



MINE.IO

A Holistic Digital Mine 4.0 Ecosystem



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Final Event - Standardisation

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*MINE.IO Final Event Workshop
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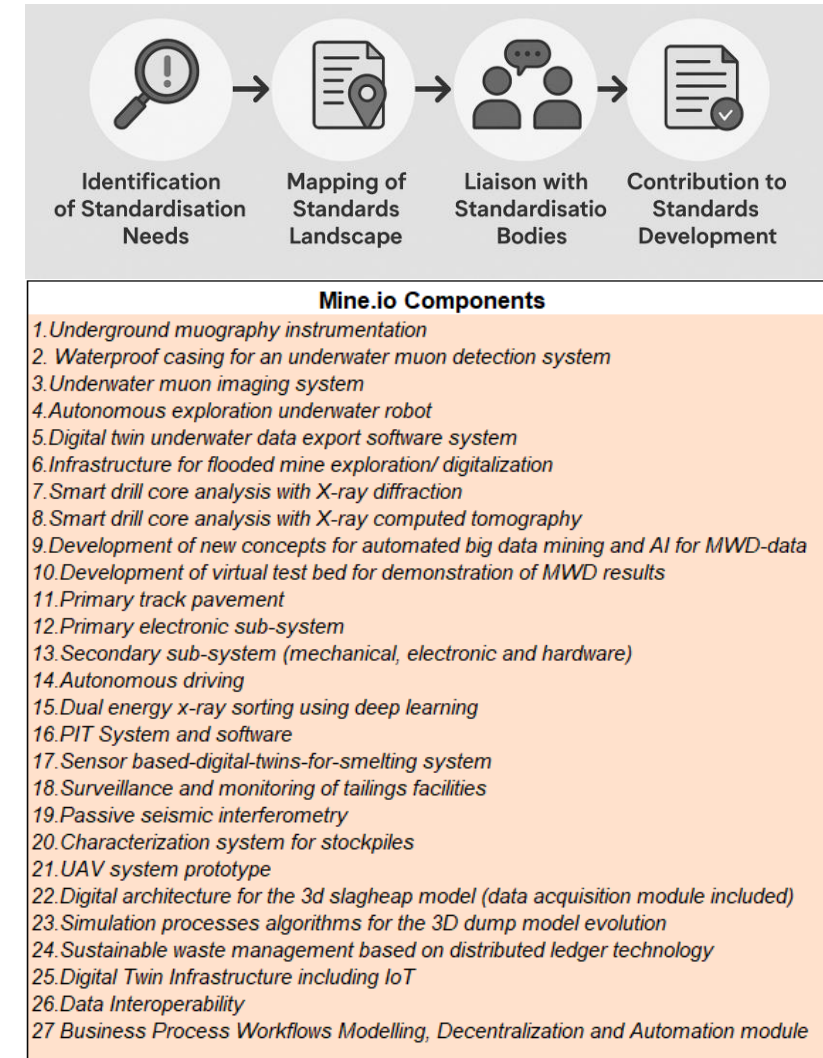
Standardisation and empowering European mining

Main objectives for the standardisation task:

- Identify the relevant standards to implement as part of the Mine.io platform
- Enable the Mine.io consortium to leverage on its results and findings to produce contributions to ongoing and future pre-normative activities of suitable standardisation bodies.

Methodology

- Early in the project, a survey among project partners was conducted to gather information on which standards they were using, contributing to, and which standards they were monitoring to keep informed of developments,
- Partners were asked to identify the standards relevant to them and identify which part of the Mine.io components they relate to,
- The purpose is to monitor relevant standards and make improvement suggestions, arising from the project,
- Results from the survey was presented in a deliverable, with updates, for all partners to have access to the standards overview.



Methodology

Sample, results from the survey

Partners	Standards	Type of involvement	Focus of this standard	Mine.io components	Relevance for Mine.io categories			
					Develop sustainable and smart mining technologies for exploitation of EU mineral resources	Contribute to a more safe and environmentally friendly, resource- and production efficient sustainable mining	Develop methods, technologies and processes aiming for digitisation and automation of raw materials production.	Contribute to the implementation of the following actions of the EU Action Plan on Critical Raw Materials: Action 8: Develop Horizon Europe R&I projects on processes for exploitation and processing of critical raw materials to reduce environmental impacts starting in 2021 and Action 3: Launch critical raw materials R&I in 2021 on waste processing, advanced materials and substitution.
PoliTO	ISO/AWI TR 3502	Develop	Robotics and automation	4, 5, 12, 14, 17	Yes	No	Yes	Yes
LTU	ISO-17757	Develop	Robotics and automation	14, 21		Yes	Yes	Yes
Innov-acts	ISO 10303	Use	Interoperability and Big Data	16	Yes	No	No	No
TECNALIA	IEEE 2418.2-2020	Use	Interoperability (sharing of data and resources between different systems)	24	No	No	Yes	Yes
University of Oulu - ICCS	Global Industry Standard on ISO 13374 - MIMOSA OSA-CBM	Develop	Mine waste management	18, 24		Yes		Yes
ACCELIGENCE Ltd	European Union Aviation Safety	Use	Interoperability (sharing of data and resources between different systems)					
	European Union Aviation Safety	Use	Robotics and automation	21	Yes	Yes	Yes	Yes

During project runtime, updates were requested, in case there had been changes/additions relative to the initial survey. Resulting in updated table.

Identified Standards Developing Organisations (SDOs)

The most important standards in the context of Mine.io, specifically benefiting the mining industries, were identified along with the corresponding *Standards Developing Organisations* (SDOs). The most important SDOs are

- **ISO** – International Organisation for Standardisation,
 - An independent, non-governmental organisation. Brings global experts together to agree on the *best way of doing things*.
- **IEC** – International Electrotechnical Commission,
 - An international standards organisation that prepares and publishes international standards for all electrical, electronical and related technologies. IEC cooperates closely with ISO.
- **SAE** – Society of Automotive Engineers,
 - SAE is the leader in connecting and educating mobility professionals to enable safe, clean, and accessible mobility solutions.

Identified standards (1/4)

The most important standards, based on the survey, were identified to be

- **ISO 10303**, “*Industrial automation systems and integration — Product data representation and exchange*”, also known as STEP, “*Standard for the Exchange of Product Model Data*”. The most relevant parts of ISO 10303 are
 - Application protocol 242 (AP242) - Managed model-based 3D engineering
 - AP239 - Product life cycle support (PLCS)
 - Product data exchange, lifecycle management and storing sensor measurements and readings
 - Jotne **actively participating** in development of the STEP standards for decades
- **ISO/IEC 19510** – Business Process Model and Notation v2.0, BPMN 2.0
 - BPMN, a graphical representation for complex business processes in a workflow (activities, decision points, data flows)
 - Enables decentralised, multipurpose blockchain enabled, collection of permits and certifications that cannot be falsified, digital signing of multi-party contracts, and automates placement of work-orders.

Identified standards (2/4)

Cont.,

- **ISO 17359** – Condition monitoring and diagnosis of machines,
 - Predictive maintenance module,
 - Provides Machine Learning (ML) and Artificial Intelligence (AI) models
 - Generic procedure for condition monitoring and fault diagnosis, promoting a proactive approach.
- **MIMOSA OSA-CBM** – Open System Architecture for Condition-Based Maintenance
 - A standard architecture for moving information in a condition-based maintenance system
 - Six functional blocks, and interface between them. (*Advisory Generation, Prognosis Assessment, Health Assessment, State Detection, Data Manipulation, Data Acquisition*)
 - Using ML algorithms to detect degradation, predict future health state, and supporting decision making in the predictive maintenance module
 - Seamless integration between Predictive Maintenance and Workflow

Identified standards (3/4)

Cont.,

- **IEEE 802.11, MQTT and HTTP – Wireless Connectivity Standards**
 - The IEEE 802.11 Standard (WiFi) is a set of protocols for implementing wireless local area network (WLAN) communication,
 - MQTT is a lightweight messaging protocol designed for sensors. Widly used in Internet of Things (IoT) applications. Used for transport IoT data from Pilot Sites' components to and from communication system
 - HTTP is a widely used application-layer protocol to transfer data over the Internet
- **EU regulations concerning Unmanned Aircraft Vehicles (UAVs) / Unmanned Aircraft Systems (UAS)**
 - Drone flights and operations, to achieve a high level of safety and security
 - EU Aviation Safety Agency (EASA)
 - ISO/TC 20/SC, standard for aircraft and space vehicles
 - GDPR, drone surveillance

Identified standards (4/4)

Cont.,

- **SAE J2954/2 – Wireless Power Transfer for Heavy-Duty Electrical Vehicles**
 - Under development. Partner ENRX member of the committee in charge of J2954/2
 - Undergoing verification-tests with third-party certification bodies in the SAE framework (Utah, USA)
 - ENRX is **actively participating** in development of the standard,
 - Inductive charging of Heavy-Duty Electrical Vehicles in underground operation,
 - Pilot site 6 – Björkdal gold mine (Sweden)

Initiated new standard - Muography

Resulting from activities in our Mine.io project, the need for standardisation related to muography technologies has been identified. *Muon Solutions Oy* and *Wigner Research Center for Physics*.

To date, there are no formal standard in muography.

The need for standardisation in this domain will be brought to discussion in the *Muographers 2026 conference* (Budapest 1-5 June 2026).

The goal is to initiate a broader community discussion on possible future directions for standardisation within the field of muography.

Ecosystem Collaboration on standards

Collaboration with “sister projects” within the same call topic



The sister projects MASTERMINE, DINAMINE, NETHELIX along with MINE.IO joined in the cluster **SMART EcoMine Hub** with a collective aim to disseminate project findings, streamline research efforts, foster innovation, and cultivate enduring partnerships.

A series of workshops were held, where insights and experience were shared between the projects. Results from the cluster collaboration on standards aimed at generating a collaborative document describing standardisation activities and results from them – In a joint Annex.



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Thank you for your attention



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