Software Design of an Elm Application

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Software Design Methodologies

Overview

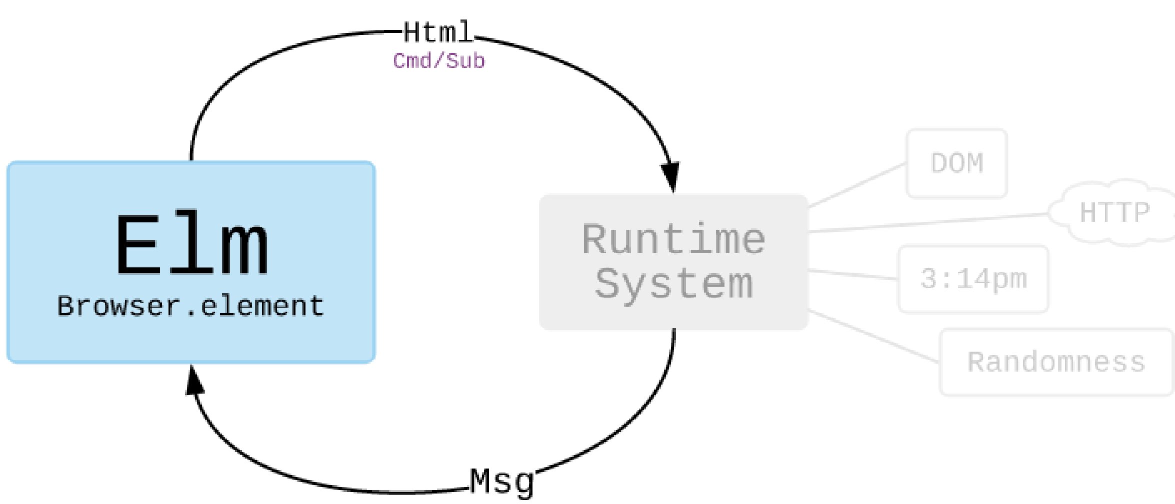
This project is a single-page web application to view Argdown [1] argument maps relating to encryption policy and exceptional access. These argument maps are a product of research for my Master's thesis on the subject of encryption policy. See the app's "About" [2] page for more.

The app is deployed to GitHub Pages here [3], though an issue [4] with the webpack configuration is preventing the map SVGs from rendering correctly. The source is available on GitHub here [5]. To run it locally, install Nodejs, Yarn, and Elm, then execute `yarn install && yarn start`.

The app is written in Elm [6], a Haskell-inspired language that transpiles to JavaScript and defines its own architecture. This report will describe how the Elm architecture impacts frontend web design, Elm's JavaScript interoperability, and design choices made for this application.

The Elm Architecture

The Elm architecture uses immutable values, one-way data-flow, and event-driven processing. It maps well to the time model developed by Rich Hickey, of Clojure [7]. Hickey's model differentiates between values, state, identity, process events, and observers. In the Elm language, all data are immutable values. The application (as the top-level identity) consists of a sequence of states. Change is managed by the runtime. The runtime generates messages (process events) based on events such as DOM actions or HTTP requests. The messages are passed to the application along with the current state. The application uses this information to produce a next state, which is returned to the runtime and mutably integrated. The visible content on the web page is generated by view functions (observers) purely from the current state. The Elm architecture documentation illustrates this as shown below [8].



Using the Elm language has several advantages over basic JavaScript and even the safer TypeScript. Its type system has no `null` value or exceptions. All situations, including empty values and error conditions are represented using ordinary data types. Additionally, all functions are complete, meaning that they *must* return a value of the type that their type signature indicates. All case statements are complete, meaning that every possible branch, including error conditions, must be handled. As a result, if an Elm application successfully compiles, it *will* run without crashing.

The architecture provides advantages as well. Although external events can still cause race conditions, Elm's time model and data-flow direction eliminate internal race conditions and simplify asynchronous JavaScript operations. The Elm architecture was a direct inspiration to Redux, which uses the same unidirectional data-flow pattern and has a reputation for enabling robust JavaScript applications.

Elm's completeness has disadvantages as well. For one thing, if you want to build a rapid prototype, you may not care to handle every possible error condition, but Elm won't compile until you do. Elm also makes JavaScript interoperability somewhat difficult. In order to keep Elm functionally pure, JavaScript not callable directly. Elm provides "ports," which are essentially JSON APIs to local endpoints on the other side of the Elm/JavaScript wall. Interop is thus possible, but the developer is forced to use it sparingly and carefully consider which side manages which portions of application state.

Design Choices for the Argdown Viewer

The goal building the Argdown viewer application is to internalize the "how" and "why" of the Elm architecture by using it in a non-trivial app. I decided to implement it as a single-page application in order to understand Elm routing and multi-level state management, and decided to dynamically generate the argument maps instead of render static images in order to explore ports and JavaScript interoperability. Deploying to GitHub Pages resulted in some interesting decisions as well. I discuss each of these next.

Elm SPA Architecture

The application is split into three main Elm files, `Main`, `Argmaps`, and `About`. `Main` defines the top-level state, renders the header, and performs URL parsing in order to determine what content to load. `Argmaps` renders the arguments via ports to the JavaScript side's Argdown manager and includes buttons to update the active map. `About` renders Markdown source content into HTML. SPAs require layering each level's state and message handling. With Elm's rigid type system, this more of a challenge than usual, but after experimenting a pattern emerged. The result is robust.

The Argdown Engine JavaScript Interop

The Argdown maps themselves are rendered using a JavaScript engine provided by the Argdown project. Deciding where to implement operations and state related to managing the engine was a challenge. Eventually, most of the map configuration settings came to reside in Elm. When a map is rendered, Elm passes the desired configuration through a port to the JavaScript side, which runs the engine and updates the map. Instead of returning HTML from the engine back into Elm, which would require complex types, Elm defines an empty DOM node to hold the map and the JavaScript mounts it directly.

Deploying to GitHub Pages

Deploying the application to GitHub pages required routing workarounds. GitHub pages routes only a single page to the hosted application. For example, if the application lives at `/arg-viewer/`, GitHub would say that the page `/arg-viewer/about` does not exist, even if the SPA contains rules to route that URL to a page. I therefore had to switch to hash-based routing. The "About" page for example exists at `/arg-viewer/#about`. Elm also expects the application to be rooted at the base path, i.e., at `/`. Because GitHub pages roots the page at `/project-name/`, I had to use Elm initialization flags to tell the application the path prefix at which it lives, so that it parses the URL and generates links relative to that base.

Summary

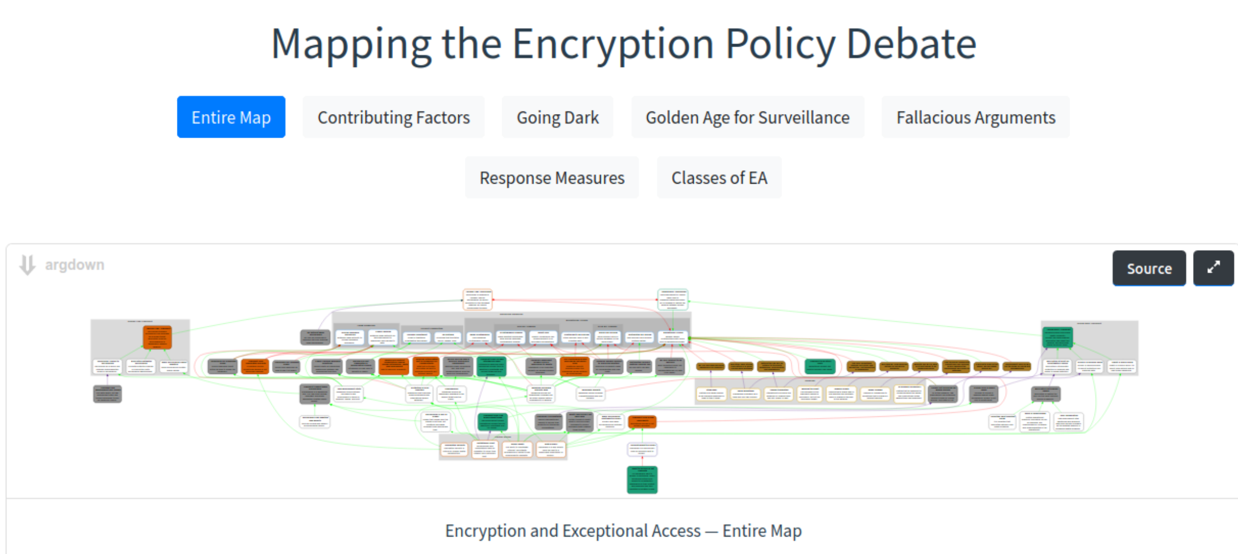
Building this application succeeded in teaching me about the benefits of the Elm architecture and how to manage state safely in event-driven environments. It implements of Hickey's time model exceptionally well for web applications. As a benefit, I also have a better understanding of Redux. I have enjoyed the unique opportunity to build a new TypeScript and Redux application at work while studying these concepts. Learning about this time model and domain-driven design as well as working on this project have directly improved the quality of that product.

This Argdown viewer serves as a way for me to feature some of my thesis research. I intend to fix the webpack configuration so that the maps render correctly online and use the website to host my thesis once it is published. In an appendix below, I include two screenshots of the app running locally as proof that it works.

References

[1] https://argdown.org/
[2] https://kkredit.github.io/arg-viewer/#about
[3] https://kkredit.github.io/arg-viewer/
[4] https://github.com/christianvoigt/argdown/issues/202
[5] https://github.com/kkredit/arg-viewer
[6] https://elm-lang.org/
[7] https://www.infoq.com/presentations/Are-We-There-Yet-Rich-Hickey/
[8] https://guide.elm-lang.org/effects/

Appendix: Screenshots



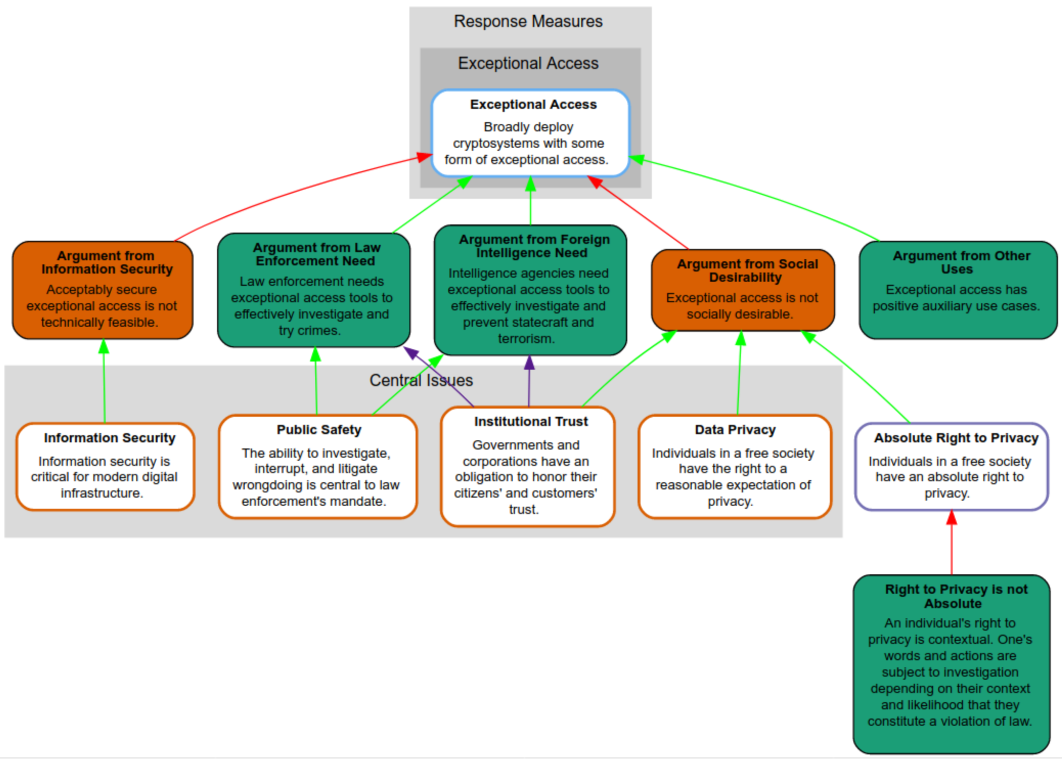
Mapping the Encryption Policy Debate

Entire Map | Contributing Factors | Going Dark | Golden Age for Surveillance | Fallacious Arguments

Response Measures | Classes of EA

argdown

Source



Encryption and Exceptional Access — Contributing Factors