Digital marketplaces based on shared data documentation principles

Dr Amit Bhave (CMCL), DOME 4.0

Dr Dirk Helm (Fraunhofer IWM), MarketPlace

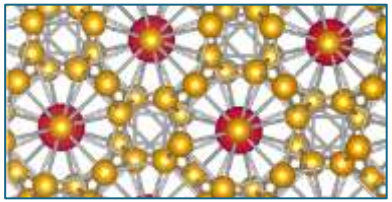
Towards Implementations of Materials and Manufacturing Commons
Berlin, Germany
04-06 April 2023

DOME 4.0 has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 953163
MarketPlace has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 760173

Digital marketplaces: industrial needs form an engineering perspective

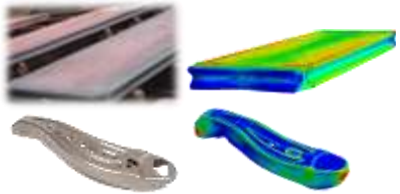
Needs for modelling and simulation for optimal materials, processes, and products

Material design



- Virtual material design, e.g. steel development
- Material discovery, e.g. substitution of critical elements
- …

Process design

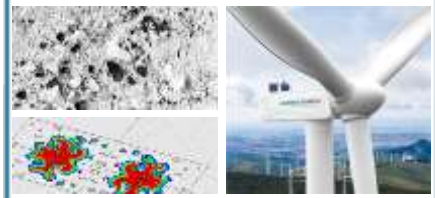


- Virtual design of processes, e.g. steel
- Analysis, evaluation, and optimization of processes & process chains
- …

Component design

- Component performance
- Computer-aided crash assessment
- Lifetime prediction
- Static design
- …

Sustainable design



- Simulation assisted sustainability analysis
- Holistic approach by incorporating the whole lifetime of a material
- …

The MARKETPLACE project is funded by Horizon 2020 under H2020-NMBP-25-2017 call with Grant agreement number: 760173

MarketPlace

Digital marketplaces: : industrial needs form an engineering perspective

The user perspective about material modelling and simulation

Industrial R&D	Researcher	Software Vendor	Consultant
■ E.g. **SMEs** in the field of additive manufacturing: »I am **interested in the properties of additively manufactured microstructures**: from the powder composition to the component...«	■ E.g. **Material modeler.** »I would like to **adapt my material models to material data** and make them available to users.«	■ E.g. **SME-Software Vendor.** » …we realized that **monolithic software solutions are neither adequate nor capable of tackling the host of phenomena occurring during production** and service life of materials and products.«	■ E.g. **SME-Consultant.** »Successful industrial **materials modelling more & more depends on assembling knowledge, software and data from a wide range of fields** which can be perplexing for SMEs and challenging even for large enterprises.«

The MARKETPLACE project is funded by Horizon 2020 under H2020-NMBP-25-2017 call with Grant agreement number: 760173

Digital marketplaces: a short overview

The platform perspective: The concept of digital marketplaces

We provide the infrastructure	You make it a marketplace.
	

The MARKETPLACE project is funded by Horizon 2020 under H2020-NMBP-25-2017 call with Grant agreement number: 760173

MarketPlace

Digital marketplaces: a short overview

Market needs on services

Access to Data	Access to software tools	Access to services	AI Services
Access to material data	Access to material modelling tool	Translation services	AI integration
Access to material modelling data	Access to simulation tools	Services broker	Data exploration
Validation and benchmark data	Configurable workflows	Education	Knowledge extraction
Catalogs on services	Solved problems	Discussion capabilities	Data evaluation
Access to simulation data	HPC services	Billing services	Trust on services

The MARKETPLACE project is funded by Horizon 2020 under H2020-NMBP-25-2017 call with Grant agreement number: 760173

Digital marketplaces: a short overview

The market perspective

Feedback analysis

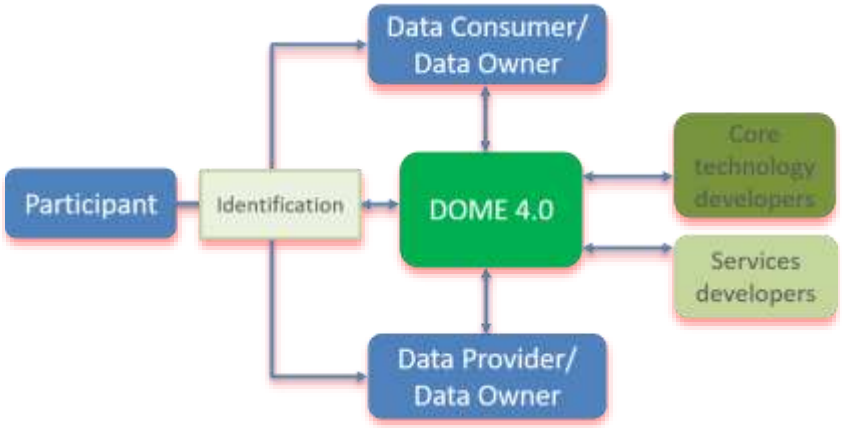
- Availability and usability of software (SaaS, **execute**)
- Finding and contacting suitable experts (**explore**)
- Promote own knowledge and expertise (**create**)
- Availability of hardware resources with installed simulation software (**execute**)
- Market your own software (**create, execute**)
- Interaction with the community (**interact**)
- Missing translators: from a technical problem to a solvable simulation task (**interact**)

Market participants and market needs

The MARKETPLACE project is funded by Horizon 2020 under H2020-NMBP-25-2017 call with Grant agreement number: 760173

MarketPlace

DOME 4.0



Digital **O**pen **M**arketplace **E**cosystem **4.0**

- An ecosystem for transactions between **data prosumers** and **data services** providers
- **Connects** with other marketplaces, OSPs, OTEs, databases and knowledge bases
- **Semantically-enriched** core and 9 industrial/B2B showcases
- **FAIR** principles of data – Findable, Accessible, Interoperable, Reusable

DOME 4.0 — H2020 Grant Agreement No. 953163

B2B showcases

DOME 4.0

NO.	B2B SHOWCASES	DATA SOURCES	INDUSTRIAL SECTORS
1	Chemistry Knowledge Graph (KG) – marine, air quality	Ontokin KB: species, thermodynamics, chemical kinetics, sensors and geo-location data	MARINE, ENVIRONMENTAL, NANOPARTICLES
2	Light weight construction – fibre reinforced plastics	Laboratory experiments, multiscale models	PLASTICS
3	Polymeric additives for coatings: anti-corrosion	Thermodynamic, Laboratory Regulatory, Modelling	POLYMERS
4	Structural adhesives: Fatigue behaviour	Experimental data, MatWeb: Materials property data	ADHESIVES
5	Production equipment tools and service catalogues (metals, plastics, high-tech)	Semantic data repositories of MARKET4.0	MANUFACTURING
6	Turnkey services & custom workflows integrating simulations and data	Materials Cloud (Open Science, FAIR data principles)	MATERIALS
7	Formulated consumer products	gPROMS (PSE), molecular simulation (UKRI), Cheméo (Céondo), and REFPROP (NIST)	CHEMICAL PROCESSES AND MATERIALS
8	Semantic Analytics of Manufacturing Assets	Bosch I4.0 Knowledge Graph, manufacturing production data	SMART MANUFACTURING
9	Virtual development of composite materials	Experimental data, material data sheets	COMPOSITE MATERIALS

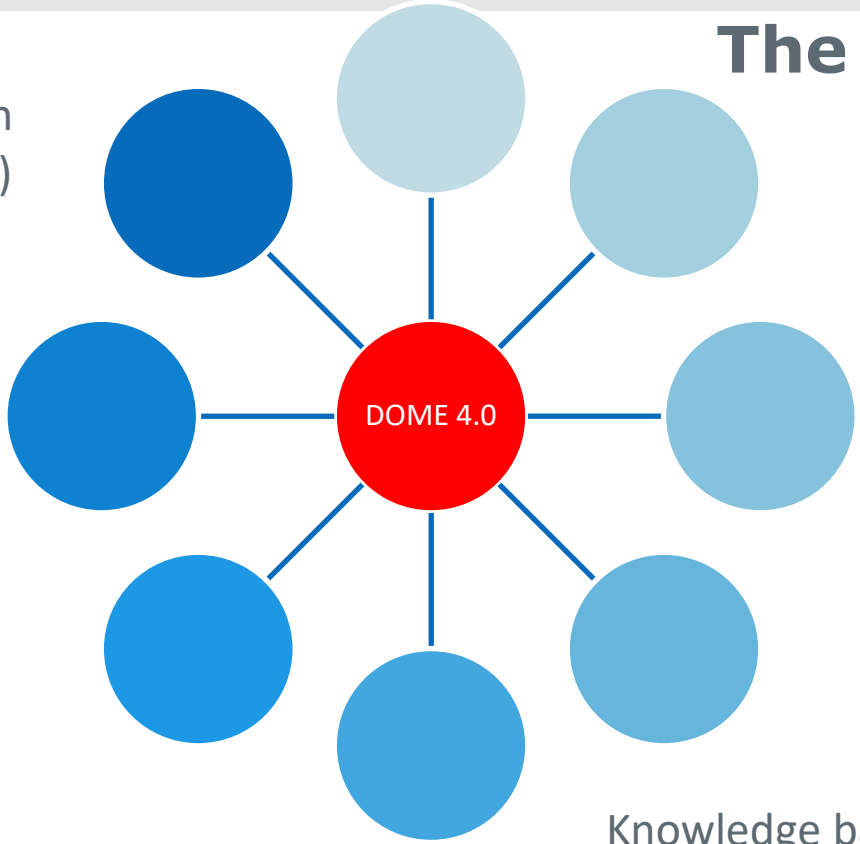
Problem space

The FAIR challenge

Open Simulation platforms (OSPs)

Marketplaces

Databases



Data prosumers

Open Translation Environments OTEs

data services providers

Knowledge bases

DOME 4.0 — H2020 Grant Agreement No. 953163

Problem space

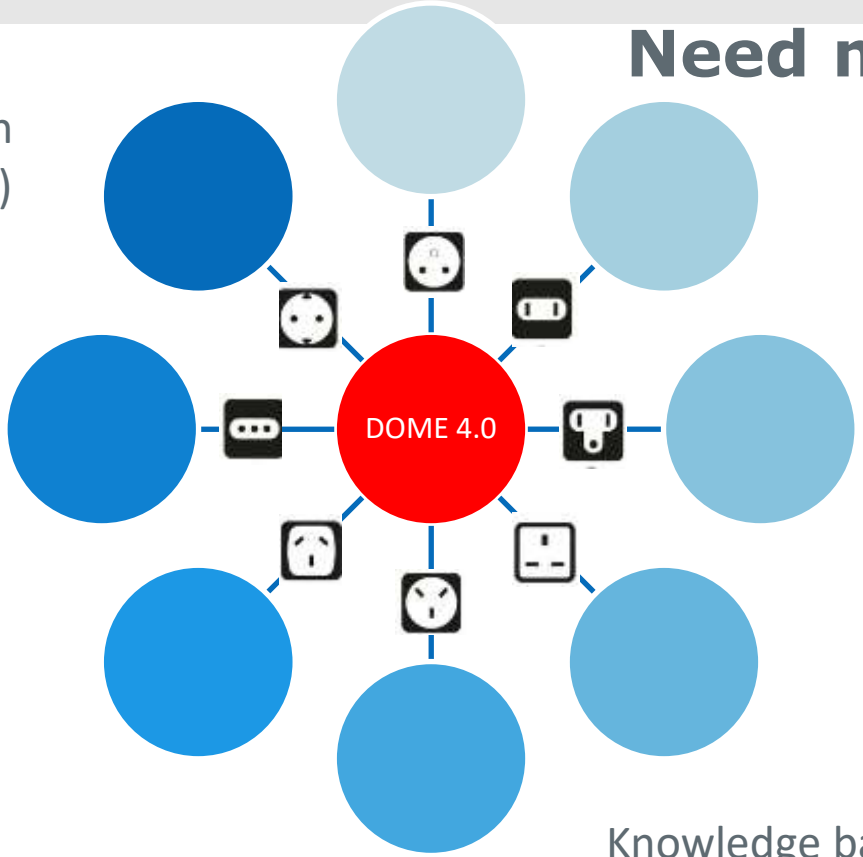
DOME 4.0

Need many connectors

Open Simulation platforms (OSPs)

Marketplaces

Databases



Data prosumers

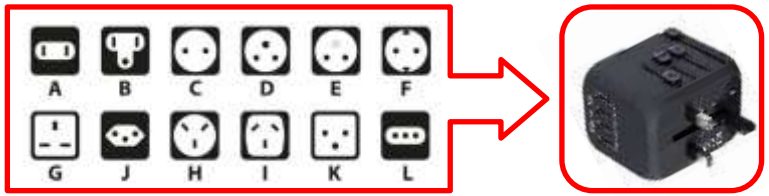
Open Translation Environments OTEs

data services providers

Knowledge bases

DOME 4.0 — H2020 Grant Agreement No. 953163

Proposed DOME 4.0 solution



Developing connectors - considerations

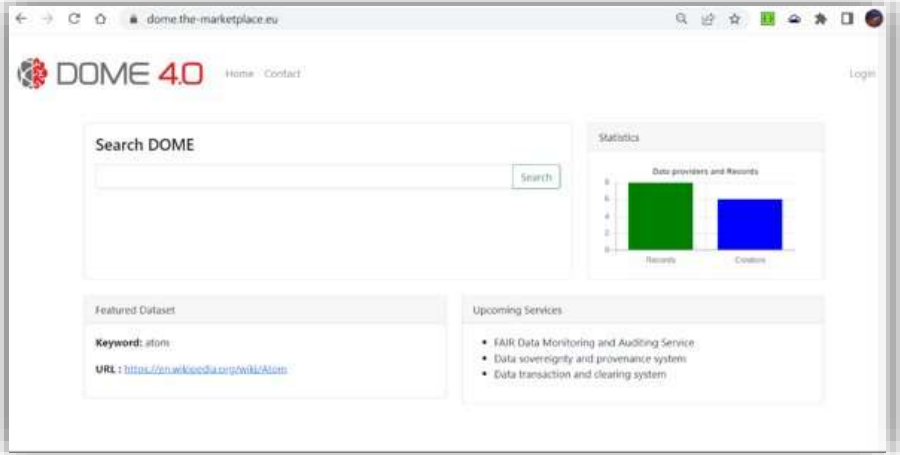
- What type of data are we aiming to get? (format, topic)
- How much data are we aiming to extract in one go? (size)
- Where is this data stored? (server & platform names)
- How do we query the servers' endpoints? (Accepted query parameters)
- Whether any tokens or account registrations are required to access the data platforms? (search for regulations and data support documents)
- How are we planning to present the data that is being returned from the server? (interact with json data)

Connector Name
Market 4.0
Theoretical Crystallography Open Database
Open database of Xtals
The open Quantum Materials Database (OQMD)
The noel materials discovery (NOMAD)
Open Materials Database
Materials Project
Crystallograph Open Database
PubChem
Chemeo

DOME 4.0 — H2020 Grant Agreement No. 953163

DOME 4.0 platform

- Web platform deployed on DigitalOcean cloud – Minimum Viable Prototype
- Upload dataset, searchable via keywords



Summary and notes for discussion

- MVP – simple with initial features, basis for all further development
- EMMO-DCAT – bridging between W3C lite ontologies with a highly expressive framework
- Ecosystem ontology based on project scope and reuse
- Standardisation with *OntoCommons*, EMMC, and EAB
- Connected to marketplaces and other projects
- The 9 B2B showcases – in progress

Project name: DOME 4.0
Digital Open Marketplace Ecosystem 4.0

Call DT-NMBP-40-2020:
Creating an open marketplace for industrial data (RIA)

The European Union Horizon 2020
Grant Agreement no. 953163

@DOME40_H2020 DOME40 www.dome40.eu