Type equation here.

Facilities to support digital twins and ontologies: STFC/DAFN

Dr Brian Matthews
DAFNI Project Lead, Scientific Computing Department,
Science and Technology Facilities Council

Science and Technology Facilities Council

Engineering and Physical Sciences Research Council

UKCRIC

DAFNI

Sir John Armitt,
Chair, National
Infrastructure Commission

"Data is now as important to UK Infrastructure as concrete or steel"

Launch of DAFNI at The Royal Society in London lst June 2019

… a **[National] digital twin** would bring together individual infrastructure models capturing data on national infrastructure and the interdependencies between infrastructure systems, supporting the development within the infrastructure sector of a data-driven economy.

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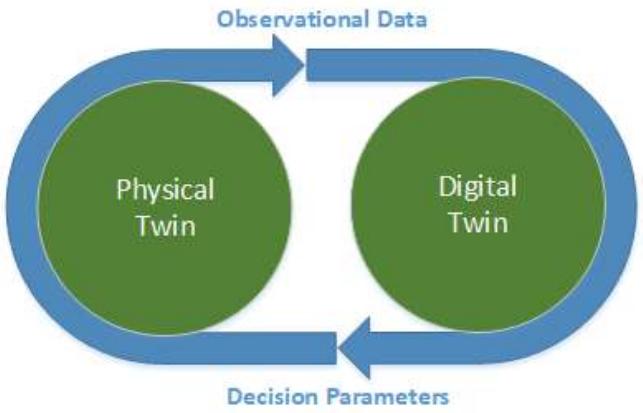
National Digital Twin

An ecosystem of digital twins connected via securely shared data (Gemini Principles 2018).



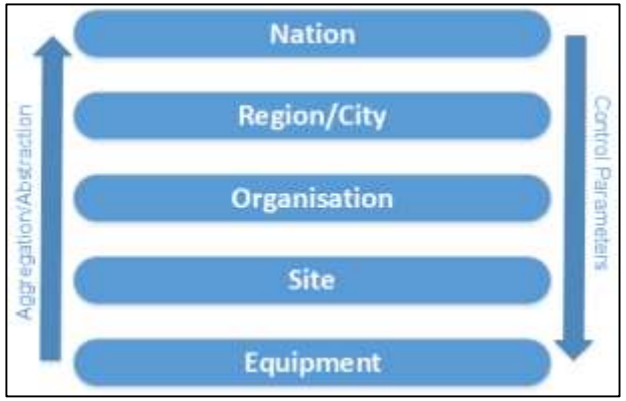
- A single NDT would not be feasible
- A Federation of different Digital Twins
  - Operated by different organisations
  - Coordinated together
- Within an Information Management Framework
  - to enable effective information management across the Digital Twins in the Infrastructure environment.
- Gemini Principles as a guide

Technical Challenges of the NDT

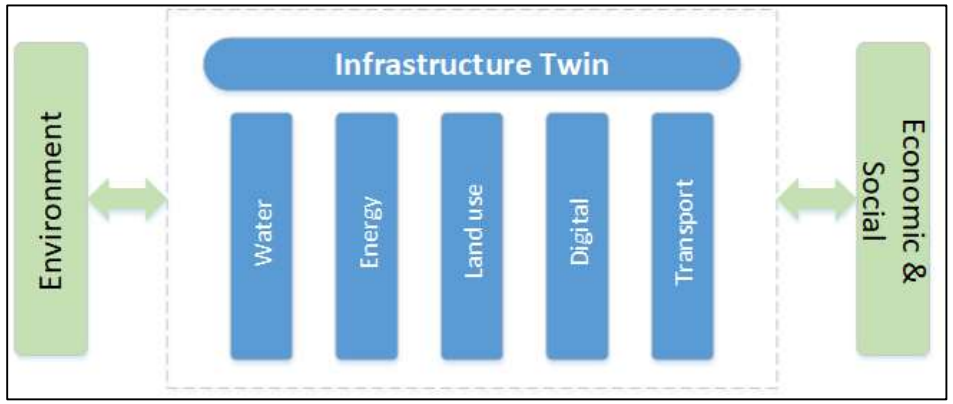
- Scaling up
  - More data
  - Higher resolution
  - More compute resources

- Data integration and exchange.
  - Share data between Twins
  - Security respected
  - Common standards for interchange and interoperation
  - Common Metadata standards

- Integration between twins
  - Capture the interdependencies
  - Integration across scales - Nation to Item
  - Integration across sectors



Integration across scales



Integration across sectors

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DAFNI

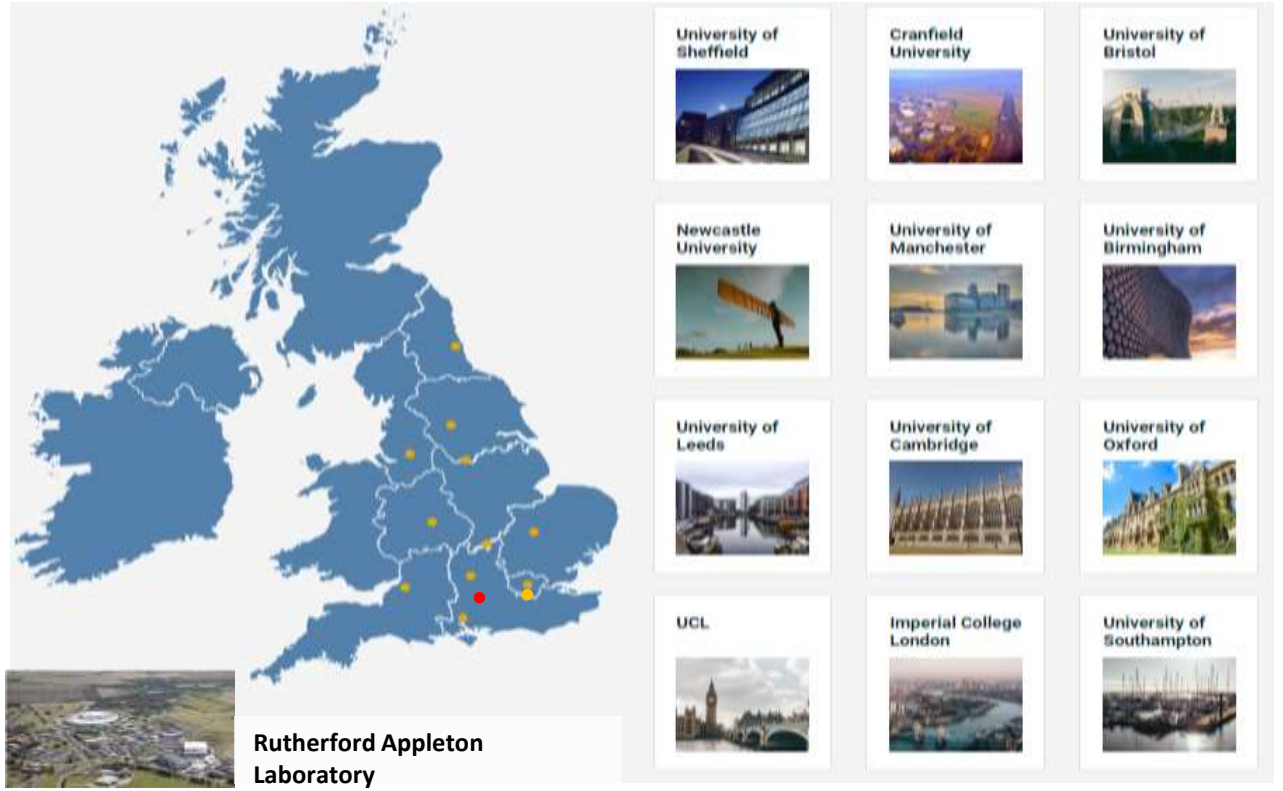
Data & Analytics Facility for National Infrastructure

Providing a computing platform to improve decision making for national infrastructure

- UK's next generation platform to support research into infrastructure decisions: planning, investment, design and operation.

DAFNI will provide the intelligence needed to revolutionise the quality, efficiency, resilience and sustainability of infrastructure systems arising from research.

- £8M investment 2017-2021 under the UKCRIC programme



Rutherford Appleton Laboratory
Harwell Didcot, Oxfordshire

UKCRIC

DAFNI provides to the Infrastructure Research Community

- A hybrid high-performance computing platform
- A secure repository for heterogeneous national infrastructure data and models.
- A collaborative platform to research and develop models of infrastructure assets.
- A place to make data and models available for long-term accessibility

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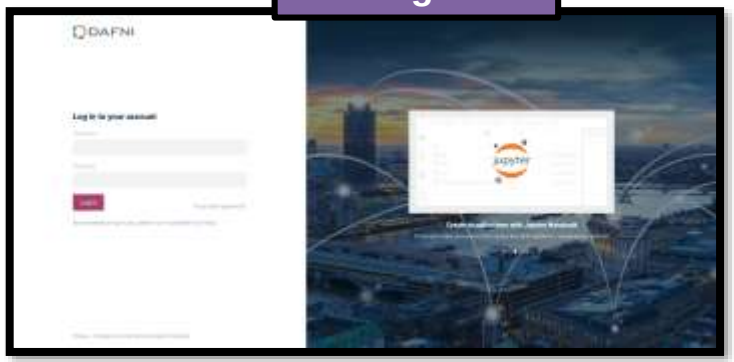
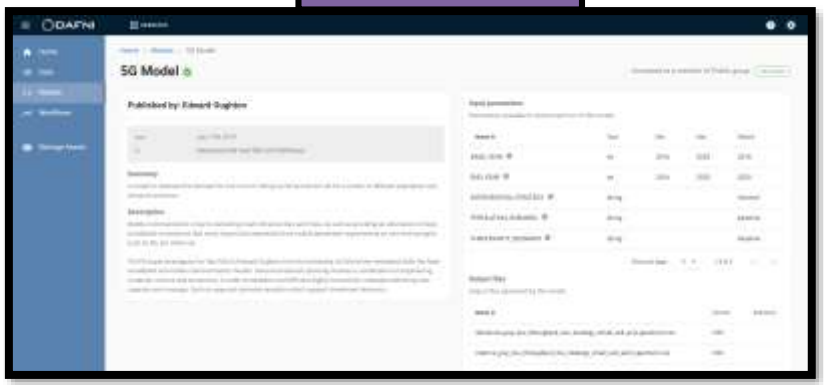
DAFNI Functionality

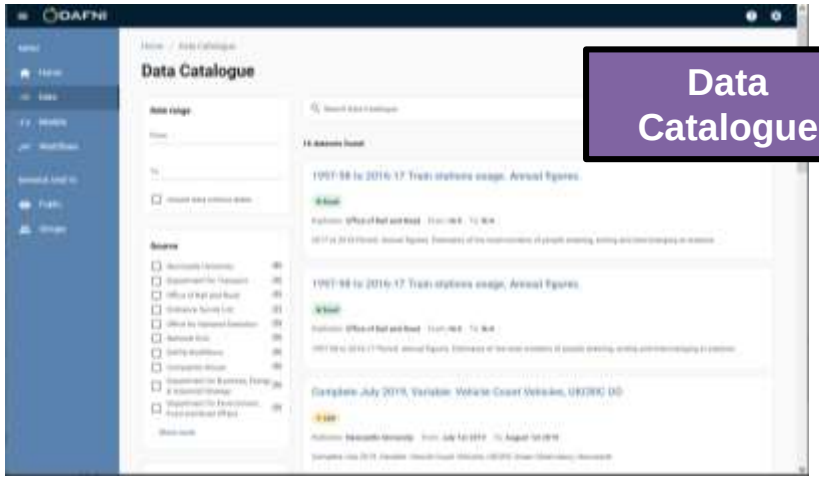
Login



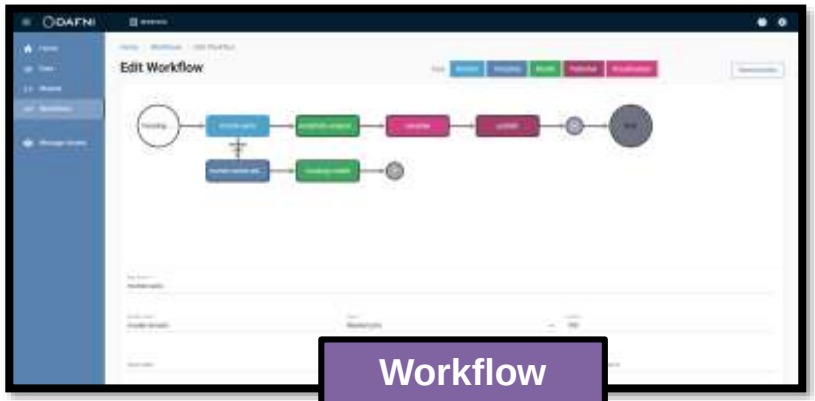
Data



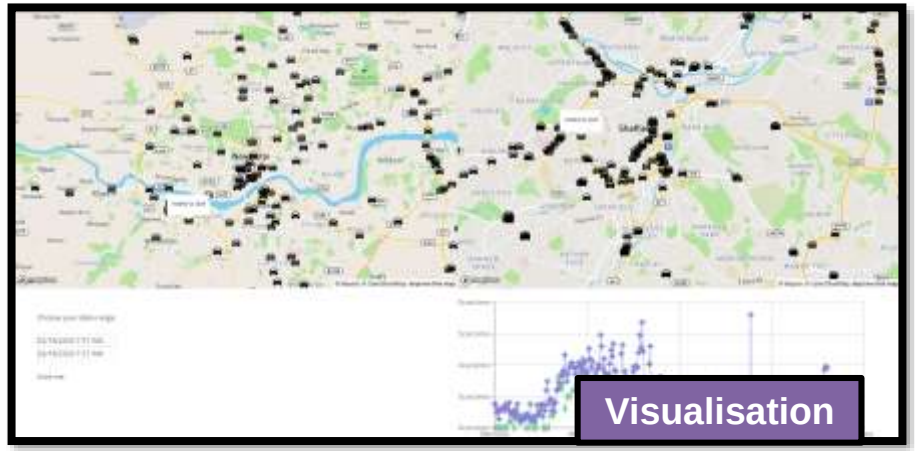
Data Catalogue



Models



Workflow Management



Visualisation

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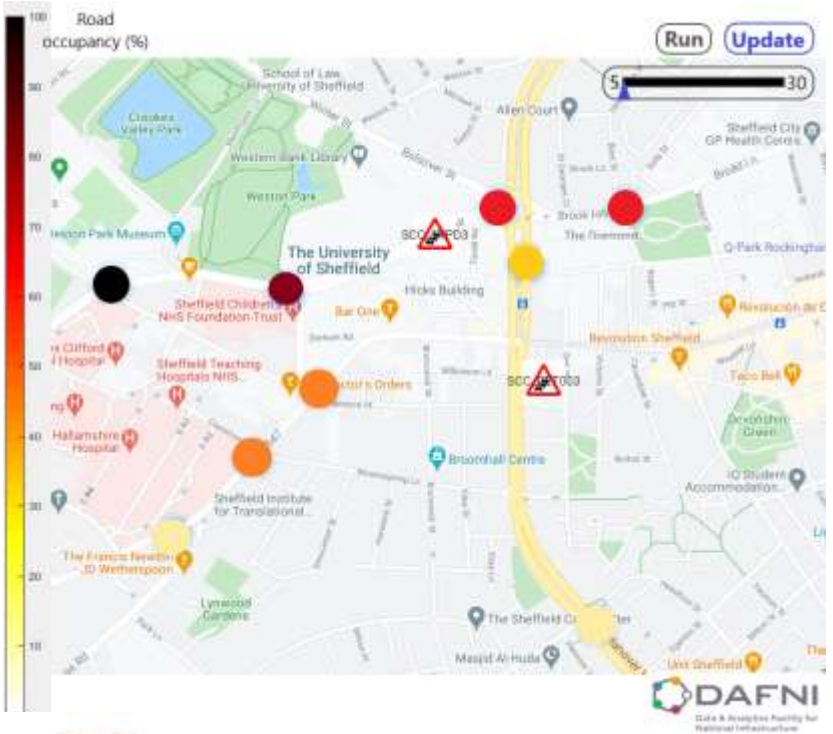
Pilot study - Traffic Digital Twin in Sheffield

- Use traffic data from the Sheffield Urban Observatory
  - 640 sensors that report traffic flow (no. of cars/min)
  - Time resolution: 5 min
- Build AI-based model
  - updates in real-time for each sensor
  - predicts evolution of traffic (ex: 30 min ahead)
- Create a digital replica of the Sheffield traffic
- Identify areas where congestion will occur



Use cases:

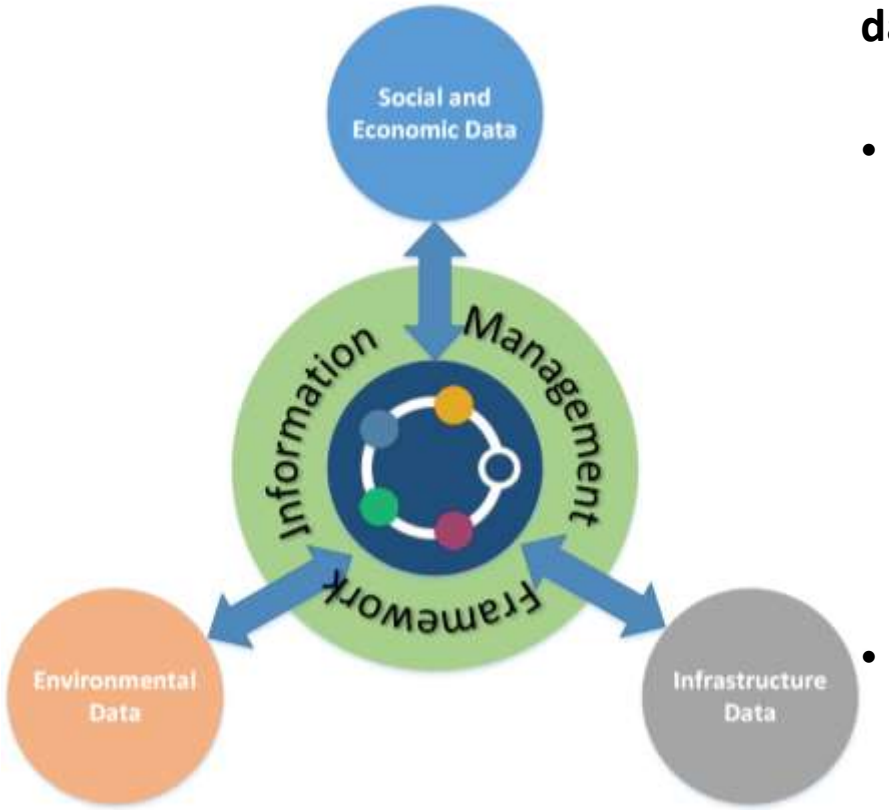
- Traffic monitoring system that predicts congested areas
- Real-time traffic flow optimization

The University Of Sheffield.

Christian Genes, Daniel Coca

DAFNI as a Information Infrastructure for NDT

- DAFNI provides a Data Hub
  - Data sharing
  - Data integration
  - Data curation
- The DAFNI NID provides
  - A trusted secure space to hold and access data
  - Importing from and linking to other data sources
- A metadata framework for the data catalogue
  - DCAT 2.0
  - Common search and access



A platform for integrating and combining data

- DAFNI's NID provides basis for representing data from different sources
  - Extensible to sectors: water, energy, transport …
  - Support an Ontological framework for data
- A data store – but not all data needs to be held centrally

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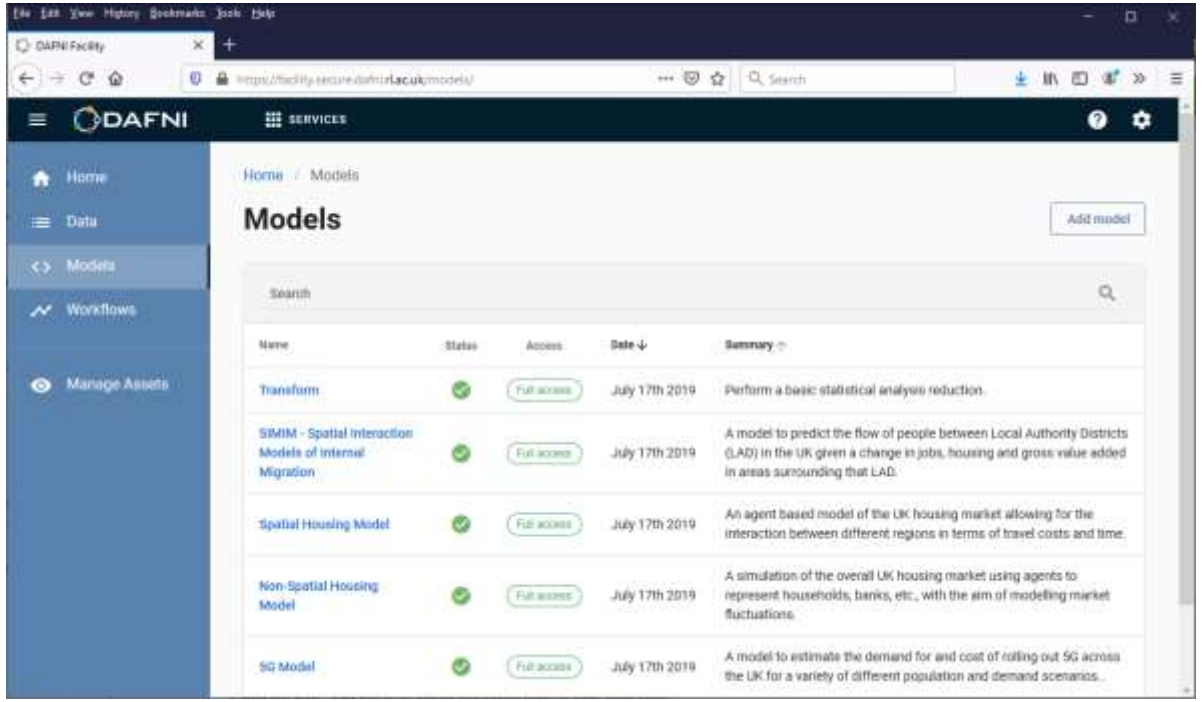
A Hub for Models

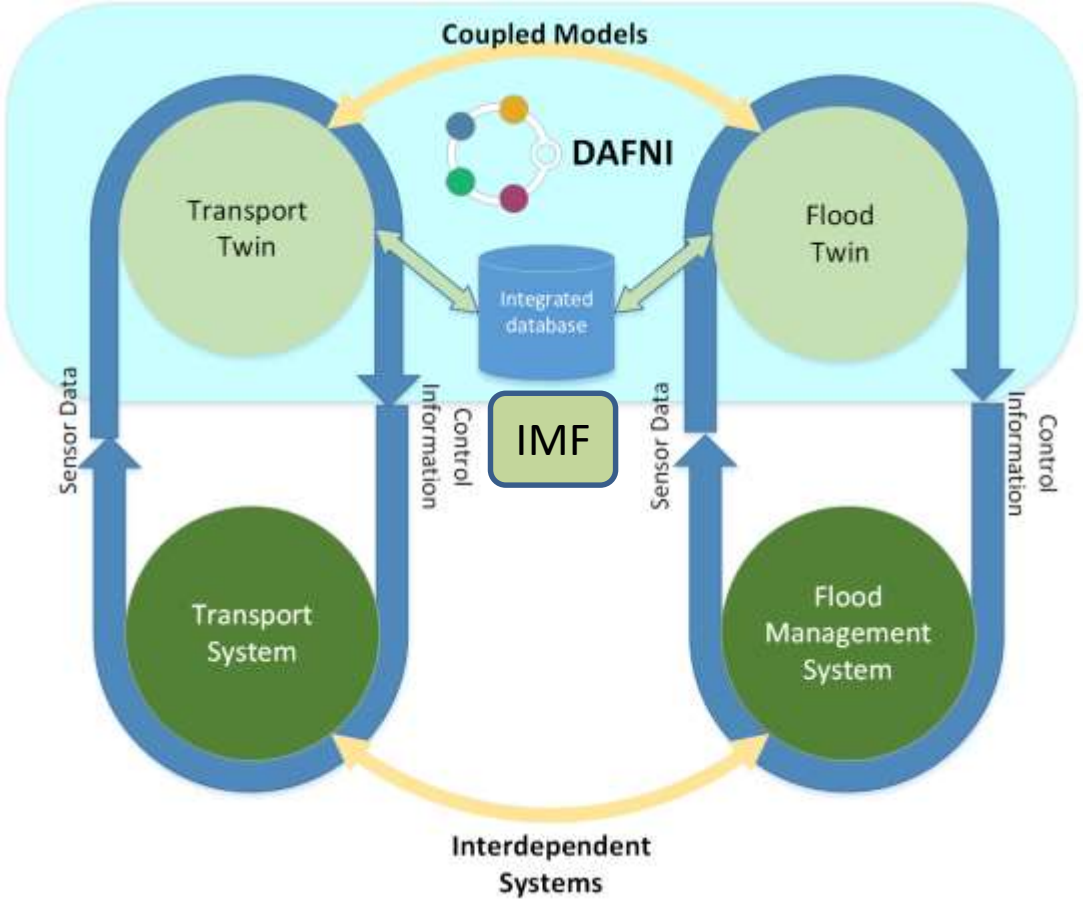
The DAFNI NIMS:

- Upload models from anywhere
  - Models “containerised” using Docker
  - Independent of code and operating systems
- Models can then be run on the HTC cluster
  - Kubernetes orchestration of containers
  - Scale up models for more compute
  - Access to data in the NID
  - Access to visualisations
- A repository of models
  - Harbor - a repository of Docker containers.
  - Sharing models
  - Within the same security framework



Coupling Models

- The NIMS allows workflows to be constructed
  - Chaining models together
  - Coupling models together
  - Connectors, transformers, filters
- Key feature of providing a NDT Ecosystem
  - Coupling different sectors
  - Coupling different scales



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DAFNI an Environment for the NDT

An environment for research collaboration in developing the National Digital Twin

researchers, government and industry exploring new ideas in modelling

DAFNI Platform offers:

- A HTC platform supporting research and technology transfer
- Data sharing within a common information infrastructure
- Scaling and coupling models
- Upholding the Gemini Principles

Still work to be done:

- Digital Twin Pilots
- Experimenting with a more dynamic data management framework
- Support for twins in workflows
- Data Ontology Support – working with Liz Varga

Supporting sustainable development of infrastructure for our regions, cities, rural areas and down to the household level.

Thank You

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