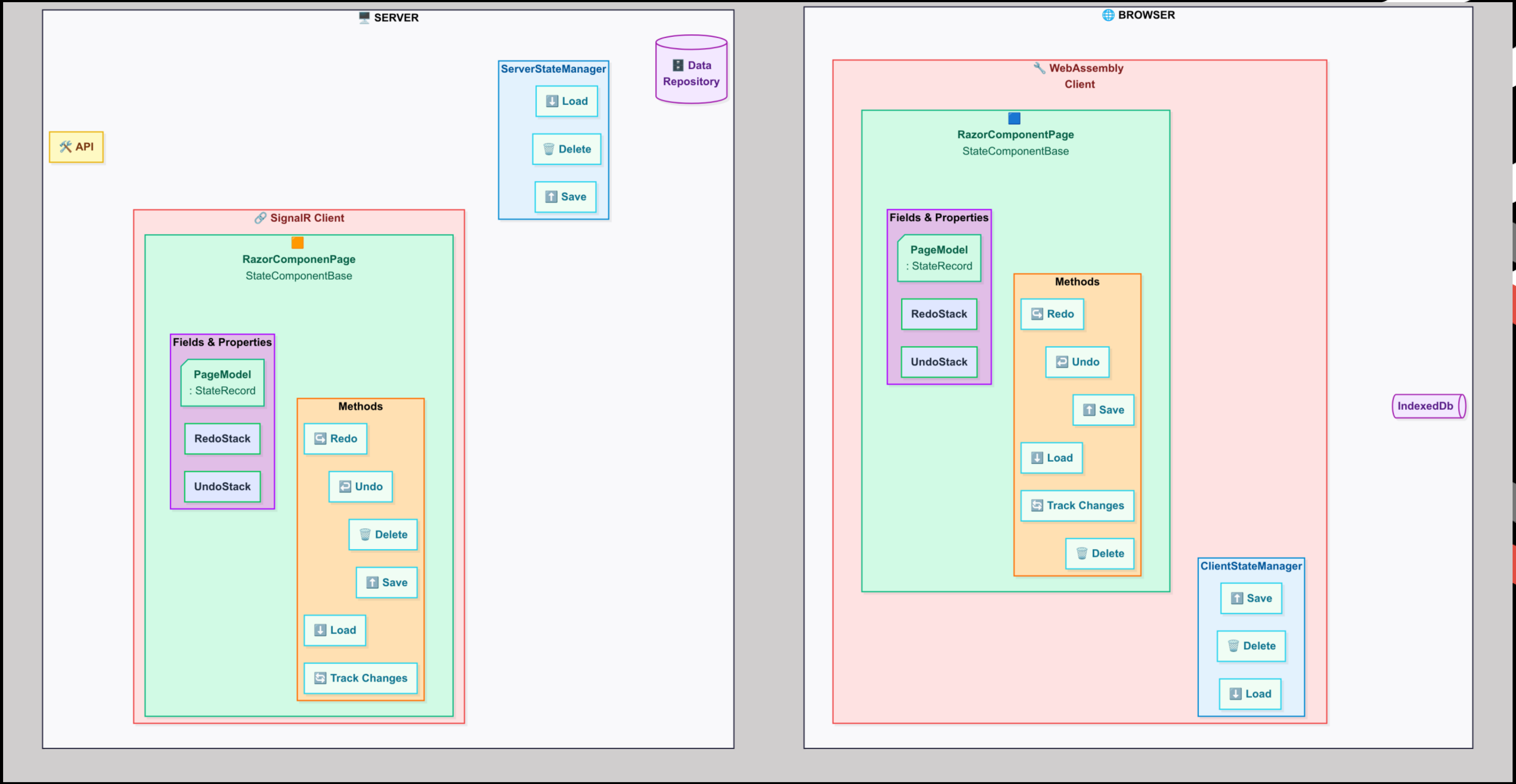
- **Goals for Blazor State Management**
  - Enable component developers to create flexible components that will work in both Interactive Server and Interactive WebAssembly modes
  - Reduce boilerplate logic like pass-through methods
    - *(e.g., clientComponent => clientService => webApi => webService => dataRepository)*
  - Provide a consistent pattern for communication between components
  - Abstract away communication from WebAssembly client to Server
  - Keep pages and components lightweight and easy to read
  - Allow generic implementations for simple use cases

Architectural Patterns for State Management

MVSM™



- **Model**
- **View**
- **State Manager**
- Model and View are tightly coupled, designed to work together with two-way binding.
- Model actually can live in either the View or the Manager class.
- State Manager is responsible for all transport and any data transformation that would take place before hitting the data storage.
- State Manager also provides us a place to add API transport logic.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ServerStateManager
Load
Delete
Save
Data Repository
SignalR Client
RazorComponenPage
StateComponentBase
Fields & Properties
PageModel
: StateRecord
RedoStack
UndoStack
Methods
Redo
Undo
Delete
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Track Changes
BROWSER
WebAssembly Client
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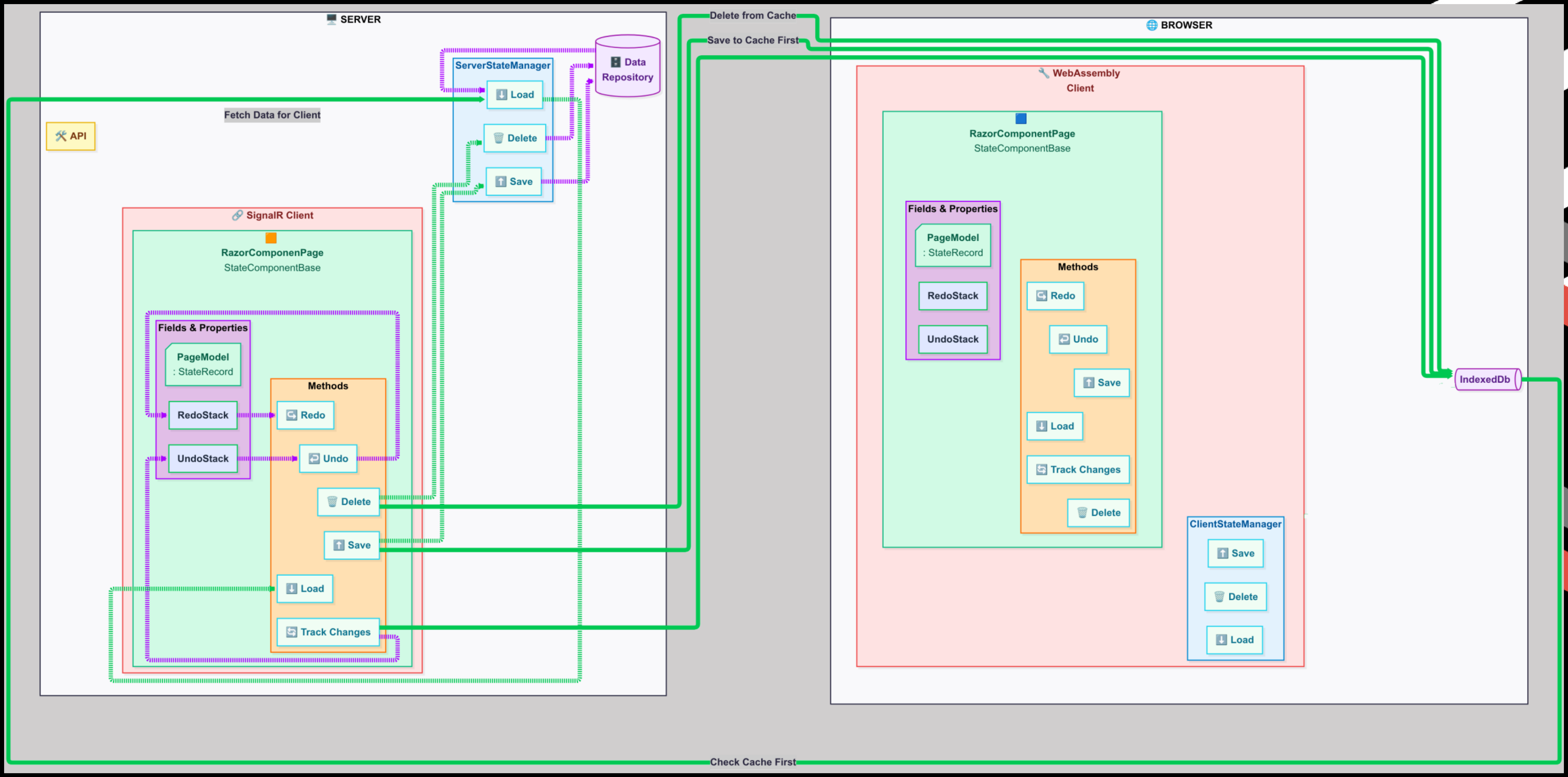
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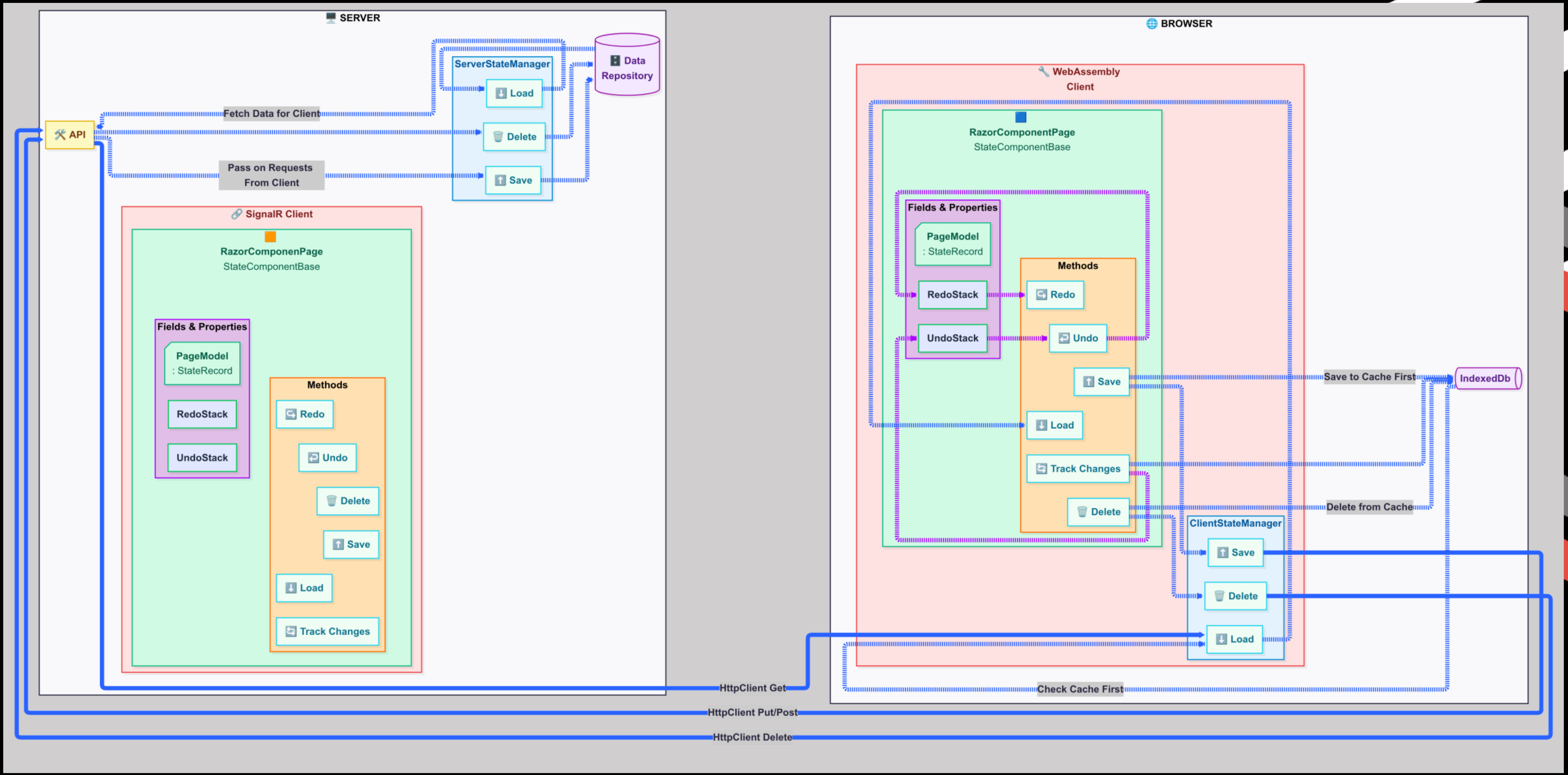

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IndexedDb
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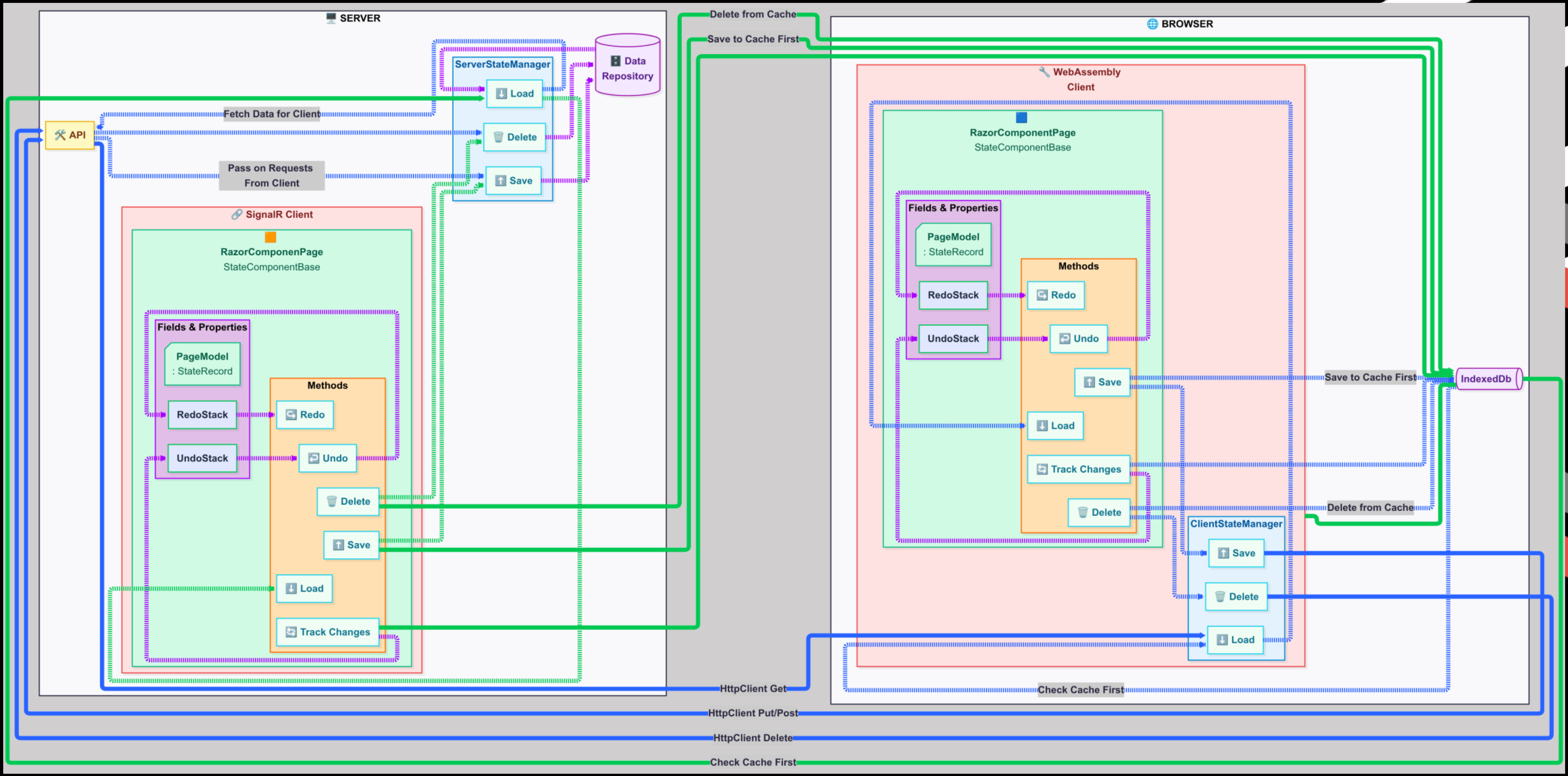
Save
Delete
Load
Check Cache First
HttpClient Get
HttpClient Put/Post
HttpClient Delete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Review

🧱 Core Concepts of State Management

- **Definition**: State management involves tracking the dynamic data of a user interface—across components, sessions, and storage layers.
- **Types of State**:
  - *Component State*: Temporary, lost on refresh or navigation.
  - *Application State*: Shared across components using cascading values, DI services, etc.
  - *User/Session State*: Stored in browser memory (e.g., localStorage, sessionStorage, indexedDb), usually not synced with the server.
  - *Persistent State*: Long-term data stored in a database or API.

Review

Blazor Render Modes & Their State Implications

- **Static Server Mode:**
  - Simple form submission and HTML rendering.
  - Limited interactivity and no real-time state updates.
  - Persistence tools: cookies, tokens, query strings.
- **Interactive Server Mode:**
  - Real-time two-way binding using SignalR.
  - Enables in-memory server-side tracking and real-time updates.
  - Challenges: reconnection handling, distributed server sync.
- **Interactive WebAssembly Mode:**
  - Fully client-side execution.
  - Rich interactivity with flexible state control
  - .Risks of state desynchronization and ID conflicts for new data.
- **Interactive Auto Mode:**
  - Hybrid approach: server-rendered first load, client-side on reload.
  - Balances fast startup with responsive interactivity.

Review

🧩 Patterns for Binding & Application State Sharing

- *Binding*:
  - @bind, @bind:event, @bind:get/set, and @bind:after allow seamless two-way data binding in Razor.
- *Component Communication*:
  - Parameters, CascadingValues, EventCallbacks, and DI Services are used to maintain shared state and coordination.

Browser Storage Techniques

- *localStorage and sessionStorage*:
  - Simple key-value stores for persistence.
- *IndexedDb*:
  - Structured object store with indexing and transaction support. Can be wrapped with JS + C# logic or NuGet packages.

Review

🧠 Architectural Patterns for Blazor

- **MVU**: Immutable, Redux-style, but not ideal for Blazor's reactive capabilities.
- **MVVM**: Familiar in .NET but verbose; Blazor doesn't require INotifyPropertyChanged.
- **MVC**: Suited for non-interactive, server-rendered apps—less effective in Blazor.

🧩 MVSM™ – A Blazor-Centric Pattern

- **Model-View-State Manager**:
  - Two-way binding between View and Model
  - .State Manager handles all data transport, persistence, and API abstraction.
  - Designed for extensibility using generics, reflection, and browser storage.

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