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



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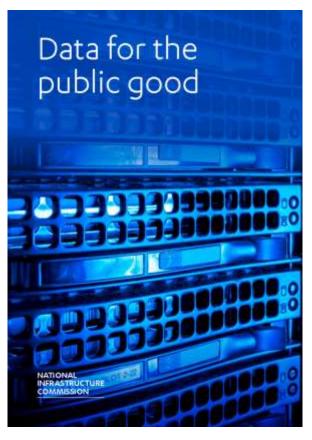


"Data is now as important to UK Infrastructure as concrete or steel"

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

Sir John Armitt, Chair, National Infrastructure Commission

... 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

Value creation

value creation

and performance

Must be as open

in possible

Curation

Must have clea

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or overment

Must provide

teterminable kisight into

Must be built on data o

in appropriate quality

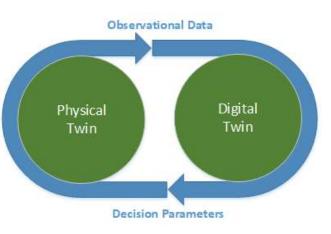
Must be able to adapt

vs technology and

the built environment

Must enable

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
 - \circ $\,$ 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

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The Gemini Principles

Public good

Must be used to

sellver genuine public

enefit in perpetuity

Aust enable security

lust be based on a

dard connected

and be secure itself

Purpose:

Trust:

Must be

trustworthy

Function:

effectively

Must function

Must have

clear purpose

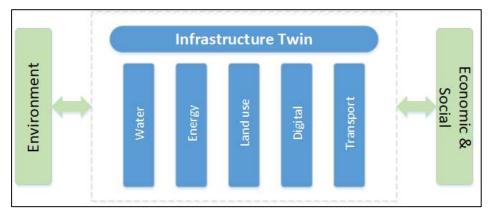


www.dafni.ac.uk

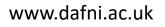
Technical Challenges of the NDT

- Scaling up
 - o 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 sectors





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Data & Analytics Facility for National Infrastructure

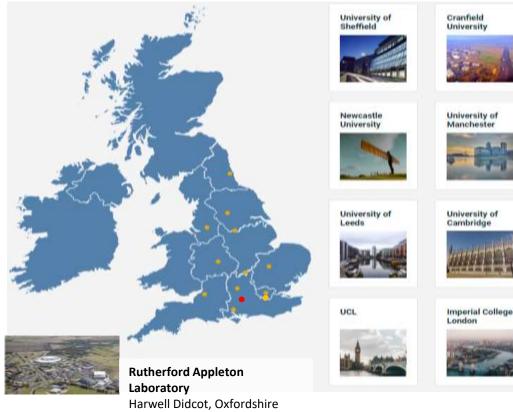
Providing a computing platform to improve decision making for national infrastructure

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









University of

University of Manchester

University of Birmingham





University of

University of flouthampte





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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

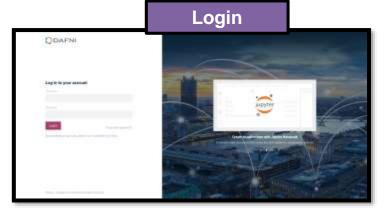


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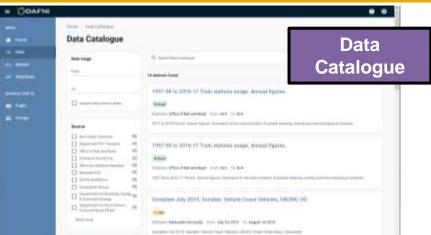


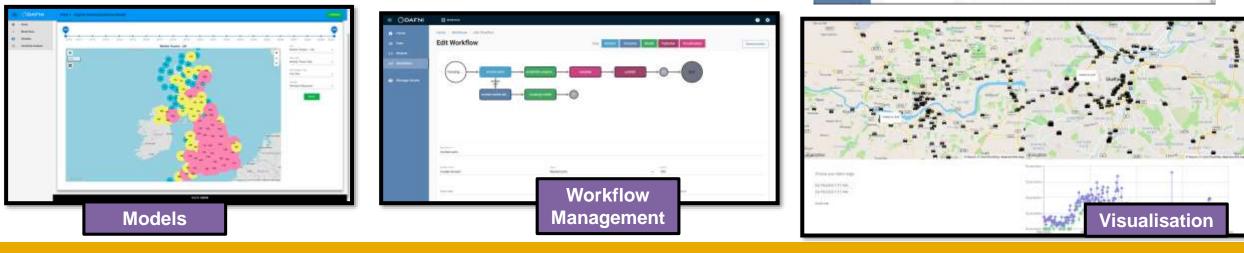


DAFNI Functionality











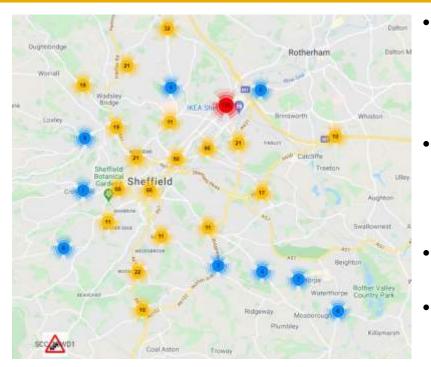
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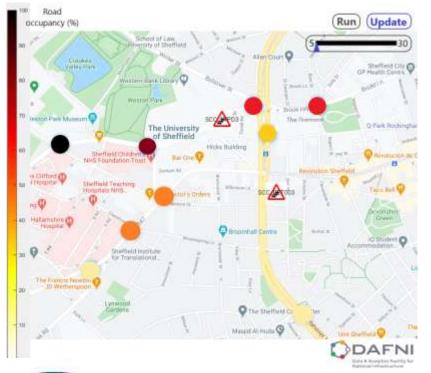


4/The/DO20ersity of Sheffield

DAFNI 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





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



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The

Of

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Sheffield.

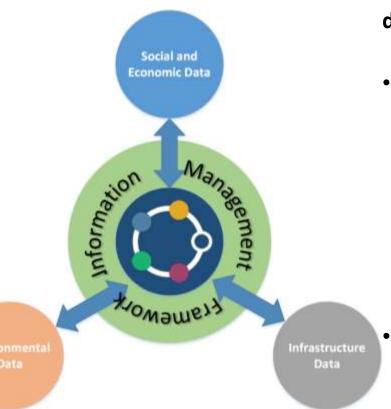


Christian Genes,

Daniel Coca

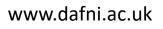
DAFNI DAFNI as a Information Infrastructure for NDT

- DAFNI provides a Data Hub
 - \circ 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
 - $\circ~$ 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
 - \circ $\,$ Independent of code and operating systems $\,$
- Models can then be run on the HTC cluster
 - \circ Kubernetes orchestration of containers
 - $\circ~$ Scale up models for more compute
 - $\circ~$ Access to data in the NID
 - Access to visualisations
- A repository of models
 - Harbor a repository of Docker containers.
 - $\circ~$ Sharing models
 - Within the same security framework

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0	Manage Asians	Transform	0	(Full access)	July 17th 2019	Perform a basic statistical analysis	reduction.	
		SIMIM - Spatial Interaction Models of Internal Migration	0	(Full access)	July 17th 2019	A model to predict the flow of people between Local Authority Districts (LAD) in the UK given a change in jobs, housing and gross value added in areas surrounding that LAD.		
		Spatial Housing Model	0	(FLE ROOMS)	July 17th 2019	An agent based model of the UK hos interaction between different region		
		Non-Spatial Housing Model	0	(Fut access)	July 17th 2019	A simulation of the overall UK housing market using agents to represent households, barries, etc., with the aim of modelling market fluctuations.		
		SG Model	0	(Full access)	July 17th 2019	A model to estimate the demand for the UK for a variety of different population		



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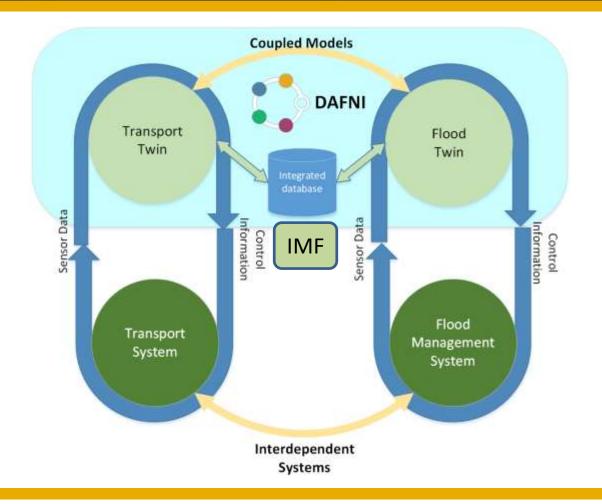




Coupling Models



- 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
 - $\circ \ \ \text{Coupling different scales}$





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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.





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