DAPSI Programme: 3rd Open Call (Round 3)

OKH P&I Phase 2: User Testing & Technical Report

Owning your own work, no matter where you publish: portability and interoperability of hardware designs through new Open Know-How standards and tools

NGI DAPSI

IoP Alliance

Introduction

Makers, designers, engineers, and others who are involved in collaborative and distributed manufacturing projects need to share their hardware projects' design and documentation files with collaborators. They are currently not able to do so in a simple way that maintains the integrity of the project's data and files. Makers are either forced to store all project files and data centrally, with all the risks this entails, or they are forced to rely on unstandardised bundling of project parts that could be missing critical component, data, and/or contain corrupted files.

The objective of the Open Know-How (OKH) initiative of the Internet of Production Alliance (IOPA) is to improve the openness of know-how for making physical goods by improving the discoverability, portability, and translatability of knowledge. Our vision is to do so in a way that frees makers from platform lock-in, terms & conditions changes and extractive high fees, and that will provide tooling that can be integrated into pre-existing hardware project hosting platforms. Building on OKH, our continuing work moves toward the goal of a decentralised manufacturing ecosystem, which will provide individual makers with the agency to produce localised products in their communities.

To progressively mature OKH, which aligns with the Open Source Hardware Definition [cite], the Internet of Production Alliance (IoPA) and Alliance stakeholders have built on the OKH initiative and have moved into the development of MVP tooling for data portability.

Research on uses of online hardware platforms, investigation of new options for decentralised data storage, and the development of tools for data interoperability and portability have continued, contributing valuable community user data toward meeting our goal of portability for hardware project know-how.

Using the tooling that we have developed makers will be able to:

- export their creative work from many platforms to decentralised or local storage,
- share their work with wider audiences,
- easily keep their designs up to date,
- build on each other's work and contributions (no matter what platforms they use), and
- secure their livelihoods and work in perpetuity.

Specifically concerned by the data and content created by 'makers' (designs and documentation for hardware, together referred to as "works"), the IOPA continues the exploration and development of tools to re-establish the boundary between makers and service providers hosting this data.

Outputs/KPIs

User Testing (Phase 2): Deploy proof-of-concept web-based data validation tool for user testing and feedback and build MVP for maker tool that can be used for converting data between selected platforms by:

- Conducting prototype user testing of an enhanced data validation tool and MVP for the conversion of data between platforms.

Open Know-How — Linked Data (OKH-LD)

We built on the work of the consortium lead, Open Source Ecology Germany, who developed an RDF linked data ontology based on the IOPA's Open Know-How standard, which we refer to as OKH-LD. This linked-data adaptation of the Open Know-How standard was used as the basis to generate project manifests from the selected platforms:

- github.com
- gitlab.com
- wikifactory.com
- thingiverse.com
- appropedia.org
- oshwa.org

The project manifests that were generated based on this schema were used as the basis for the MVP data portability tooling developed during this phase.

Data Validation

One of the advantages of using RDF in the OKH-LD specification is that we are able to use Shape Expressions (ShEx) for validation and transformation of data in the project manifests. Developing a Shape Expression (ShEx)[1] based on the OKH-LD ontology, and incorporating it into the portability apps that we developed, allows us to test the content of the manifest against the OKH-LD ShEx schema to provide enhanced validation of the data, and transform it into other data formats and structures (e.g. Solid Containers).

The Shape Expression that's used for validation of the manifests that are generated based on the OKH-LD specification can be found on GitHub:

- OKH-LD Project Shape Expression: https://github.com/iop-alliance/okh-solid-app/blob/main/src/shapes/okhProject.shex

MVP Tooling for Data Portability

Following the results of phase one of the DAPSI OKH P&I project, additional survey research with maker community members was conducted to inform development of prototype tooling for project file portability. Data collection and analysis informed our understanding of maker 'must-haves' for a prototype, covering multiple characteristics of documentation types, schematics, file formats, and preferred storage platforms. Criteria for a proof of concept and test cases were identified for data validation/conversion and mapping, which lent to the development of:

- **OKH Project Porter:** prototype tool to allow users to extract project files from target platforms to their own devices.
- **OKH Solid App:** enables makers to use the "Open Know-How" open data standard to transfer files from target platforms for decentralised storage in Solid Pods. Web interface: https://solid-app.internetofproduction.org

The goal of this tooling is to provide makers the ability to convert the data and files held on various platforms to a format that allows them to either store all affiliated project data and files locally on

their devices, or in a decentralised manner by porting it to a Solid Pod. These tools also enable makers to share their work easily with others by simply sending a single OKH project manifest file rather than all project files. User testing of the developed MVP tools was carried out and the resulting feedback will be used to further develop and refine these solutions.

A video demonstrating the prototypes can be viewed at: https://iop.link/dapsi-demo

OKH Solid App

The Solid ecosystem/protocols are an ideal way of storing and sharing project data and files, and the OKH Solid App that we developed is the only Solid App that addresses the specific needs of makers for decentralised storage of data and files for hardware projects.

Features:

- Use of OKH-LD manifests to convert and export data and files from target platforms to a Solid Pod
- Makers can manage access control to project files stored on their Pods
- Makers can create a Login and obtain a Solid Pod from three providers via the OKH Solid App or authenticate via certificate (WebId-TLS).

Links and info:

Information about the OKH Solid App, including an overview, motivation for development, information about Solid Pods and the development team are provided on the app's About page:

- https://solid-app.internetofproduction.org/about
- prototype can be accessed at: https://solid-app.internetofproduction.org
- code repository for the OKH Solid App can be accessed at: https://github.com/iop-alliance/okh-solid-app

Project Porter

The OKH Project Porter provides tooling that takes an OKH-LD manifest as input, and generates a bundle from it, which includes a copy of the original manifest file and all of the files that the manifest describes. There are two version of the tooling:

- graphical user interface (GUI) that runs on Windows, MacOS, and Linux
- command line interface (CLI) version

Links and info:

Further information on the OKH Project Porter, the source code, and instructions on how to run the CLI or download the command-line binaries can be found at: https://github.com/iop-alliance/okh-project-porter

Intended Audience and UX Testing

The IOPA includes members representing many aspects of manufacturing. To place our efforts on personal data portability, we focused on makers, product designers, and engineers who have a need to maintain control and ownership of their hardware projects' data, designs, and documentation and share them with collaborators and the wider public. The term 'makers' is applicable far beyond hobbyists doing DIY projects at home and in maker spaces. In addition to those makers, this work supports farmers, scientific researchers, humanitarian aid workers, healthcare providers, and many

others in a global network whose livelihood and vocation requires the ability to locally manufacture equipment that would otherwise be prohibitively expensive or logistically challenging to acquire.

Those who are involved in collaborative and distributed manufacturing projects need the ability to share their hardware projects' design and documentation files with collaborators, in a way that maintains the integrity of the project's data and files. This ability does not currently exist; makers are either forced to store all project files and data centrally, with all the risks this entails, or they are forced to rely on unstandardised bundling of project parts that could be missing critical component parts, data, and/or contain outdated files.

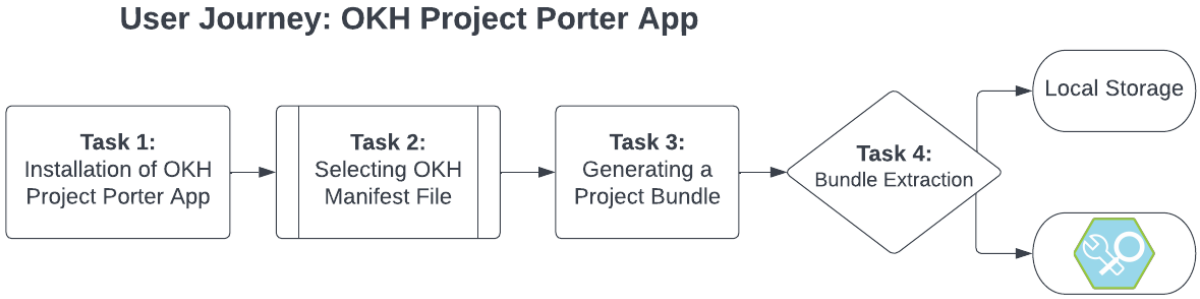
To that end, our research and development focuses specifically on addressing all issues associated with the following three scenarios:

- Designers and makers who publish their documentation in self-hosted or generic file repositories.
- Platforms that provide tools for designers to publish their documentation online.
- Platforms that aggregate, index or link to open hardware designs.

User Testing: Experience Mapping

We conducted user testing of both tools developed during Phase 2 of the DAPSI OKH P&I project, namely the **OKH Project Porter** and the **OKH Solid App,** using Kalbach's experience mapping framework[2].

IOPA community members were invited to participate in user testing, which was meant to be conversational, to help identify pain points and possible solutions for each step in the following user journey:



- **Task One: OKH Project Porter App Install** - *By the end of Step One, the user should have the OKH Project Porter App Downloaded and installed on their local machine.*
    - Task One/Path1: via terminal `okh-project-porter`
    - Task One/Path2: via GUI Tool
        - Windows: download
        - MacOS: download
        - Linux: download
- **Task Two: Selecting OKH Manifest File** - *By the end of Step One/Path1, the user should have located a project manifest file; By the end of Step One/Path2, the user will have validated a manifest file, making sure that all data required to generate an OKH Bundle is present.*
    - Task One/Path1 [a]: search of manifests in preexisting platforms (.yml)
    - Task One/Path2 [b]: selection of manifest from selected repository (.ttl)

[2] Kalbach, J. (2016). Mapping experiences: a guide to creating value through journeys, blueprints and diagrams. O'Reilly Media Inc.

- **Task Three: Generate a Project Bundle** - *By the end of Step Two/Path 1, the user should have generated a bundle from the manifest on the local file system (FS) using terminal; By the end of Step Two/Path 2, the user should have generated a bundle from the manifest on the local file system (FS) using terminal/GUI.*
    - Step Two/Path1: By the end of Step Two/Path 1, the user should have generated a bundle from the manifest on the local file system (FS) using terminal.
    - Step Two/Path2: By the end of Step Two/Path 2, the user should have generated a bundle from the manifest on the local file system (FS) using terminal/GUI.
- **Task Four: Bundle Extraction** – *By the end of Step the user should have extracted and stored all affiliated project files onto a local system, or into a generated Solid Pod.*

Pain points and possible solutions were identified for prototype refinement; ongoing testing with community members is currently being conducted. Feedback on the OKH Solid App and Project porter were tested on the following platforms:

- Windows
- Mac
- iPhone
- Android/Pixel3
- Linux

Conclusion

With the tooling and standards that were developed in the DAPSI OKH P&I project, makers are now able to convert the data and files held on various platform to a format that allows them to store it locally or in a decentralised manner by porting it to a Solid Pod. This is the first time the portability of project data from various hardware project hosting platforms has been enabled by generating and sharing a single OKH manifest file, combined with the tooling that utilises this standard. These tools enable makers and designers to share their work easily with others by simply sending a project manifest file rather than all project files.

Next Steps

- Dissemination of the research findings and prototype development, showcasing the utility that the OKH-LD manifest, along with the tooling developed of this work, provides specifically for file and data portability for maker projects.
- Recommendation to develop tooling for point-of-need OKH-LD manifest generation, such as a browser extension.
- Continue the development of the OKH-LD ontology for hardware project metadata and align all involved stakeholders in developing a shared vocabulary for data exchange.
- Encourage platforms to enable the automatic generation of OKH-LD manifests to allow for easier sharing of project data and files.
- Enhance the functionality of the OKH Solid App and seek partnerships to develop new applications based on the OKH-LD data standard within the Solid ecosystem.

Appendix

Screenshots

OKH Solid App

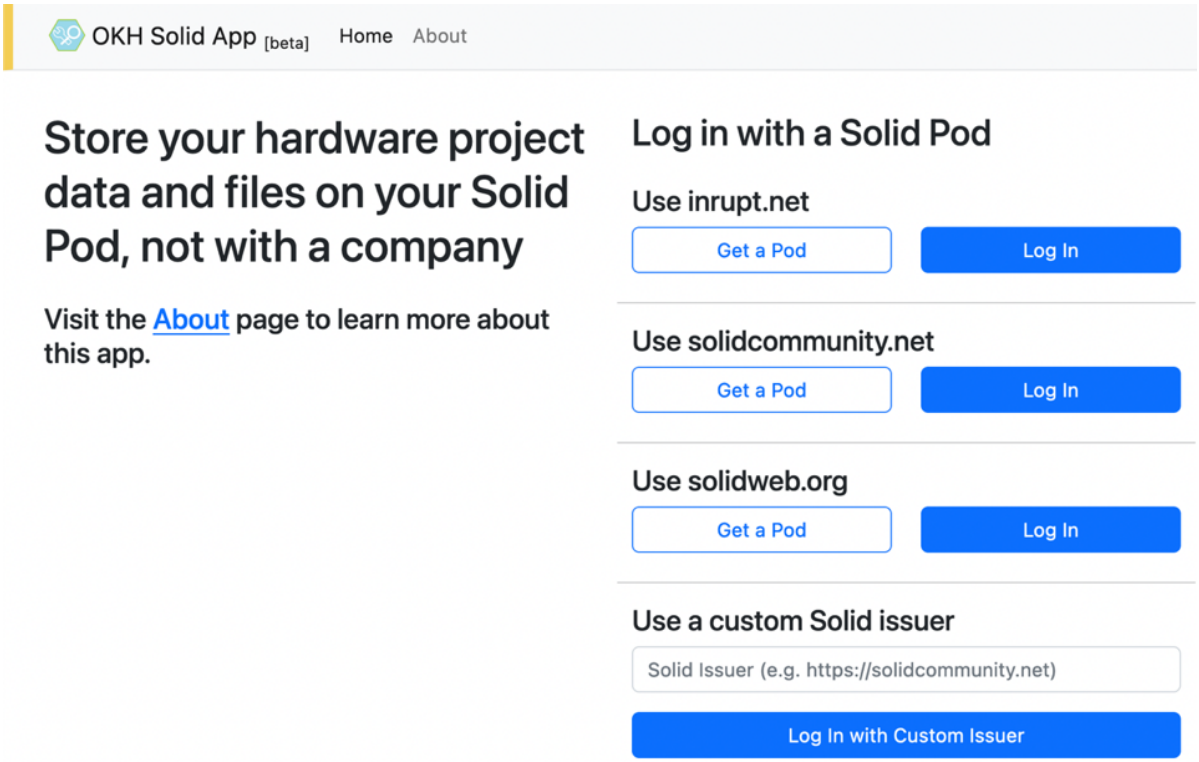


Fig 1: Landing UI for https://solid-app.internetofproduction.org

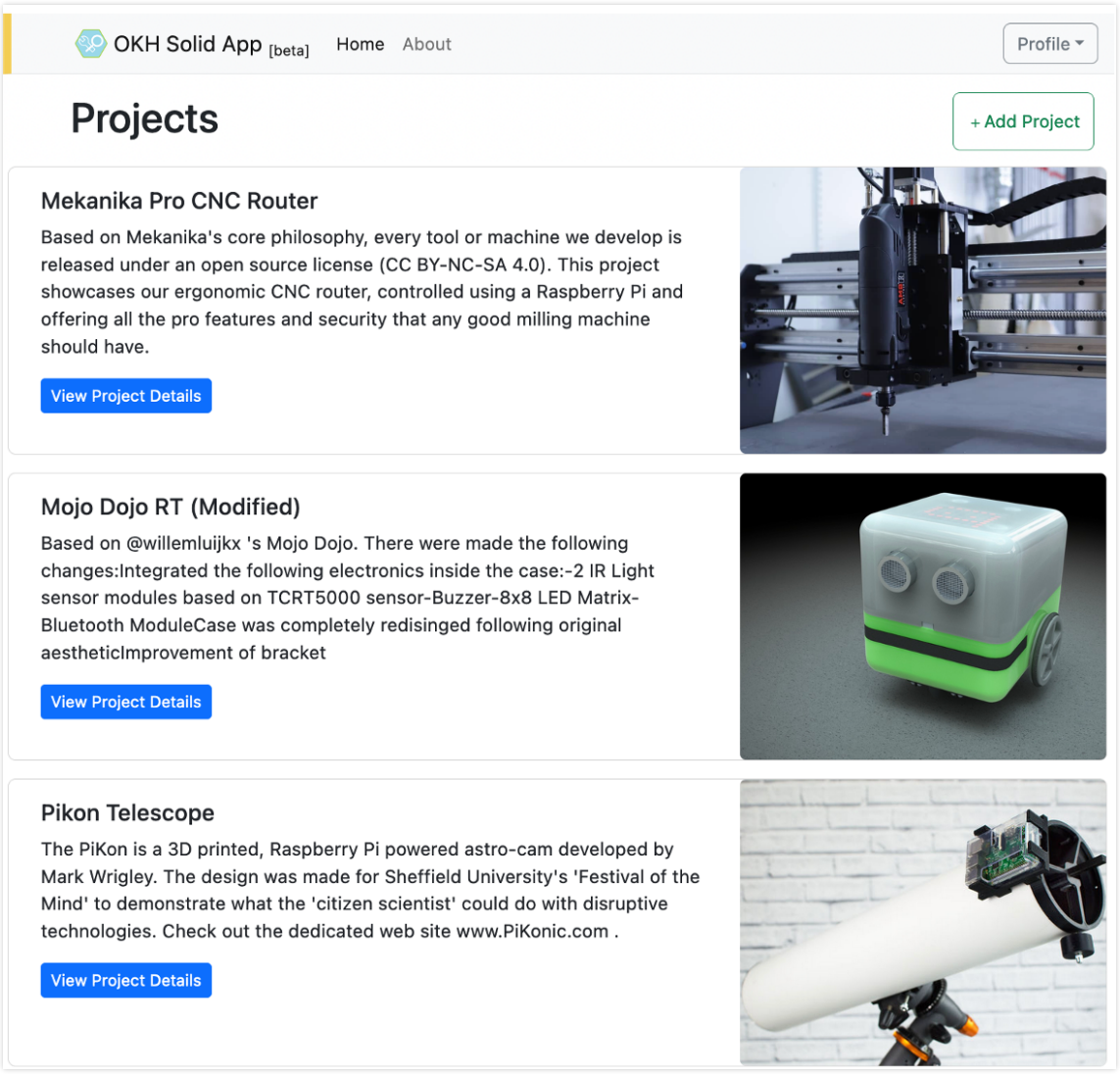


Fig 2: screenshot of OKH Solid App showing a list of hardware projects stored in a Solid Pod

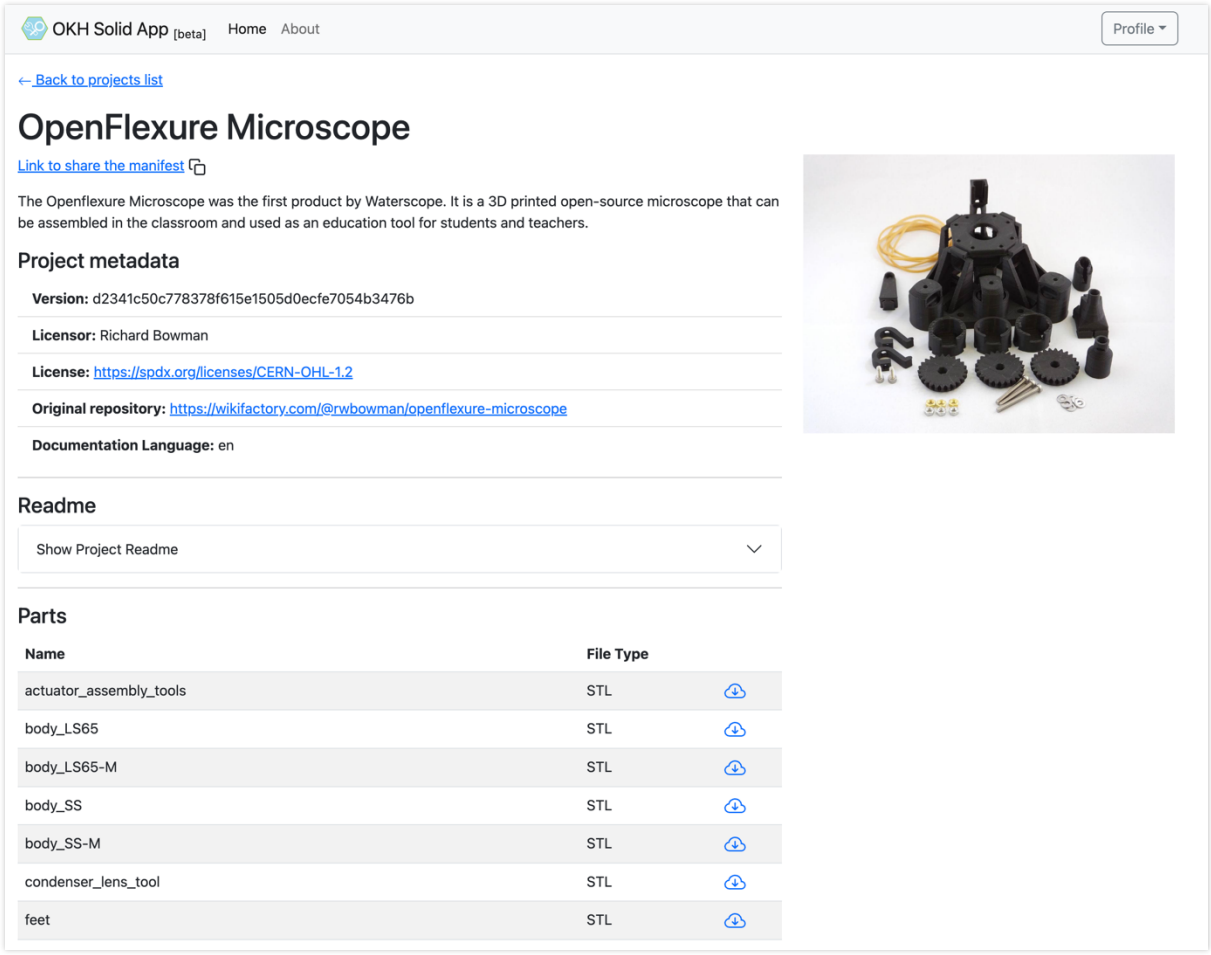


Fig 3: screenshot showing the OKH Solid App displaying a hardware project's data and its design files stored in a Solid pod

OKH Project Porter

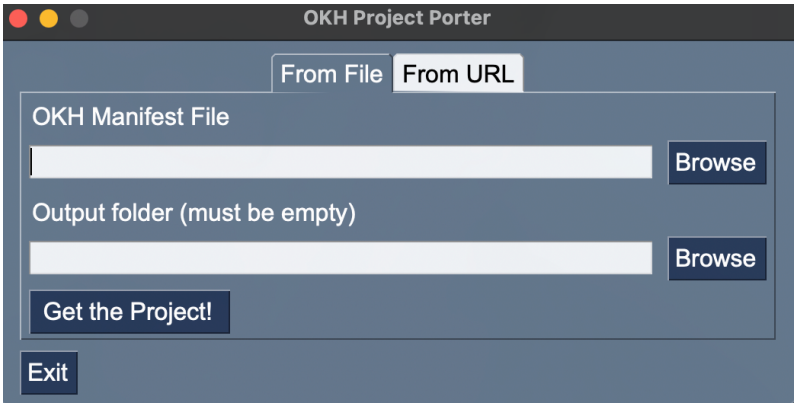


Fig 4: screenshot showing the OKH Project Porter GUI interface showing the options available to the user for selecting a manifest file and the output folder for the ported project files

Ontology Visualisation

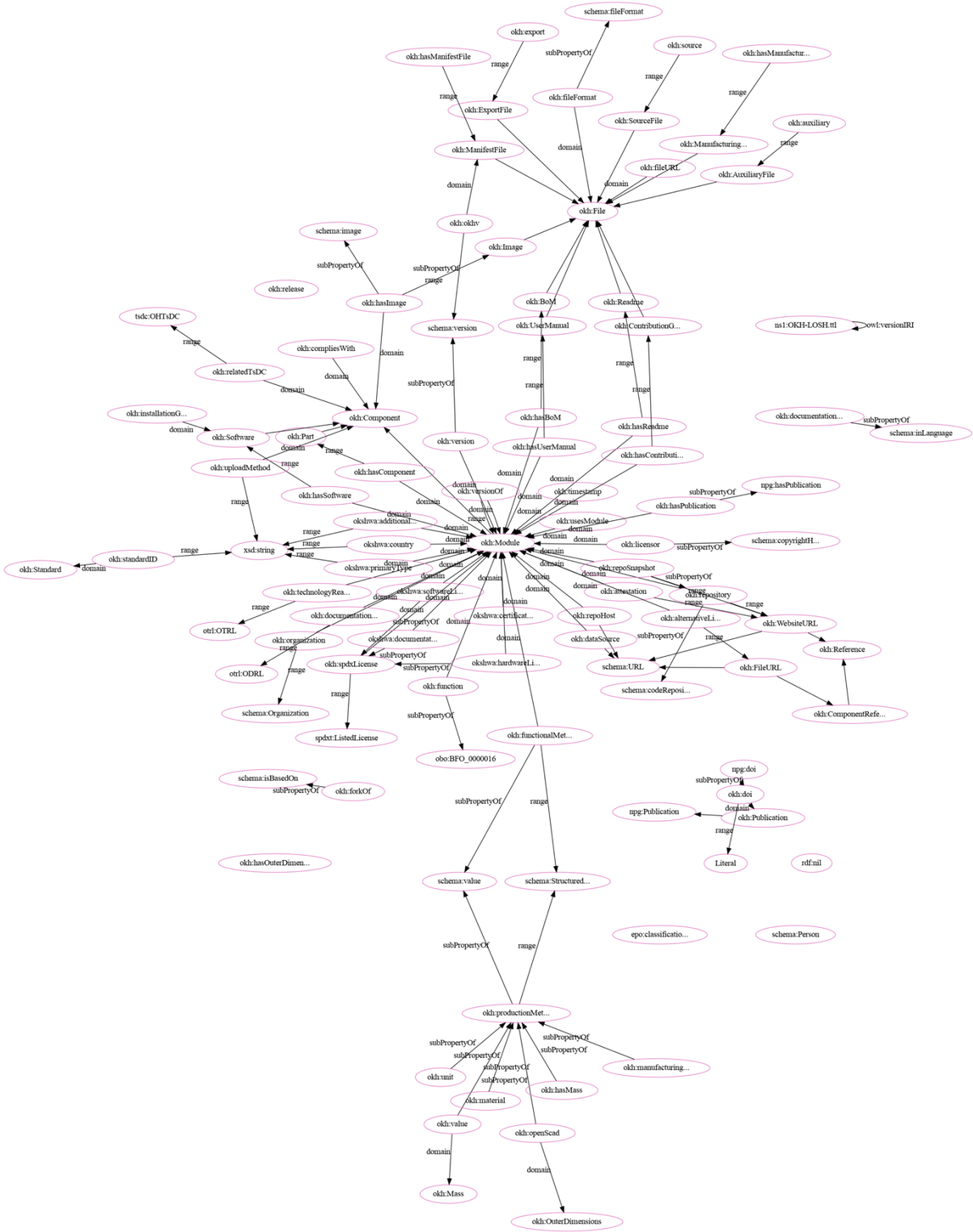


Fig 5: Visualisation of the OKH Linked Data ontology that was used for creating RDF manifests for hardware projects