C-ABLE

Authors
Andrei Maria, Ágoston Reischl, Peter Soulard, Luc Hardonk

Group ID
E1

INTRODUCTION

As the International Cable Protection Committee approaches the 2030 deadline for adapting the submarine cable industry to the S-100 standard [1], there are a few challenges that they need to overcome. The International Hydrographic Organization's (IHO) S-100 standard provides a universal framework for digital hydrographic data products and services. Designed as a successor to the S-57 format, the S-100 standard supports enhanced geospatial data modeling and interoperability, catering to a wide range of applications, including Electronic Navigational Charts (ENCs), maritime spatial planning, and autonomous navigation systems.
The key challenges are the lack of understanding and knowledge about the new standard within the industry, and also the absence of systems that provide solutions for the technical requirements. The introduced system aims to resolve some of the challenges.

PROBLEM STATEMENT

- The currently used kmz/kml and spreadsheets **formats will not be accepted**
- **Lack of consensus** on the new format – The S-100 only describes requirements
- Cable damage **risks** due to imprecise data
- Sensitive and highly valuable information that **competitors do not want to share**
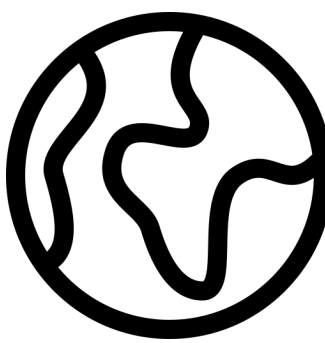- **Limited legislation** on high seas – areas beyond national jurisdictions

PROPOSED SOLUTIONS

The C-Able system provides solution to some of the challenges:
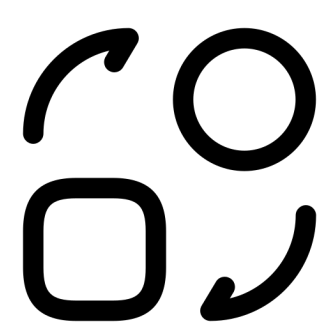
CONVERTER
A converter tool that takes the old format and generates an S-100 compliant JSON format, that is structured hierarchically, easy to use, lightweight and web based applications handle them with ease.

VISUALIZER
A visualizer tool to show the precise location of the cables and their intersections with other cables or different controlled territories.

CABLE MANAGEMENT
An interface to manage the cables that are stored in the system. It allows the creation, modification and removal of the cables and their metadata.

ARCHITECTURE

Cable visualizer

DATA

Users can upload two data types to the webpage: KML/KMZ are XML-based formats in which useful data points are found in Placemark elements, with links indicated by LineString elements. The system parses all the useful information into a hierarchical JSON file. This is the other possible format which can be uploaded, and must contain the kml-specific cable information points, such as the route name, the nodes and the links, with the corresponding coordinate information.

METHODS

Upon uploading a kml/kmz file, the converter extracts the useful information into Python map-based structure, and outputs it into a JSON format file. This file is stored in a designated sub-folder, and can be edited in the webpage editor. The files can be overviewed and managed using a JavaScript backend.

The Overview page visualizes the cables and the data stored in the JSON files. It leverages several JavaScript libraries for dynamic cable and zone crossing detection and their demonstration, as seen on the right.

USER EXPERIENCE

The design of the interface accommodates the three main workflows that a user may take in order to achieve their desired result.

- **Converting a kml/kmz file** to the new JSON-based format. This is done on the "Converter" tab, and allows one to immediately edit any errors that may have been inherited from the input file.
- **Managing the available routes.** This is the functionality of the "Manage routes" tab, where uploaded files can be edited, exported and removed. If a user has a JSON route, this is also where they can upload this without going through the converter step.
- Getting an **overview of the submitted routes.** This can be found on the "Overview" tab, where each route and the relevant zones can be highlighted, and where more information about them can be seen. A preview of this is also available in either of the previous steps.

USER TEST RESULTS

The user interface was tested by individuals who were unfamiliar with it, but had previous understanding of the project. The tests utilized the "Think-Aloud" approach and the users were asked to complete three tasks, where the time and errors were tracked. After completing all the tasks, the users were asked to rate ten System Usability Scale [2] statements from 1 to 5, where 1 accounts for "strongly disagree" and 5 accounts for "strongly agree".

Converter
The file converter successfully converted a kml/kmz file into a JSON file while complying with the S-100 format.

Visualization
The visualization tool succeeded in visualizing the uploaded cables on a map, while also showing the territorial areas.
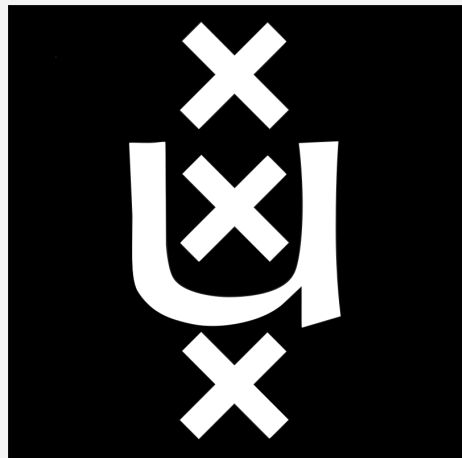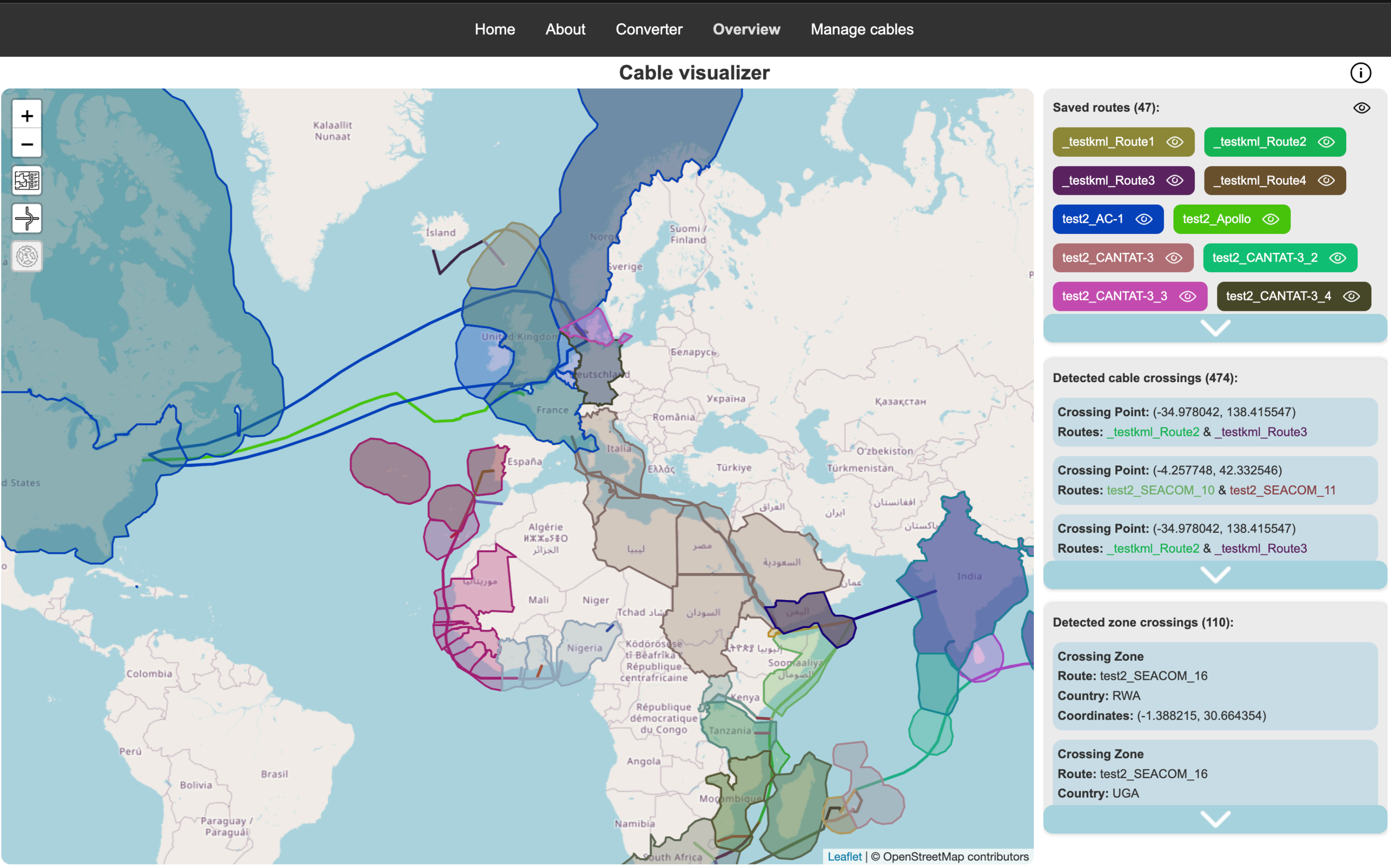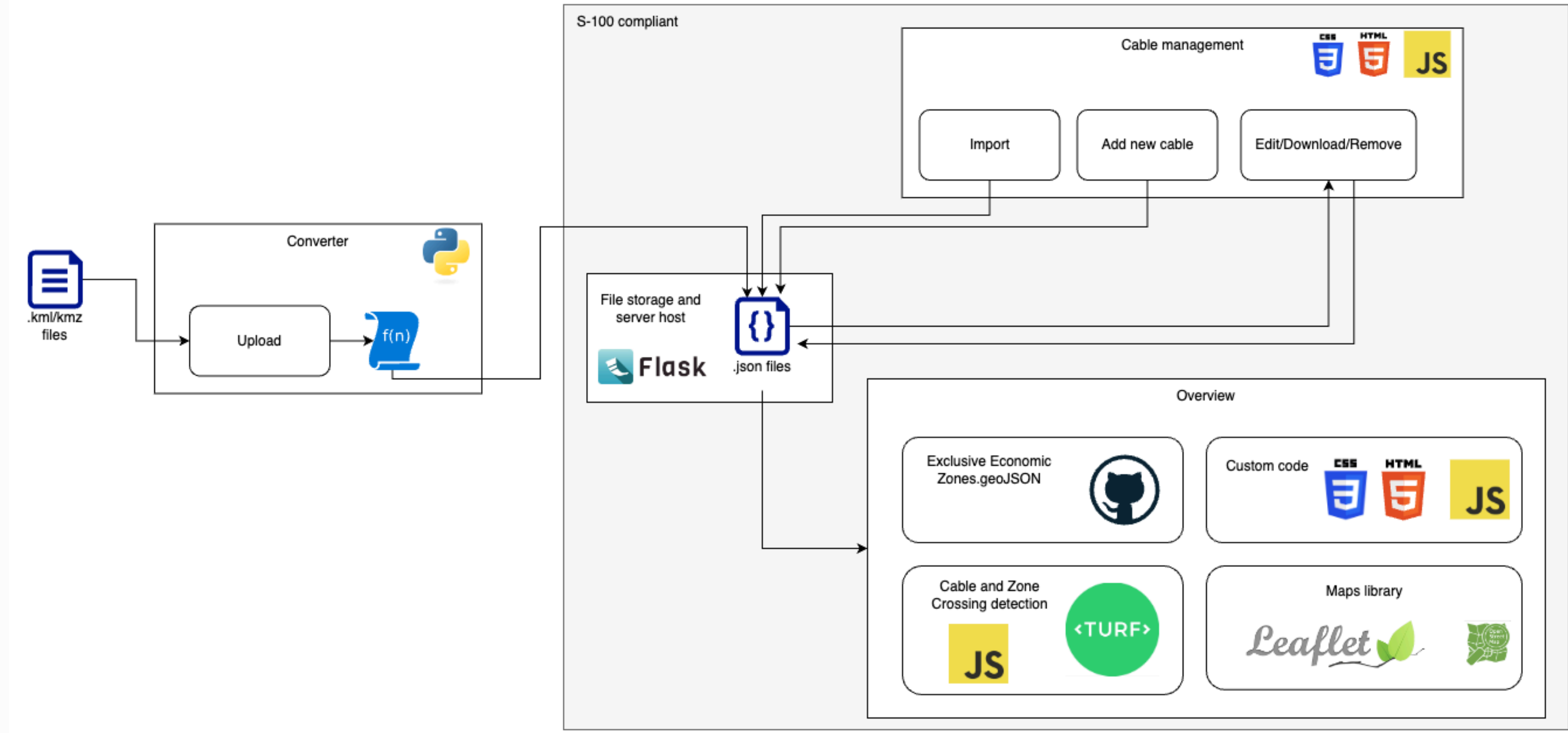
User testing
The SUS test had an average score of 82.5, which indicates that the interface is user friendly.

CONCLUSION

The application provides a clear answer to the file format challenge by proposing a general purpose S-100 compliant file extension. While it depends on the data quality, the format allows highly precise data that can be efficiently stored.
The user interface encourages stakeholders to use the system throughout the lifecycle of the cables.

DISCUSSION

With further research and deeper understanding of the different requirements of the companies that lay, own or maintain the submarine cables, a new file extension standard should be proposed, with clear instructions on what kind of data and precision is expected from the providers. This could also ignite competition for independent development companies to create new tools.

FUTURE WORK

1. User tests show that the interface is already user friendly, but the comments made during the interview indicate that the user experience could be improved.
2. The system needs further development to ensure security and scalability.
3. A secure communication channel needs to be implemented that enables stakeholders from different companies interact with each other on intersections of interest.

DEMO VIDEO

TEASER VIDEO

RELATED LITERATURE

[1]: 100 project | IHO. https://iho.int/en/s100-project

[2]: How To Use The System Usability Scale (SUS) To Evaluate The Usability Of Your Website | https://usabilitygeek.com/how-to-use-the-system-usability-scale-sus-to-evaluate-the-usability-of-your-website/