



Deliverable D6.3 – Industrial, Partner and Standardisation network liaison report

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Document History

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V0.1	18 Oct 2024	Stijn Donders (SISW)	Reflecting project achievements in this domain up to date.
V0.2	28 Oct 2024	Adrien Scheuer, Laszlo Farkas, Stijn Donders (SISW)	Internal check and feedback. Updates included in document.
V0.3	29 Oct 2024	Nikos Chondrogiannis (INTRA), Bojan Boskovic (CNT), Bijan Yadollahi (CMCL)	Prefinal document status shared with key contributing partners for some inputs/questions/checks.
V0.4	8 Nov 2024	Stijn Donders (SISW)	Processed received inputs & updates, consolidating 'Final Draft' for Review. Sent it to the internal Reviewers (INTRA & CMCL) with UNR in copy.
V0.5	13 Nov 2024	Bijan Yadollahi (CMCL), Nikos Chondrogiannis (INTRA)	Review and Comments
V1.0	19 Nov 2024	Stijn Donders (SISW)	Addressed reviewer comments into the proposed Final Version of D6.3. Sent it to Amit Bhave (CMCL) and Willem van Dorp (UNR) for final review.
V1.1	28 Nov 2024	Amit Bhave (CMCL)	Final review and revisions, in particular, regarding DOME 4.0's semantic backbone.
V1.2	29 Nov 2024	Willem van Dorp (UNR)	Finalization

Executive Summary

DOME 4.0 intends to offer an intelligent semantic industrial data ecosystem for knowledge creation across the entire materials-to-manufacturing value chains. The multi-sided and multi-asset nature of DOME 4.0 has required a strategy that reaches out to a broad community, going beyond individual research and innovation endeavours. It has been an important objective to consolidate a critical-mass community around the DOME 4.0 ecosystem and to create the conditions that facilitate the adoption of DOME 4.0. For this purpose, from the onset of the project, the interaction with and communication to the research and industry community has been prioritized. The overall baseline has been the DOME 4.0 community-building plan, with several tasks contributing synergistically to the community-building effort; in particular, those in Work Package 5 (Industry Commons Cooperation) and Work Package 6 (Dissemination, Communication and Liaison).

Within this overall plan, the DOME 4.0 project defined 3 key stakeholder groups as important targets for dissemination: industrial end-users, partner networks, and to standardisation bodies. This Deliverable D6.3 reports that the dissemination to these key stakeholders has been performed along the lines of the overall DOME 4.0 communication and dissemination plan.

DOME 4.0 aims to facilitate knowledge extraction through ontology-driven semantic data interoperability and modern data processing technologies using Machine Learning (ML) and Artificial Intelligence (AI). Open to all players in the sector, DOME 4.0 hopes to advance data-driven knowledge generation in the materials and manufacturing sectors as well as eventually other key sectors. This has been demonstrated on the basis of 9 Showcases, which inspired public domain publications and knowledge/people exchanges at workshops, conferences and blogposts. The partner networking employed the EMMC and the newly founded CODEX cluster as catalysts for the collaboration. In the area of standardization, next to interaction with standardisation body CEN, the focus has been put on the adoption of standardized components and best practices into the DOME 4.0 platform, leveraging the lessons learned through the Industry Commons Cooperation.

Table of Contents

Executive Summary.....	2
Table of Contents.....	3
List of Figures	4
List of Tables	4
1. Introduction	5
1.1 Fit within the overall DOME 4.0 community building plan	5
1.2 Dissemination towards industrial end users, partner networks and standardisation bodies	5
2. Industrial End Users	7
2.1 The 9 B2B Showcases	7
2.2 Examples of publications with / towards Industry.....	9
3. Partner Networks.....	11
3.1 EMMC context	11
3.2 CODEX Cluster.....	11
3.3 Further Partner Network connections	13
4. Standardisation Bodies	15
4.1 Standards and best practices adopted in DOME 4.0.....	15
4.2 Standardisation Bodies.....	15
5. Conclusions	17
6. Lessons Learnt.....	17
7. Deviations from Annex 1.....	19
8. References	20
9. Acknowledgement	23

List of Figures

Figure 1: The 9 B2B Showcases [11] addressed in DOME 4.0.....	8
Figure 2: Blog: The daunting task of Big Data Management [27].....	10

List of Tables

No table of figures entries found.

1. Introduction

The multi-sided and multi-asset nature of DOME 4.0 as “Marketplace of Marketplaces” requires a strategy that reaches out to a broad community, going beyond individual research and innovation endeavours. It has been an important objective to consolidate a critical-mass community around the DOME 4.0 ecosystem and to create the conditions that facilitate the adoption of DOME 4.0. Accordingly, the DOME 4.0 project has adopted a strategy for dissemination within partner networks, industrial end-users, and standardisation bodies. This dissemination effort has been a subset of the overall dissemination and communication strategy of the project implemented in WP6, which is reported/synthesized into D6.1 [2].

1.1 Fit within the overall DOME 4.0 community building plan

Given the importance of community-building to facilitate the adoption of the DOME 4.0 Ecosystem by a critical-mass community, there are several tasks foreseen in the project that focus synergistically on different aspects contributing to this goal [3]. In particular,

- Work package 6 focuses on dissemination and communication, including:
 - Dissemination to the general public, incl. DOME 4.0 website and blog, fact sheets, social networks as LinkedIn and Twitter, ... (task 6.1)
 - Dissemination towards partner networks, industrial end-users and standardisation and policy-making bodies (task 6.2)
 - Industrial Engagement Open Days (task 6.3)
 - Hackathons and Industry Commons Ecosystem (ICE) Lab (task 6.4)
 - Education and training (task 6.5)
- Work package 5 focuses on cooperation and community-building within Industry Commons, to ensure the connectivity with all related & relevant EU-funded initiatives, as well as contributions to standardization and best practice definition.

1.2 Dissemination towards industrial end users, partner networks and standardisation bodies

This Deliverable D6.3 focuses on an important subset of the DOME 4.0 community-building plan [3]: the dissemination towards industrial end-users, partner networks and standardisation bodies. This dissemination has been realized largely in line with the planning as outlined in Deliverable D6.2 [3], with following approach to dissemination:

- **Industrial end users:** This includes industrial companies that are potential end users of the technology developed within DOME 4.0. Industries for which the project showcases are directly relevant will be targeted (data consumers, data producers, service providers, product providers and consumers). Several paths for reaching industrial end users exist, including:
 - through the Project’s External Advisory Board (EAB),
 - through the partner networks and the broader dissemination effort in WP6,
 - by means of the 9 DOME 4.0 showcases as an important channel to translate the DOME 4.0 platform and methodology achievements into visual and tangible demonstration of potential end user value in a variety of industry sectors,

- through the DOME 4.0 Hackathons, allowing to share in-depth the capabilities of the DOME 4.0 platform, and the Industry Open Days. setting the rhythm to present the highlights to the wider research and industry community.
- **Partner networks:** To capitalize on the network value of pre-existing partner networks, the focus has been put on connecting with ongoing EU research projects that are related to DOME 4.0 (in terms of scope, objectives, activities, ...). This allows enlarging the circle of DOME 4.0 and its consortium to a much wider relevant research and industry community.
- **Standardization bodies:** here, European Standardisation bodies have been considered: CEN (European Committee for Standardisation), CENELEC (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute), other potential stakeholders such as national standardisation bodies or the Small Business Standards association representing the interests of small and medium-sized enterprises in standardisation. Moreover, the cross-fertilization with the partner networks has enabled an inventory and assessment of standards and best practices of potential relevance for the DOME 4.0 technical-scientific planning; a selection has been made and motivated in Deliverable D5.5 [10], which has been adopted in the project R&D work.

The following Sections of this Deliverable D6.3 will describe the achievements of the DOME 4.0 partners in the dissemination towards the 3 key target groups:

- Section 2: Industrial End Users
- Section 3: Partner Networks
- Section 4: Standardisation Bodies

As underlined in Section 1.1, this effort has been an integral part of the DOME 4.0 community building plan, which represents a complement to, and reinforcement of, other community-building efforts, for example, the cooperation and engagement with Industry Commons as executed in WP5. This dissemination effort is a subset of the total Dissemination and Communication effort in Task 6.1, along the guidelines set in the (internal) DOME 4.0 document “Dissemination and Communication Plan” [1], which has served as a guideline to the partners for their dissemination and communication actions. Throughout DOME 4.0, WP6 leader INTRA has motivated all partners to pursue Dissemination & Communication actions and keep track of their activities and output in an (internal) ‘Online Dissemination Tracker’ worksheet. The overall Dissemination and Communication achievements of DOME 4.0 are synthesized and summarized in D6.1 [2].

2. Industrial End Users

Industrial end users refer to industrial companies that are potential end users of the technology developed within DOME 4.0. Industries for which the project showcases are directly relevant have been mainly targeted: data consumers, data producers, service providers, product providers and consumers.

DOME 4.0 adopted a structure that naturally allowed consolidating the project outcomes and setting up dissemination channels to reach industry as well as academic community. This included:

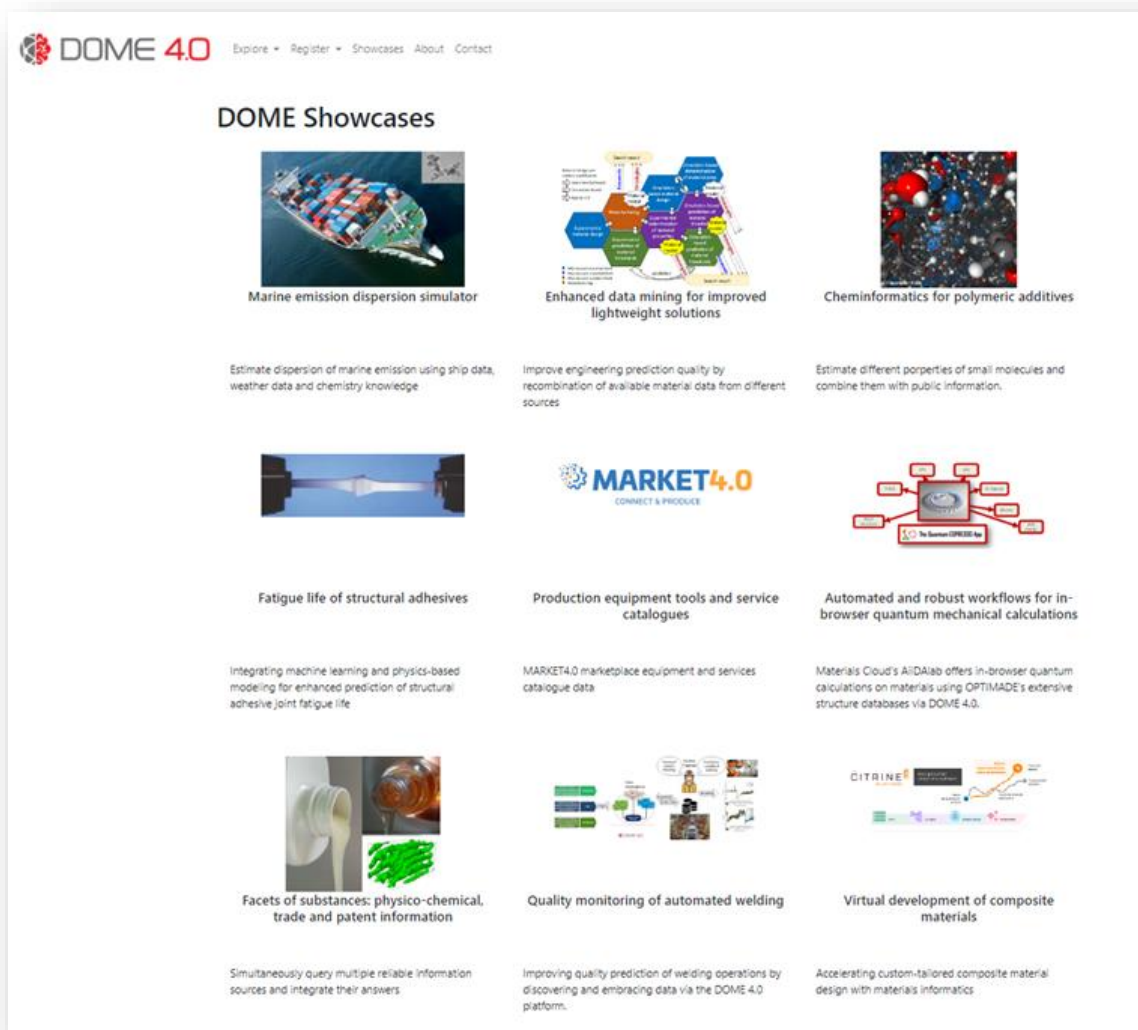
- The [DOME 4.0 consortium](#), a mix of industry partners, research centres and universities;
- The DOME 4.0 EAB (External Advisory Board), adding additional parties from industry and academia that closely follow-up the research and provide regular feedback;
- The partner networks with related bodies and projects, see further in Section 3;
- The overall dissemination effort in WP6, which is reported in D6.1 [2]. This Section reports on the subset of work done with and towards industrial end users;
- The DOME 4.0 **Industry Open Days** [4][5], which have set the rhythm to present the highlights to the wider research and industry community, refer to [6] for the synthesis;
- The DOME 4.0 **Hackathons** [7], which have allowed to share in-depth the capabilities of the DOME 4.0 platform to the industry and research community, refer to [8] for the synthesis.

2.1 The 9 B2B Showcases

DOME 4.0 is a technology innovation platform and ecosystem of broad applicability across sectors. For such solutions, it is known that industrial end users can be approached most convincingly through a proof-of-concept on an application case with which they have affinity in their business. After all, by seeing the advantages on such familiar use case, they can more easily understand the value for their product/process development and business, and moreover they can use these results to discuss internally and get internal buy-in and approval to engage with the technology innovation.

Therefore, the DOME 4.0 B2B showcases are a key channel to translate the DOME 4.0 platform and methodology achievements into visual and tangible demonstration of potential end user value in a variety of industry sectors. DOME 4.0 comprises 9 showcases [11], from polymer processing and structural adhesive technologies to quantum computation and marine air quality, as listed here and illustrated in Figure 1.

1. Chemistry Knowledge Graph - Marine, Air Quality And Nanoparticles
2. Lightweight Construction - Fibre Reinforced Plastics
3. Polymer Additives for Corrosion Protection
4. Structural Adhesives: Fatigue Life
5. Production Equipment and Service Catalogues
6. Turnkey Services and Custom Workflows Integrating Simulations And Data
7. Formulated Consumer Products
8. Semantic Analytics of Manufacturing Assets
9. Virtual Development of Composite Materials



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DOME Showcases



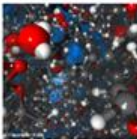






 <p>Marine emission dispersion simulator</p> <p>Estimate dispersion of marine emission using ship data, weather data and chemistry knowledge</p>	 <p>Enhanced data mining for improved lightweight solutions</p> <p>Improve engineering prediction quality by recombination of available material data from different sources</p>	 <p>Cheminformatics for polymeric additives</p> <p>Estimate different properties of small molecules and combine them with public information.</p>
 <p>Fatigue life of structural adhesives</p> <p>Integrating machine learning and physics-based modeling for enhanced prediction of structural adhesive joint fatigue life</p>	 <p>MARKET4.0 CONNECT & PRODUCE</p> <p>Production equipment tools and service catalogues</p> <p>MARKET4.0 marketplace equipment and services catalogue data</p>	 <p>Automated and robust workflows for in-browser quantum mechanical calculations</p> <p>Materials Cloud's AiDAlab offers in-browser quantum calculations on materials using OPTIMADE's extensive structure databases via DOME 4.0.</p>
 <p>Facets of substances: physico-chemical, trade and patent information</p> <p>Simultaneously query multiple reliable information sources and integrate their answers.</p>	 <p>Quality monitoring of automated welding</p> <p>Improving quality prediction of welding operations by discovering and embracing data via the DOME 4.0 platform.</p>	 <p>CITRINE</p> <p>Virtual development of composite materials</p> <p>Accelerating custom-tailored composite material design with materials informatics</p>

Figure 1: The 9 B2B Showcases [11] addressed in DOME 4.0.

The Showcase results have been built up throughout the DOME 4.0 project; the status and achievements were presented in several different occasions, including a dedicated workshop in October 2024 [12]. The results and achievements served to illustrate the transformative impact of the DOME 4.0 Platform on the synthesis of knowledge and the exchange of data throughout the materials and manufacturing sectors. They are key enablers for positioning the DOME 4.0 Platform as an emerging industrial data marketplace ecosystem, which emphasizes interoperability. Thanks to its formal ontology-based support, DOME 4.0 facilitates seamless integration of heterogeneous data, tools, and services. The showcases also inspired already multiple publications, as described hereafter in Section 2.2.

2.2 Examples of publications with / towards Industry

From the overall DOME 4.0 dissemination material collected in the frame of Task 6.1 [2], here are some examples of industry collaboration and/or dissemination:

- CMCL as DOME 4.0 coordinator presented the approach on data, its meaning (semantics) and context, related to cross-sector digital twins for improve decision-making in industry [13].
- The Showcase 9 R&D effort (SISW) was performed together with global diversified chemicals company SABIC (member of DOME 4.0 EAB) and with Citrine Informatics, whose Citrine Platform provides AI/ML capabilities. This work was published on Siemens' Simcenter blog [13], on the Citrine blog [18] and on LinkedIn as to maximize the cross-network-dissemination.
- CMCL represented DOME 4.0 project at the TechConnect and Smart City Connect Expo [16] in the US in September 2022. The DOME 4.0 coordinator delivered an innovation pitch under the innovation track "AI, Data, Cyber, Software", and disseminated project findings on data sharing, interoperability, and semantics in dealing with industrial data, to a wide range of audiences from industry, academia, public sector, and government.
- CMCL shared DOME 4.0 findings in enabling data interoperability and data sharing at the Materials Research Exchange (MRE) 2022 event [17] in London (UK) in Oct. 2022. The theme of the event was on materials research towards future challenges from the data aspect, and the event had over registered 1500 delegates from industry, academia, public bodies.
- BOSCH published a paper [15] on the Industry 4.0 technology development, its impact on industries as BOSCH' welding monitoring application, and the role of machine learning (ML) based data analytical applications, which in the case of welding monitoring enabled more efficient and accurate welding monitoring quality.
- Two blogposts by SINTEF describe the evolution of DOME 4.0 into a data marketplace [25] and subsequently into an industrial data marketplace that supports critical business decisions in organisations [25].
- CMCL and BOSCH represented DOME 4.0 at the SemIIM Workshop [20] in Athens (Greece) in November 2023, each delivering a presentation. This represented an opportunity to liaise with the relevant scientific & industrial community – incl. OntoCommons project partners – on seamless data sharing and integration e.g. via data marketplaces and across value chains.
- The Showcase 4 R&D work (SISW and FRAUN) was performed together with Citrine Informatics, an industrial company active in AI/ML. You can read all about it on the Siemens Simcenter blog [22] and on the Citrine blog [23]; the post was also shared on LinkedIn as to maximize the cross-network-dissemination.
- CMCL presented the keynote talk "Connecting digital twins for a shared understanding, Powered by The World Avatar™" at the "Digital Twin Cities Conference: Bridging the gap between vision and reality" at Chalmers (28 Nov. 2023, Gothenburg, SE) [21]. This covered an overview of DOME 4.0, its semantic interoperability framework and Showcase 1 R&D on digital virtual sensors for air quality. It was presented to a wide range of industry participants.

- CMCL presented its digital virtual sensor for Air Quality at the Digital Twin Conference 2024 [24]. This sensor takes into account data sources as including ship locations (AIS), ship types, fuels used, emissions dispersion, and local weather conditions, serving esp. port cities.
- Fraunhofer IWM published the DOME 4.0 Showcase 2 technology innovation outcome (on adopting Big Data for improved prognosis) into the CU Reports magazine [26]. CU denotes Composites United e.V., the German association for composite materials, which is an important connection to the German scientific and industrial network related to composites.
- The blogpost [27] by SISW describes the daunting task of Big Data management, and how DOME 4.0 contributes to solutions that help industry and beyond in this domain. The inspiration came from industrial applicability discussions at the Second Industry Open Day [5].

This blogpost [27] makes clear that **EU R&D projects like DOME 4.0 are mission-critical** in our new world of AI-enhanced digitalization and our collective move to a more sustainable economy. This is confirmed by two quotes of DOME 4.0 participants [5], who also look ahead on what needs to happen in the future if the materials ecosystem is to really shine in the world of digital-twin-based, AI-driven engineering [27]:

- *“It is an honor and a pleasure to lead the DOME 4.0 team. The relentless efforts from the project partners as well as the ongoing engagement with other sister projects across Europe and our External Advisory Board have enabled the project to complete its six milestones. The topics ranged from semantic data exchange, data provenance and sovereignty, ecosystem ontology to the onboarding of external data providers,”* concludes Dr. Amit Bhawe (CMCL).
- Adds Dr. Bojan Boskovic (CNT): *“Siemens is a large multinational company. It is absolutely essential to have industrial engagement from the large multinational companies who do understand the value of the high quality of the data and utilize it. Without our industrial partners and companies like Siemens, creating marketplace projects like DOME 4.0 wouldn’t make any sense.”*



Figure 2: Blog: The daunting task of Big Data Management [27].

3. Partner Networks

To capitalize on the network value of existing partner networks, the focus has been put on connecting with ongoing EU research projects that are related to DOME 4.0 (in terms of scope, objectives, activities, etc.), covering the wide application range of NMBP (Nanotechnologies, Advanced Materials, Biotechnology, and Advanced Manufacturing and Processing) application domains. This has allowed enlarging the circle of DOME 4.0 and its consortium into a much wider relevant research and industry community, with the EMMC network and the CODEX Cluster as important entities.

3.1 EMMC context

The European Materials Modelling Council (EMMC) is a non-profit organization [30] in the wider area of materials modelling. It was created in 2019 to ensure continuity, growth and sustainability of EMMC activities for all stakeholders including modellers, materials data scientists, software owners, translators and manufacturers in Europe. The EMMC considers the integration of materials modelling and digitalisation critical for more agile and sustainable product development.

The DOME 4.0 project originates from the EMMC research networking and collaboration context, with multiple partners of DOME active in EMMC. The EMMC organizes the biennial EMMC International Workshop, featuring speakers from industry and reaching a wider audience in research and industry community. This event series has provided the DOME 4.0 consortium with dissemination opportunities [2] in the 2021 and 2023 editions. In particular, the EMMC workshops allowed to share/exchange materials modelling & simulation advances with international research & industry community. Also, EMMC webinars, e-news and other event opportunities have provided dissemination channels for DOME 4.0, reaching both the research and industry community. The cooperation with the EMMC also includes publishing the outcomes of the projects, disseminating the results and events through the EMMC channels, and even sharing the open-source codes on the repositories.

Several other EU funded projects have arisen in recent years, multiple also rooted in the EMMC context, and all aiming to work together to push the boundaries of digital transformation in materials science. DOME 4.0 has adopted the strategy to link with these projects to seek complementarities and synergies. This comprised becoming part of the CODEX Cluster (see section 3.2) and linking also with projects not (yet) part of the CODEX Cluster, which have innovation objectives in common with DOME 4.0.

3.2 CODEX Cluster

The CODEX Cluster (*“Collaborative Open Data Exchange for Advanced R&I”*) is a consortium of projects and initiatives that work together to push the boundaries of digital transformation in materials science. The **CODEX Cluster** aims to advance materials science and manufacturing through innovation, collaboration, digitalization, standardization, and advanced technologies. Their goal is to develop open and accessible platforms, tools, and methodologies that facilitate data-driven decision-making, tackle industry challenges, and promote sustainable development and competitiveness in their sectors.

Under the **Horizon Results Booster** action, DOME 4.0 has joined the CODEX Cluster, upon leadership of INTRA. The activities related to the organization and creation are described in Deliverable D6.1 [2]. The CODEX Cluster has become an important channel for the DOME 4.0 team to organize and streamline the contact with partner projects (hence also linking to further industry partners). The CODEX Cluster activities related to Partner Networks are hence included in this Section of deliverable D6.3.

At the time of consolidating this Deliverable D6.3, the following **7 research projects** have already joined the collaborative efforts of the CODEX Cluster, listed here:

1. CHARISMA [31]
2. DOME 4.0 [32]
3. MatCHMaker [33]
4. MUSICODE [34]
5. NanoMECommons [35]
6. OntoTrans [36]
7. OpenModel [37]

A description of the CODEX Cluster and its partners can be found in Deliverable D6.1 [2]. An overview of the involved research projects with further description can be found online [46][47]. As part of the CODEX Cluster, DOME 4.0 benefits from a collaborative environment that fosters shared knowledge, resources, and expertise. This synergy helps accelerate the pace of innovation and ensures that advancements in one area can benefit the entire cluster. Few examples of dissemination activities (with more info in D6.1 [2]):

- The OIP 2023 workshop [48] included presentations on open innovation for modelling, design and manufacturing. The meeting was organized by 3 liaison projects (MUSICODE, VIPCOAT and OpenModel), with several DOME 4.0 partners (from SISW, UKRI, FRAUN, SINTEF, UNIBO) contributing to the meeting and to the synchronization with these other projects.
- The Second Industry Open Day at SISW in October 2023 [5] included participation and presentation from the MUSICODE project consortium.
- The NanoMECommons project organized its NanoMECommons Open Day 2024 in Cambridge (UK) on November 20, 2024. Several DOME 4.0 team members are involved: CNT (organizer and opening speaker), and invited speakers from SISW, UKRI, UCL, UNIBO and Goldbeck Consulting (GCL, the project subcontractor). Further industrial invited speakers from Airbus, Johnson Matthey, Keysight Technologies. The virtual platform **nanoMATexpo** will be presented [52], aimed to enable community development and virtual exhibition platform dedicated to support commercialization of nanomaterial applications.

The DOME 4.0 consortium has launched its Portfolio Dissemination Plan, by successfully submitting the Module B of the HRB service. This module focuses on designing and executing a comprehensive plan to disseminate information about the CODEX Cluster's activities and accomplishments. Towards enhanced brand identity, the HRB created a logo for the cluster along with promotional materials, which are key to strengthen the online and physical presence:

- A CODEX Cluster flyer, which is available for download [53].
- A CODEX Cluster movie, which can be found on YouTube [54].

At the Workshop “DOME 4.0 Showcases – A Guided Tour” [11] presented by SISW, UCL, INTRA and all Showcase owners, the value of the CODEX Cluster was underlined by INTRA as follows:

“The CODEX Cluster is a collaborative of individual projects, bringing them together to share their knowledge and resources. By working as a team, these projects can achieve much more than they would alone. The cluster’s main goal is to create a space where industries and researchers can exchange data, tools and ideas, making the entire manufacturing process more streamlined and sustainable. CODEX is about breaking down silos, whether it’s between industries or data systems, so that we can unlock new possibilities for innovation. Whether it’s reducing carbon emissions in construction or improving the safety of materials in consumer products. The Codex cluster is at the forefront of these advancements”.

Summarizing, the CODEX cluster is a consortium of projects and initiatives that work together to push the boundaries of digital transformation in materials science and achieve impact to industry. The CODEX Cluster contributes to advancing materials science and manufacturing through innovation, collaboration, digitalization, standardization, and advanced technologies. The goal is to develop open and accessible platforms, tools, and methodologies that enable data-driven decision-making, tackle industry challenges and promote sustainable development and competitiveness in their sectors. DOME 4.0, as part of this cluster, benefits from the collaborative environment that fosters shared knowledge, resources, and expertise. This synergy helps accelerate the pace of innovation, ensuring that advancements are shared.

3.3 Further Partner Network connections

Beyond the collaboration with the CODEX Cluster partners, DOME 4.0 consortium and partners have also liaised with multiple additional research projects, including the following EU research projects in the wider domain of materials and manufacturing digitalization:

- VIMMP [38] and MarketPlace [39] are two earlier projects in the domain of materials modelling marketplaces; their work has been a source of background information and lessons learned for DOME 4.0.
- SimDOME [40] focused on simplifying and unifying complex materials modelling workflows
- OntoCommons [41] focused on standardisation of data documentation across all domains related to materials and manufacturing. The interaction of DOME 4.0 with OntoCommons, led by UNIBO, has been a key source of inspiration for the DOME 4.0 standardisation efforts as reported in Section 4.1. The interaction included participation in workshop as [44][45].
- VIPCOAT [42] has been focusing on a virtual open innovation platform for active protective coatings guided by modelling and optimization. Interactions included the Open Innovation Platform (OIP) events co-organized by VIPCOAT, with DOME 4.0 participation [48]. In the 3rd

Hackathon [7] of DOME 4.0, SINTEF presented a hack related to VIPCOAT, showing how the VIPCOAT workflow could be added to the DOME 4.0 platform as additional “Tool and Service”.

- DigiPass [43] started in 2024 as an EU-funded coordination and support action (CSA) focusing on harmonization of advanced materials ecosystems serving strategic innovation markets to pave the way to a Digital Materials & Product Passport.

Some of these projects were also covered in cooperation activities, as has been reported in D5.1 [9].

The combined links with CODEX Cluster and additional projects has proven to be a fertile ground for exchange of people and ideas, sharing announcements of project events and cross-attending events.

4. Standardisation Bodies

4.1 Standards and best practices adopted in DOME 4.0

The cross-fertilization with the partner networks has enabled an inventory and assessment of standards and best practices of potential relevance for the DOME 4.0 technical-scientific planning. This took place in the **Industry Commons Cooperation** work package in the DOME 4.0 project, and a detailed overview and evaluation can be found in Deliverable D5.5 [10]. It became clear that relying on standards and best practices is a way to make sure the burden on the data providers and consumers is as small as possible.

It was concluded that the following key aspects of the DOME 4.0 ecosystem research and development will mainly benefit from adopting standards and best practices:

- How data is documented and handled
- how the ecosystem is built
- and how it is used.

Especially in these domains, the DOME 4.0 consortium has therefore aimed throughout the project duration to adhere to standards and use standardised components instead of creating new alternative solutions and has adopted best practices to guide the research work.

As elaborated in Deliverable D5.5 [10], the main standards and best practices adopted in DOME 4.0 have been in the areas of data documentation though (1) ontologies/taxonomies/vocabularies, (2) the FAIR principles [45][56], and (3) the separation of data and metadata. Also adoption took place in the area of software development, tools and technologies - limited to what has been deemed relevant for DOME 4.0 [10], for example by using standardized components to the extent possible and reusing existing building blocks as much as possible [10], as to allow efficient R&D to put together the DOME 4.0 platform in line with community interest.

BOSCH organized a workshop on OntoCommons Demonstrators and Use Cases in Stuttgart, Germany (Nov 7-8, 2022) [58], with the objective to demonstrate the power of Standardisation. Also, CMCL and GCL contributed from the DOME 4.0 team, and there was a Use Case demo & panel contribution by Siemens in the programme, which was followed by a large audience from industry and scientific community.

Through the close collaborations with the sister Industry Commons project OntoCommons, the DOME 4.0 team took a pro-active approach towards documentation, and both aligned to, and significantly contributed to, such efforts in this OntoCommons CSA action [41].

4.2 Standardisation Bodies

In the DOME 4.0 community building plan, standardisation bodies were shortlisted as potential dissemination channels. The rationale was that if DOME 4.0 had adopted a formal standard from a renowned and connected standardisation body, then additional dissemination opportunities could have been sought with that standardisation body and its network.

The following standardization bodies were considered

- CEN (European Committee for Standardisation)
- CENELEC (European Committee for Electrotechnical Standardization)
- ETSI (European Telecommunications Standards Institute)

Each of these standard bodies recognizes the value of Small and Medium Sized Enterprises (SMEs) for economy and prosperity as well as for innovation, and hence include SMEs as specific target in their standards-related actions and dissemination, e.g. with local support, success stories and best practices. Together they also allow connecting to national standardisation bodies, with 34 national member countries being represented in CEN (with the 34 national standardization bodies) and CENELEC (with the electrotechnical standardization committees); the Member country representatives constitute the final decision-makers within CEN and CENELEC.

DOME 4.0 has liaised actively with CEN, which supports standardization activities in relation to a wide range of fields and sectors including air and space, chemicals, construction, consumer products, defense and security, energy, the environment, food and feed, health and safety, healthcare, ICT, machinery, materials, pressure equipment, services, smart living, transport and packaging. Their broad expertise and wide application sector coverage has been considered as the best match with DOME 4.0.

This included the participation of DOME 4.0 partners INTRA, CMCL and CNT in a CEN workshop [57] to align on developing standardised and reliable methods for real-world industrial use. This workshop was initiated through NanoMECommons [35], one of the related EU research projects that DOME 4.0 liaises with. The meeting included the review of innovative tools for data sharing, reference materials, specialised ontologies, and standardised data documentation within the field of nanomechanical characterization, in particular the CHADA/MODA/ontologies as developed by the EMMC [30].

It is noted that the DOME 4.0 consortium did not take a decision to adopt a formal standard from a standardization body, during its R&D activities. As explained in Section 4.1, the needs of DOME 4.0 were met with adopting best practices and standards from the Industry Commons Cooperation and related R&D connections and publications in order to develop the DOME 4.0 ecosystem. Uniquely, within DOME 4.0, ontologies (e.g. ecosystem, showcase-specific application level, etc.) form the backbone of the semantic back-end that enabled a consensus-based, formal and explicit representation of underlying cross-sector data. This semantic approach securely positions DOME 4.0 to be able to align (e.g. via mapping) with any cross-sector data standard that will be established in future. Setting such a cross-sector data standard and associated protocols for data sharing are currently an active area of research and is beyond the scope of the DOME 4.0 project.

Dissemination actions through a specific standardisation body mainly make sense when a standard of that standardisation body is adopted in the R&D work. Accordingly, for DOME 4.0, such dissemination actions focused on a particular standardization body have not been made a priority, beyond the liaison activity with CEN that is reported above.

5. Conclusions

DOME 4.0 targets to provide an intelligent semantic industrial data ecosystem for knowledge creation across materials-to-manufacturing value chains in industry. Therefore, since the project start, priority has been given to the interaction with and communication to the research and industry community. This Deliverable D6.3 reports that the dissemination to 3 key stakeholders – industrial end users, partner networks and standardization bodies – has been performed along the lines of the overall DOME 4.0 communication and dissemination plan.

The DOME 4.0 approach is to facilitate knowledge extraction through ontology-driven semantic data interoperability and modern data processing technologies using Machine Learning (ML) and Artificial Intelligence (AI). DOME 4.0 is open to all players in the sector, and aims to advance data-driven knowledge generation in the materials and manufacturing sectors, and eventually in several other sectors.

This ambition has been demonstrated on the basis of 9 **B2B Showcases** (referring to the Business-to-Business nature), which inspired public domain publications and knowledge/people exchanges at workshops, conferences and blogposts. The partner networking employed the EMMC and the newly founded CODEX cluster as catalysts for the R&D collaboration. In the area of standardization, next to interaction with standardization body CEN, the focus has been put on the adoption of standardized components and best practices into the DOME 4.0 platform, leveraging the lessons learned through the Industry Commons Cooperation.

Uniquely, DOME 4.0 developed and implemented ontologies (e.g. ecosystem, showcase-specific application level, etc.) that form the backbone of the semantic back-end and enable a consensus-based, formal and explicit representation of underlying cross-sector data. This semantic approach positions DOME 4.0 to be able to align (for example. via mapping) with any cross-sector data standard that will be established across Europe in future.

6. Lessons Learnt

Lessons learned from the activities carried out within the DOME 4.0 project, e.g. as inspiration for future research projects along similar lines:

- Keep attention to the ‘materials focus vs. general digitalisation’ balance in the R&D activities. For instance, DOME 4.0 originated from a materials modelling research context, but the DOME 4.0 concepts developed have a broader applicability potential
- Through DOME 4.0, the importance of striking a balance between agility (via software, adoption, etc.) and standards (wherever established) has been an impactful lesson. The flexibility offered by the development and adoption of a semantic back-end positions DOME 4.0 to map and thus align with any cross-sector data standard that will be established in Europe.

- Recommended focus for the consortium to have the platform up and running including data management capability, to be able to maximally benefit from the workflow execution; it is through the range of Showcases that industry sector users can be reached most effectively.
- The importance of maintaining strong connections with industry and industry networks was emphasized for all 9 showcases (SCs) from the outset
- Throughout the Showcase (SC) development stages – feasibility, offline execution, and online execution on the DOME 4.0 platform – communication with industrial stakeholders has been crucial. This included both individual interactions (e.g. with SABIC for SC9, Citrine Informatics for SC4 and SC9, CMCL with port authorities for SC1) and grouped initiatives like regular presentations to and interactions with the DOME 4.0 EAB members. These efforts culminated in the Showcase dissemination workshop held in October 2024.
- The DOME 4.0 consortium engaged in an extensive cooperation with several relevant initiatives fairly early in the project. Such cooperations have proven very useful for the project, as they meant the technical development in the project could be put to an early test, the best experiences and success stories across these initiatives to be shared, and a wide network of relevant stakeholders to be formed. A special case of such cooperations were carried out with the Industry Commons sister project **OntoCommons**. The DOME 4.0 team proactively contributed to the data documentations and standardization activities in that project, and ensured the outcomes of both projects are aligned.
- The overall state of the platform development as well as the associated TRL levels (reflecting the research nature of the project) should be considered in any interaction with the external industrial parties.
- The liaison, communications and discussions with a wider range of stakeholders also helped inform the technical developments in the DOME 4.0, also impacting the value offering, business and sustainability aspects of the project. Activities at this front were **truly cross-WP** and a team effort, and the DOME 4.0 project has benefited from these in multiple ways.

7. Deviations from Annex 1

There are no deviations from Annex 1.

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3	Research	INTRA	Netcompany-Intrasoft
4	University	UNIBO	Alma Mater Studiorum – Università di Bologna
5	University	EPFL	Ecole Polytechnique Federale de Lausanne
6	Research	UKRI	United Kingdom Research and Innovation
7	Large Industry	SISW	Siemens Industry Software NV
8	Large Industry	BOSCH	Robert Bosch GmbH
9	SME	UNR	Uniresearch B.V.
10	Research	SINTEF	SINTEF AS
11	SME	CNT	Cambridge Nanomaterials Technology LTD
12	University	UCL	University College London



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