DAFNI

PV2023, CERN
Wednesday, 3rd May 2023

DAFNI – Supporting Infrastructure Research in the 21st Century

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Science and Technology Facilities Council

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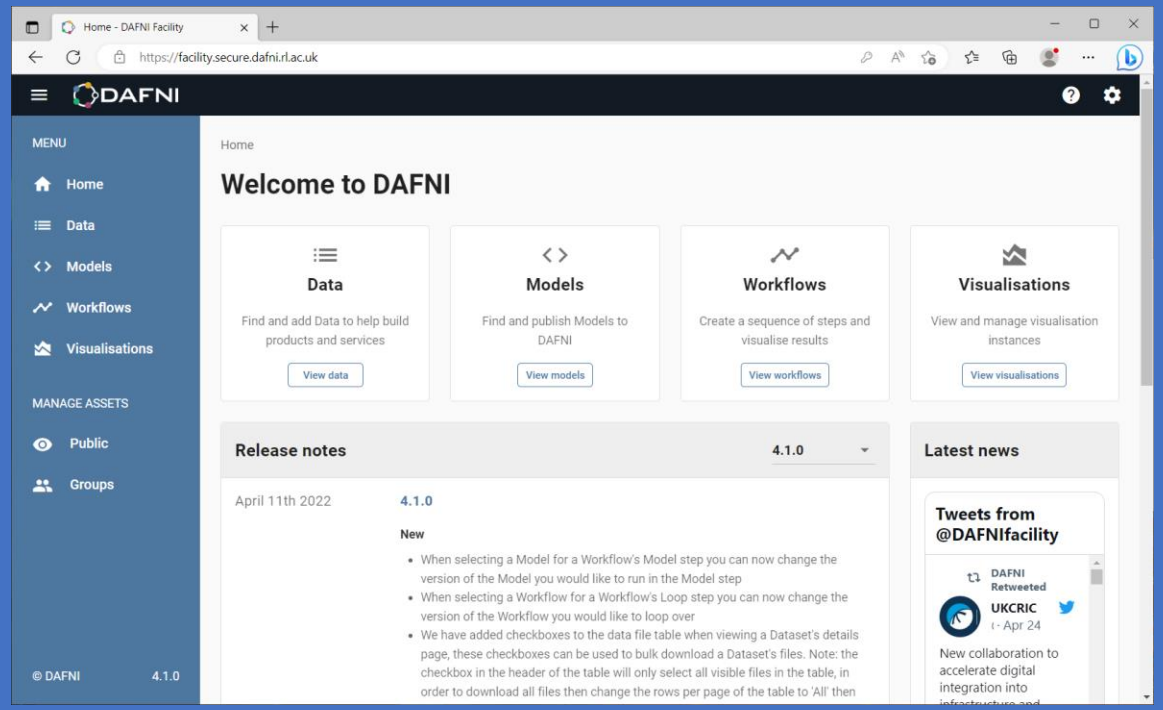
What is DAFNI ?
(Data & Analytics Facility for National Infrastructure)



DAFNI provides a powerful computing resource accessible through a web based front-end.

Aimed primarily at supporting infrastructure research projects.

We provide a legacy space for research projects, with data, models and workflows, preserved in searchable catalogues for the future.

https://www.dafni.ac.uk

DAFNI Hardware and Infrastructure

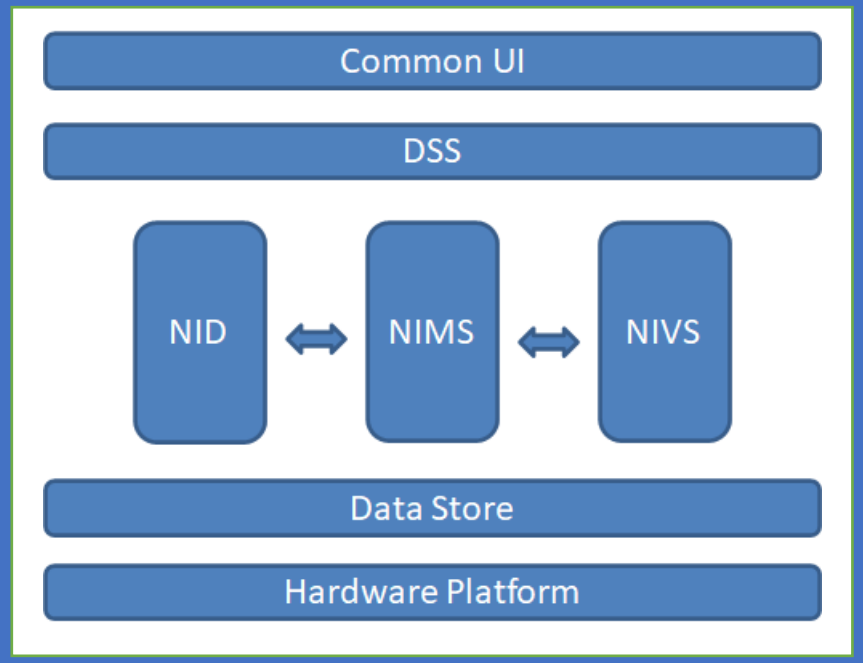
Underpinning DAFNI is a dedicated High Throughput Computing (HTC) Cluster which is comprised of 27 nodes and a total of 792 CPU's, backed by a working memory of 16.8 TB.

We current have 1.3 PB mixed storage available.

Kubernetes is currently used to manage the system, and with Podman, handles containerisation within DAFNI.

Containerisation of models allows DAFNI not support models from a diversified set of languages and OS Systems.

DAFNI Architecture



NID – National Infrastructure Database

NIMS – National Infrastructure Modelling Service

NIVS – National Infrastructure Visualisation Service

DAFNI provides searchable cataloguing of data, models and workflows (systems of models). Full support for user defined metadata.

DSS – DAFNI Security Service

DAFNI Architecture

National Infrastructure Database

The NID provides a searchable catalogue of data for DAFNI, and manages the uploading and publication of data. It handles the metadata provided with the data, and a searchable catalogue.

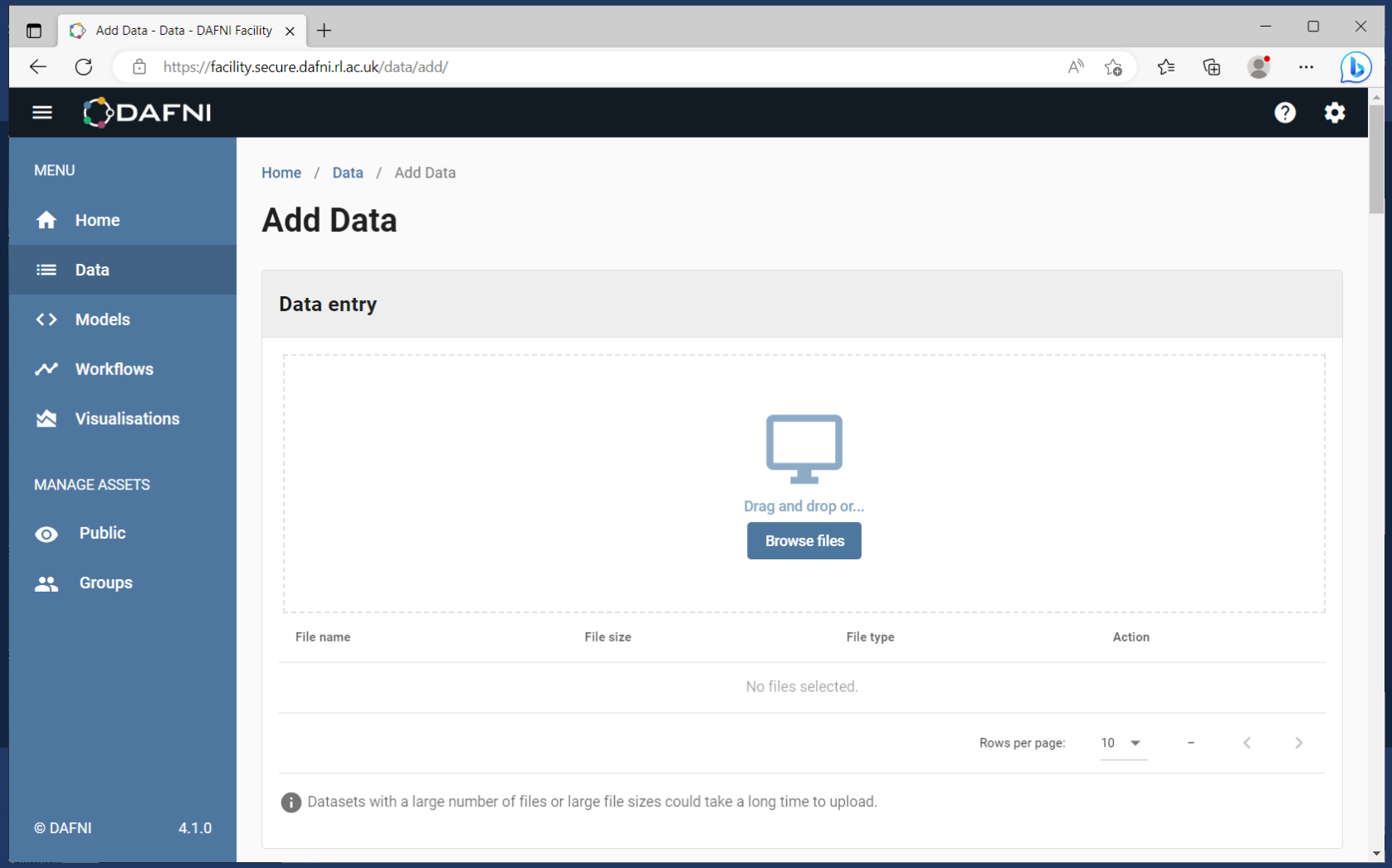
National Infrastructure Model Service

The NIMS provides a suite of accessible (user submitted) models and facilitates the development of multi-systems models. Models are containerised (using docker) which allows models to be uploaded and used in workflows regardless of language or OS.

National Infrastructure Visualisation Service

The NIVS supports basic graph construction, and also supports Jupyter notebooks for more advanced analysis of data.

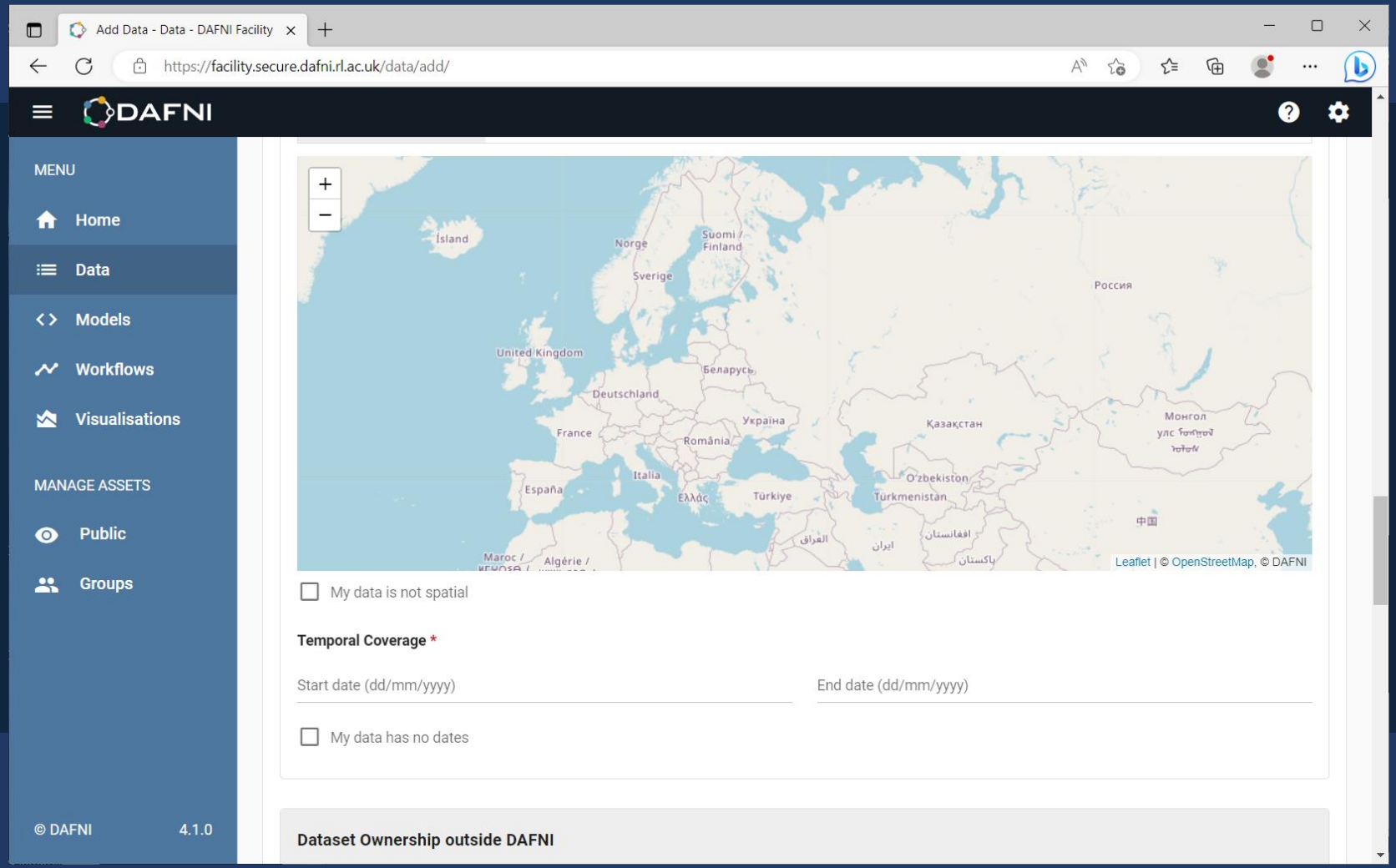
DAFNI from a Users Perspective



Data can be directly uploaded to DAFNI, and can be submitted in any data format required.

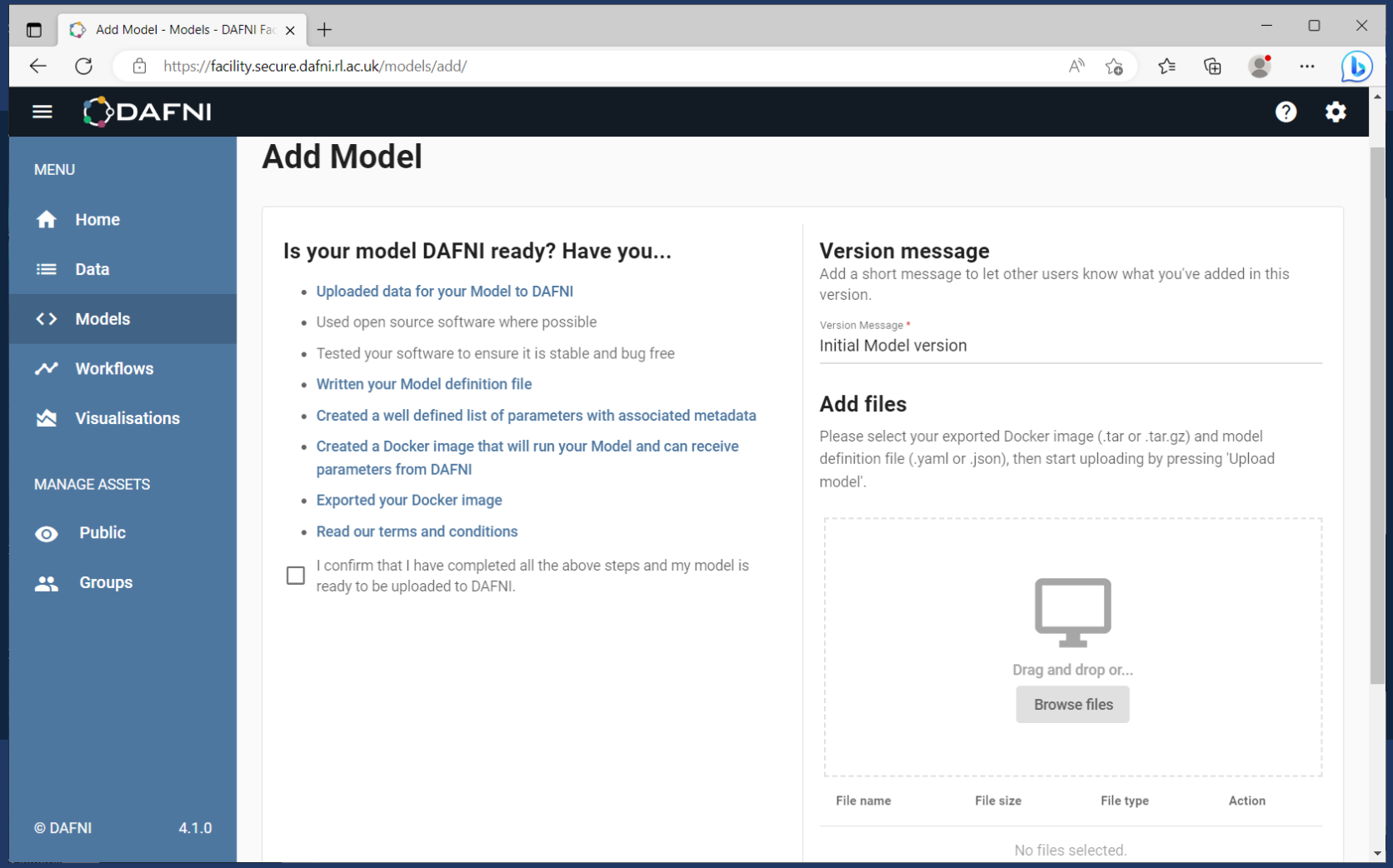
This data can be accessed by can be directly analysed using Python notebooks, and the graph interface

DAFNI from a Users Perspective



Users can define a set of meta-data for future catalogue searches and forms a powerful tool for finding data and cataloguing it in an easily accessible manner.

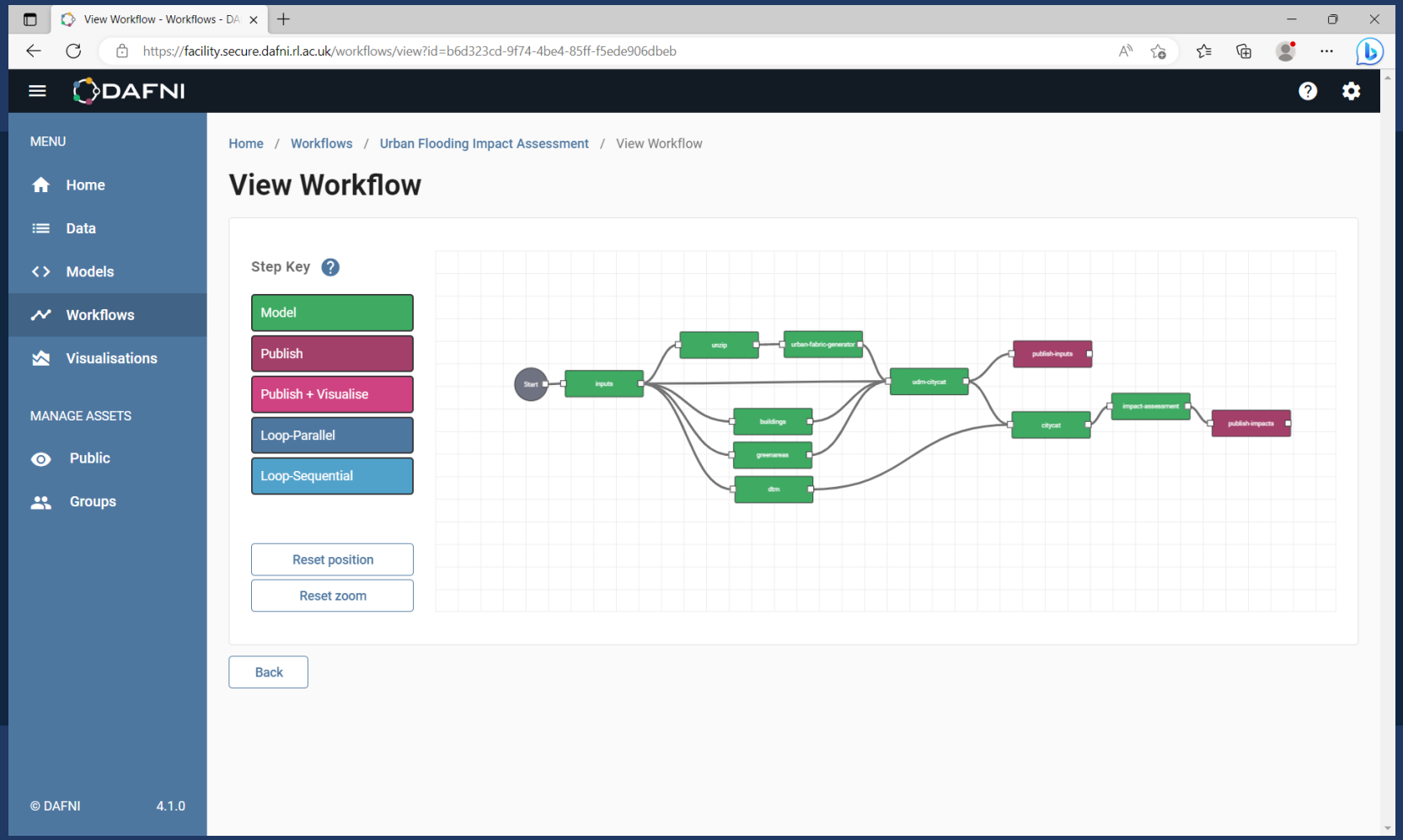
DAFNI from a Users Perspective



Users can add models directly to DAFNI using the NIMS interface. The model is first containerised by the user and is added, along with a configuration file (yaml)

Though currently the onus is on the user for dockerisation, we expect to automate this procedure to make things easier for users !

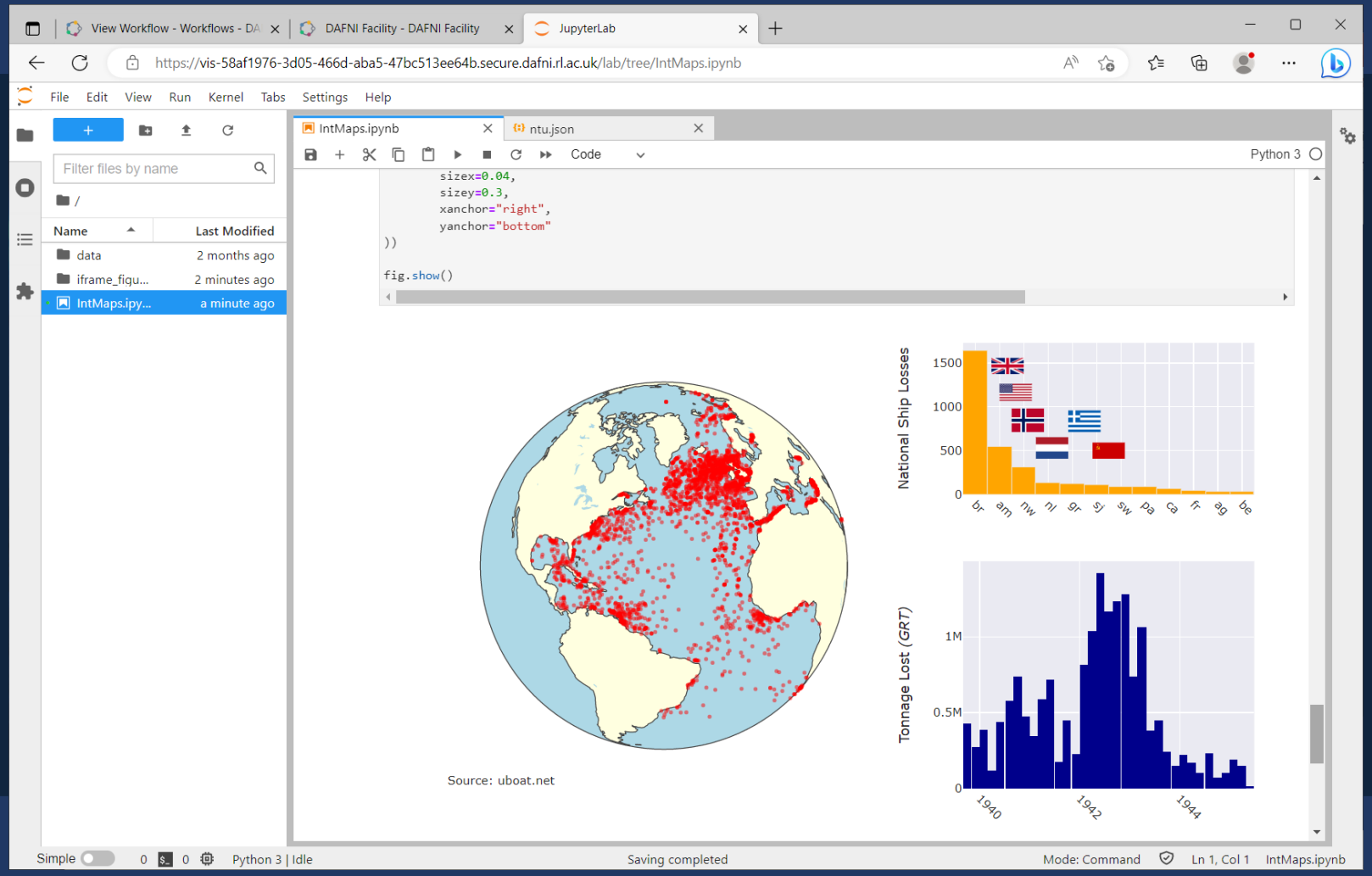
Data, Models and Workflows



Users can create workflows dynamically using the workflow building tools.

This gives flexible support for building systems of models in DAFNI, and it should be noted these models can be in any language or written in any OS (assuming docker support !)

Data, Models and Workflows



DAFNI supports a highly flexible visualisation support with Jupyter notebooks, which allows users to analyse data produced in the workflow stage.

We also limited support for an interactive graph building tool.

Projects Hosted on DAFNI
CReDo – Climate Resilience Demonstrator

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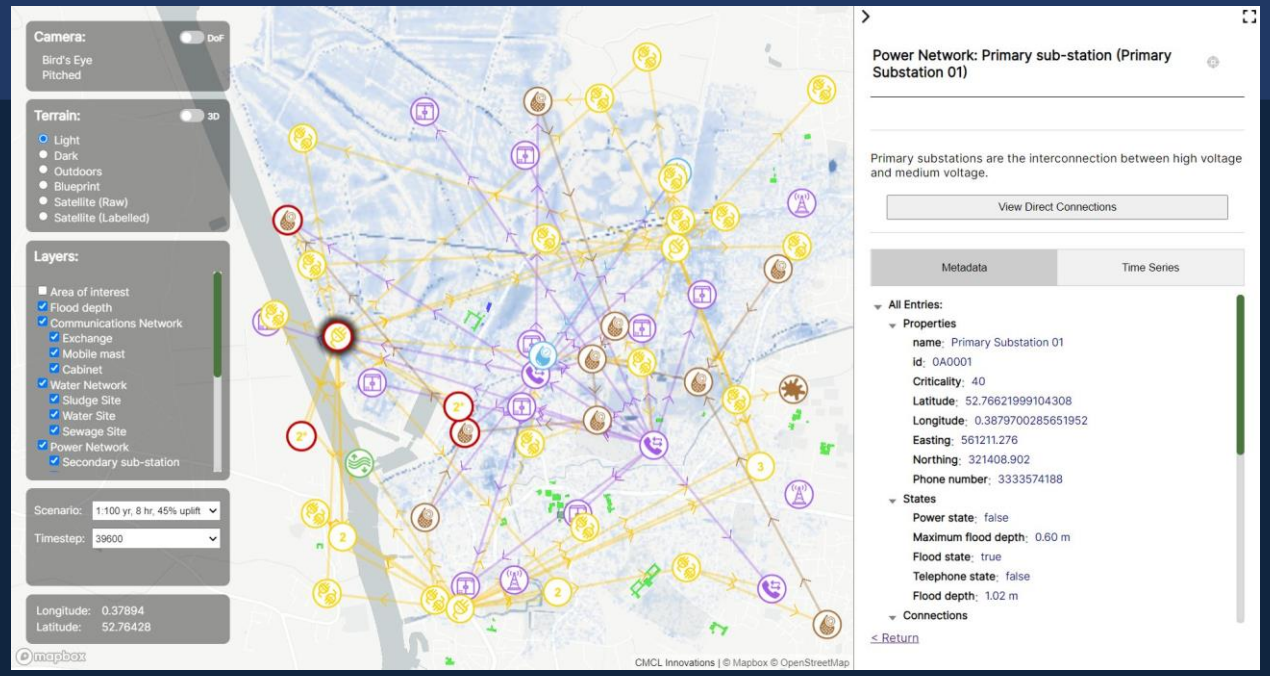

The CReDo project aims to investigate the impact of climate change on infrastructrure networks, and how we can mitigate the potential economic and social damage caused.

CReDo is currently focussed on the impact of flooding on infrastructure networks, possibility of interrelated sites going down. Evidence based decision support for flood mitigation was also provided.

DAFNI also will facilitate secure data holding for BT, Anglian Water, and UKPN.

Projects Hosted on DAFNI
UCL (University College, London) Shipping Model

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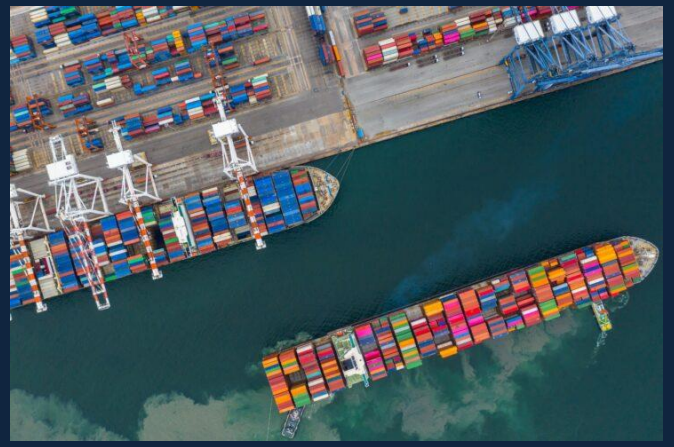

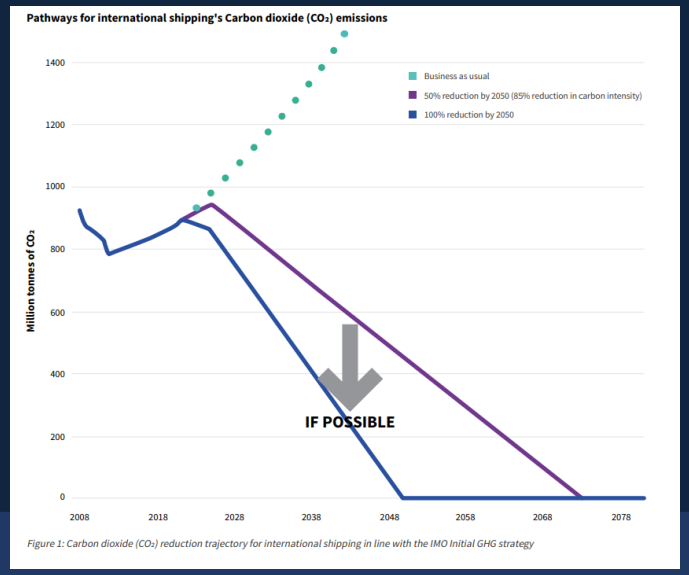

Figure 1: Carbon dioxide (CO_2) reduction trajectory for international shipping in line with the IMO Initial GHG strategy

Global shipping is currently responsible for 2-3 % of CO2 emissions, and with a business as usual scenario extrapolated into the future we could expect emissions from shipping to increase anywhere from 50-250 % in the next three decades.

Cargo shipping has adopted a practice know in SFTW (steam fast, then wait) which has been encouraged by maritime law. Unfortunately this often results in shipping burning more fuel than is necessary to reach their destination in time.

The UCL pilot shipping project tracks the movements of selected ships and evaluates the potential fuel that can be saved (recorded as anywhere between 20-60 %). Information can then be relayed through the INMARSAT communications system to the ship.

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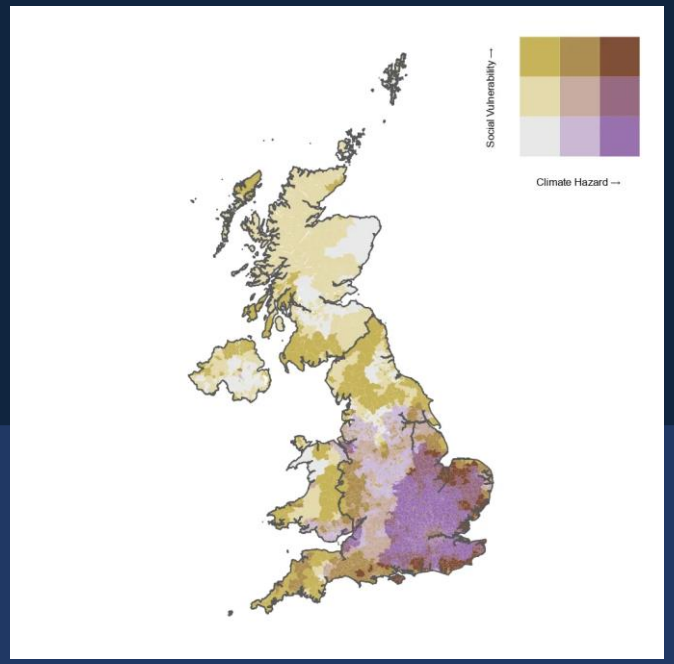
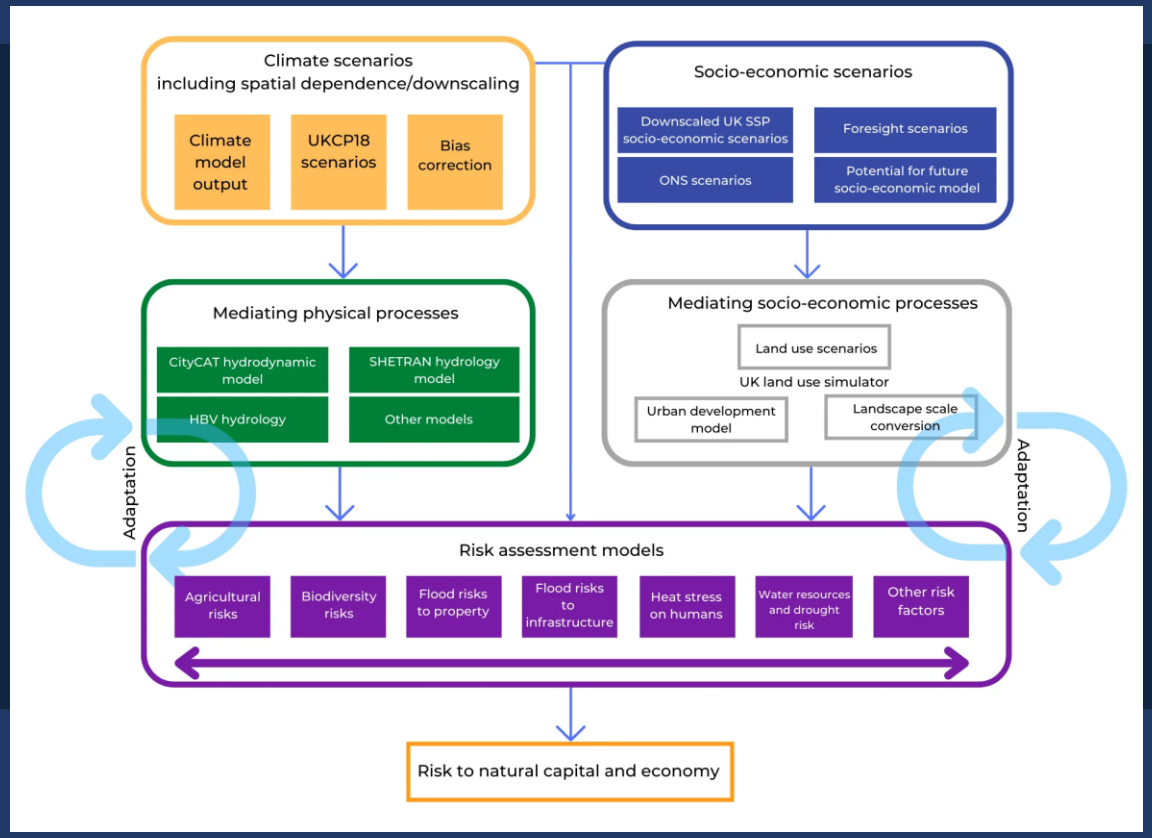
Projects Hosted on DAFNI
OpenCLIM

OpenCLIM is a major climate change project in the UK, using a multi-model approach, which seeks to assess the potential impact of climate change, and to investigate possible adaptions that could be made.



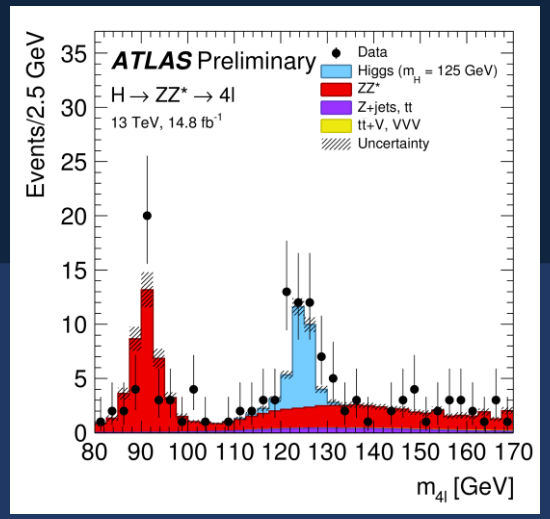
One of the major advantages that DAFNI provides to OpenCLIM is in the workflow framework, which allows OpenCLIM to seamlessly form multi-model frameworks in a straightforward manner (with docker taking care of any differences in language & OS choice).



Digital Twins & Infrastructure

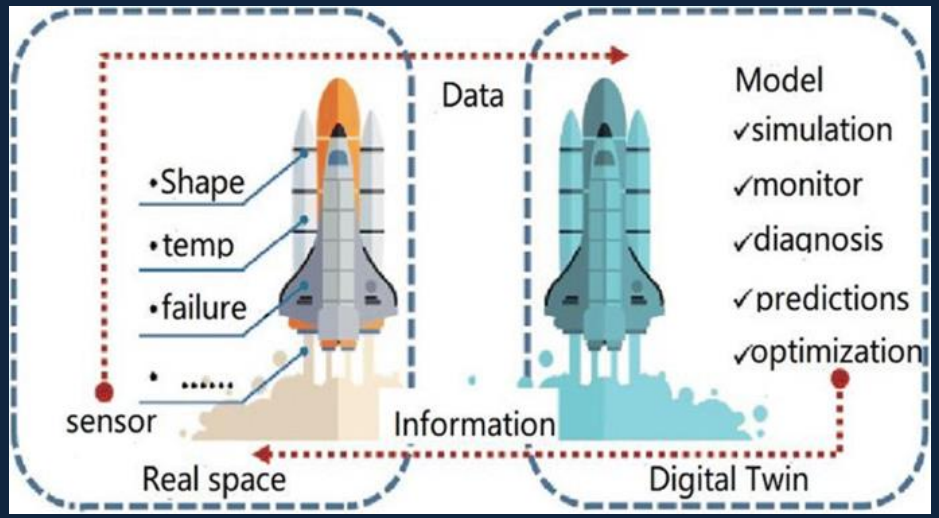
One important concept that has been of interest since DAFNI's inception is that of digital twins.

A digital twin, in essence, involves modelling of a real world scenario, and where appropriate tuning the model based on the comparison of results



DAFNI hosts a Sheffield Traffic Model (2021) which predicted traffic flows using historical data provided by 640 sensors

The concept of a digital twin was created by NASA and dates back to the Apollo 13 accident.



Since we're at CERN ! This may be somewhat familiar & is in essence is what happens with Monte Carlo Simulation is tuned, and then used with real data taken at a collider experiment (in the graph the position of the blue bump (generated by MC) has been tuned to 125 GeV).

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UK Research & Innovation (UKRI)
Building a Secure and Resilient World

DAFNI has setup the Centre of Excellence for Resilient Infrastructure Analysis as part of the wider 5 Year UKRI programme : Building a Secure and Resilient World.

£ 1.4 Million of total funding will be available to support infrastructure research, which will be expected to focussed on three main areas of interest.

1) Supporting key models in the area of resilience

2) Developing a resilience framework

3) Exploring resilience scenarios

Further details are available on our website : https://www.dafni.ac.uk

https://www.ukri.org/what-we-offer/browse-our-areas-of-investment-and-support/building-a-secure-and-resilient-world/

Summary and Conclusion

The UKRI ‘Building a Secure and Resilient World’ (BSRW) programme will become a major focus for DAFNI this year, with £ 4 million of funding being allocated to DAFNI.

We expect £1.4 million of this funding to go towards funding new projects focussed on infrastructure resilience.

Work will continue on improving and enhancing the web-front end and the underlying DAFNI infrastructure. One change we are planning is to automate dockerisation for users (this is a step many find quite tricky to do themselves).