Bachelorarbeit am Institut für Informatik der Freien Universität Berlin

Human-Centered Computing (HCC)

How does an editor for dynamic resources for users with different levels of expertise look like and how can it be conceptualized and implemented within the constraints of an exisiting ecosystem?

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Berlin, den December 13, 2022

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Abstract

In recent years, the shift from print to digital publishing has increased the need for tools that allow publishers to quickly build and configure apps and websites. While progress has been made in this area with the development of general purpose website builders and headless content management systems, the internal tools and software used by publishing administrators also need to evolve and improve.

The goal of this bachelor thesis is to conceptualize, plan, and implement an UI editor for apps and websites used by publishers, particularly in Germany and the UK. The editor will be built using a web framework called "Purple Experience," which is used to deliver apps and websites generated from the same configuration and assets to end users. This service is closely linked to other existing software systems that are used to edit content, manage apps, and deliver content.
This "brownfield" software project presents both challenges and opportunities. The flexibility of the editor is restricted by existing workflows and software that cannot be changed, but it also has a diverse group of users who have varying levels of experience with these software products. These users, who include internal framework developers, customer support, and project developers, as well as external people at publishing houses, provide valuable insights into their current workflows and how they believe the editor can improve their productivity and enjoyment.
To gain these insights, the use of existing software was evaluated, and multiple user research methods, including moderated observations and interviews, were applied. The outcome of this research will be useful as guidance for future software development projects for internal tools at companies, or in environments where constraints exist but a user base is already in place to provide valuable input and feedback.
The outcome should be usable as guidance for future software development projects for internal tools at companies or in environments where constraints may exist, but also an approachable, already present user base can give valuable input and feedback.

Based on the evaulations oth the user research phase, I built an interactive prototype using modern web technologies like react, express.js and Typescript. This was deployed using continous integration to a controlled group of test users. This allowed to get quick feedback and iterate fast, until the tool can be made available to a broader audience.

TODO: the outcomes of the thesis consist of a working software product that is actively used by early adopters, as well

Zusammenfassung

<Hier sollten Sie eine kurze, aussagekräftige Zusammenfassung (ca. eine Seite) Ihrer Arbeit geben, welche das Thema der Arbeit, die wichtigsten Inhalte, die Arbeitsergebnisse und die Bewertung der Ergebnisse umfasst.>

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Vorwort

Allgemeine Hinweise zur Erstellung einer Abschlussarbeit

- Beachten Sie, dass diese Vorlage für einen zweiseitigen Ausdruck angelegt wurde.
- Über die Papierqualität können Sie entscheiden, aber wir empfehlen aber Seiten mit wichtigen, farbigen Grafiken auch in Farbe auszudrucken und dabei ein höherwertiges Papier zu verwenden.
- Bitte stimmen Sie mit dem Betreuer Ihrer Arbeit auch den Zweitgutachter ab. Die Anfrage des Zweitgutachters erfolgt von Ihnen. Es ist an dieser Stelle sinnvoll, die Anfrage mit einer kurzen Zusammenfassung der Arbeit zu stellen.
- Bitte beachten Sie, dass Sie Ihre Abschlussarbeit mit einer Klebebindung versehen, eine Ringbindung ist nicht erwünscht.

1 Introduction

1.1 Topic and context

In the evergrowing world of software companies, many once startups are now in the situation where they maintain a large software ecosystem and have complcated dependencies of other services or users, but still want to improve their systems by developing new components and tools.

This poses the challenge of improving the software from **TODO: definition of good software?**, while beeing restricted by the ecosystem. Greenfield development, as it is taught for the majority of books, can't be applied freely without breaking existing features or behaviours. Thus, applying HCI methods for user research and user experience-focused design might needs to be approached in a diffrent way then during greenfield development. Also, the common problem of tight deadlines and limited resources allocated by managers tend to lead to premature releases and unstable software. Instead of developing software to maximize the three HCI factors **See HCD principles / factors src, anme the tree?** for the actual users, often ideas from individual stakeholders like the executive floor are realized without adding real value.

On the other hand, having an exsisting user base which works with exisiting tools is a great fundament to evaluate what "real users" need. So HCI methods applied to them can yield more helpful and focused results. **rephrase**

Many of the resources or literature about HCI seem to assume a mostly free degree while developing new tools, and also assume a wide user base with diverse demographic features **is this valid engilsh?**.
List literature srces that dont speak about brownfield development? Find a contra example that does cope with brownfield

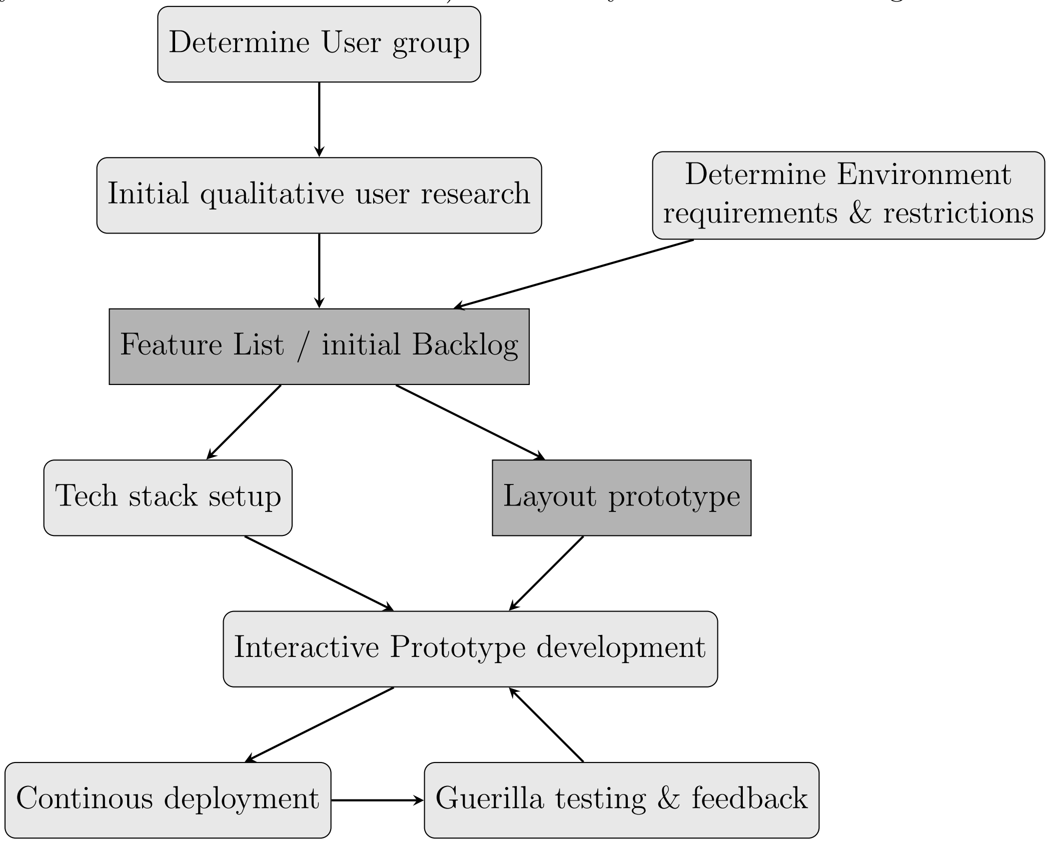
1.2 Goals of this work

- Was sind die mit dieser Arbeit verfolgten Ziele? Welches Problem soll gelöst werden?
- Eine Beschreibung der ersten Ideen, der vorgeschlagene Ansatz und die aktuell erreichten Resultate
- Eine Beschreibung, welchen Beitrag die Arbeit leistet, um das vorgestellte Problem zu lösen
- Eine Diskussion, wie die vorgeschlagene Lösung sich von bestehenden unterscheidet, was ist neu oder besser?

The goal of this thesis is to implement a new software product, an UI Editor for Apps & Websites of digital publishing customers, which is embedded in an existing software ecosystem. During that process, diffrent HCI methods get applied and

1.3 Procedure for the research and implementation

While writing the software and thesis, I followed the an software design process described in [2, p. 104]. There, the process is divided into a "Idea" phase using design thinking, lean ux for first prototypes and then agile development (in my case a relaxed SCRUM version). Abstractly it looks as following:


Determine User group
Initial qualitative user research
Determine Environment requirements & restrictions
Feature List / initial Backlog
Tech stack setup
Layout prototype
Interactive Prototype development
Continous deployment
Guerilla testing & feedback

2 Kapitel

- Abhängig vom Ziel der Arbeit und dem verwendeten Forschungsdesign unterscheidet sich dieser Hauptteil der Arbeit erheblich.

- Eine sehr allgemeine Struktur ist die folgende:
  - Hintergrund der Arbeit (Theoretische Einordnung der Arbeit)
    - Hier sollte enthalten sein, welche Anwendungen in diesem Bereich bereits existieren und warum bei diesen ein Defizit besteht.
    - Falls genutzt, sollten hier die entsprechenden Algorithmen erläutert werden.
    - Es sollten die Ziele der Anwendungsentwicklung, d.h. die Anforderungen herausgearbeitet werden. Dabei sollte die bestehende Literatur geeignet integriert werden.
  - Umsetzung (Praktischer Anteil der Arbeit)
    - Zunächst sollte die Softwarearchitektur und die genutzten Anwendungen, APIs etc. erläutert werden. Ebenfalls gehört dazu das Datenbankschema.
    - Es sollten die zentralen Elemente der Software (abhängig von der Aufgabenstellung) beschrieben werden, wie implementierte Algorithmen oder das Oberflächendesign.
    - Zentraler Quellcode sollte entsprechend aufgelistet werden:

```java
public class Main {
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

  - Evaluation (zumeist nur für Masterarbeiten relevant)
    - Jede Software muss auch getestet werden. Dieses Tests werden entweder mit einem vorgegebenen Datensatz erfolgen oder aber die Evaluation erfolgt auf Basis von Experimenten. In diesem Kapitel sollte daher entweder der genutzte Datensatz oder der experimentelle Aufbau beschrieben werden.
  - Ergebnis und Diskussion

∗ Die Ergebnisse der Anwendung werden in diesem Kapitel vorgestellt und anschließend diskutiert. Wenn möglich sollte die Ergebnisse in Relation zu bestehenden Arbeiten in dem Bereich erörtert werden.

3 Theoretical background

This thesis can be divided into two mayor areas of theoretical background. Human-Computer-Interaction (HCI) and project specific background.

3.1 HCI

Let me start by explaining the HCI aspects and why this thesis approaches the area from an not so common standpoint.
Many HCI books (e.g. [4] or [2]) implicitly assume Greenfield development, which "[...] is in its most distinct form when a new product is created from scratch – a new product or product platform, based on new technology, using new methodology and implemented by people who are new to it all." [1].
While they mention *Environmental requirements* as part of the requirement discovery, this usually is more focused on what abilities the users have (TODO), and not on the restrictions imposed by older software companies, especially those colloquially called "enterprise".

There, besides the omnipresent time and capacity restrictions and sometimes not that constructive inputs from stake holders, often development must be used. In this approach, new capabilities are added to the software, while relying on the exisitng technology and knowledge. [1].
Therefore, some of the HCI methods must get a bit adapted to fit into this system.

Also, the UI Editor developed for this thesis has to be counted as internal tooling, so it is reserved for a quite specific user base. Not every person on the internet should edit these apps and dynamic resources, as they require understanding of web technologies and the digital publishing nomenclature.

3.2 Project specific background

To understand the usecase and value of the UI Editor, we first have to declare the fundamentals of the environment the editor will be embedded in.

The publishing houses resp. their digital departments (in the following "customer") purchase the license for an app or website (in the following just "app", as there is not much difference besides the end medium).

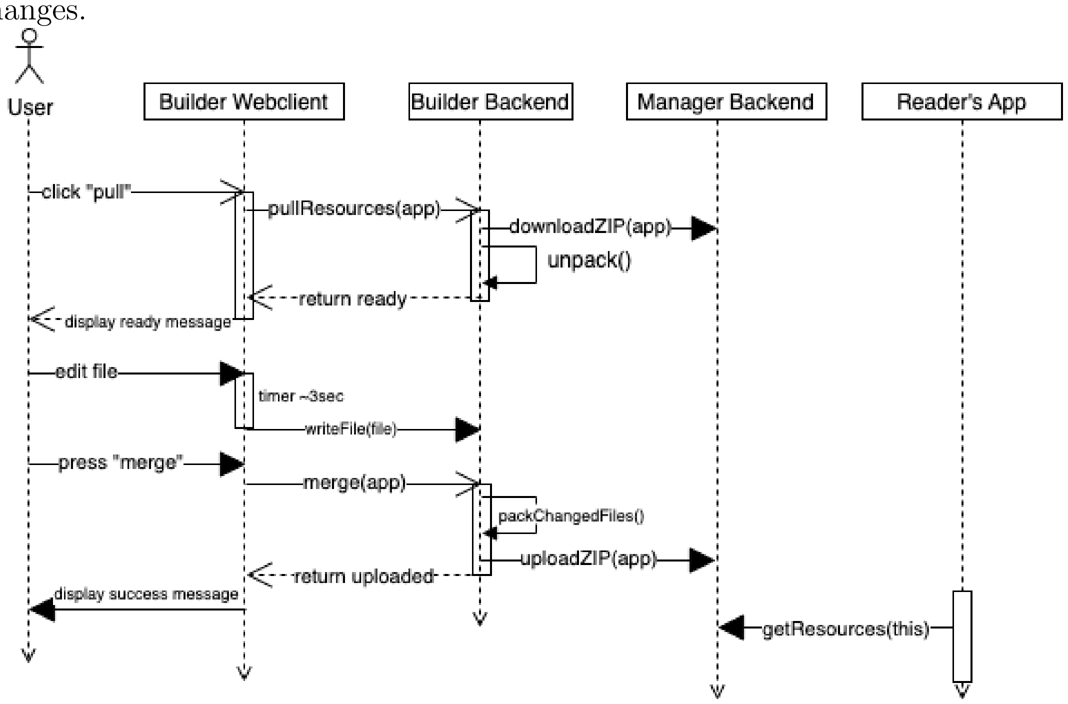
Then, they can import content via multiple ways, or the editors write the content directly inside the tools provided as an Software-As-A-Service (SaaS).

The apps are running an Meta framework build ontop of Angular, which is completely configurable via JSON files descripting the routing, rendering of

diffrent components, connecting data sources (an API abstraction) with those components, loading assets like images and ads, and styling the whole page with CSS.
These configs and assets are stored on an file system called *dynamic resources*.

Dynamic resources are individually managed and loaded for every app. This way, on mobile phones the endusers download an native core app, which in turn just downloads the dynamic resources and executes the angular app with the configs provided from the resources. Similar, when a end user requests a website, the backend server just looks up the dynamic resources matching this Domain or URL, and renders the website using that config. This way, all customers can share the same server instance(s), or at least don't require extra build artefacts per app.
If you have worked with larger JSON files before, you may recall that they get convoluted quite fast. Also, manually downloading ZIP files, unpacking them, chaning assets and config files, packing them and uploading and hoping one didn't introduce a typo anywhere is an inefficient an at times quite dangerous workflow.
At Sprylab, there exists an tool called "Storefront Editor", which is used as the foundation for this new editor. In the section about (TODO: LINK!!!) User Research, I will outline the positive aspects and approaches which I reused for the new editor, as well show the missing features and features the interview candidates noted as confusing, not working or slowing odwn their work.

The following UML sequence diagram displays a typical interaction of a user with the editor; pulling the current version, editing a file and merging the changes.



4 3 - Related work

TEasfaflbaflhawlih a saf lahflahef awhj aef

5 4 - User research and analysis

To avoid the common problem in software development where products are built based on the ideas of individual stakeholders who may not even use the product, instead of relying on meaningful user input, I applied various methods of user research commonly used in Human-Computer Interaction (HCI) and evaluated their effectiveness in the context described earlier.

A starting point for qualitative user research is to define the goals through the help of the SMART Criteria <TODO cite>.

For these criterias, I defined the overall goal as following:

- **specfic** - improve the workflow of users modifying dynamic resources
- **measurable** - interviews after testing period, concerning working speed and confidence when editing resources, user tracking
- **assignable** - research implementation will mostly be conducted by me, with input from CTO & product owner, connection to external users through customer service team
- **realistic** - new software platform which reacts quicker, prvides more safety regarding errors and is scalable and extensible in the future. Limiting factors are time (as I only have three months for the first phase, including writinh this thesis)
- **time-related** - the new software should have at least the same feature set and be usable by company-internal users until the end of 2022

5.1 Identifying and categorizing users and user groups

In order to effectively design and implement the UI editor, it is crucial to understand the needs and preferences of the various users and user groups who will be using the tool. Therefore, the first step in the user research process was to identify and categorize the different users and user groups who will be using the editor. This included both internal and external users, as well as users with different levels of experience and expertise. By understanding the characteristics and needs of each user group, we can ensure that the UI editor is tailored to their specific requirements and can be used effectively by all users.

As explained earlier, because we had a preceeding, less powerfull tool to edit the resources, which was used mostly by company-internal developers and managers, but also available to some external customers. As a first step, I collected a list of mail adresses that accessed the tool by looking at the logs, and wrote a mail to our developers who would be interested in working with me for both design phase and later as alpha and -beta testers.

Then, I derived the follwoing commomn factors from the users, most of which I personally know, which made the communication and categorization a lot easier.

- **quantitative usage** There were users who relied on the tools for most of their work, while others like the external customers accessed the tool a few times a year.
- **common tasks** I <grob> categorized the common tasks into three groups:

  Heavy configuration Mostly internal devs used the tools to build new apps and websites from scratch (or derived from exisiting apps), making many modifications, from structural changes to the seperate views, menus, data sources and more, over styling and translating messages to diffrent languages.

  Moderate configuration Project devs and customer support people copy resources from existing apps and adapt them for new brands, which often includes changing colors and logos, adapting texts or switching authentification flows.

  Small changes External customers often only use the tools to exchange some ads, translations or logos, which affects a small set of files.
- **expertise** <kann man bei schlechter software gut erkennen, leute mit viel erfahrung checken sachen, aber ist für neue nicht intutitiv>

5.2 Process and vizualize the outcomes of the initial user research phase

5.2.1 2x2 Opportunity Matrix

This two-dimensional vizualization of a set of proposed features prooved helpful when prioritizing tasks with other stakeholders, as it shows the (approximated) cost of implementation as well as the value the feature can have for users.

The matrix I used is a slightly modified adaption from [2, p. 181], replaced the term ”idea originality” on the x-axis with ”Value”.

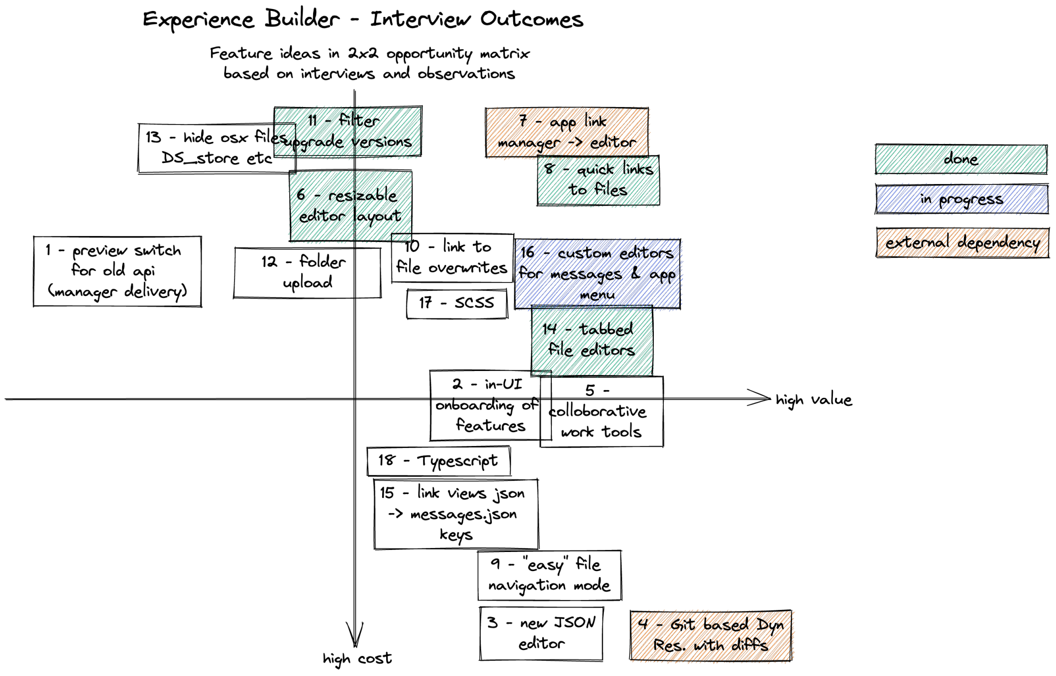

Experience Builder - Interview Outcomes
Feature ideas in 2x2 opportunity matrix based on interviews and observations
11 - filter upgrade versions
13 - hide osx files DS_store etc
7 - app link manager -> editor
8 - quick links to files
6 - resizable editor layout
1 - preview switch for old api (manager delivery)
12 - folder upload
10 - link to file overwrites
16 - custom editors for messages & app menu
17 - SCSS
14 - tabbed file editors
2 - in-UI onboarding of features
5 - colloborative work tools
high value
18 - Typescript
15 - link views json -> messages.json keys
9 - "easy" file navigation mode
3 - new JSON editor
4 - Git based Dyn Res. with diffs
high cost
done
in progress
external dependency

Figure 5.1: 2x2 Opportunity Matrix during the early phases of development

6 5 - Prototyping

After collecting the inital user feedback, I started drawing minimal digital "paper" prototypes using Figma to gather vizualizations of the proposed UI layouts. Two ideas emerged from the interviews: a (file-)editor-centric layout and a preview-centric layout.
The editor-centric layout is inspired by modern text editors / IDEs like VS Code (`https://code.visualstudio.com/`), which was mentioned as reference during the interviews multiple times. There, the central pane is the editor for the currently open file, while in the sides additional panes for file management, preview and more can be shown. The familarity especially to developers, who are used to IDE layouts, could help new users adopt patterns to work with the UI they use in other tools as well.

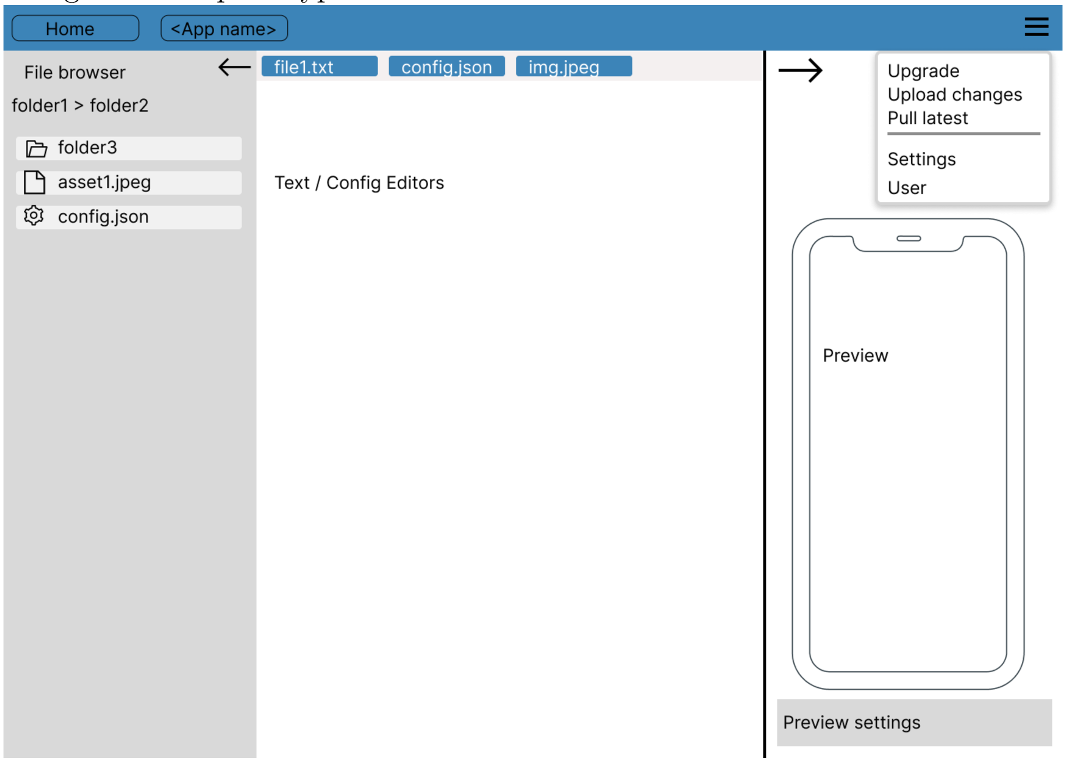
The idea for a preview-centric layout was inspired by popular generic website builders like `https://wix.com` or `https://wordpress.com`, where the user can see the page in an interactive mode, move, rename or place elements, and then has on the side additional panels like one with information & options about the currently selected one.
Ultimately our choice fell to the editor centric layout, the following are some of the reasons for it over the preview-centric one:

- The configuration structure of the Experience framework was not built with preview-based editing in mind. A lot of functionality is hidden inside the components and invisible for the user, often components only appear under specific conditions that are not easily reproducable in the editor environment. Thus, editing in a preview-centric mode could in many situations lead to more confusion by the editors than speed the process up.

- After evaluation of some avaialble libraries and examples, we concluded that building a reliable and usable preview-centric editor is more complicated, and even without the time restricition of my bachelor thesis, I proposed to not go this way, as it was unclear if it even could result in a viable product in reasonable time. For editor-centric UIs, many thirdparty libraries exist, that can be integrated into the UI. Some relevant are Monaco Editor (the VS Code Open source text editor part) for editing generic web related files like CSS and JS with automatic syntax highlighting and error detection, and an JSON Editor for work with json configs where we could provide a schema.

- Even though this should not be a exclusion criterion, the old tool used a editor-centric layout. Using a compeletely diffrent layout could make the switch to the new tool for users of the exisitng one much harder, as they have to adapt to new layout and possibly new workflow.

Figma static prototype



6.1 Implementation and deployment

The phase of implementation and deployment followed an agile development process, where I could deploy changes easily to get fast feedback from users. I strucutured the chapter into the follwoign parts:
(TEMPORARY, use latex subchapter list?)

- Software stack
- CI/CD
- Security (Protocols and audits)
- Scalability
- Automated Testing
- User Testing, Internal Beta and Monitoring
- Communication and Documentation

6.1.1 Software stack

A common point appearing in brownfield software projects, or generally in larger companies and software ecosystems, is the limitation in technologies that should be used for a new project. Else, one may chose the latest and greatest language or framework for that usecase, but maintainability and availability of persons to review and collaborate are important as well. To reduce overhead of learning new languages, tech stacks and keeping the infrastrucuture manageble, often a small set of languages and frameworks is provided by the devops- or infrastructure team. In my case, the most important point was the availability of additional persons with knowledge. The contraints from devops side were not that tight, since the code gets deployed in Kubernetes, a containerized environment anyways, so as long as it can run on a linux VM, it could get deployed.
In the end, I decided to use Typescript (`https://www.typescriptlang.org`) on both back- and frontend. The advantages are wide availability of persons who also work with it, a mature ecosystem, and shared type declarations between server and client, reducing the risk of creating incompatabile data instances by accident.

The rest of the stack is fairly common in the web developemnt industry as well, the frontend uses React JS as a rendering and reactivity framework, with additional libraries for state management, UI Components and API query management on top.

For the backend, I used Node as a Javascript runtime, combined with the most used HTTP server framework for Node, Express JS [3]

asd

7 Zusammenfassung und Ausblick

- Die Zusammenfassung sollte das Ziel der Arbeit und die zentralen Ergebnisse beschreiben. Des Weiteren sollten auch bestehende Probleme bei der Arbeit aufgezählt werden und Vorschläge herausgearbeitet werden, die helfen, diese Probleme zukünftig zu umgehen. Mögliche Erweiterungen für die umgesetzte Anwendung sollten hier auch beschrieben werden.

Bibliography

[1] Johanna Wallén Axehill et al. “From Brownfield to Greenfield Development – Understanding and Managing the Transition”. eng. In: *INCOSE International Symposium* 31.1 (2021), pp. 832–847. ISSN: 2334-5837.

[2] Christopher Reid Becker. *Learn Human-Computer-Interaction.* 2020. ISBN: 978-1-83882-032-9.

[3] Vano Devium. *Top Node.js Web Frameworks.* URL: `https://github.com/vanodevium/node-framework-stars` (visited on 12/13/2022).

[4] Jennifer Preece Helen Sharp Yvonne Rogers. *Interaction design - beyond human-computer interaction, 5th Edition.* Wiley, 2019. ISBN: 978-1-119-54725-9.

Appendix

7.1 Erster Teil Appendix

7.2 Zweiter Teil Appendix