Comparison of Technology

# Server-side Web Runtimes and Frameworks

Server-side Web Frameworks (also called Web Application Frameworks are toolkits and libraries that are used to write, maintain and scale web applications. These can help with session management, managing users, authorisation, security, formatting, interfacing with databases and other common web development tasks. (Server-Side Web Frameworks, 2019)

In other words, the Web Application framework is what makes hosting a website or application possible without a lot of extra effort. *Everything* that a web application does that isn’t handled client side – from serving http requests in a timely fashion, to keeping data secure, to responsively handling user data – is affected by the web application framework that’s selected.

Furthermore, any updates, maintenance, troubleshooting, or other developer tasks will involve the Web Application Framework, so the ease of use and the available tools and APIs.

Because of the impact this has on almost every aspect of a website, it’s important to choose a web framework that suits the needs of the application being developed.

## Bun.sh

#### About Bun

Bun is a toolkit for TypeScript and JavaScript apps designed by Jarred Sumner. Bun 1.0 was released on September 8, 2023 (Sumner et al., 2023)

Bun runs on the JavaScriptCore engine, and is designed to be compatible with Node.js projects with few to no changes. (What Is Bun? | Bun Docs, n.d.)

While Bun works as a server runtime, and can be used as a back end, it also includes other tools, such as a package manager. Bun as a runtime is compatible with JSX, TSX and Typescript – Bun’s transpiler will automatically convert files of these types to vanilla JavaScript before running them. (What Is Bun? | Bun Docs, n.d.)

Where a web standard API exists that is relevant to Bun as a server runtime, Bun implements these where possible. Bun includes several native APIs – these are primarily to deal with server-side tasks. (Bun, 2024)

Bun implements a SQLite3 driver natively, which can be imported from a built-in module bun:sqlite. (Bun, 2023)

Bun’s promotional material often seems to emphasize its speed over competitors.

Bun’s documentation is well-structured and offers various guides

#### Installation

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Bun can be installed on a Windows operating system by running the above command, provided by Bun’s website, through either the Command prompt or PowerShell.

## Deno

#### About Deno

Deno is a JavaScript, TypeScript and WebAssembly runtime that uses Rust, the V8 JavaScript Engine and Tokio. Deno is open source, and has native support for JSX and TypeScript. (Deno: The Easiest, Most Secure JavaScript Runtime | Deno Docs, n.d.)

It’s possible to import modules from Node.js directly into Deno by using node: as a specifier while importing. This allows for Deno to natively use most built-in Node modules natively. (Use Node.js Built-in Modules - Deno by Example, 2024)

Deno’s docs include a QuickStart guide, (First Steps, 2024) as well as various other examples and guides. (Deno by Example, 2024)

Deno can also connect to multiple databases, including Redis, MongoDB and PostgreSQL (Deno by Example, 2024)

Deno has a dedicated Discord, and its Where to Get Help Page links to the Deno tags on Stack Exchange and dev.to (Where to Get Help, 2024)

#### Installation

A screenshot of a computer

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Deno can be installed in a Windows operating system by running the command above using Windows PowerShell. This does not work through regular Windows Command Prompt.

The command to run is provided on the Deno site, along with simple instructions on how to run it.

## Express and Node.js

#### About Node.js

Node.js is an asynchronous, cross-platform, open source JavaScript runtime designed to handle many concurrent connections. (Node.js Foundation, 2019) (Node.js, 2024)

Node.js is built on Google’s V8 Engine, outside of the browser, and is a popular environment and tool. When Node performs a blocking operation, such as reading or writing a file, it will do this asynchronously, performing other tasks in the event loop until a response comes back. (Introduction to Node.js, n.d.)

While Node.js is natively compatible with JavaScript, it can also be used with TypeScript (Node.js — Node.js with TypeScript, n.d.)

Node.js is not a framework or programming service, but it is often used for building back-end applications, such as APIs or for Web Apps or Mobile Apps. (Node.js vs Express.js, 2020)

#### About Express

Express is an application framework that provides features for web and mobile applications. (OpenJS Foundation, 2017) Express adds to Node.js’s server functionality, simplifying its APIs and adding new features. (Node.js vs Express.js, 2020)

#### Installing Node.js

Node.js can be installed in the form of a prebuilt installer, can be downloaded in the form of source code or prebuilt binaries, or can be installed via command line – the download page for Node.js provides commands to install Node and verify the installation if you wish to do it this way. (Node.js — Download Node.js®, 2024)

#### Installing Express

Express can be installed using Node Package Manager via the command line. Express is installed as a package on a per-application basis, and can be installed either temporarily or added as a dependency. (Installing Express, n.d.)

## Further considerations

While other frameworks exist, such as Django and Flask, which are both based on Python, and Ruby on Rails (Server-Side Web Frameworks, 2019) I have been focusing my research on JavaScript and TypeScript environments due to a desire to make the development experience more cohesive, as this way my front and back end can follow a consistent language, and switching between maintaining and developing different parts of the full stack web application should be easier.

# Databases and Data Stores

## SQLite

SQLite is a SQL database library built in C. According to the SQLite website, SQLite is a fast, reliable, serverless SQL database that can make and process SQL requests. (SQLite, n.d.)

Because Bun has a native API that includes SQLite3 as mentioned above, it may be worth considering SQLite as a database if Bun is included in the stack, especially as SQLite plays to Bun’s strengths – it seems like both Bun and SQLite focus on being high-speed applications.

## MongoDB

MongoDB is a document-oriented NoSQL database. Document oriented databases are typically used to store unstructured or semi-structured data. (What Is NoSQL? NoSQL Databases Explained, n.d.)

NoSQL databases often use denormalised data, and may contain data duplication. This is because NoSQL focuses on structuring data with a focus on how it will be queried over following a relational schema, such as may be found on a relational database. NoSQL solutions rarely include support for joins. (NoSQL Data Modeling Techniques, 2012)

In cases where embedding data in entities is not feasible, such as with many-to-many relationships and with data that is frequently modified, separate data entities can be joined at query time, which may cause a performance hit. (NoSQL Data Modeling Techniques, 2012)

## PostgreSQL

PostgreSQL is an open source, object oriented, ACID-compliant relational database system. Postgre is mostly conformant with the SQL standard, with 170 of the 179 features for SQL core performance met in version 16 of PostgreSQL. Postgre supports many file types, including document/JSON format. ("PostgreSQL: About," n.d.)

## Redis

Redis is an in-memory data store that allows for quick access to documents, and supports various data types and structures. ("Community edition," n.d.)

# Hosting and Content Distribution

## Digital Ocean’s Droplets

Digital ocean’s Droplets are virtual machines running on Virtual Hardware, supporting Ubuntu, Debian, CentOS, AlmaLinux, Rocky, and Fedora. A droplet can function as an entire server. ("Droplet features :: DigitalOcean documentation," n.d.) Droplets start at $4 USD per month for the cheapest plan available. ("Pricing overview," n.d.)

## Digital Ocean Managed Database Service

Digital Ocean also offers managed database services for a starting price of $15 USD per month. This service has multiple Databases available include MongoDB, Kafka, MySQL and PostgreSQL. ("Managed database pricing," n.d.)

Digital Ocean allows customers to upgrade to higher-level plans as their platform grows and they need increased allocation of hardware.

## Cloudflare Pages

Cloudflare Pages is a JAMstack platform. Pages that have been pushed to a connected GitHub or GitLab account can be automatically built and deployed. Cloudflare pages can have dynamic functionality through integration with Cloudflare workers. ("Cloudflare Pages," n.d.) Cloudflare pages has support for multiple common frameworks, including Angular, React, Svelte, Next.js, and Vue. ("Framework guides," n.d.)

## Cloudflare Workers

Cloudflare Workers is a content distribution service that allows you to deploy code “serverlessly” across Cloudflare’s global network. Cloudflare workers start at free for up to 100,000 requests per day. ("Cloudflare Workers," n.d.)

# Frameworks and libraries on the front-end

## Angular

Angular is an open-source Web Application Framework, released in 2016 as a sequal to AngularJS. Angular is designed for the creation of Single Page Applications. ("What is angular ?," 2024) Angular includes a component-based framework, a variety of integrated libraries, and a suite of developer tools. Angular supports both JavaScript and TypeScript. ("Angular," n.d.)

Angular allows a user to use components, which are pieces of code that can define the appearance and behaviour of parts of a web page in such a way that the developers can reuse them over and over. ("Angular," n.d.)

Angular supports multiple first-party libraries, including Angular router, Angular Forms, Angular HttpClient, Angular Animations, Angular PWA, and Angular Schematics. Angular’s Command Line Interface allows for some tasks to be performed more easily. ("Angular," n.d.)

MVC is a code pattern in angular, standing for Model View Controller. The model represents a web page’s data, that may be updated by the client, or by API calls to the server. The View represents the User Interface – the elements the user can visually see, their presentation and layout. And the Controller represents the behaviour of the page – scripts, interactive elements, and API calls, for example. (Miller, 2024)

Angular uses two-way data binding, which means that any update to the data model will update the view, and any update to the view will update the model (Miller, 2024)

## React

React is a user interface library that allows developers to use code and markup called JSX, or JavaScript Extension. React is not a framework on its own, but can be used alongside frameworks in order to create something closer to a full-stack application. ("React - the library for web and native user interfaces," n.d.)

One of React’s features is the Virtual DOM, a copy of the Real DOM that is held in memory. Instead of updating the real DOM directly, which can cause the whole document to re-render with every change, the virtual DOM can receive multiple small updates without re-rendering, and then push them all to the real DOM at once, reducing the time it takes to make changes to a page. This also means that instead of writing detailed instructions on how to update the UI, a developer can just write what they want the UI to look like, and the Virtual DOM will take care of the actual process of updating the browser to match. ("What is the virtual DOM in react?," 2024)

## Vue

Vue is a framework which provides many features necessary to front-end web development. Vue’s Single File Component, called an SFC, contains a component’s logic, style, and template in a singular .vue file. ("Introduction," n.d.)

## Svelte and Sveltekit

Svelte is a Javascript UI framework which aims to take the load off the browser runtime by doing as much optimisation as possible during the build step. (*Svelte • Cybernetically enhanced web apps*, n.d.)

SvelteKit is the official Svelte framework for building Svelte applications. Svelte renders the UI, but SvelteKit is in charge of things like updating the UI when a link is clicked, build optimisations, offline support, and more, all following modern best practices. SvelteKit is powered by Svelte and Vite, making it possible to create interactive web applications. ("Introduction • Docs • SvelteKit," n.d.) ("SvelteKit," n.d.)

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