Ref. Ares(2026)8612592 - 17/09/2026

Artificial Intelligence in Manufacturing leading to Sustainability and Industry5.0

Project Acronym:

AIMS5.0

Grant agreement no: 101112089

Deliverable no. and title	**D8.3 – AIMS5.0 Impact Assessment**	
Work package	WP8	Impact (exploitation, dissemination, standardization)
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Version number	V1.0	
Date	16/09/2026	
Status	Final	
Dissemination level	SEN	

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Document History

Version	Date	Author name	Reason
v0.1	22.04.2026	Laura Leja	Draft
V0.2	11.08.2026	Laura Leja	Chapter 1, 2, 3.1, 3.2
V0.3	25.08.2026	Laura Leja	Draft
V0.4	10.09.2026	Laura Leja	Draft
V0.5	14.09.2026	Erwin Schoitsch	Chapter 1, 3.4, Appendix B
V0.6	15.09.2026	Marek S. Tatara	Chapter 3.4
V0.7	15.09.2026	Marek S. Tatara	Chapter 4, formatting
V1.0	16.09.2026	Kārlis Freivalds	Review and minor edits

Publishable Executive Summary

This public deliverable, D8.3, is the final report of Work Package 8 (Impact: exploitation, dissemination, standardisation) of the AIMS5.0 project. It closes the series opened by D8.1 and D8.2 and consolidates three years of impact-related work, based on the final collection of the project's Impact Assessment Framework and, for exploitation, on a reconciliation with the project deliverables.

In communication, the consortium reported 443 activities, more than half of them participation in external events such as SPS Italia, Hannover Fair, and AUTOMATICA, with a conservatively estimated reach of at least 550,000 contacts.

In dissemination, 331 outputs were reported and 82% of them are published or accepted: 116 conference papers, 94 conference presentations, 38 journal articles, and 55 doctoral, master's, and bachelor's theses. The portfolio more than doubled since the intermediate assessment.

In exploitation, the final register holds 179 exploitable results where all of the project partners contributed. 86% are implemented or under final tests, 85 are joint results shared by two to five organisations, and readiness levels range from TRL 4 to TRL 8. From this portfolio 39 Key Exploitable Results were selected by a documented procedure: 8 horizontal enablers, such as reference architectures and platforms used across use cases, and 31 use-case results. The register and an interactive explorer remain with the consortium so that the portfolio can be maintained.

From the standardisation viewpoint, dedicated efforts to improve partner reporting and awareness have yielded significant improvements in being aware of the relevant standardization landscape. The final "Use Case" oriented assessment of standardization involvement revealed a lot of additional standards relevant for the specific application fields of the use cases and deepening the knowledge of standards already at time of research developments and not only during the production phases. Partners increased understanding the various roles partners can play in the standardization process - from expressing interest and using standards to actively monitoring and participating in (or even chairing) standardisation bodies. AIMS5.0 had contributed and will continue in future with its expertise to the evolving standardisation landscape, particularly in smart manufacturing, AI, IoT, cybersecurity and robotics. The collaboration with the ARROWHEAD project led to excellent achievements in standards around SysML V2.0 (OMG), IETF and others. In supporting other work packages (in particular WP3 (Cyber architecture for AI supported sustainable production) and WP7 (Human acceptance, trust and ethics for Digital Workspaces) with knowledge about relevant standards and regulations, the standardization task could also benefit from their analysis of standards needs and gaps in system architecture and human-centred change management Long-term commitment of key partners will carry on the standardization work in upcoming ChipsJU and other projects.

The exploitation plans, open results, publications, theses, and standardisation commitments documented here are the consortium's lasting contribution to a European manufacturing industry that adopts AI sustainably, and are offered to industry, academia, and standardisation bodies to build on.

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1. Introduction

1.1 Objective and scope of the document

This deliverable presents the final assessment of impact-related activities undertaken within Work Package 8 of the AIMS5.0 project. It consolidates the methods, data, and results developed over the three-year project period and builds on the foundations established in Deliverables D8.1 and D8.2.

The report covers four interconnected dimensions of project impact: communication with external audiences; dissemination of scientific and technical results; exploitation of project outcomes by consortium partners; and engagement with relevant standardisation bodies. It reports the final consolidated dataset, explains the assessment methodology, and summarises the outcomes, achievements, and planned post-project continuation of these activities.

1.2 Structure of the deliverable report

The document is structured in five principal parts. Following this introduction, the impact assessment methodology describes the final Impact Assessment Framework, data collection process, and quality-assurance approach. The main report then presents results for communication, dissemination, exploitation, and standardisation. A summary consolidates the principal findings and final impact indicators. References and appendices provide supporting material, including abbreviations and an overview of relevant AI standards.

2. Impact Assessment Methodology

2.1 Impact Assessment Framework - Methodology and Data

The impact assessment in AIMS5.0 has been conducted through a structured, iterative methodology developed over all three project years. The central instrument is the Impact Assessment Framework (IAF), an Excel-based questionnaire distributed to all consortium partners, covering four categories: communication, dissemination, exploitation, and standardization. The first year established the framework and collected baseline data (reported in D8.1); the second year refined it and significantly improved data quality through direct partner engagement (reported in D8.2); the third year represents the final and most complete iteration, producing the dataset that underpins all results presented in this deliverable.

2.1.1 Impact Assessment Framework - Final Iteration

The Impact Assessment Framework reached its mature form during Year 3 of the project. Building on the refinements introduced in Year 2 — including the addition of the "Bachelor's Thesis" dissemination category, the cross-validation pipeline with EU portal data, and Crossref-based publication enrichment the framework was deployed for a third and final time across all consortium partners. The resulting dataset represents the most complete picture of the project's impact that has been compiled to date, covering activities at partner, use case, work package, project, and beyond-project levels.

2.1.2 Actions Taken in Y3 and Final Data Collection

Lessons learned from the previous two rounds of data collection shaped the approach taken in Year 3. Targeted engagement sessions were held with partners whose Year 2 submissions remained incomplete, particularly regarding standardization activities and exploitation results tied to specific use cases. A final project-wide call for data was issued with clear deadlines and a reference to the recorded training session available in the project repository. The Y3 collection also specifically requested forward-looking information exploitation plans and standardization commitments beyond the project end date — which had not been systematically captured in earlier rounds. The data used for establishing the final exploitation results registry was extended by taking into account not only the questionnaire, but also other deliverables and partner clarifications to form the final and complete picture of what was achieved in the project.

2.1.3 Automated Processing and Final Data Analysis Pipeline

The data analysis for D8.3 relies on the finalized codebase developed and extended throughout the project. The pipeline performs automated deduplication using fuzzy matching across partner submissions, cross-validates dissemination entries against records in the EU portal in both directions and enriches publication records with metadata retrieved via Crossref where DOIs are available. The outputs of this pipeline charts, tables, and aggregated statistics form the analytical basis for all results presented in Chapter 3.

Table 1: Final Communication and Dissemination dataset used.

Indicator	Final value	Basis
Partners submitting a questionnaire	45	45 organisations represented in the consolidated Communication/Dissemination workbook

Communication entries	443	Non-empty communication records; 428 have a specified activity type and 15 are uncategorized
Dissemination entries	331	Non-empty dissemination records; 327 have a specified type and 4 are uncategorized
Total entries analysed	774	Communication + dissemination records
Distinct titled dissemination outputs	227	90% fuzzy-title clusters among 319 titled entries; 12 untitled entries excluded
Delivered dissemination entries	271 (81.9%)	Published or Accepted

Table 1 defines the evidence base used in Sections 3.1 and 3.2. Raw dissemination entries are retained for partner-level participation analysis, while de-duplicated titles are used when reporting distinct project outputs.

2.2 Final Inputs Refinement and Quality Assurance

Prior to generating the analysis, the aggregated dataset underwent a multi-stage quality assurance process. Direct partner feedback sessions were used to resolve ambiguities and fill remaining gaps. WP5 and WP6 leads were consulted to validate the list of exploitable results originating from use cases. The final dataset was checked for internal consistency — for example, ensuring that results reported as "beyond project" exploitation are supported by corresponding exploitation narrative from the responsible partner. Only after this process was the dataset considered ready for analysis and public reporting.

3. Report on Impact-related Activities

3.1 Communication

Communication activities supported the visibility of AIMS5.0 and the transfer of information on project progress and results to industrial stakeholders, the research community, related European initiatives and wider external audiences. The updated consolidated Communication dataset contains 443 reported activities from consortium partners. Of these, 428 entries have a specified activity type, while 15 records contain other classification. These all activities cover event participation and organisation, social media, website and blog content, audiovisual material, printed communication, press releases, webinars and other outreach formats.

The communication portfolio remained strongly event-oriented. Event Participation accounts for 243 entries, representing 54.9% of all reported communication activities, followed by Event Organization (64), Social Media Posts (33), Website/Blog Articles (27), Other communication activities (26), Website Information (10), Promotional Videos (9). The remaining categories comprise webinars and training activities, printed material, press releases, and thesis-related presentations (seen in Table 2).

Communication was implemented at several levels of the project. The largest number of entries was associated with individual use cases (103), followed by Project-level activities (87), Work Package activities (55), Beyond Project activities (50) and Partner-level activities (40). Other or mixed-level activities (13) and Multi-Partner communication (12). This distribution indicates that the communication strategy combined communication embedded directly in technical activities and use cases with broader external outreach. At the same time, 83 entries (18.7%) do not specify an engagement level, indicating that further improvement in reporting completeness would be beneficial (see in Figure 1; figure shows that event participation is the main communication mechanism at every level and is particularly prominent at Beyond Project level). Digital channels contribute fewer records but complement event-based outreach).

Quantifiable audience-reach information is available for 268 of the 443 communication entries (60.5%). Using a conservative parsing approach for numeric values and clearly expressed lower bounds (for example “50+” or “>100”), the cumulative reported reach is at least 549,328 audience contacts. This value should be interpreted as a lower-bound indicator rather than a unique-person KPI, because 175 activities lack a usable quantitative reach value, several entries use approximate or minimum values, and the same person may be reached through multiple activities.

Table 2: Key Communication indicators.

Indicator	Result	Interpretation
Communication entries	443	Updated consolidated communication records
Event participation	243 (54.9%)	Largest communication category
Beyond Project event participation	40	External event engagement outside the consortium
Entries with quantifiable audience reach	268 (60.5%)	175 entries have no usable quantitative reach value
Reported audience reach	≥549,328	Conservative lower bound from 268 quantifiable entries
Entries with populated Link field	218 (49.2%)	172 entries contain an explicit http/https URL
Entries linked to a use case	259 (58.5%)	Use-case traceability

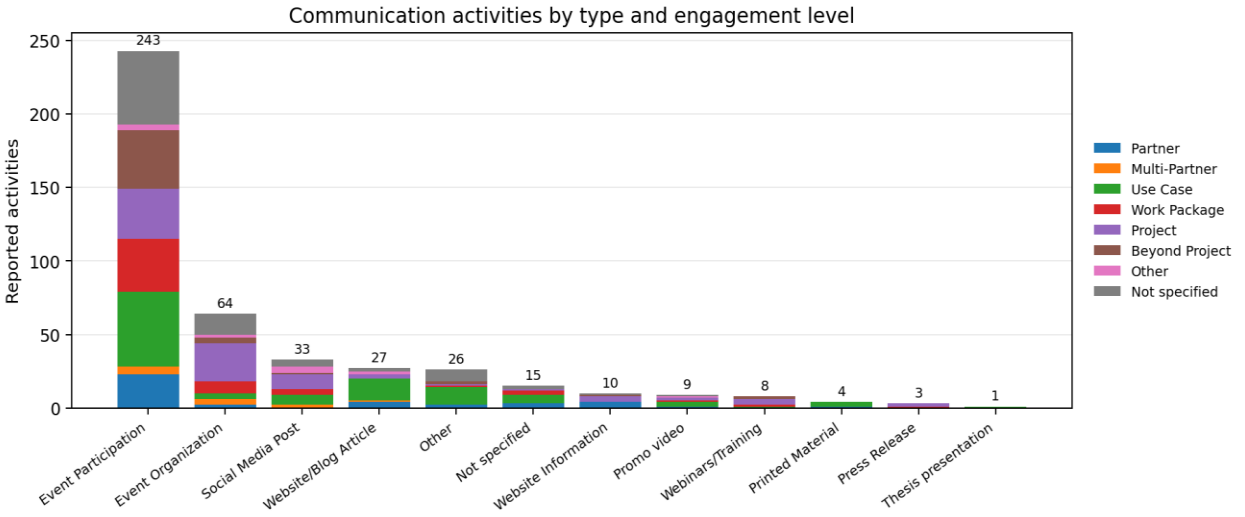

Figure 1. Communication activities by type and engagement level (updated IAF dataset).

3.1.1 Event Participation and Project-Organized Events

Participation in external events constituted the principal communication channel of AIMS5.0. The updated dataset contains 243 Event Participation entries and 64 Event Organization entries. Event participation ranged from use-case and work-package meetings to industrial fairs, academic and technology conferences and external European forums.

Importantly, 40 Event Participation entries were classified at the Beyond Project level, indicating that AIMS5.0 results and activities were presented in settings extending beyond the immediate consortium. Reported examples include SPS Italia, Hannover Fair 2024 and AUTOMATICA 2025, alongside numerous research conferences, workshops and other sector-specific events. These activities created opportunities to present intermediate and final results through demonstrations, presentations, posters and direct interaction with industrial and research stakeholders.

It should be particularly noted that AIMS5.0 communication activities also supported strategic collaboration and external visibility through participation in major international conferences and dedicated Industry 4.0/5.0 sessions, organized by project partners. Project partners were represented at events including J3C 2025 – IFAC Joint Conference on Computers, Cognition and Communication(https://j3c.org/), the IEEE/IFIP Network Operations and Management Symposium (NOMS, https://noms2026.ieee-noms.org/), and SAFECOMP 2025 (https://safecomp2025.se/). Participation in these events provided opportunities to present AIMS5.0-related research, exchange knowledge with academic and industrial stakeholders, and strengthen links with relevant research communities and potential collaboration partners. Such conference-based communication complemented the project's broader dissemination activities by increasing the visibility of AIMS5.0 results beyond the consortium and supporting continued cooperation in AI-enabled manufacturing, dependable systems and Industry 5.0 (see Figure 2).



Figure 2. Building stronger partnerships.

3.1.2 Digital Communication - Website, Blog, and Social Media

Digital communication complemented event-based outreach and provided channels through which project information could remain accessible independently of physical events. The final dataset contains 33 Social Media Post entries, 27 Website/Blog Article entries and 10 Website Information entries.

In the updated dataset, Event Participation has the largest quantifiable cumulative reach, with at least 336,219 contacts across 148 of 243 entries for which a usable reach value is available. Social Media Posts account for at least 98,003 contacts across 31 of 33 entries, giving social media the highest reach-data coverage among the major communication categories (93.9%). A further 99,545 quantifiable contacts are associated with 10 communication records whose activity type is not specified. The results therefore show that events dominate both activity volume and currently quantifiable reach, while social media provides comparatively consistent reach reporting.

The interpretation of these figures nevertheless requires caution. Audience reach was not systematically reported for every activity, and partners used different formats, including exact counts, approximate values and lower-bound expressions. Consequently, the values are most useful for comparing the relative contribution and reporting completeness of communication channels rather than for calculating a precise number of unique individuals reached.

Figure 3 compares reported audience reach across communication channels. Quantifiable reach is available for 268 of 443 communication entries (60.5%), with a conservative cumulative lower-bound estimate of 549,328 contacts. In addition, 259 communication entries are linked to at least one use case, 358 to a work package or task, and 218 have a populated Link field.

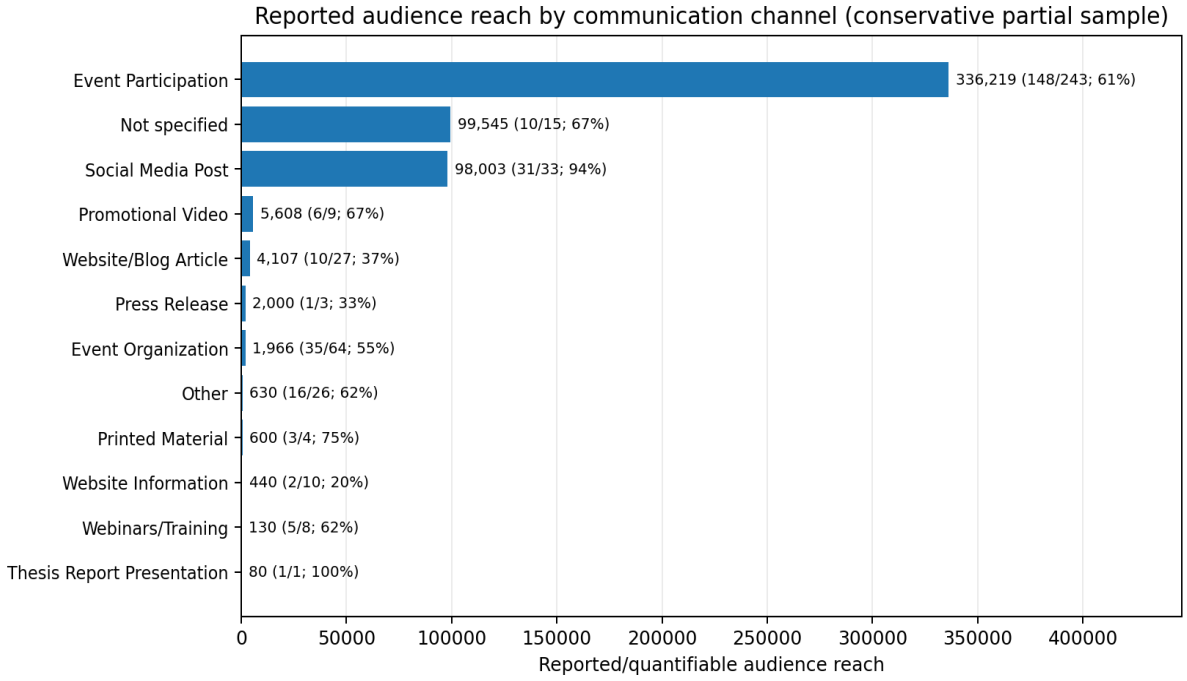

Figure 3. Reported audience reach by communication channel (conservative partial reporting sample).

3.1.3 Promotional Videos and Audiovisual Materials

Audiovisual communication formed a smaller but relevant component of the AIMS5.0 communication portfolio. The updated dataset contains nine Promotional Video entries, six of

which contain quantifiable audience information, representing a conservative reported reach of at least 5,608 contacts. Promotional videos were used at project, work-package and use-case levels to present technical concepts and demonstrators in a format accessible to audiences beyond the immediate research teams. The current Communication dataset explicitly links promotional-video entries to UC4, UC8 and UC9. Other video records do not specify a use case.

3.2 Dissemination

3.2.1 Scientific Publications and Conference Contributions

Conference-related dissemination constitutes the largest component of the scientific portfolio. After normalizing obvious type-label typos, the updated dataset includes 116 Conference (Proceedings) Publication entries, 94 Conference Presentation entries and 38 Journal Publication entries.

A high proportion of conference-related outputs have reached a delivered stage. Ninety-seven of 116 Conference (Proceedings) Publication entries are Published or Accepted (83.6%). For Conference Presentations, 84 of 94 entries (89.4%) are Published or Accepted, while 22 of 38 Journal Publication entries (57.9%) have reached Published or Accepted status. The remaining journal manuscripts provide an additional pipeline of planned, in-progress or submitted work. The dissemination record includes contributions to established journals and conferences in AI, industrial automation, semiconductor manufacturing, production systems and related areas. Examples already documented in the project reporting include Engineering Applications of Artificial Intelligence, IEEE Transactions on Semiconductor Manufacturing and IEEE Industrial Electronics Magazine, as well as conference series including IEEE/IFIP NOMS, Winter Simulation Conference and other international scientific events. D8.2 similarly documented the breadth of the project's publication and conference activity.

Open-access and persistent-identifier metadata have improved but remain incomplete. Among the 271 Published or Accepted dissemination entries, 78 are marked as open access (28.8%), 148 are marked No and 45 have no open-access value. DOI information is available for 89 of the 331 dissemination records overall, including 87 of the 271 Published or Accepted entries. These rates should be interpreted primarily as indicators of metadata completeness rather than as a definitive assessment of open-access compliance.

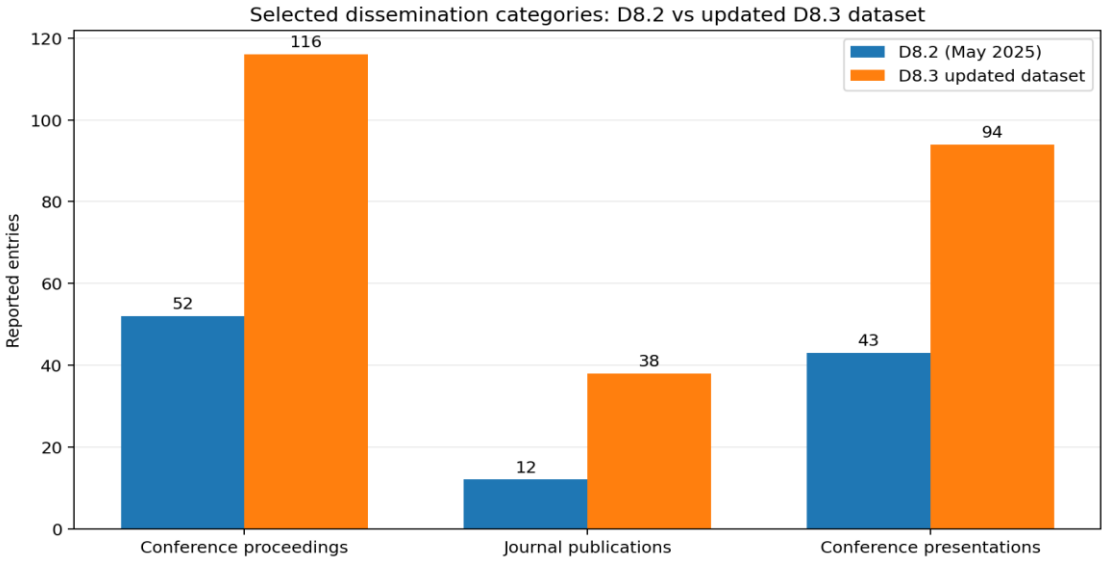

Figure 4. Selected dissemination categories in D8.2 and the updated D8.3 dataset.

Figure 4 provides a like-for-like comparison for the three categories that are consistently reported in both deliverables. Compared with D8.2, the updated D8.3 dataset increases from 52 to 116 Conference (Proceedings) Publication entries, from 12 to 38 Journal Publication entries and from 43 to 94 Conference Presentation entries. Thesis counts are discussed separately because the final data required additional classification cleaning.

3.2.2 Research Training and Capacity Building

AIMS5.0 has also contributed to research training through academic work conducted in connection with the project's technical topics. The final dataset contains 6 Doctoral Dissertation entries, 39 Master's Thesis entries and 10 Bachelor Thesis entry.

3.2.3 Open Science - Code Repositories and Datasets

Two Dataset entries are recorded, and both are Published and marked as open access. Across all 331 dissemination records, 89 entries contain a DOI. Among the 271 Published or Accepted entries, 78 are marked open access, 148 are marked No and 45 have no OA value. Because DOI and OA metadata remain incomplete, these figures are treated as data-quality indicators rather than a compliance assessment.

3.2.4 Partner-by-Partner Dissemination Highlights

IAF dataset represents contributions from partners with different roles, research capacities and exploitation objectives. Academic and research-performing organisations naturally account for a significant share of peer-reviewed scientific outputs and academic theses, while industrial partners contribute through technical presentations, demonstrations, event participation and dissemination connected directly to use cases.

Partner-level statistics should therefore be used primarily to demonstrate the breadth of participation rather than to establish a ranking among consortium members. A partner-attributed table in the appendix can usefully report the number and type of dissemination entries, the number reaching Published or Accepted status, DOI availability and open-access reporting.

The partner scorecard shows broad participation but different dissemination profiles. TUe reports 25 dissemination entries, followed by IFD (24), NXP (23), RUG (21), BME (19), RSA FG and HSZG (17 each), AITIA (13), and UNIPD and WUW (12 each). Delivered outputs are particularly high for IFD (23), NXP (21), BME (19), TUe (18), RUG and RSA FG (17 each), AITIA (13), and UNIPD (12). Joint outputs are counted for each contributing partner at the partner level; project-level de-duplication is addressed separately through title matching.

3.2.5 Research Dissemination

Scientific and technical dissemination represents a major component of the external impact generated by AIMS5.0. The updated Impact Assessment Framework contains 331 dissemination entries, covering peer-reviewed publications, conference contributions, academic theses, scientific event organisation, keynote contributions, datasets, whitepapers and other dissemination outputs. Of these, 327 entries have a specified dissemination type and four records are not classified by type.

At the time of the updated analysis, 212 dissemination entries are Published and 59 Accepted, meaning that 271 entries, or 81.9% of the reported dissemination portfolio, have reached a delivered status. A further 22 entries are Submitted, 14 Planned and 9 In Progress. Six activities

are reported as Rejected/Discontinued, one as TBD, and eight entries lack a defined status. This distribution indicates that a large majority of the reported dissemination portfolio has progressed beyond planning and preparation stages, while a smaller pipeline may continue to mature around and after the formal project end.

The updated dataset contains 331 dissemination entries compared with 154 entries reported in D8.2, an increase of 177 records. In particular, Journal Publication entries increased from 12 in D8.2 to 38 in the updated dataset, Conference (Proceedings) Publication entries from 52 to 116, and Conference Presentation entries from 43 to 94. This supports the conclusion that scientific dissemination continued to develop after the intermediate assessment, and the broader final-round consolidation of partner submissions.

Partner-level duplicate reporting remains an important methodological consideration. Of the 331 dissemination records, 319 contain a publication/output title. Applying the 90% fuzzy-title similarity threshold used in the supplied analysis notebook results in 227 distinct title clusters among these 319 titled records. The remaining 12 dissemination entries lack a publication title and are therefore not included in this title-based distinct-output count. Figure 5 shows both output volume and maturity. Conference proceedings and conference presentations form the largest categories, while journal publications and academic theses retain a visible pipeline of planned, in-progress or submitted work. The chart also makes the small number of unclassified dissemination records visible rather than silently excluding them.

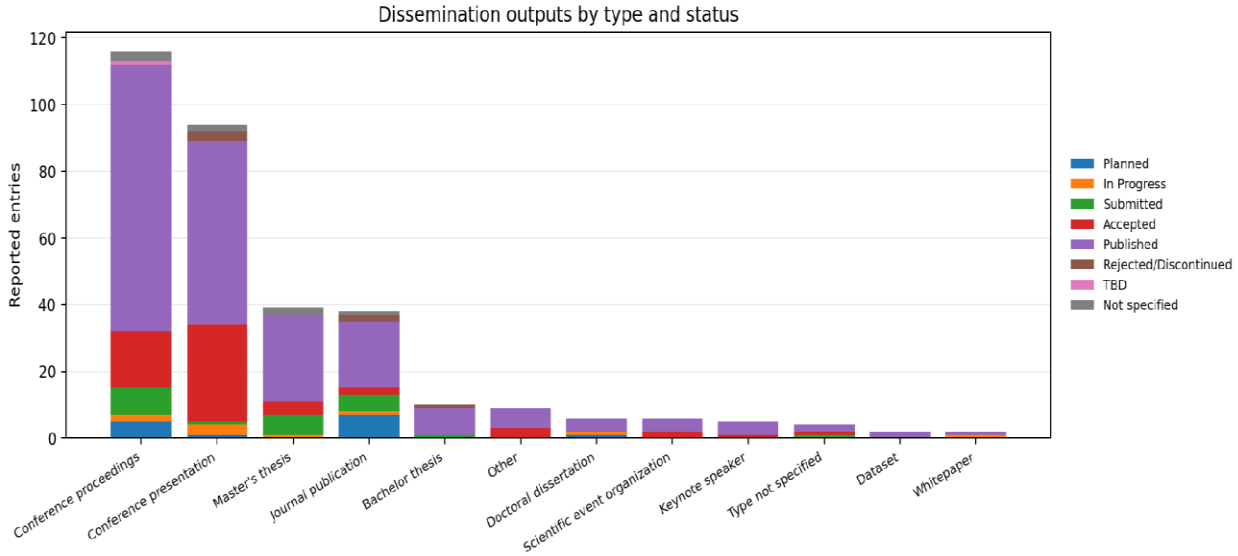

Figure 5. Dissemination outputs by type and status (updated IAF dataset).

- 116 Conference (Proceedings) Publication entries;
- 38 Journal Publication entries;
- 94 Conference Presentation entries;
- 39 Master's Thesis entries;
- 6 Doctoral Dissertation entries;
- 10 Bachelor Thesis entries;
- and 28 entries distributed among other or unclassified dissemination formats, including scientific event organisation, keynote contributions, whitepapers, datasets and other activities.

The visibility and accessibility of scientific outputs remain areas requiring final metadata consolidation. DOI information is currently available for 89 dissemination entries, while 78 of the 271 Published or Accepted entries are marked as open access. In addition, 45 delivered

entries have no open-access value. These figures indicate that DOI and open-access metadata should be completed and cross-checked for peer-reviewed publications wherever possible before the final public report is submitted.

3.2.6 Dissemination of Project Results

AIMS5.0 supported the digital communication of project results through the project website, social media and audiovisual materials. As shown in Section 3.1, these channels complemented the broader communication activities of the project. The final Communication dataset contains 27 Website/Blog Article entries, 10 Website Information entries, 33 Social Media Post entries and 9 Promotional Video entries. Among the digital communication channels, social media was the most consistently quantified major channel, accounting for at least 98,003 reported contacts across 31 entries with available reach data. While Event Participation generated the largest quantifiable cumulative audience reach across all communication activities, social media provided a substantial and regularly measurable contribution to the project's overall communication reach.

3.2.7 ST8.3.3 AIMS5.0 Events-Based Communication

Events remained the principal communication channel used by the consortium. The updated dataset includes 243 Event Participation entries and 64 Event Organization entries. Of the Event Participation entries, 40 are classified as Beyond Project, demonstrating substantial engagement with audiences outside the consortium.

Reported activities include participation in major industrial and technology events such as SPS Italia, Hannover Fair and AUTOMATICA, as well as academic conferences, workshops and other sector-specific events. Intermediate and final project results were communicated through presentations, demonstrations, posters and supporting communication materials adapted to the relevant audiences.

Quantifiable audience figures are available for 148 of the 243 Event Participation entries, corresponding to a conservative reported reach of at least 336,219 contacts. Since several partners may report participation in the same event, reach values include estimates and lower bounds, and audience information is incomplete, these figures represent communication records and partial reported reach rather than the number of unique events or unique individuals reached.

3.3 Exploitation

The primary goal for Y3 in the context of impact was to complete the picture of the project's exploitable results and to bring every result to a state in which it can be reported in the final report and, for the most important ones, presented at the final review. Two aspects changed compared with the previous years. First, the collection was no longer driven by the questionnaire alone. The results described in the final use-case deliverables of WP5 and WP6, and in the exploitable-foreground table of the final periodic report, were reconciled with the partners' questionnaire entries, so that a result demonstrated in a use case but never reported as exploitable is now part of the register. Second, the entries were consolidated into a single register with stable identifiers. Each result is owned by exactly one partner and lists the other beneficiaries, so that joint results are counted once, and duplicates reported by several partners are merged rather than deleted.

The consolidated catalogue contains 179 exploitable results owned by 51 of the 54 consortium partners. Two further partners appear as beneficiaries of results owned by their use-case partners, and the only partner absent from the register is Ibermatica (IBR), which left the consortium during the project. This compares with 59 exploitable results reported in Y2 [2] and with the 36 proposal-stage results listed in Y1 [1]. Part of the growth is the progress made results that were work in progress in Y2 are now identifiable outcomes with a status and a readiness level, and some are new results that were implemented as part of the project and reached the level when it's worth to track them separately. Part of it is reconciliation and some of the results were identified with the use-case deliverables and partners, which continued the joint identification with the use-case leads started in Y2.

3.3.1 Exploitable Results and Key Exploitable Results

The Impact Assessment Framework introduced in Y1 collects exploitable results - any outcome of the project that a partner intends to utilise, whether commercially, in its own operations, in further research, or in education. The type taxonomy of the questionnaire (laboratory, teaching materials, product/process innovation, new product, patent, new IP, code/repository, new jobs, other exploitable result, extended in Y2 with datasets) reflects this broad reading, and so does the consolidated catalogue/register. An M.Sc. course, an open-source benchmark, and a product already sold to customers are all exploitable results, and all of them are legitimate outcomes of a research and innovation action.

The European Commission's guidance uses a narrower term for reporting and review purposes. A **Key** Exploitable Result is "*a result selected and prioritised due to its high potential to be 'exploited' i.e. to make use and derive benefits, downstream the value chain of a product, process or solution or, an important input to policy, further research or education*", and the criteria recommended for identifying KERs are "*the degree of innovation, the exploitability, and the impact"* of a result [3]. A KER is not a category of result but the outcome of a selection among the exploitable results, and the guidance expects a project to present a small number of them as the critical ones, while all of them can be tracked.

The register labels every entry as a KER because the partners already refer to their results by these identifiers. In this section the two terms are therefore used deliberately: exploitable result for any of the entries, and Key Exploitable Result only for the subset selected for the final review. Applying the definition to the catalogue, two kinds of results are qualified as key results (with the following terminology adapted within a project):

1. **Horizontal KERs** are enablers that several use cases or partners build on, or that are released under a public governance vehicle such as an open-source foundation, for example the Open Access Platform, the Arrowhead framework, or the Digital Reference ontology. Their main impact lies in their reach and contribution to open science and technology.

2. **Use-case KERs** are demonstrated results with a concrete exploitation route, *i.e.* results whose owner names how, by whom, and when they will be used, be it in production, on the market, or in research and education. The results that have high potential of exploitation (or are already exploited) were selected here.

Conversely, three kinds of results are exploitable results but not KERs:

- results not yet demonstrated (planned or in progress),
- results still at an early stage of development (a reported TRL of 4),
- components of a larger result, where the larger result is the KER and its components are presented with it.

A result that serves a single partner or a single use case is not excluded on that account, nor is a result whose owner reports no TRL or marks it as not publicly showable. The latter only limits what can be shown at the review. Datasets, laboratories, and teaching materials are eligible, since the definition explicitly covers input to further research and education. The remaining results are no less relevant, but the report treats them as exploitable results rather than KERs.

3.3.2 Final Overview of Exploitable Results

The current status of the exploitable results is presented in Figure 6. 154 of the 179 results (86%) are implemented or under tests, *i.e.* in operational use or in final validation: 91 are implemented and 63 are under tests. 20 results are still in progress, 2 are planned (a patent application and a university course), and for 3 the partner did not state a status. This picture differs from Y2, when most of the 59 results were in progress and only a few were implemented or under tests. It reflects both the end of the project and the fact that the reconciliation updated many statuses that partners had not revised in their questionnaires.

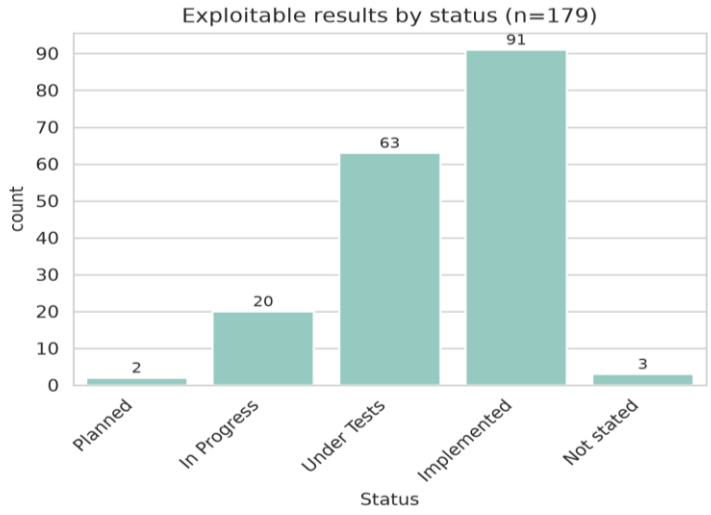

Figure 6. Current statuses of the exploitable results.

Figure 7 presents the engagement level of the results. As in Y2, most of the results are reported at the use-case level (117), which is natural for a project with 20 use cases. The upper layers are now well populated: 16 results are project-level achievements, 14 are work-package results, and 8 are already exploited beyond the project, *i.e.* applied outside the use case or the consortium that produced them. 15 results are partner-level and 9 are labelled multi-partner. The level field understates collaboration, however. The beneficiaries field shows that 85 results involve more than one partner, and it is that field, rather than the level, that is used below to describe joint exploitation.

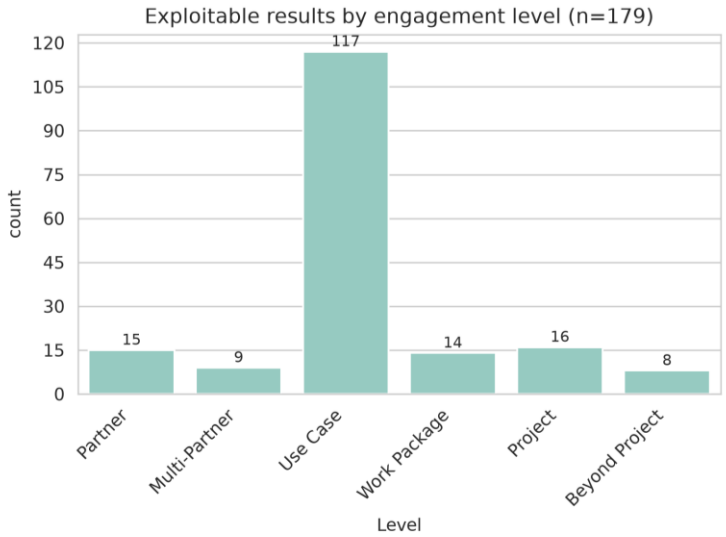

Figure 7. Engagement levels of the exploitable results.

The type of the exploitable results, along with their status, is presented in Figure 8. Product and process innovations (64) and new products (30) remain the largest groups. The new products are also the group with the largest share still under tests (19 of 30), in line with the longer qualification cycles of hardware and of products for the semiconductor industry. Code repositories (33), datasets (5), laboratories (9), and teaching materials (7) form the academic part of the portfolio. 31 of the 33 code repositories, all 5 datasets, and all 30 new products are implemented or under tests. The 19 results classified as other exploitable result are mostly methodologies, demonstrators, and process know-how that do not fit the product categories. New intellectual property is reported for 11 results and 1 patent application is planned. Compared with Y2, when the same categories were present but dominated by results in progress, every category except the patent now contains implemented results.

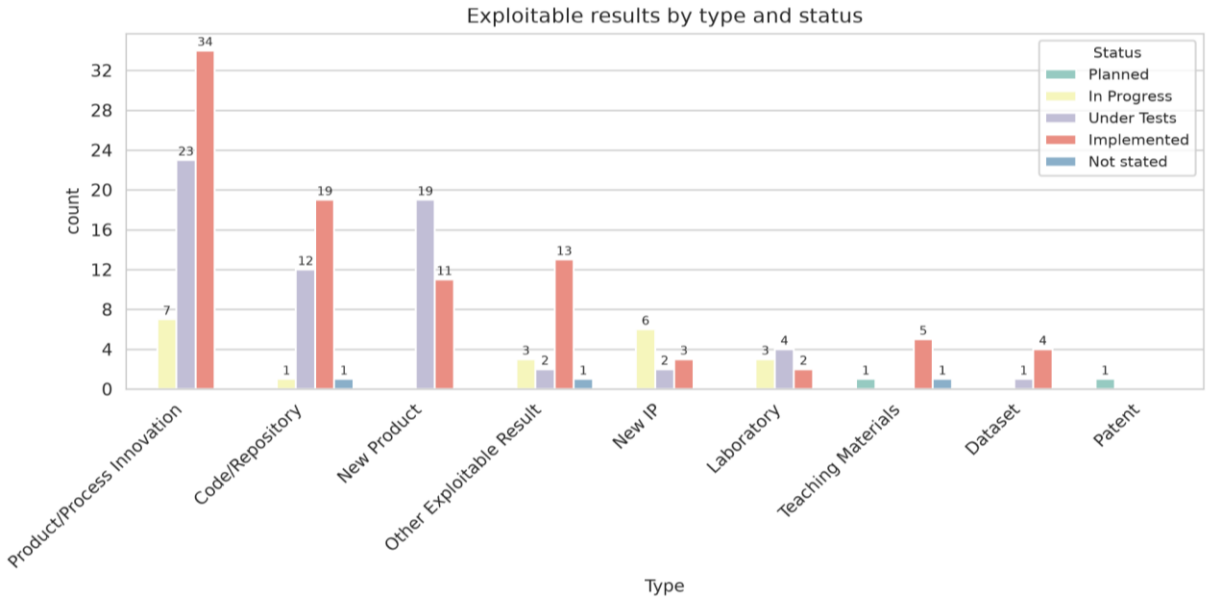

Figure 8. Types of exploitable results shown along with their current status.

Following the remark of the reviewers of the second reporting period that the outcomes of universities and research and technology organisations (RTOs) should be given the same visibility as the high-TRL industrial results, Figure 9 breaks the result types down by the type of the owning organisation. Large enterprises own 63 results, universities 50, small and medium-sized enterprises (SMEs) 38, and RTOs 28. All 14 universities and all 9 RTOs of the consortium

own at least one result, as do 16 of the 18 large enterprises and 12 of the 13 SMEs. The profiles differ in a consistent way. Large enterprises report mainly product and process innovations (34) and results classified as other (12), and SMEs report new products (15) and product and process innovations (11). Universities account for 19 of the 33 code repositories, 5 of the 7 teaching materials, and 5 of the 9 laboratories, and RTOs for 3 of the 5 datasets. These are the results through which the project know-how is transferred to the research community and to future engineers, and they are an equally important part of the exploitation. Ownership[1] understates the academic contribution, however. Universities and RTOs are involved, as owner or as co-owner, in 115 of the 179 results: besides the 78 they own, they are co-owners of 37 results owned by industrial partners (20 by large enterprises, 17 by SMEs), 28 of them product or process innovations and new products, and 32 of them already implemented or under tests. In other words, more than a third of the industrial results carry a university or RTO contribution, which is the pattern of technology transfer the reviewers asked to see.

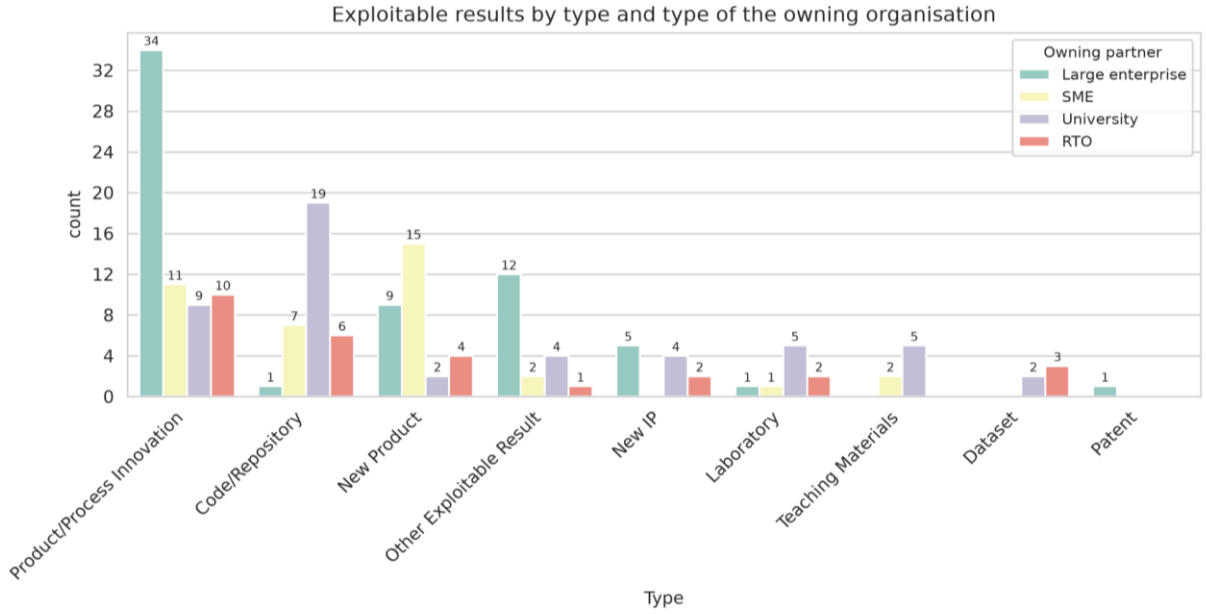

Figure 9. Types of exploitable results by the type of the owning organisation.

Figure 10 shows how the results are distributed across the partners. The distribution is broad rather than concentrated: the largest owner reports 9 results, 7 partners report 7 or more, and 31 of the 51 owning partners report 3 or more. The 7 partners with a single result of their own are all beneficiaries of further results shared with their use-case partners.

[1] In the registry, each exploitable result has exactly one owner, and may have other involved partners listed.

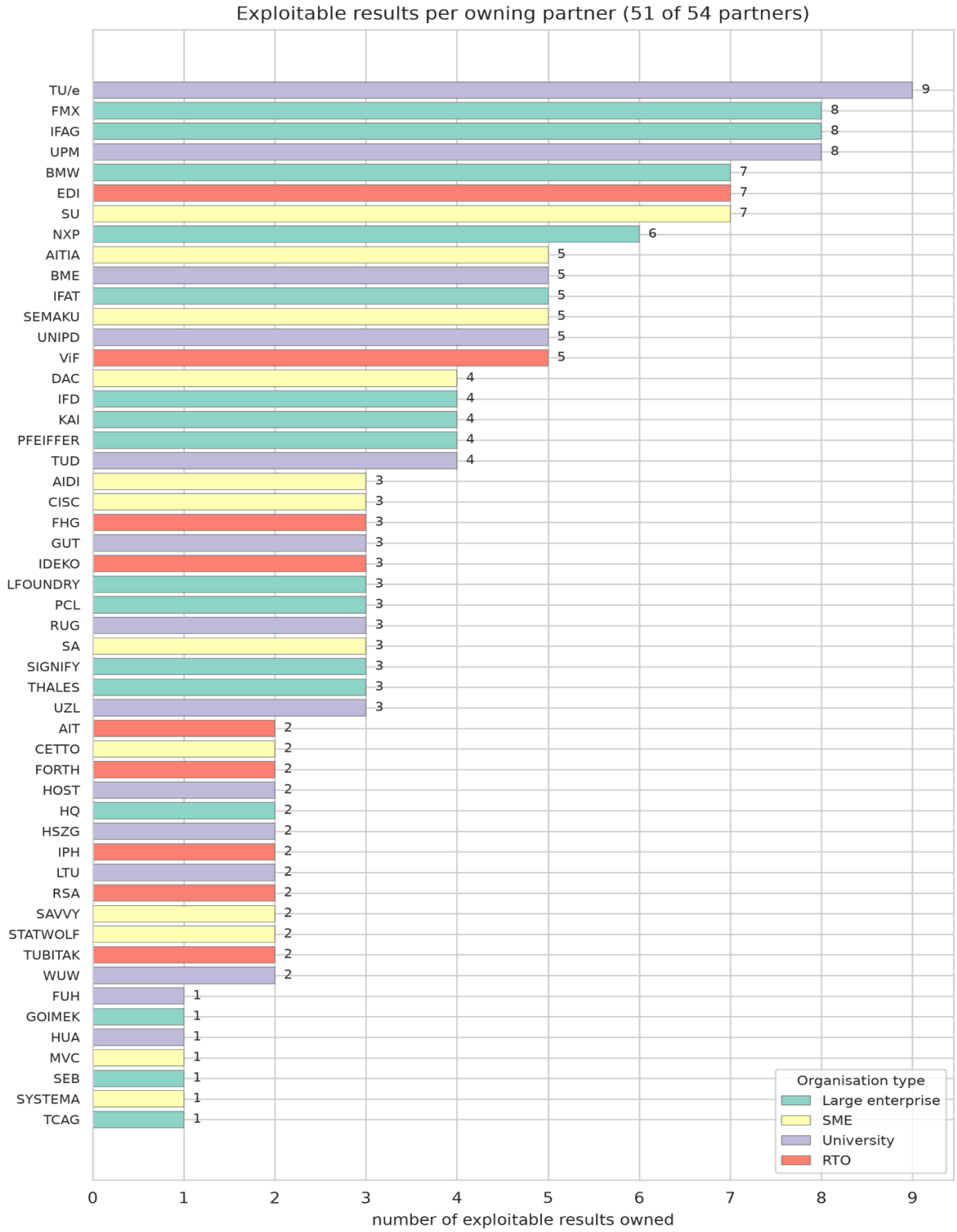

Figure 10. Exploitable results per owning partner, coloured by the type of organisation.

The technology readiness level was collected for the first time in Y3, and 111 of the 179 results report one, as Figure 11 shows. The levels are those stated by the partners - where a range was reported, the lower bound is used. The reported levels range from TRL 4 to TRL 8: 20 results at TRL 4, 32 at TRL 5, 29 at TRL 6, 23 at TRL 7, and 7 at TRL 8, so 59 results report TRL 6 or higher and 30 report TRL 7 or higher. The distribution by organisation type is as expected. Of the large-enterprise results with a TRL, 25 of 33 are at TRL 6 or higher, and of the SME results 19 of 24, whereas university results cluster at TRL 4 and 5 (27 of 36), consistent with their role

of developing methods that the industrial partners then integrate. The TRL is not stated for 68 results. For many of them - courses, datasets, laboratories, and internal process changes - the scale does not apply, and the missing values are not treated as a gap.

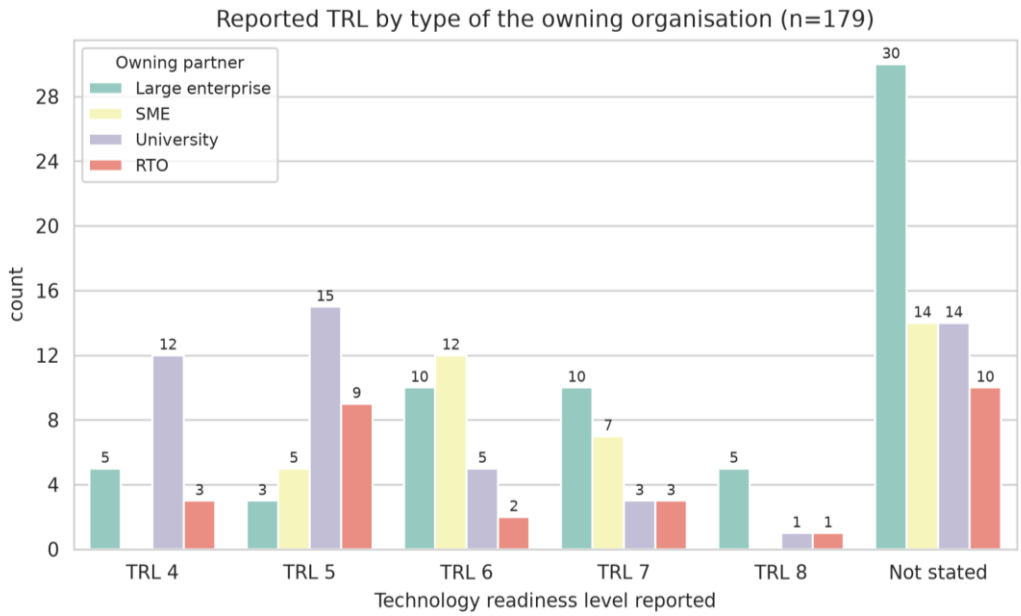

Figure 11. Technology readiness level reported for the exploitable results, by type of the owning organisation.

3.3.3 Use-Case and Work-Package Outcomes

Figures 12 and 13 collect all 179 results in the layered form used in Y2, ordered by engagement level, tagged with the use case (or, where none applies, the work package) they originate from, and coloured by type. The 117 use-case results fill their own figure, Figure 13, and the 62 results at partner, multi-partner, work-package, project, and beyond-project level are shown in Figure 12. Compared with the Y2 diagram, the use-case layer has more than doubled, and the project and beyond-project layers are populated by results that started in one use case or work package and have since been generalised. Examples are the semantic-web and ontology tooling of WP2 and WP4, the Arrowhead framework release and its tooling in WP2 and WP3, the Open Access Platform, and the results of SEMAKU and Pfeiffer that are already used outside the consortium.



Figure 12. Overview of the exploitable results at partner, multi-partner, work-package, project, and beyond-project level, tagged with the use case or work package of origin and coloured by type.



Figure 13. Overview of the exploitable results at use-case level, tagged with the use case of origin and coloured by type.

All 20 use cases have at least one exploitable result, and most have several, as presented in Figure 14. The distribution is uneven, as expected for use cases of different size and maturity. UC04 (AI-based improved connection between production and logistics, 17 results), UC15 (productionised machine learning models at scale, 14), and UC08, UC13, and UC14 (9 each) lead, while UC10 reports 2 results and UC20 4. The bars are split by status. In 8 use cases every result is implemented or under tests (UC04, UC05, UC07, UC08, UC09, UC10, UC11, and UC17), and in UC14 all but one, which is the expected profile for demonstrators that completed their final evaluation in the last months of the project. Several use cases had no exploitable result in the Y2 overview - all of them are now covered.

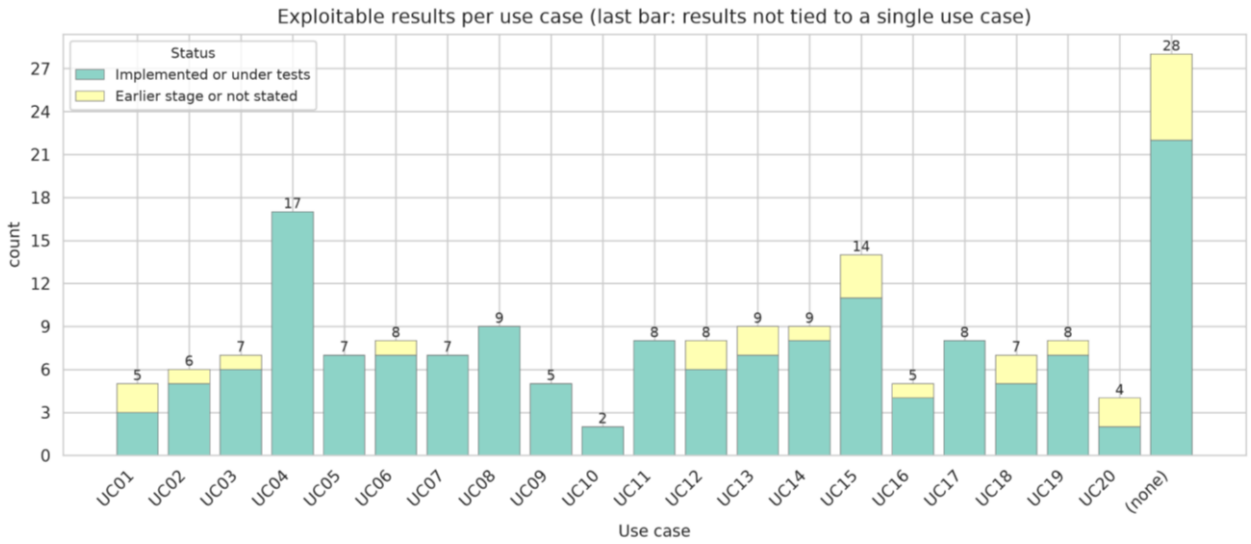

Figure 14. Exploitable results per use case, split by status, with the results not tied to a single use case in the last bar.

The 28 results without a use case are the horizontal outcomes of the project rather than a gap in the register. They are the work-package, project, and partner-level results in Figure 12. for instance:

- the AI methods, ontology-learning, reasoning, and evaluation frameworks released as open code by TU/e (WP2)
- the Eclipse Arrowhead 5.2 release with its planner, copilot, and training material (AITIA, BME, and LTU, WP2 and WP3)
- the Digital Reference ontology (IFAG, WP4) and the production-trace and event-data tooling that SEMAKU already exploits beyond the project (WP4 and WP6)
- the AI regulatory-compliance assistant and the user-acceptance methodology of WP7
- the university courses and industry trainings that carry the project know-how into curricula (AITIA, BME, LTU, and SEMAKU).

Figure 15 counts the results by work package. WP6 contributes to 85 results and WP5 to 59. The technology work packages WP2 (24), WP3 (17), WP4 (9), and WP1 (6), and the human-acceptance, trust, and ethics work of WP7 (2), show that the enabling technologies and the human-centred work are exploited in their own right and not only through the demonstrators.

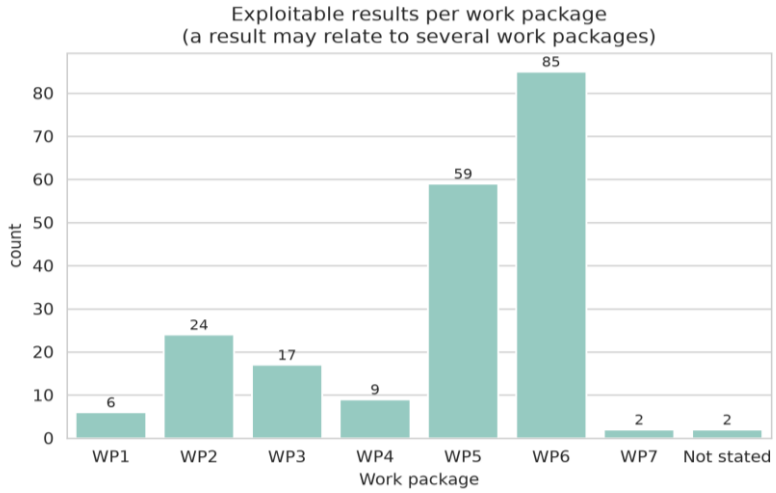

Figure 15. Exploitable results per work package, where a result may relate to several work packages.

3.3.4 Joint and Multi-Partner Exploitation

The reviewers of the second reporting period asked that exploitation cases should not be limited to single partners. The owner and other beneficiaries field of the questionnaire makes this measurable: 85 of the 179 results (47%) involve two or more consortium partners, and together they connect 52 organisations. Only 9 of them carry the label *multi-partner* in the level field, so the level alone understates how much of the exploitation is shared, and the beneficiaries field is used here instead. Most joint results involve 2 partners (55), 19 involve 3, 9 involve 4, and 2 involve 5. The joint results are also where industry and research meet: 62 of the 85 combine a large enterprise or an SME with a university or an RTO, 16 are industry-to-industry collaborations (such as AIDI and CETTO in UC01, KAI and IFAT in UC15, or Husqvarna (HQ) and SEB in UC03), and 7 are collaborations between universities and RTOs. The joint results are as mature as the rest of the portfolio: 37 are implemented and 37 under tests.

Figures 16 and 17 show the collaboration structure. The results are drawn as circles and the organisations as squares coloured by organisation type. Results with an identical set of partners are drawn as one node carrying the count. With 85 joint results and 52 organisations the graph no longer fits on one page. Figure 16 presents the largest connected cluster (54 results and 33 organisations) and Figure 17 the seven smaller clusters (31 results and 19 organisations).

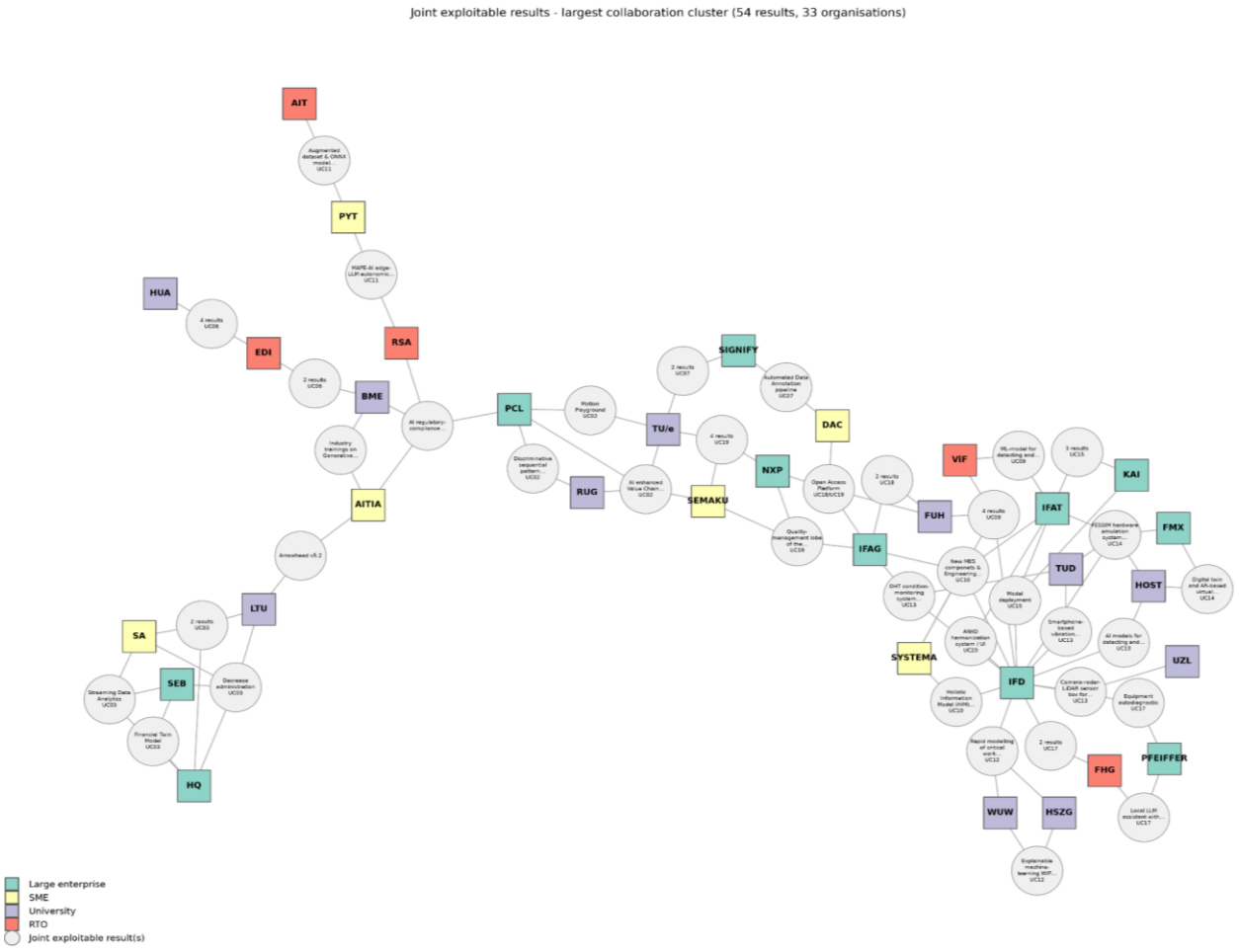

Figure 16. Joint exploitable results (circles) and the organisations involved (squares, coloured by type of organisation) in the largest collaboration cluster.

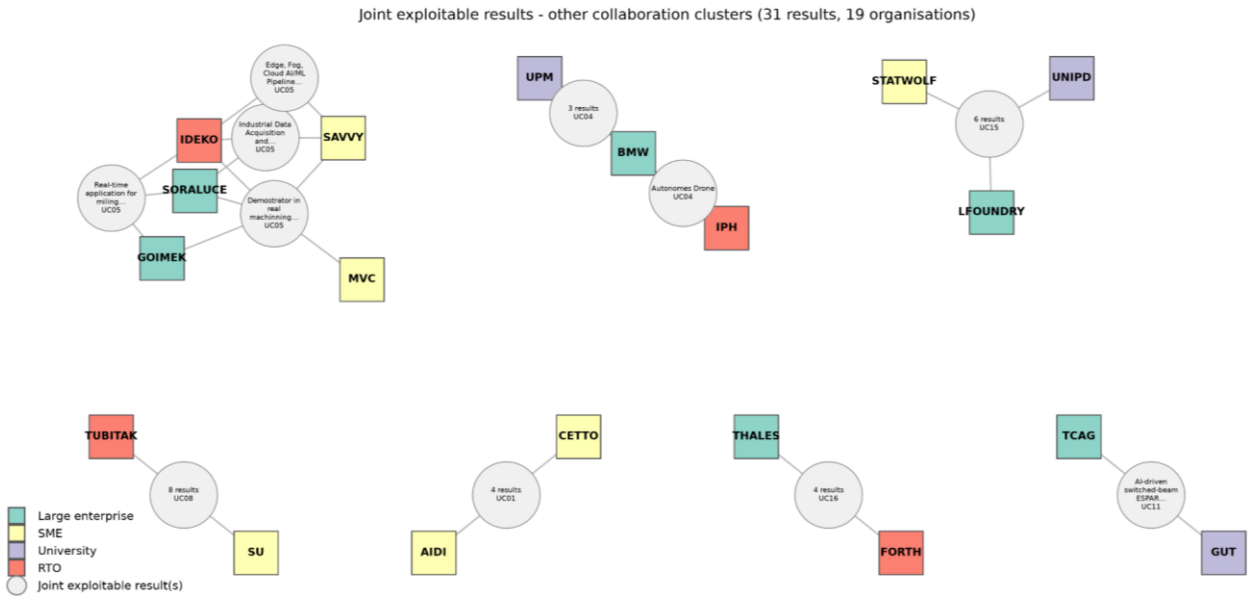

Figure 17. Joint exploitable results and the organisations involved in the remaining collaboration clusters.

The largest cluster is the semiconductor supply chain around the three Infineon sites (IFAG, IFAT, and IFD). IFD, the Dresden site, is the most connected organisation with 17 joint results, spanning the energy-aware scheduling of UC09, the MES components of UC10, the work-centre modelling of UC12, the sensor and condition-monitoring results of UC13, the virtual commissioning of UC14, the model deployment of UC15, and the contamination management of UC17. This industrial core is linked through the Digital Reference ontology and the Open Access Platform (UC18 and UC19) to the WP2 and WP4 results of TU/e and SEMAKU. From there the cluster continues through UC02 and the Arrowhead ecosystem (AITIA, BME, LTU, and RSA) to the robotics results of UC06, the servitisation results of UC03, and the indoor-farming results of UC11. The smaller clusters are use-case-specific: the machine-tool results of UC05, the LFOUNDRY, STATWOLF, and UNIPD results of UC15, the SU and TUBITAK results of UC08, the BMW, UPM, and IPH results of UC04, the AIDI and CETTO results of UC01, the THALES and FORTH results of UC16, and the TCAG and GUT antenna result of UC11.

Table 3 lists the joint results that involve three or more partners, grouped by the partners involved. Together with the 55 two-partner results, they form the pool from which the joint KERs for the final review are selected.

Table 3. Joint exploitable results involving three or more partners, grouped by the partners involved.

Partners involved	Exploitable result	Origin	Status
FMX, HOST, IFAT, IFD, TUD	FESSIM hardware emulation system for virtual commissioning	UC14	Implemented
GOIMEK, IDEKO, MVC, SAVVY, SORALUCE	AI-based tool-condition monitoring demonstrated on Soraluce milling machines in production at Goimek	UC05	Implemented
ViF, FUH, IFD, SYSTEMA	Fab energy-consumption forecasting model, smart-meter energy and media accounting per tool and product, data collection for epitaxy tools, energy-aware scheduling rules for batch machines	UC09	2 implemented, 2 under tests
SYSTEMA, IFAG, IFAT, IFD	Real-time manufacturing execution system on the RAMII architecture, with engineering process	UC10	Under tests

AITIA, BME, RSA, PCL	AI regulatory-compliance assistant	WP7	Under tests
DAC, IFAG, FUH, NXP	Open Access Platform	UC18, UC19	Implemented
PCL, RUG, TU/e, SEMAKU	Architecture for an AI-enhanced consumer-goods value chain enabling mass customisation, proven in a real value chain	UC02	Implemented
HQ, LTU, SA, SEB	Zero-administration servitisation platform automating operators' administrative tasks	UC03	Implemented
LFOUNDRY, STATWOLF, UNIPD	Interpretable anomaly detection, AI-based classification of aluminium corrosion patterns, post-maintenance virtual metrology and chamber-health monitoring, methodology for post-maintenance virtual metrology, production-grade industrial AI and MLOps platform, reusable deployment toolkit	UC15	2 implemented, 2 under tests, 2 in progress
NXP, TU/e, SEMAKU	Natural-language access to industrial knowledge graphs (SPARQL-CAR), final-test reject prediction from traceability data, stochastic supply-chain master planning, end-to-end supply-chain simulation model	UC19	1 implemented, 2 under tests, 1 in progress
NXP, IFAG, SEMAKU	Quality-management lobe of the Digital Reference ontology	UC19	Implemented
SA, HQ, LTU	Lawn-quality assessment and blade-sharpness prediction from mower sensor and sound data	UC03	Implemented
SA, HQ, SEB	Edge AI analytics platform for robot fleets (Stream Analyze Engine)	UC03	Implemented
IDEKO, GOIMEK, SORALUCE	Real-time tool-breakage detection for milling machines	UC05	Implemented
SAVVY, SORALUCE, IDEKO	Industrial data acquisition and connectivity libraries	UC05	Implemented
KAI, IFAT, IFD	Deep-learning SEM defect classification pipeline running in production	UC15	Implemented
IFD, TUD, IFAG	Overhead-transport condition-monitoring system with sensor fusion	UC13	Under tests
WUW, HSZG, IFD	Rapid modelling of critical work centres	UC12	Under tests

3.3.5 Exploitation Readiness and Post-Project Plans

The exploitation of most results continues after the project ends, which is expected. The project closes in September 2026 and several results are deliberately timed to reach the market afterwards. The register makes it possible to describe this pipeline.

Results exploited beyond the project

Eight results, listed in Table 4, are reported by their owners at the beyond-project level. They are applied outside the use case or the consortium that produced them, and they are the clearest evidence of technology transfer. In Y2 two results were reported at this level, the SEB Financial Twin Model and a Pfeiffer particle analyser - both are still there. Seven results have joined them: a second Pfeiffer instrument, the gas analyser, the SU camera-based detection and tracking software for autonomous mobile robots (AMRs), and four SEMAKU results that grew out of WP4 - three code repositories for production-trace and event-data analysis, released to the research community and used in the company's customer projects, and a university course. The classification as beyond-project is open for interpretation, however, the presented results are targeted for use outside of the project as well therefore can be classified as such.

Table 4. Exploitable results already exploited beyond the project.

Partner	Exploitable result	Type	Origin	Status
PFEIFFER	Gas analyser for ammonia and acid contaminants with edge-based anomaly detection	Product/process innovation	UC17	Under tests
PFEIFFER	10 nm airborne-particle counter with edge-based anomaly detection	Product/process innovation	UC17	Under tests
SEB	Financial twin model for pricing and costing servitised products	New IP	UC03	In progress
SU	RGB/ToF camera-based object detection and tracking software for AMRs	New product	UC08	Under tests
SEMAKU	Library for detecting recurring patterns in production event traces	Code/repository	WP4, WP6	Implemented
SEMAKU	Tooling for aggregating production event data across systems	Code/repository	WP4, WP6	Implemented
SEMAKU	Tooling for aggregating and comparing production traces	Code/repository	WP4, WP6	Implemented
SEMAKU	Information Systems in Manufacturing - Industry 4.0 and the Semantic Web (university course)	Teaching materials	WP4	Implemented

Timetable, target markets, and intellectual property rights

The three fields that describe the exploitation plan are summarised in Figure 18, where the partners' statements have been grouped by keyword. The grouping is approximate and serves only to give an overview. A timetable for commercial or scientific use is stated for 82 results. 23 are already in use or available, and 37 name 2026, *i.e.* within the project or immediately after it, typically the productive roll-out of a validated demonstrator. 14 extend explicitly beyond the project, to 2027 or later, or describe a continuation after the final review, and for 8 the statement describes ongoing work without a date. The results with the longest horizons are the new products in the semiconductor and machinery domains, which is consistent with their qualification cycles.

A target market is stated for 126 results. Most partners describe it as a sector or customer segment rather than a geography (64 results, typically semiconductor and microelectronics manufacturers, machine-tool builders, or operators of AMR fleets). 29 name European or national markets, 20 name global or intercontinental markets, 9 name the research or academic community, which is how the open-code and teaching results are exploited, and 4 describe company-internal deployment across the partner's own sites.

The intellectual property rights exploitation field is filled in for 66 results. Commercial licensing or sale is the most frequent arrangement (31), followed by open-source or open-access release (13), proprietary or internal use (9), and 8 results for which the partner states explicitly that no IPR protection is planned. 4 results are covered by patents or patent applications, and for 1 the arrangement is still to be determined. This field remains the least complete of the register,

although sometimes the licensing/IPR aspects require full operational solution in order to determine the most suitable option.

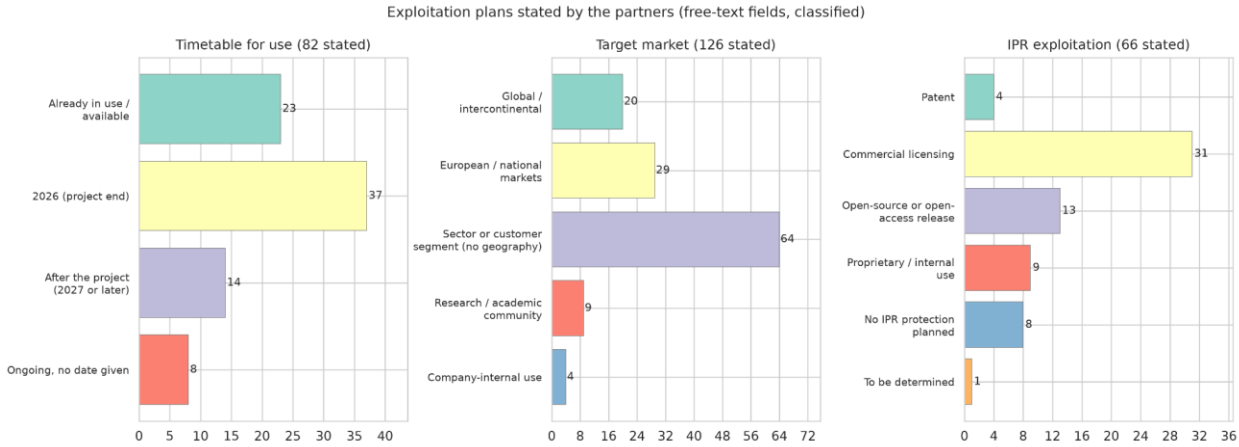

Figure 18. Timetable for use, target market, and IPR exploitation stated by the partners, grouped.

3.3.6 The Exploitable Results Explorer

One of the Y3 actions announced in Y2 was the advancement of the analytical codebase used to process the partners' inputs, in particular to improve data visualisation. For the exploitable results this was implemented as an interactive explorer, a small web application developed by WP8 that reads the register and offers three views. The *Explore* view, shown in Figure 19, presents the results and the organisations as a graph, in which a result is connected to every partner that owns or benefits from it, and optionally also to the use cases and work packages it belongs to. Nodes can be coloured by type, level, status, or organisation type, and the filters narrow the graph to any combination of organisation type, result type, level, status, work package, and organisation, or to the joint results only. The *Coverage gaps* view, shown in Figure 20, answers the portfolio questions asked in this section - which use cases and which partners have no result, and how the results are distributed across them - independently of the filters. The *Maintain* view is a tabular visualization in which the register can be listed. The derived values (joint-result indicator, completeness, use-case coverage) are recomputed automatically from the questionnaire and consolidate sources (like listed by the partners, WP leads, found in other deliverables), so that the figures of this section and the register are always produced from the same data.

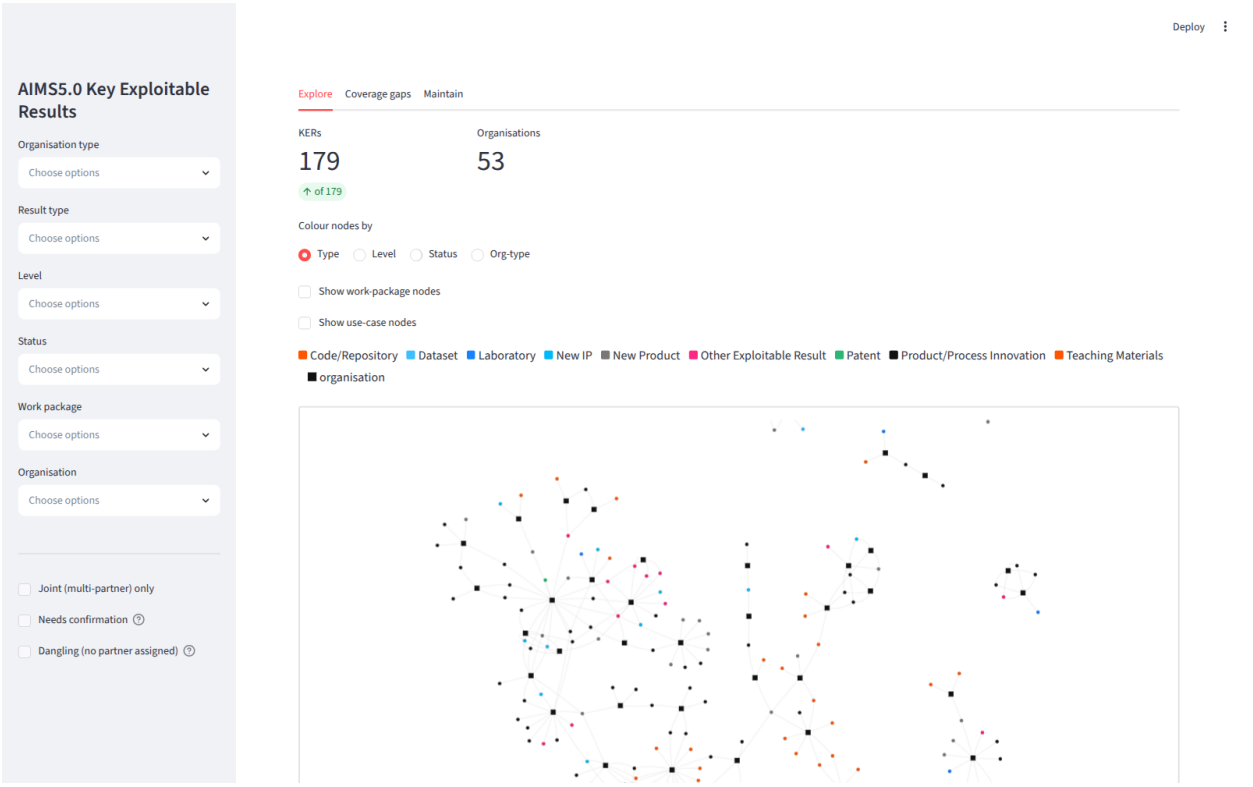

Figure 19. The Explore view of the exploitable-results explorer, with results (small nodes, coloured by type), organisations (black squares), and the filters.

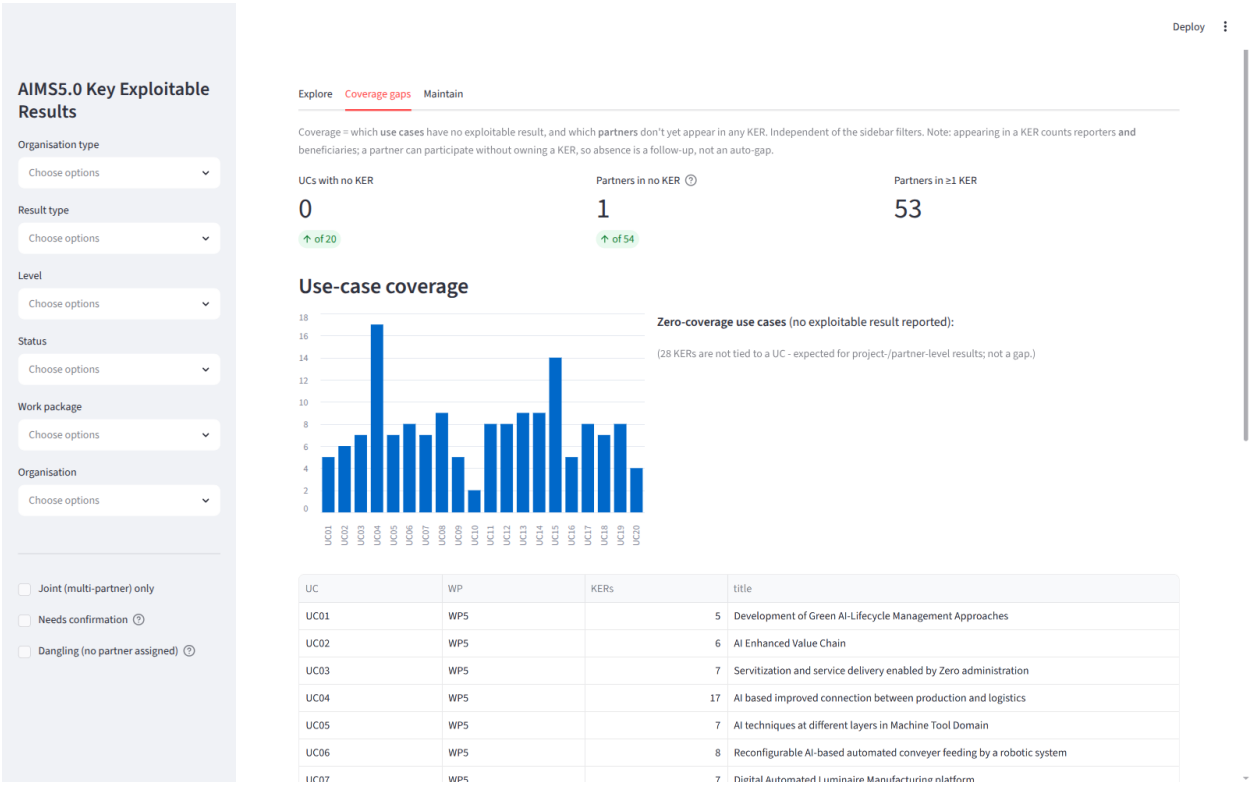

Figure 20. The coverage gaps view of the explorer, showing the use-case and partner coverage of the register.

The explorer proved useful in two ways. During the compilation of the register it made duplicates and unmatched entries visible: a result reported by two partners appears as a node connected to both, and a result whose partner name could not be matched to the consortium list appears unconnected. It also let WP8 check each partner's portfolio in a single view before returning it for confirmation. For the reporting it provides what a static table does not offer. The graph in Figures 16a and 16b is a print rendering of the same structure, but in the explorer a reviewer can start from any organisation, follow its results to the partners it shares them with, and read the full entry of each result in a tooltip. The explorer and the software that generates the figures of this section are kept with the register, so that the portfolio can continue to be maintained after the project.

It is intended to be used only as an internal project tool, but with the number of reported exploitable results, it proved to be an invaluable tool for preparing this report, and evaluating completeness of the data.

3.3.7 Selection of the Key Exploitable Results

The results reported in this section are the full portfolio. Nevertheless, it is difficult to navigate over all 179 exploitable results, therefore we propose to name a few Key Exploitable Results. The selection of them applies the following rules:

1. First, the selection is by impact, not by partner type - the most impactful outcomes are presented, explicitly including those of universities and RTOs, and not only the high-TRL industrial cases.
2. Second, exploitation cases need not be tied to a single partner, joint, multi-partner cases are encouraged, which is why Section 3.3.4 treats them explicitly and why Table 3 is organised by partnership rather than by owner.
3. Third, presentation time at the review is spent on the KERs in depth, with the remaining results covered as highlights.

Applied to the register, these points translate into the following selection procedure. The search space is first reduced by the three exclusion rules: 25 results are not yet demonstrated and 8 further results report TRL 4. Results that belong together are then grouped into families, so that a pipeline reported as deployment, update, and monitoring, or a product line reported as storage system, mobile robot, and robot cell, is assessed once. 31 such families cover 80 of the remaining 146 results. Each result or family is then scored against the three criteria the Commission recommends:

- Degree of innovation which asks whether the result is quantified against a baseline or is first of its kind.
- Exploitability which asks whether an exploitation vehicle exists today - production use, a launched product, a live licence, a signed contract, a foundation release - or is only intended.
- Impact which asks whether an operational-scale outcome is attributable to the result, or whether other partners and use cases demonstrably build on it.

A stated exploitation strategy counts only when it names a route, an actor, and a next step. A target market that names a sector rather than a geography is accepted. Results scoring high on all three criteria form the KER list, results strong on two of them form a reserve, and the rest remain exploitable results. Balance between partner types is checked afterwards, not scored.

The procedure yields 39 KERs: 8 horizontal and 31 use-case KERs, listed in Tables 5 and 6. 27 of them are joint results. Their owners are 16 large enterprises, 10 SMEs, 8 RTOs, and 5 universities, with further universities and RTOs as co-owners, and every use case is represented by at least one KER.

Table 5. Horizontal Key Exploitable Results.

Key Exploitable Result	Owner, co-owners	Origin	Status	Evidence
Digital Reference ontology and its lobes	IFAG, NXP, SEMAKU	WP4, UC18, UC19	Implemented	Released under the Apache-2.0 licence with a public website, 17 of the 20 use-case ontologies integrated in 15 lobes, the semantic backbone of WP4
Eclipse Arrowhead 5.2 with its Go implementation, Copilot, and course	AITIA, LTU, BME	WP2, WP3	Implemented, TRL 7	EPL-2.0 release under Eclipse Foundation governance, used in UC02, UC03, UC05, UC08, and UC11 and by the Open Access Platform
Open Access Platform	DAC, IFAG, FUH, NXP	WP4, UC18, UC19	Implemented, TRL 6	Marketplace for semiconductor data, tools, and ontologies with Arrowhead access control, 17 use-case ontologies hosted
RAMII-based MES components and engineering process	SYSTEMA, IFAG, IFAT, IFD	UC10	Under tests, TRL 7	Production backbone synthesised across UC09, UC12, UC15, and UC17, about 350 equipment set-ups coupled at IFAT, product roadmap to 2027
AI Toolbox for industrial AI integration	BME	WP2	Implemented, TRL 5	Public wiki, its integration paradigm is referenced by six other results of the register
AI-Gym framework for developing and validating AI models on live IIoT streams	RSA	WP2, UC11	Under tests, TRL 5	Released as open source in the Eclipse Arrowhead organisation, 23% energy reduction in the UC11 greenhouse control
AI regulatory-compliance assistant	AITIA, BME, RSA, PCL	WP7	Under tests, TRL 6	Checks industrial AI use cases against the AI Act and the GDPR, paid per-assessment service planned
QETAM user-acceptance methodology	HUA	WP7	Implemented, TRL 6	Applied in the project-wide user-acceptance study, published open access for adoption by future projects

Table 6. Use-case Key Exploitable Results, by use case of origin.

Key Exploitable Result	Owner, co-owners	Origin	Status	Evidence
Energy and CO2 management pipeline for injection moulding	AIDI, CETTO	UC01	Implemented, TRL 6	Machine energy measurement system in production at Cetto, internal roll-out at Cetto
AI-enhanced value-chain architecture with production quality dashboard and BPMN execution engine	PCL, RUG, TU/e, SEMAKU	UC02	Implemented, TRL 7	Production quality dashboard at TRL 8 in OneBlade manufacturing, Arrowhead-compatible BPMN execution engine at TRL 7
Zero-administration servitisation	HQ, LTU, SA, SEB	UC03	Implemented, TRL 7	In operation in Husqvarna's commercial Smart Lawn Service, administrative effort reduced by more than 80%, more than 100 customer contracts and 250

				connected mowers
Edge AI analytics platform	SA, HQ, LTU, SEB	UC03	Implemented, TRL 7	Commercial product running from one code base on x86, ARM, and RISC-V, model development time reduced by about 92%
Drone-based factory digitisation with AMR map generation	BMW, IPH	UC04	Under tests, TRL 6	Rescans about 70% faster with 99% area coverage, roll-out in BMW plants under way
Real-time tool-condition monitoring for milling machines	IDEKO, GOIMEK, SORALUCE, SAVVY, MVC	UC05	Implemented, TRL 5	Running on two Soraluce machines in production at Goimek, 70% breakage and 90% anomaly detection at 1.5 s latency
Motif discovery and signal segmentation toolkit	MVC	UC05	Implemented, TRL 5	Live, licensed web application, segmentation effort reduced from 70 to 32 hours
Robotic bottle-feeding cell	EDI, HUA, BME	UC06	Under tests, TRL 5	End-to-end success of 76 to 96%, offered as work cell and technology-transfer package
3D metal printing at consumer-part cost	SIGNIFY	UC07	Under tests, TRL 6	Die-cast parts replaced, machines being designed for launch, customer samples in the market
Intelligent scheduling of the 3D printer hub	SIGNIFY, TU/e	UC07	Implemented, TRL 8	In daily operation in Turnhout, second generation handed over to Signify
Camera- and LiDAR-based perception suite for AMRs	SU, TUBITAK	UC08	Under tests	Contract with a delivery-truck manufacturer, deployed in a 5G teleoperated cargo vehicle
Task and traffic management for heterogeneous autonomous vehicles	TUBITAK, SU	UC08	Implemented, TRL 7	Task time reduced by 25% and traffic conflicts by 40%, deployed in the MEXT smart factory
EEG-controlled exoskeleton	SU, TUBITAK	UC08	Under tests, TRL 6	81% intent accuracy, licensing to exoskeleton makers as an add-on control kit
Energy-aware fab scheduling and energy accounting	ViF, FUH, IFD, SYSTEMA	UC09	Under tests	Field test with productive lots at IFD: 750 kWh peak reduction, electricity cost reduced by 11%, EUR 2.8 million savings potential identified
Chiller-network anomaly detection and prediction	ViF, IFAT	UC09	Under tests, TRL 6	98.6% accuracy validated by facility experts, business plan and spin-off assessment under way
ThreatGet CRA-compliance threat modelling	AIT	UC11	Implemented, TRL 8	Cyber Resilience Act coverage raised from 20% to 58%, commercial and research licences
Nerve real-time execution environment	TCAG	UC11	Under tests, TRL 7	Latency reduced by 35% and jitter by 75% on 35,000 measurements, productisation into the NERVE portfolio
AI-steered ESPAR antenna with wireless testbed and course	GUT, TCAG	UC11	Under tests, TRL 5	8 dB gain over an omnidirectional baseline, testbed and a course with 50 students

Wafer-test scheduling and capacity-check model	IFAT	UC12	Implemented, TRL 7	In productive use for several months, OEE increased by 1%
LogiFabSim fab and AMHS simulation	TUD	UC12	Implemented, TRL 5	About ten times faster than benchmark simulators, public release
Condition monitoring of overhead transport with sensor fusion	IFD, TUD, IFAG, HOST	UC13	Under tests, TRL 6	Failure prediction above 75%, downtime reduced by 20%
FESSIM virtual commissioning of material-handling automation	FMX, HOST, IFAT, IFD, TUD	UC14	Implemented, TRL 7	LUNA cell handed over eight weeks earlier than planned, customer tool downtime reduced by 50%
HERO-SCOUT mobile robot and FlatStocker 3.0 storage system	FMX	UC14	Implemented, TRL 7	Evaluated under productive conditions at Infineon Dresden, product sales with market-share targets
Deep-learning SEM defect classification pipeline	KAI, IFAT, IFD	UC15	Implemented, TRL 8	In production for the first four high-volume 12-inch technologies, 88.1% accuracy against a target of 80%
Interpretable anomaly detection and industrial MLOps platform	LFOUNDRY, STATWOLF, UNIPD	UC15	Implemented, TRL 6	Root-cause analysis time reduced by 43% and monitoring time by 55%, all UC15 KPIs achieved
CeRULEo remaining-useful-life framework	UNIPD	UC15	Implemented, TRL 5	MIT-licensed open source with external users, component lifetime increased by 32%
AI-based electromagnetic design methodology for RF MEMS	FORTH, THALES	UC16	Implemented	Re-design time reduced by 50%, fabrication time by 25%, gold waste by 45%, all targets exceeded
ML-driven contamination monitoring and control	IFD, FHG, PFEIFFER	UC17	Implemented, TRL 6	About 80% of contamination monitoring ML-supported, continues in the 300 mm module extension from July 2026
AMC analyser and particle counter with edge anomaly detection	PFEIFFER, IFD	UC17	Under tests, TRL 8	Commercially available options on the existing instruments
ANKO harmonised test-wafer control	IFAT, IFD	UC20	Implemented, TRL 7	76% harmonisation across Villach and Dresden, test-wafer cost reduced by 14%, about EUR 700,000 saved
Xplorer RFID, NFC, and BLE inline label testers	CISC	WP3	Under tests, TRL 7	Software licensing with market-share targets

3.4 Standardization

Standardization represents one of the most distinctive and long-horizon impact pathways for a project like AIMS5.0. The technologies addressed by the project AI in manufacturing, digital twins, dependability and safety of AI systems, IoT, robotics are all areas in which international (ISO, IEC, ETSI) and industrial association (OMG, IEEE, ASAM etc.) standards are actively evolving, and where the results of cutting-edge research projects can directly inform the normative frameworks that will govern the adoption of these technologies at scale. The AIMS5.0 consortium has engaged with this opportunity throughout the project, and this chapter presents the final picture of that engagement, together with a forward-looking account of how key partners intend to continue contributing to standardization after the project ends.

3.4.1 Updated Standardization Landscape

This section provides the final update to the standardization landscape across key domains: smart manufacturing, AI, IoT, digital twins, dependability, robotics, cybersecurity, automotive, reflecting regulatory and standards developments (including EU AI Act standardization mandates) up to the project end date.

An extensive overview, status 2025, was already provided in D8.2 [2], chapter 4. In this section only some relevant updates will be provided.

3.4.1.1 IoT and Digital Twin Eco-System

IoT international standardization is on the one hand covered mainly by ISO/IEC JTC1 SC41 and includes Digital twin standards too. AIOTI, the Alliance for Internet of Things Innovation, does standardization work (WG 03) with ETSI, which are published as ETSI TS (Technical Specifications) and develops also various reports (e.g., AIT was contributor to several of these documents). Digital Twin standards are also developed by ISO TC184. Additionally, there are several activities in other groups and different domains (see *Figure 21: Digital Twin Eco-System (Source: ISO/IEC JTC1 SC41 WG and AIOTI WG03 Standardization)*):

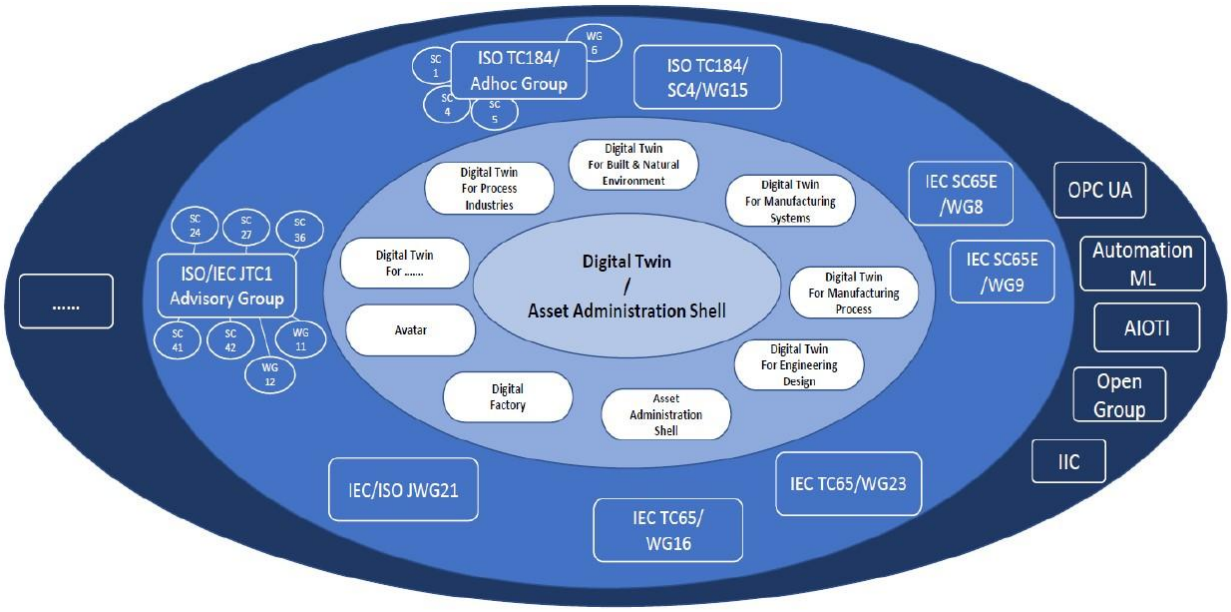

Figure 21: Digital Twin Eco-System (Source: ISO/IEC JTC1 SC41 WG and AIOTI WG03 Standardization)

The architectural aspects of the digital twin framework for manufacturing are covered by ISO TC 184 SC4 (source ISO 23247).

“Industrial IoT (IIoT)” is standardized by the IIC (Industrial Internet consortium), and there is a connecting technical report ISO/IEC TR 30166:2020 “IoT – Industrial IoT” of ISO/IEC SC41 on the relationship between SC41 IoT standards and IIoT.

A new initiative is on “Physical AI”, the implementation and use of AI in IoT systems, started in an As-hoc Group 36 this year. There is a call for members around and partner AIT has applied to join and will try, as lead of the standardization task 8.3, to motivate other partners as well.

The initiative is described (shortened citations from the official “Strategic Business Plan”):

> *“IoT is a system concept that uses many technologies that are standardized by other JTC 1 entities and SDOs. These technologies include sensors, actuators, networking and communications, database and big data, distributed and cloud computing, analytics, digital twins and AI technologies.”*
>
> *Digital Twins (DTw) are also an enabler of “”Smart Everything, being based on measurements that creates an evolving profile of the entity or system in the digital world, it provides important insights on system performance, leading to actions in the real world such as a change in system and process design, or optimizing business performance.*
>
> *IoT systems as well as digital twins are data intensive. A significant part of the data consumed by digital twins come from sensors. Thus, they need to develop/use data space standards.*
>
> *Physical AI refers to intelligent systems that directly interact with the physical world by perceiving their environment, making decisions, and taking actions autonomously. Unlike conventional AI systems that primarily operate in digital environments, Physical AI bridges the gap between the digital and physical domains, enabling machines to sense, understand, predict, and act in real-world situations.”*

This initiative is now located in an Ad-hoc Group (AhG 36) to study the situation for fundamental standards, which will need consideration and collaboration with many other standardization groups covering the particular properties and requirements of systems listed below. AhG 36 should

- Explore and analyse use-cases of IoT and Digital Twin enabling Physical AI;
- Prepare a draft Technical Report (TR) on Use Cases of IoT and Digital Twin enabling Physical AI;
- Conduct thorough research on JTC 1/SC 7, JTC 1/SC 42, ISO/TC 299, IEC/TC 65 (including its SCs), ISO/TC 184(including its SCs) and ITU-T SG21;
- Identify further liaison needs; and,
- Maintain close collaboration with the Physical AI TTR being developed by JTC 1/AG 2 JETI

“Physical AI” is not just a technology; it facilitates the interaction of many contributing technologies in a “systems-of-systems” manner:

- AI as a „Brain“ for cognition, learning and computing (AGI, World Models)
- (Real-time) IoT as a „Nervous system“ for signal transmission, coordination and feedback
- Sensors for perception

- Actuators for control
- Robotics for embodiment and action
- Semiconductors for computing
- Digital Twin for simulation, prediction, risk evaluation, and decision support
- Edge-Cloud Orchestration for AI
- Cybersecurity for AI safety

The citation shows how far these topics are of interest for AIMS5.0 and follow-up projects. As demonstrated by the use cases, many of these challenges have been covered to a certain extent by AIMS5.0 project work, and results will be useful for contributions to this initiative.

3.4.1.2 AI Standards and the EU AI-Act Standardization Request

The number of AI standards is still increasing. Annex B lists all currently published or evolving standards of ISO/IEC JTC1 SC42 (AI), marked red if published 2026 or if the status (from AWI to CD, DTS, DTR, DIS or FDIS) has changed 2026. Now there are 44 AI-Standards (including 5 Big Data Standards) published and 48 under development. Annex B also includes another set of standards considering AI impact and requirements in context of domain standards. Further details have been already discussed in D8.2 [2], there have only to standards published in the meantime and on started development. A note at the end of the SC42 table indicates some upcoming new work items which are at the moment not included in the official listings.

The **European Commission's AI Act** served as a foundational guide, outlining ten critical requirements for **high-risk AI systems**. These include:

1. Risk management system for AI systems [Art. 9 AI-Act]
2. Governance and quality of datasets used to build AI systems [Art. 10 Data and data governance]
3. Record keeping - built-in logging capabilities in AI systems [Art. 11 Techn. doc., Art. 12 record-keeping]
4. Transparency and information to the users of AI systems [Art. 13 Transparency and user info]
5. Human oversight of AI systems [Art. 14 Human oversight]
6. Accuracy specifications for AI systems [Art. 15 Accuracy, robustness and cybersecurity]
7. Robustness specifications for AI systems [Art. 15 Accuracy, robustness and cybersecurity]
8. Cybersecurity specifications for AI systems [Art. 15 Accuracy, robustness and cybersecurity]
9. Quality management system for providers of AI system [Art. 17 QM for providers]
10. Conformity assessment for AI systems [Art. 19 + Art. 43 Conformity Assessment]

These requirements highlight the need for harmonized standards to support compliance and ensure the safe and responsible deployment of AI technologies across Europe.

CEN/CENELEC received the mandate as ESO (European Standardization Organization) to develop the "harmonized standards" which allow the involved parties (suppliers, applications) to derive a "presumption of conformity" by providing evidence to have followed the standards' requirements. The basic EN-Standards (some applying existing ISO/IEC SC42 standards or adapting them, a few must be developed anew) are listed below (latest summary):

- prEN 18229: AI trustworthiness framework – Logging, transparency and human oversight, accuracy, robustness.
  NEW: This standard was after some discussions now split up into 5 parts to address each of the 5 trustworthiness properties individually.

  - prEN 18229-1: AI trustworthiness framework – Part 1: AI trustworthiness framework – Part 1: Logging
  - prEN 18229-2: AI trustworthiness framework – Part 2: Transparency
  - prEN 18229-3: Human oversight
  - prEN 18229-4: Accuracy
  - prEN 18229-5: Robustness
- prEN 18228: AI Risk Management
- prEN 18281: Artificial Intelligence – Evaluation methods for accurate computer vision systems
- prEN 18282: Artificial Intelligence – Cybersecurity specifications for AI systems
- prEN 18283: Artificial Intelligence – Concepts, measures and requirements for managing bias in AI systems
- prEN 18284: Artificial Intelligence – Quality and governance of datasets in AI
- prEN 18285: AI Conformity assessment framework
- prEN 18286: Artificial Intelligence – Quality management system for EU AI Act regulatory purposes

The project closely monitored the development of such norms and integrates their approach throughout the relevant activities.

3.4.1.3 Automotive Standards and AI, Regulations

Automated Driving Systems and intelligent sensors and controls are the main technical drivers for AI-Applications in the automotive sector. Standards are very important because of severe safety impact. There is sever progress: PAS 8800 (AI safety) published, to become standard in future, and new standards under development; SotiF update; ISO 26262: several TRs published, now integration by Part-Groups into next version of ISO 26262.

Figure 22 depicts the interrelationships between functional safety, cybersecurity, automated driving systems and AI functional safety standardization (latest update):

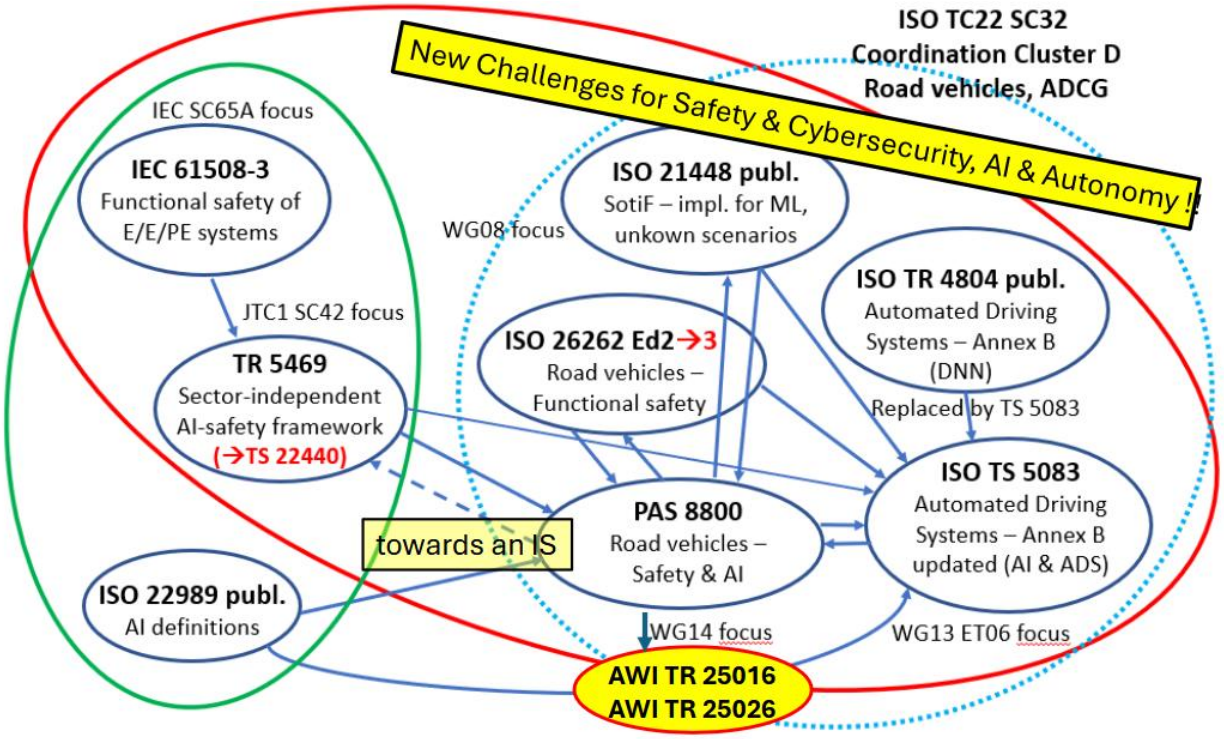

Figure 22: Automotive Standardization Clusters and AI (Updated 2026)

Overview of AI-related standards in ISO TC22 SC32: Road vehicles - Electrical and electronic components and general system aspects

- **WG 13: Safety for driving automation systems**
  - ISO/TS 5083:2025 Road vehicles — Safety for automated driving systems — Design, verification and validation → New Version ISO/WD TS 5083 [Under development]
- **WG 14: Safety and Artificial Intelligence (Liaison: WG13, ISO/IEC SC42 AI)**
  - **ISO/PAS 8800:2024** Road vehicles — Safety and artificial intelligence (publ.)
  - ISO/AWI TR 25016 [Under development] Application of ISO PAS 8800 to automotive use cases
  - ISO/AWI TR 25026 [Under development] Methods and metrics for evaluating road vehicle AI safety

Figure 23 depicts the relationship between regulations and standards (and partner involvement).

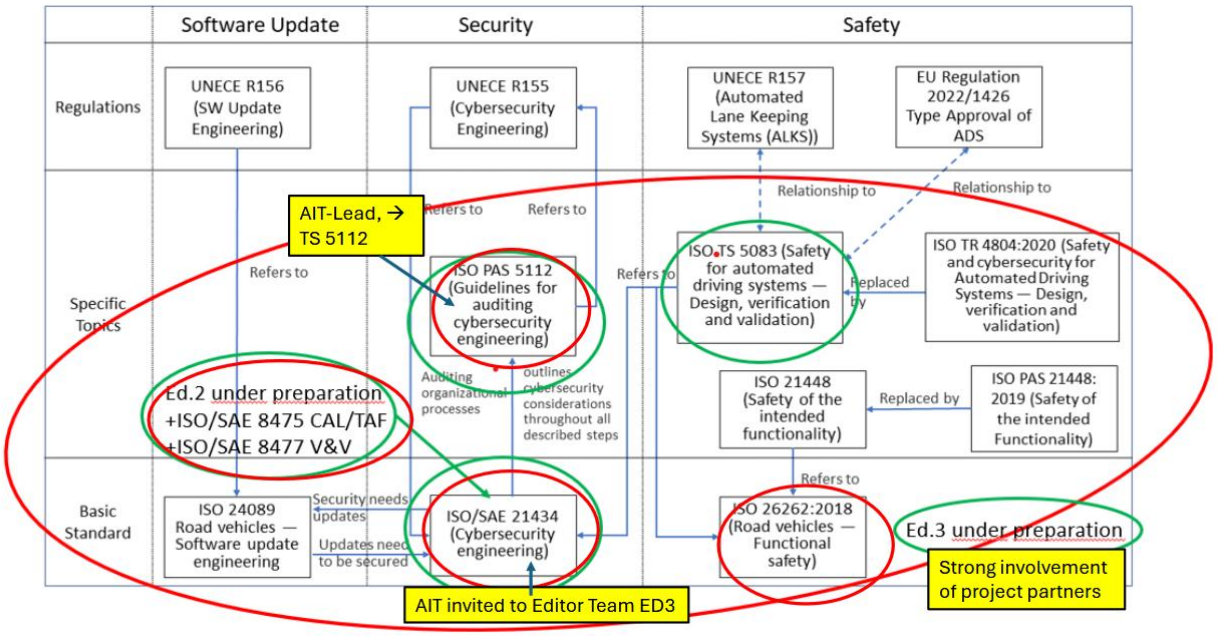

Figure 23: Automotive regulations and standards & Partner involvement

3.4.1.4 AI Ethics and Guidelines

Since AI applications with autonomous decision making will influence decisions targeting our daily life and human sovereignty, Ethical concerns, human controllability and understanding are becoming important issues for a free, democratic society.

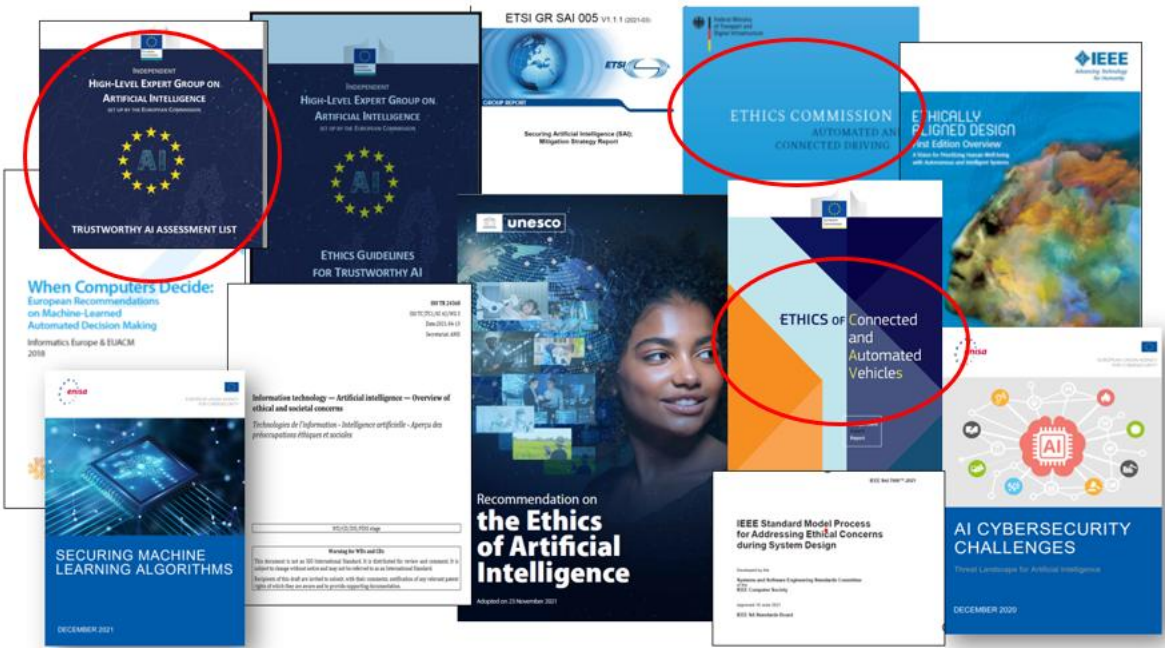

Figure 24: Guidelines, Recommendations and Standards for societal aspects of AI and Cybersecurity

The guidelines relevant for the collaboration between Task 8.3 and WP 3 respective WP7 are marked. In WP7, digital workspaces, the ALTAI (Assessment List for Trustworthy AI) was applied in WP7 and described in D7.3 [5], which was developed jointly by WP3, WP7 and WP8. For the automated driving sector, the reports of the German and the EC Ethics commission for "Connected and Automated Driving" are also marked. For further details on relevant standards see D7.3 [5].

3.4.2 The CRA Standardization Landscape (Cyber-Security Resilience Act)

3.4.2.1 Framework

The EN 40000 series is developed by CEN/CLC/JTC 13/WG 9 under standardisation request M/606 (C(2025)618) and forms the horizontal layer applicable to all products with digital elements:

- EN 40000-1-1: Vocabulary
- EN 40000-1-2: Principles, product risk management, lifecycle activities
- EN 40000-1-3: Vulnerability handling
- EN 40000-1-4: Generic security requirements

Parts 1-2 and 1-3 were monitored in detail because they carry the process and lifecycle expectations directly relevant to AIMS5.0 engineering activities. Part 1-1 is terminological and part 1-4 (generic security requirements, scheduled last) was not yet available in a form that would allow technical assessment within the project runtime.

Vertical standards sit on top of the horizontal layer: the ETSI EN 304 6xx series and the CENELEC drafts prEN 50764, prEN 50765, prEN 50766. prEN 50770, addressing operational technology and therefore the part of the vertical landscape closest to the AIMS5.0 industrial and IIoT scope, remains at an open status regarding acceptance as harmonized standard by EU.

3.4.2.2 prEN 40000-1-2: Principles, risk management, lifecycle activities

The draft under review (WI JT013089, dated 2026-07-08) has completed enquiry; the text is prepared for CEN Formal Vote. It is built on four principles. risk-based approach, security by design, secure by default, transparency, elaborated in two clauses:

- Clause 6, product risk management: context establishment → acceptance criteria → risk assessment → risk treatment → communication → review.
- Clause 7, lifecycle activities: planning, requirements, architecture and design, implementation, verification and validation, production and distribution, monitoring, decommissioning, and handling of third-party components.

Two aspects are of practical significance for any use of the document as a compliance instrument:

- Normativity is partial. Per Table B.2, the "Rationale and guidance" material and the whole of Clause 5 are informative. Only the Input, Requirement, Output and Assessment criteria elements are normative.
- The CRA mapping is informative, not an Annex ZA. The mapping is contained in Annex B (Table B.1). The document states explicitly that its generic assessment criteria do not by themselves guarantee CRA compliance, and that manufacturers must apply vertical standards or a justified control selection to claim presumption of conformity.

The Clause 6 risk management sequence is structurally compatible with the model-based threat and risk analysis applied in AIMS5.0 UC11, which follows the same context → assessment → treatment logic; the difference lies in the granularity of the evidence expected at each step rather than in the process itself.

3.4.2.3 prEN 40000-1-3: Vulnerability handling

The draft (WI JT013090, dated 2026-07-24, WG 9 N 858) structures vulnerability handling into six phases: Preparation, Receipt, Verification, Remediation, Release, Post-release, and maps to CRA Annex I Part II (1)–(8) in the informative Annex ZA, Table ZA.1.

Substantively it refines EN ISO/IEC 29147 and EN ISO/IEC 30111 together with ISO/IEC TR 5895, and adds three requirements of direct engineering relevance:

- a mandatory SBOM, including hardware component identification;
- a regular testing and review regime;
- a secure update distribution mechanism.

One editorial item remains open in §5.2.6.3.1 (PRE-5, outsourced development). The SBOM and secure update requirements are the two items with the clearest implications for AIMS5.0-type architectures, where components are integrated from multiple suppliers and updated in the field.

3.4.2.4 Open points at EU level

As of the cut-off, no CRA harmonised standard has been ratified as an EN or cited in the Official Journal. Two consequences follow directly:

- the presumption of conformity under Article 27(1) is not yet available; and
- consequently, under Article 32(2), products falling under Annex III Class I currently cannot use the internal control conformity assessment route.

Delivery of parts 1-2 and 1-3 was targeted for August 2026, the vertical standards for October 2026, and part 1-4 for 30 October 2027. HAS assessment and citation in the Official Journal

follow only after delivery, so effective availability of presumption of conformity will lag these dates.

3.4.3 Partner **Contributions and Roles in SDOs (3 Year Evolution)**

Overview of partner/SDO involvement

This section presents the highlights of partner involvement and contributions to standardization bodies (from "Interested" to "Chairing") across Years 1, 2, and 3, showing the growth driven by the consortium's training and engagement effort.

The evaluation of data shows, that the domain coverage and coverage of international SDOs improved considerably over the potential spectra (the “count” represents the count of different SDOs or domains addressed per partner, not of partners – a partner could identify several (different) domains or SDOs). Roles are focusing on general involvement, the “chairing” of standardization groups is still restricted to one key partner (AIT). The following diagrams shows a broad coverage of the sectors and relevant SDOs.

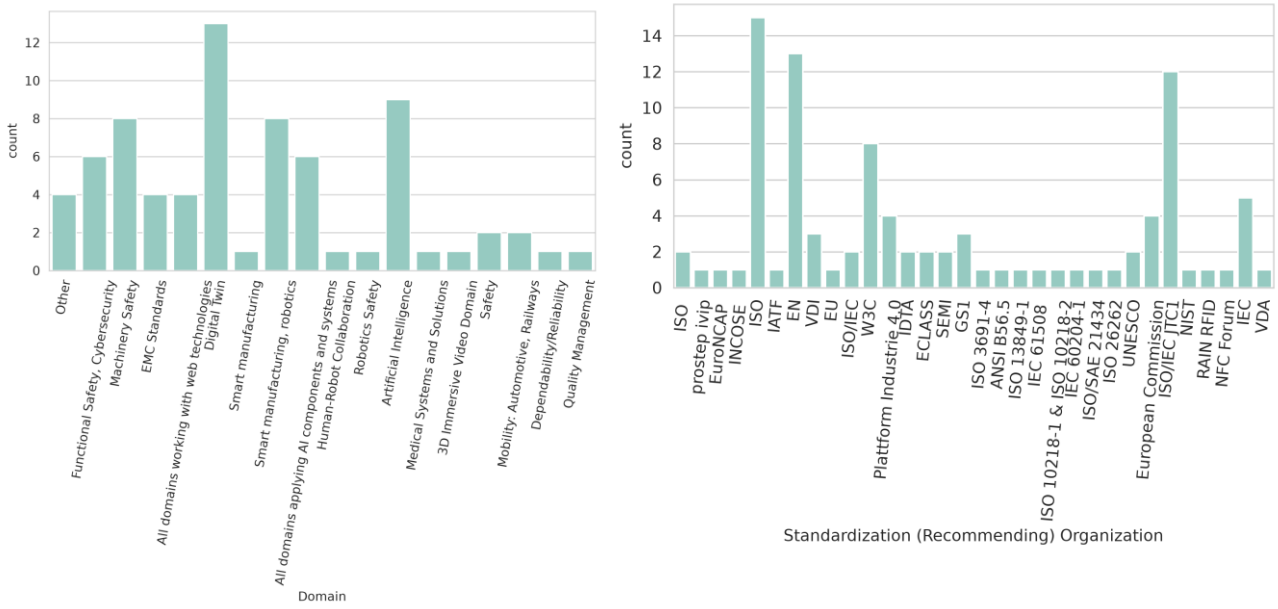

Figure 25: Domains of Standardization involvement and type of SDOs as addressed by partners

3.4.4 Highlights of partners’ involvement and contribution to standards

3.4.4.1 Active contribution: Cybersecurity (CRA Cyber-Security Resilience Act)

Active contribution to ISO/DTS 5112 - Scope and role

ISO/DTS 5112 "Road vehicles — Guidelines for auditing cybersecurity engineering" provides the audit guidance accompanying ISO/SAE 21434. It supports the planning, conduct and reporting of cybersecurity engineering audits and is a key instrument for consistent assessment of cybersecurity processes across the supply chain, including in the context of UN R155 and CSMS-related conformity work. AIT holds the International Project Leadership, with Christoph Schmittner acting as Project Leader.

Progress

Within the project runtime the document was finalised for submission to the DTS ballot. Work concentrated on resolution of comments on the working draft and on editorial and technical consolidation of the text, with particular attention to:

- consistency of terminology and clause references with ISO/SAE 21434;
- alignment of the audit process description with the generic auditing guidance of ISO 19011;
- clarity of the guidance for auditors assessing distributed cybersecurity activities across organisational boundaries.

Comments proposing a more extensive restructuring of the references to ISO 19011 were discussed within the project team and deferred to a future revision so as not to delay the DTS ballot; this was agreed with the commenting expert.

Next steps beyond the project

The consolidated draft is submitted for the DTS ballot, followed by the ballot period and, depending on the outcome, comment resolution and preparation of the publication-ready text. Continued participation in the responsible working group meetings and coordination with the national mirror committee is foreseen beyond the AIMS5.0 runtime.

3.4.4.2 SysMLv2 Library for SOA: Arrowhead in Collaboration with AIMS5.0

At the **OMG technology meeting in Reston**, Asma Smaoui (CEA), Jerker Delsing (LTU), and Géza Kulcsár (PTC) presented ongoing work on the 'SysMLv2 library for SOA' (Service-Oriented Architecture), based on MBSE activities in the Arrowhead fPVN and AIMS5.0 projects. The resulting Arrowhead DSL (Domain Specific Language) is applicable to integration of AI and automation into production and products.

What the presentation focused on

The presentation followed a clear technical path. It introduced the background and resources behind the work, revisited the SysML v1.6 version of the Eclipse Arrowhead DSL, reviewed previous and updated versions of the Arrowhead SysMLv2 library, and explained the translation path from Arrowhead DSL based in SysMLv1 to SysMLv2. It also included concrete use cases, current work related to integration with ISO 23726-3, and forward-looking perspectives.

Building on established Arrowhead foundations

A central message of the session was continuity. The first versions of the Eclipse Arrowhead DSL were developed in the EU project Arrowhead Tools using SysML v1.6. The presentation further explained that the SysML v2 DSL version and the Arrowhead core system library were primarily developed by Oystein Haugen, mainly using the Eclipse Papyrus tool. This shows a consistent evolution from earlier modelling approaches toward a more advanced SysMLv2 environment.

The engineering logic behind this work remains closely connected to the Eclipse Arrowhead engineering process, which is based on ISO 81346 and exploits service-oriented architecture. This connection is important because it links structured engineering practice with interoperable system design, which is highly relevant for modern industrial environments.

From SysML v1.6 to SysMLv2

The presentation described the Eclipse Arrowhead DSL profile as a framework in which the Y axis reflects the Eclipse Arrowhead fundamental architecture part, while the X axis follows the ISO 81346 engineering process. This creates a modelling structure that connects architecture and engineering workflow in one consistent view.

The updated SysMLv2 library reflects Eclipse Arrowhead v5.2 and includes both core systems and support systems. It also follows the Eclipse Arrowhead engineering process across black box architecture, white box architecture, and implementation. In practical terms, this makes the library relevant not only for system representation, but also for the full development path from concept to implementation.

A practical translation workflow

A particularly useful part of the presentation was the explanation of how the transition from SysMLv1 to SysMLv2 is being handled. The mapping from SysMLv1 to SysMLv2 for the Arrowhead DSL is supported through a translation implemented in Papyrus. According to the presentation, this translation is based on Xtend templates, uses the Papyrus UI to launch the translation from a UML file, creates a SysMLv2 project with references to SysML libraries, and generates a .sysml file that can be imported into SysOn or Cameo for improved diagrams.

The workflow itself was presented in a very direct way: create the Arrowhead Library, run the translation, and generate the .sysml from the .uml. Even in this concise form, it represents an important enabling step for broader adoption of SysMLv2 in complex industrial and system-of-systems settings.

Use cases and wider impact

To demonstrate practical relevance, the presentation included a smart city lighting system use case with three generations of smart light technology. The example features detection of presence, direction, and speed, while enabling lighting for an estimated movement trajectory. This helps translate the modelling work into a concrete application context.

A second use case focused on DEXPI in the process industry. This was linked to a broader inter-standard discussion involving SysML v2, ISO, IDO, STEP, the Arrowhead Framework Ontology, the Industrial Data Ontology, OWL, traceability, consistency and correctness, lifecycle management, inference V&V, and use-case knowledge graphs. Together, these elements show that the work goes beyond one library and contributes to broader questions of semantic interoperability and digital engineering.

The presentation also pointed toward lifecycle management and digital threads, describing a direction toward a SOA digital engineering platform built around the Eclipse Arrowhead SysML v2 library, system-of-systems models, and domain libraries. It further highlighted LLM-assisted ontology engineering, noting that LLMs can support tasks such as abstraction level identification, meta-level flattening from MOF to TBox or ABox, cross-ontology alignment and mapping, fixing inconsistencies, and TBox or ABox gap reasoning.

Conclusion

Presented by Asma Smaoui (CEA), Jerker Delsing (LTU), and Géza Kulcsár (PTC), the session highlighted important ongoing work on the SysMLv2 library for SOA within the Eclipse Arrowhead context. Beyond the technical progress itself, it also showed how collaboration between connected initiatives can strengthen shared understanding and create valuable links across projects. In this sense, the exchange also stands as a relevant point of connection between Arrowhead fPVN and AIMS5.0 projects, reflecting a broader spirit of cooperation around industrial digitalization, interoperability, and advanced engineering approaches.

3.4.4.3 Further Contributions

Work in IEC TC56, Dependability, is ongoing in critical areas (lead of National Mirror Group):

- WG 2 - Dependability techniques are key for HW aspects (reliability mathematics etc.).
- WG 3 – Management and systems, and

- WG 4 – Dependability of information systems cover also system and DevOps aspects. WG 4 includes open systems, Internet of Things (IoT), Systems of Systems (SoS) and dependability of IT security.
- PNW 56-2083 ED1 - NP Dependability in Realization and Utilization of low volume production and not-tested or partly testable items.
- PWI 56-26 Standardized data format for mission profiles.

Collaboration with WP3 and WP7: Results with respect to standardization:

As consequence of the close cooperation of WP8 in standardization, a good overview on standardization activities and impact (usage) is provided in Deliverable D3.3 [4] and D7.3 [5].

Section 3 of D3.3 describes the engagement in European and international standardization organizations. This covers CEN/CLC JTC21 working on the European harmonized Standards for the AI-Act. Partners are partially active in WGs (WG4 Foundational and Societal Aspects; WG5 Cybersecurity for AI Systems) via national mirror committees (ÖVE, VDE/DIN, etc.) and related ISO/IEC groups. ISO/IEC JTC1 SC42 has many members from partner organizations and companies. AIT and LE partners are active ETSI. ARROWHEAD related standardization in OMG is described already. D3.3 contains a list of complementary standardization organizations, e.g., IETF, ITU, ISA, OMG) and relevant ISO or IEC standards.

Another highlight in D3.3 is a review of ongoing standards developments in AI, IoT, Robotics, Intelligent Transport Systems and Industrial Automation, including human-machine collaboration, most standards under development in early stages (ISO/IEC SC42 WG4 Human-machine teaming, IEC SC65A SC24 Collaborative safety – Human machine-collaboration; IEC TC65 WG31 Agentic AI in industrial automation), or in Robotics (Service robots travelling around humans, ISO 18646-7; ISO 21423 Autonomous mobile robots for industrial environments, ISO WD 25785-1 Humanoid robots).

Section 5.3 of D3.3 provides an overview of standardisation recommendations to fill gaps in WP3 Architecture, referencing also the CRA and AI-Act regulations. This is a valuable contribution to standards landscape evolution. These recommendations constitute a point of engagement in ongoing standardization in

- CEN/CENELEC JTC21,
- IEC TC65 (IEC 62443 Industrial cybersecurity, and IEC 62541 (OPC UA - AI model Arrowhead interface)),
- ISO/IEC JTC1 SC42 (AI),
- OMG SysML v2 (model-based system engineering),
- ISO TC199 (Machinery safety),
- ISO TC 299 (Robotics) and
- ISO 50001 (Energy management systems).

D7.3 [5] summarizes, among others, the results of the collaboration between WP8 and WP7. It addresses the trust, ethics and change management to digital workspaces.A first focus is on the EU Regulations concerning societal environments: GDPR, CRA and AI-Act. It highlights the role of supporting standards in this context, focussing on privacy, security, governance and human-machine teaming. AIT is the contact to the human-machine teaming evolving standards, being a member of these relatively newly created WGs. Trustworthiness, controllability, bias, and in particular, for industrial and mobility applications, functional safety and AI. Continuous participation in these AI-standardization groups (national and international) in meetings allows to transfer project experiences to standards. The application of the ALTAI Framework in AIMS5.0 is described.

3.4.5 Use Case-Oriented Standards Assessment - Final Results

This section presents the completed use-case-oriented standards assessment (introduced in D8.2 [2]), mapping each of the 20 AIMS5.0 use cases to the standards that govern them or could benefit from them, and documenting where partners have awareness of, used or monitored them and in some cases actively contributed to standards development in working groups or committees. If standards are used, then monitoring and knowledge should be assumed.

The tables show a very broad spectrum of relevant standards and knowledge of them, use if necessary, and standardization activities in selected cases. In some cases, up to my knowledge, the companies or organizations are involved in standardization activities, but not the specific group active in AIMS5.0.This is particularly valid for large enterprises. The assessment at least demonstrates that awareness and knowledge of existing standards has been raised and improved through the workshops and presentations at the AIMS5.0 core team meetings, General Assemblies and (in most cases joint) Deep-Tech Workshops.

Note: The excellent standardization achievements in the area of Cybersecurity and in context of AIMS5.0/ARROWHEAD in OMG and IETF are reported in 3.4.4.1 and 3.4.4.2. The overview over the partner-related standardization involvement is summarized in 3.4.3 and already in D8.2 [2].

Short Summary of the USE CASE oriented Standards Assessment and Involvement Survey:

1) All 20 Use Cases show a sufficient, in many cases extensive and broad knowledge and awareness of relevant or related standards in their area of interest (column “fair knowledge” and “status”)
2) In many cases the standards have also been taken into account already for development of the use cases (column “used” or “monitored”)
3) “Monitored” covers even more standards than used. Please note, that in cases where standards are used, “monitored” has to be assumed even if this was not marked separately.

- Specific active standardization was reported in the following use cases:
  Use Case 4: AI based improved connection between production and logistics
  - ISO/CD 18646-7 - Robotics — Performance criteria and related test methods for service robots — Part 7: Travelling around humans
  - ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements
- Use Case 8: AI supporting and strengthening human and manufacturing cycles.
  - ISO/CD 18646-7 - Robotics — Performance criteria and related test methods for service robots — Part 7: Travelling around humans
  - ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements
- Use Case 16: AI enhanced production and performance of RF transceivers for civilian SATCOM and radar avionic applications
  - 9001:2015 - Quality management system (TUV AUSTRIA procedures) -
    i) MICROELECTRONICS, NANOELECTRONICS AND OPTOELECTRONICS RESEARCH
    ii) DEVELOPMENT OF NANOSTRUCTURE MATERIALS AND FABRICATION PROCESSES

- USE CASE 18: Using semantic Data Model as base for AI optimized economic & ecologic/societal supply chain improvements
  - Semantic web standards (RDF, SPARQL, JSON, OWL, SKOS) for the generation of the Digital Reference model, therefore UC models also adhere to the the standards applied.
  - The Digital Reference recieved a general update to the OWL2 standard within the second year of AIMS.
  - The UC 18 model generated for the ecological operating curve and economic operating curve uses RDF for its relationship ontology structure, and OWL for the language.

4) The impact of/from AIMS5.0 to USE CASE oriented standards involvement was reported in several use cases in some detail (summarized here):

- USE CASE 3: Servitization and service delivery enabled by Zero administration
  The standards from OASIS MQTT, IETF TLS (RFC 8446), ISO/IEC/EEEE 42010 und ITU-T/ISO/IEC X.509 were used for prototype/PoC implementation, and experiences from AIMS5.0 will be considered for second PoC on Arrowhead virtual cloud for multi-stakeholder collaboration
- USE CASE 5: AI techniques at different layers in Machine Tool Domain
  Reports mainly the interplay between the AIMS5.0 Use Case 5 and the impact of/for the referenced standards (types of activity)
- USE CASE 6: Reports mainly the usefulness of the standards referenced for AIMS5.0.

For details reported, see Appendix C.

3.4.6 Outlook on Standardization Beyond the Project

This section unique to D8.3 describes the long-term standardization commitments of leading partners (AIT, ViF, TTTech, Infineon, and relevant OEMs) beyond the project end, providing concrete plans for ongoing engagement with IEC TC56, ISO/IEC JTC1 SC42, IEC TC65, and other relevant bodies, given that standardization timelines routinely extend years beyond a 3-year research project.

long term commitment of key partners in industry and research, which is guaranteed in AIMS5.0, since many partners are active in related and following projects of Horizon Europe and Chips-JU and in all of them active in standardization. The standardisation activities referenced in this deliverable and in D7.3 [5] resp. D3.3 [4], indicate the ongoing processes and standardisation areas.

- Continuation of the collaboration with CEN/CENELEC to refine the list of standards relevant to CRA and AI act requirements.
- Continuation of the collaboration with International Standardisation Organisations (ISO, IEC, ISO/IEC) and ETSI.
- Continuation of bringing ARROWHEAD related results to standardisation as indicated before.

Recommendations from D7.3 [5] and D3.3 [4] constitute a point of engagement in ongoing standardization in

- CEN/CENELEC JTC21,
- IEC TC65 (IEC 62443 Industrial cybersecurity, and IEC 62541 (OPC UA - AI model Arrowhead interface)),

- Functional safety and AI: IEC SC65A IEC 61508 JWG21, ISO/IEC SC42 JWG4
- IoT and Digital Twin: AhG 36, Physical AI
- ISO/IEC JTC1 SC42 (AI),
- Human-machine collaboration (ISO/IEC SC42 WG4 in IEC TC65 WG31 and SC65A WG24)
- OMG SysML v2 (model-based system engineering),
- ISO TC199 (Machinery safety),
- ISO TC 299 (Robotics) and
- ISO 50001 (Energy management systems).
- IEC TC56 Dependability

During the end of AIMS5.0, the initiative “Physical AI” was started by ISO/IEC SC41 IoT and Digital Twin and will be supported by AIMS5.0 partners after the project fed by the experiences of the project. Standardization is an ongoing activity, based on previous work in the related areas of technology development and application.

3.5 Summary of Key Achievements

The AIMS5.0 project has, over its three-year lifetime, generated a broad range of impacts spanning scientific dissemination, industrial demonstration, technology exploitation, and international standardization.

In communication, the project recorded 443 communication activities, with a conservative quantifiable audience reach of at least 549,328 contacts through a combination of event participation, digital outreach, website and social media communication, and audiovisual content.

But dissemination, the project recorded 331 dissemination entries. These include 248 scientific publications and conference contributions comprising 116 conference proceedings publications, 94 conference presentations, and 38 journal publications, as well as 55 academic theses (6 doctoral dissertations, 39 master's theses, and 10 bachelor's theses). These results demonstrate both the scientific visibility of AIMS5.0 and its contribution to research training and capacity building.

In exploitation, 179 exploitable results have been identified and documented, with a significant number already in use or under active commercialization by industrial partners.

In standardization, the consortium has progressed from initial awareness and engagement towards active application of standards (see Use-Case oriented assessment) and monitoring as well participating in relevant international standardization activities related to AI-enabled manufacturing and associated technologies. Highlights are in the area of Cybersecurity (ISO), ARROWHEAD DSL (OMG), Automotive. Other contributions have been and are ongoing for AI (human-machine collaboration, ethics), Dependability and Functional safety. An initial step for the future was set by joining the “Physical AI” initiative of IoT and Digital Twin AhG 36.

4. Summary

AIMS5.0 generated impact along the four pathways that Work Package 8 planned, monitored, and supported. Table 7 summarises the final indicators reported in chapters 2 and 3.

Table 7. Key impact-related numbers related to all WP8 areas.

Area	Indicator	Final value
Communication	Reported activities, of which event participations	443/243
	Reported audience reach (lower bound)	> 550,000 contacts
Dissemination	Reported outputs, of which published or accepted	331/271 (82%)
	Conference papers, conference presentations, journal articles	116/94/38
	Doctoral, master's, and bachelor's theses	6/39/10
Exploitation	Exploitable results in the final register	179
	Results implemented or under tests	154 (86%)
	Joint results shared by two or more partners	85
	Key Exploitable Results selected (horizontal/use-case)	39 (8/31)
Standardisation	Use cases assessed against relevant standards	20

Communication combined outreach embedded in the use cases and work packages with project-level visibility. External events were the principal channel, followed by events organised by partners, social media, and the project website. The reach figure is a lower bound, since only 60% of the activities carry a usable audience figure.

Dissemination grew from 154 entries at the intermediate assessment to 331, with journal articles, conference papers, and presentations each more than doubling. The 55 theses and the courses recorded in the exploitation register are a lasting contribution to research training. DOI and open-access metadata improved but remain incomplete.

Exploitation rose from 36 results at proposal stage to 59 in Year 2 and 179 in the final register, through progress of the technical work and through reconciliation with the final use-case deliverables and the periodic report. The portfolio is mature: 91 results are implemented and 63 under tests, and the 85 joint results are as mature as the rest. Commercial licensing or sale is the most frequent IPR arrangement, followed by open-source release. 39 Key Exploitable Results, 8 horizontal enablers and 31 use-case results, were selected by a documented procedure, each with a stated exploitation route. The register and the exploitable-results explorer are handed over so that the portfolio can be maintained.

Standardisation progressed from awareness to active use, monitoring, and contribution. The use-case-oriented assessment covered all 20 use cases and revealed many additional standards relevant to their application fields. Highlights are the cybersecurity contribution supporting the Cyber Resilience Act, the SysML v2 library for service-oriented architectures brought to OMG with the Arrowhead community, automotive AI safety, and ongoing work on dependability, functional safety, and the harmonised standards under the EU AI Act.

The end of the funded period does not end the impact of AIMS5.0. The exploitation plans in section 3.3 [4] describe products, tools, platforms, methods, and courses that will reach their markets in the coming years, and the commitments in section 3.4 carry the project's insights into the standards that will govern AI in manufacturing, through partners active in the relevant committees and in follow-up Chips JU and Horizon Europe projects.

5. References

[1] Deliverable D8.1
[2] Deliverable D8.2
[3] European Commission: European Research Executive Agency. (2025). Disseminating and exploiting results: a starter kit for EU-funded research and innovation projects. Publications Office of the European Union. https://data.europa.eu/doi/10.2848/1949672.
[4] Deliverable D3.3
[5] Deliverable D7.3

6. Appendices

6.1 Appendix A - Abbreviations

Abbreviation	Meaning
AG	Advisory Group
AGI	Artificial General Intelligence
AhG	Ad-hoc Group
AI	Artificial Intelligence
AIMS5.0	Artificial Intelligence in Manufacturing leading to Sustainability and Industry5.0
AIOTI	Alliance for Internet of Things Innovation
ALTAI	Assessment List for Trustworthy Artificial Intelligence
AMC	Airborne Molecular Contamination
AMHS	Automated Material Handling System
AMR	Autonomous Mobile Robot
ARM	Arm processor architecture (Advanced RISC Machines)
ASAM	Association for Standardisation of Automation and Measuring Systems
ASI	Austrian Standards Institute
AWI	Approved Work Item
BLE	Bluetooth Low Energy
BPMN	Business Process Model and Notation
CD	Committee Draft
CEN	European Committee for Standardization (Comité Européen de Normalisation)
CENELEC / CLC	European Committee for Electrotechnical Standardization
CO2	Carbon dioxide
CRA	Cyber Resilience Act
CSMS	Cyber Security Management System
DAmd	Draft Amendment
DevOps	Development and Operations
DEXPI	Data Exchange in the Process Industry
DIN	Deutsches Institut für Normung (German standards body)
DIS	Draft International Standard
DOI	Digital Object Identifier
DoW	Description of Work
DSL	Domain-Specific Language
DTR	Draft Technical Report
DTS	Draft Technical Specification
DTw	Digital Twin
EC	European Commission
ED	Edition
EEG	Electroencephalography
EN	European Standard (Europäische Norm)
EPL	Eclipse Public License
ESO	European Standardization Organization
ESPAR	Electronically Steerable Parasitic Array Radiator
ETSI	European Telecommunications Standards Institute
EU	European Union
FDIS	Final Draft International Standard
FPP	Full Project Proposal
GDPR	General Data Protection Regulation
HAS	Harmonised Standards
HW	Hardware
IAF	Impact Assessment Framework
IDO	Industrial Data Ontology
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers

IETF	Internet Engineering Task Force
IFAC	International Federation of Automatic Control
IFIP	International Federation for Information Processing
IIC	Industrial Internet Consortium
IIoT	Industrial Internet of Things
IoT	Internet of Things
IP	Intellectual Property
IPR	Intellectual Property Rights
IS	International Standard
ISA	International Society of Automation
ISO	International Organization for Standardization
IT	Information Technology
ITU / ITU-T	International Telecommunication Union / ITU Telecommunication Standardization Sector
J3C	IFAC Joint Conference on Computers, Cognition and Communication
JETI	Joint Emerging Technologies and Innovation
JTC	Joint Technical Committee
JWG	Joint Working Group
KER	Key Exploitable Result
KPI	Key Performance Indicator
LE	Large Enterprise
LiDAR	Light Detection and Ranging
LLM	Large Language Model
MAS	Multi-Agent System
MBSE	Model-Based Systems Engineering
MEMS	Micro-Electro-Mechanical Systems
MES	Manufacturing Execution System
ML	Machine Learning
MLOps	Machine Learning Operations
MOF	Meta-Object Facility
NFC	Near Field Communication
NOMS	IEEE/IFIP Network Operations and Management Symposium
NP	New Work Item Proposal
NWIP	New Work Item Proposal
OA	Open Access
OEE	Overall Equipment Effectiveness
OEM	Original Equipment Manufacturer
OMG	Object Management Group
OPC UA	Open Platform Communications Unified Architecture
OWL	Web Ontology Language
PAS	Publicly Available Specification
PNW	Preliminary New Work item
prEN	Draft European Standard (projet de Norme Européenne)
PT	Project Team
PWI	Preliminary Work Item
QM	Quality Management
RED	Radio Equipment Directive
RF	Radio Frequency
RFID	Radio Frequency Identification
RGB	Red, Green, Blue (colour camera imaging)
RISC / RISC-V	Reduced Instruction Set Computer
RTO	Research and Technology Organisation
SAFECOMP	International Conference on Computer Safety, Reliability and Security
SBOM	Software Bill of Materials
SC	Subcommittee
SDO	Standards Developing Organization
SEM	Scanning Electron Microscope / Microscopy
SG	Study Group

SOA	Service-Oriented Architecture
SoS	System of Systems
SotIF	Safety of the Intended Functionality
SPARQL	SPARQL Protocol and RDF Query Language
SPS	Smart Production Solutions
SQuaRE	Systems and software Quality Requirements and Evaluation
STEP	Standard for the Exchange of Product model data
SysML	Systems Modelling Language
TC	Technical Committee
ToF	Time of Flight
TR	Technical Report
TRL	Technology Readiness Level
TS	Technical Specification
TTR	Technology Trend Report
UC	Use Case
UI	User Interface
UML	Unified Modeling Language
URL	Uniform Resource Locator
VDE	Verband der Elektrotechnik, Elektronik und Informationstechnik (German association)
ÖVE	Österreichischer Verband für Elektrotechnik (Austrian Electrotechnical Association)
WD	Working Draft
WG	Working Group
WI	Work Item
WP	Work Package

6.2 Appendix B - Overview of AI Standards

6.2.1 AI Standards of ISO/IEC JTC1 SC42 Artificial Intelligence

Artificial Intelligence (37) published (RED: published 2026, violet: published 2025)

- ISO/IEC 4213:2022 Information technology — Artificial Intelligence — Assessment of machine learning classification performance
- ISO/IEC 5259-1:2024 Artificial Intelligence — Data quality for analytics and ML — Part 1: Overview, terminology, and examples
- ISO/IEC 5259-2:2024 Artificial Intelligence — Data quality for analytics and ML — Part 2: Data quality measures
- ISO/IEC 5259-3:2024 Artificial Intelligence — Data quality for analytics and ML — Part 3: Data quality management requirements and guidelines
- ISO/IEC 5259-4:2024 Artificial Intelligence — Data quality for analytics and ML — Part 4: Data quality process framework
- **ISO/IEC 5259-5:2025** Artificial intelligence — Data quality for analytics and machine learning (ML) — Part 5: Data quality governance framework
- **ISO/IEC TR 5259-6:2026** Data quality for analytics and machine learning (ML) - Part 6: Visualization framework for data quality
- ISO/IEC 5338:2023 Information technology — Artificial intelligence — AI system life cycle processes
- ISO/IEC 5339:2024 Information Technology — Artificial Intelligence — Guidelines for AI applications
- ISO/IEC 5392:2024 Information technology — Artificial intelligence — Reference architecture of knowledge engineering
- ISO/IEC TR 5469:2024 Artificial intelligence — Functional safety and AI systems
- **ISO/IEC TS 6254:2025** Information technology — Artificial intelligence — Objectives and approaches for explainability of ML models and AI systems

- ISO/IEC 8183:2023 Information technology — Artificial intelligence — Data life cycle framework
- ISO/IEC TS 8200:2024 Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems
- ISO/IEC TS 12791:2024 Information technology — Artificial intelligence — Treatment of unwanted bias in classification and regression machine learning tasks
- **ISO/IEC 12792:2025** Information technology — Artificial intelligence — Transparency taxonomy of AI systems
- ISO/IEC TR 17903:2024 Information technology — Artificial intelligence — Overview of machine learning computing devices
- **ISO/IEC TR 20226:2025** Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems
- **ISO/IEC TR 21221:2025** Information technology - Artificial intelligence - Beneficial AI systems
- ISO/IEC 22989:2022 Information technology - Artificial intelligence — Artificial Intelligence Concepts and Terminology
- ISO/IEC 23053:2022 Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)
- ISO/IEC 23894:2023 Information technology — Artificial Intelligence — Guidance on Risk Management
- ISO/IEC TR 24027:2021 Information technology — Artificial Intelligence (AI) — Bias in AI systems and AI aided decision making
- ISO/IEC TR 24028:2020 Information technology — Artificial Intelligence — Overview of trustworthiness in artificial intelligence
- ISO/IEC TR 24029-1:2021 Artificial Intelligence — Assessment of the robustness of neural networks — Part 1: Overview
- ISO/IEC 24029-2: 2023 Artificial Intelligence — Assessment of the robustness of neural networks — Part 2: Methodology for the use of formal methods
- ISO/IEC TR 24030:2024 Information technology — Artificial Intelligence — Use cases (**Withdrawn version 2021)**
- ISO/IEC TR 24368:2022 Information technology — Artificial Intelligence (AI) — Overview of ethical and societal concerns
- ISO/IEC TR 24372:2021 Information technology — Artificial Intelligence — Overview of computational approaches for AI systems
- ISO/IEC 24668:2022 Information technology — Artificial intelligence — Process management framework for big data analytics
- ISO/IEC TS 25058:2024 Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Guidance for quality evaluation of artificial intelligence (AI) systems
- ISO/IEC 25059:2023 Software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality model for AI-based systems
- ISO/IEC 38507:2022 Information technology — Governance of IT — Governance implications of the use of artificial intelligence by organizations
- ISO/IEC 42001:2023 Information technology — Artificial intelligence — Management system
- **ISO/IEC 42005:2025** Information technology — Artificial intelligence — AI system impact assessment
- **ISO/IEC 42006:2025** Information technology — Artificial intelligence — Requirements for bodies providing audit and certification of artificial intelligence management systems
- **ISO/IEC TR 42106:2026** Information technology — Artificial intelligence — Overview of differentiated benchmarking of AI system quality characteristic
- **ISO/IEC TS 42112:2026** Information technology — Artificial intelligence —Guidance on machine-learning model training efficiency optimization

- ISO/IEC TS 42119-2: 2025 Artificial intelligence —Testing of AI – Part 2: Overview of testing AI systems

Other responsibility:

- ISO/IEC AWI TS 29119-11:2020- Software and systems engineering — Software testing — Part 11: Guidelines on the testing of AI-based systems (under responsibility of ISO/IEC JTC1 SC 7)

Big Data (5) published, plus one under ISO/IEC JTC1 SC27 (Cybersecurity)

- ISO/IEC 20546:2019 Information technology - Big data - Overview and vocabulary
- ISO/IEC 20547-1:2020 Information technology — Big data reference architecture — Part 1: Framework and application process
- ISO/IEC TR 20547-2:2018 Information technology — Big data reference architecture — Part 2: Use cases and derived requirements
- ISO/IEC 20547-3:2020 Information technology — Big data reference architecture — Part 3: Reference architecture
- ISO/IEC 20547-4:2020 Information technology — Big data reference architecture — Part 4: security and privacy (**developed** by **ISO/IEC JTC1 SC27,** IT security, cybersecurity and privacy protection)
- ISO/IEC TR 20547-5:2018 Information technology — Big data reference architecture — Part 5: Standards roadmap#

Under Development (49) (change of status included: DTS, DTR, DIS, FDIS)

Currently under publication: Change of status (to CD, DIS, etc. marked too in colour!)

Note: DTS, DTR, FDIS expected to be published soon!
(Status Change (AWI□CD□DIS□FDIS, DTR, DTS) RED: new 2026; violet new 2025)

- ISO/IEC DIS 4213 Artificial intelligence – Performance measurement for AI classification, regression, clustering and recommendation tasks
- ~~ISO/IEC AWI TS 17847: Information technology — Artificial intelligence — Verification and validation analysis of AI systems~~ - replaced by 42119-3
- ISO/IEC DTR 18988: Artificial intelligence — Application of AI technologies in health informatics
- ISO/IEC CD TS 22440-1 – Artificial intelligence — Functional safety and AI systems — Part 1: Requirements
- ISO/IEC CD TS 22440-2 – Artificial intelligence — Functional safety and AI systems — Part 2: Guidance
- ISO/IEC CD TS 22440-3 - Artificial intelligence — Functional safety and AI systems — Part 3: Examples of application
- ISO/IEC DTS 22443 Information technology — Artificial intelligence— Guidance on addressing societal concerns and ethical considerations.
- ISO/IEC AWI 22989-2 - Artificial intelligence —Concepts and terminology – Part 2: Healthcare
- ISO/IEC 22989:2022/DAmd1 - Information technology – Artificial intelligence — Artificial Intelligence Concepts and Terminology – Amendment 1
- ISO/IEC 22989:2022/CD Amd2 - Information technology – Artificial intelligence — Artificial Intelligence Concepts and Terminology – Amendment 2
- ISO/IEC 23053:2022/FDAmd1 - Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML) – Amendment 1
- ISO/IEC 23053:2022/AWI Amd2 - Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML) – Amendment 2

- ISO/IEC CD TR 23281 - Artificial intelligence — Overview on AI tasks and functionalities related to natural language processing.
- ISO/IEC **DIS** 23282 - Artificial intelligence — Evaluation methods for accurate natural language processing systems
- ISO/IEC **FDIS** 24029-3 Artificial intelligence (AI) — Assessment of the robustness of neural networks — Part 3: Methodology for the use of statistical methods
- **ISO/IEC CD TR 24030** Information technology — Artificial intelligence (AI) — Use cases
- **ISO/AWI TR 24492** Standardization needs for the application of artificial intelligence in the financial services industry
- ISO/IEC **FDIS** 24970 Artificial intelligence - AI system logging
- ISO/IEC **DIS** 25029 Artificial intelligence - AI-enhanced nudging
- **ISO/IEC AWI 25058** Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Measurement and guidance for quality evaluation of AI systems
- ISO/IEC **FDIS** 25059 Software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Quality models for AI-based systems
- ISO/IEC AWI TS 25223 Information technology - Artificial intelligence - Guidance and requirements for uncertainty quantification in AI systems
- ISO/IEC **CD** TS 25258 Information technology - Artificial intelligence - Hybrid AI inference framework for AI systems
- ISO/IEC **CD** TR 25523 Information technology - Artificial intelligence - Overview of data profiles for analytics and ML
- **ISO/IEC AWI TS 25566** Terminology and concepts for domain engineering of AI systems
- **ISO/IEC CD TS 25568 -** Information technology — Artificial Intelligence — Guidance on addressing risks in generative AI systems
- **ISO/IEC AWI TS 25569** - Artificial Intelligence — Implementation guidance on de-identification of data used in Machine Learning (ML)
- **ISO/IEC WD TS 25570** - Information Technology — Artificial Intelligence — Reliability assessment of AI systems
- **ISO/IEC CD TS 25571** - Artificial Intelligence — Example template for documenting ethical issues of an AI system
- **ISO/IEC CD 25589** Information technology — Artificial intelligence — Framework for human-machine teaming
- **ISO/IEC CD 25590** - Information technology — Artificial intelligence — Guidance for output data quality of generative AI applications
- **ISO/IEC AWI 25623** Artificial intelligence — Machine learning (ML) model description framework
- ~~**ISO/IEC AWI 25651** - Information technology — Artificial intelligence — Guidance on the implementation of ISO/IEC 42001 (AI management system)~~ - **replaced by ISO/IEC AWI 42003**
- **ISO/IEC AWI 25704** Artificial Intelligence — Process assessment model for AI system life cycle processes
- **ISO/IEC AWI TS 25864** Information technology - Artificial Intelligence (AI) - Resilience assessment of AI systems
- **ISO/IEC AWI 25870** Artificial intelligence — Reporting framework for AI incidents
- ISO/IEC AWI 25872-1 Artificial intelligence — Knowledge enhancement for pretrained machine learning models — Part 1: Framework
- **ISO/IEC AWI 25880** Artificial Intelligence - Requirements and guidance for the organizational implementation of human-machine teaming
- **ISO/IEC AWI TS 26312** Information technology — Artificial intelligence — Identification and treatment of bias in AI by healthcare organizations
- **ISO/IEC AWI TS 26320** Information technology — Artificial intelligence — Corpus development and maintenance for natural language processing systems (NEW April 2026)

- **ISO/IEC AWI 42003** - Information technology — Artificial intelligence — Guidance on the implementation of ISO/IEC 42001 (AI management system)
- ISO/IEC **DIS** 42007 Information technology — Artificial intelligence — High-level framework and guidance for the development of conformity assessment schemes for AI systems
- ISO/IEC **DIS** 42102 - Information technology — Artificial intelligence — Taxonomy of AI system methods and capabilities
- ISO/IEC **CD** TR 42103 Information technology — Artificial intelligence — Overview of synthetic data in the context of AI systems
- ISO/IEC **FDIS** 42105 - Information technology — AI— Guidance for human oversight of AI system
- ISO/IEC **CD** TR 42109 Information technology — Artificial intelligence —Use cases of human-machine teaming
- ISO/IEC **CD** TS 42111 Information technology — Artificial intelligence —Guidance on light-weight AI systems
- ISO/IEC DTS 42119-3.**2** Artificial intelligence —Testing of AI - Part 3: Verification and validation analysis of AI systems
- **ISO/IEC AWI TS 42119-7** Artificial intelligence — Testing of AI — Part 7: Red teaming
- **ISO/IEC AWI TS 42119-8** Artificial intelligence — Testing of AI — Part 8: Quality assessment of prompt-based text-to-text systems that utilize generative AI

NEW PWI (Preliminary Work ITEM): "Governance and management of human oversight of AI systems**"**

NEW NWIP: Artificial Intelligence - Framework for structured multi-agent interaction in AI systems (MAS) (April 20, 2026)

6.2.2 AI-related Standards in other domains (Examples)

ISO TC22 SC32: Road vehicles - Electrical and electronic components and general system aspects

WG 13: Safety for driving automation systems

- ISO/TS 5083:2025 Road vehicles — Safety for automated driving systems — Design, verification and validation ▫ New Version ISO/WD TS 5083 [Under development]

WG 14: Safety and Artificial Intelligence (Liaison: WG13, ISO/IEC SC42 AI)

- ISO/PAS 8800:2024 Road vehicles — Safety and artificial intelligence
- ISO/AWI TR 25016 [Under development] Application of ISO PAS 8800 to automotive use cases
- ISO/AWI TR 25026 [Under development] Methods and metrics for evaluating road vehicle AI safety

ISO TC 204 Intelligent transport systems:

- **ISO/DTR 12786** "Intelligent transport systems — Big data and artificial intelligence supporting intelligent transport systems — Use cases"
- **ISO CD 25581-1** - Sustainable mobility and transportation — Mobility Services Using AI and Big data — Part 1: Role Model

ISO TC268 SC2: ISO/DIS 25581-1 (E) - Sustainable mobility and transportation — Mobility services using AI and big data — Part 1: Role model

IEC Industrial Automation and Control: (IEC TC65, SC65A):

- **IEC TC65 WG 31 Industrial Agents and multi-agent Systems:** Standard IEC 63718 Agentic AI in industrial automation
- **IEC SC65A WG24 Human-machine collaboration**– Standard IEC 63662 - Human-machine collaborations Part 1: Coordination of multiple risk assessments

IEC TC62 Medical devices/robotics

IEC PT 63450 **Testing of Artificial Intelligence / Machine Learning-enabled Medical Devices**

ISO TC 199 Safety of machinery:

- ISO TR 22100-5 — Relationship with ISO 12100 - Implications of artificial intelligence machine learning.

ISO TC20 SC16 Uncrewed Aerial systems

- agrees to create a new working group for "Artificial Intelligence" to create standards to address “AI safety and ethics in aviation use”. The WG will also evaluate existing ISO AI standards that were not developed for aviation use to determine applicability/suitability for use in an aviation capacity. ISO/TC 20/SC 16 appoints Wes Ryan as working group convenor and Jon Daniels as the working group secretary. (K237 2026-06-04)

- **ISO/NP TS 26776** Guidelines for the management of use of Artificial Intelligence (AI) for space systems

ISO-IEC_JTC_1-SC_38-ISO/IEC JTC1 SC38 WG_3 Cloud computing

- NWPI_on_IS_26191_-AI_services_on_cloud_computing
- ISO/IEC JTC1 SC38 WD 20151-2 Cloud computing and distributed Platforms - Dataspace trust frameworks

ISO TC 110 SC2 Safety of powered industrial trucks:

ISO TC 110 SC2 WG15 Driverless industrial trucks (newly established May 2024)

- ISO 24134:2006 Industrial trucks — Additional requirements for automated functions on trucks (new version under development)
- **ISO 3691-4:2023** Industrial trucks — Safety requirements and verification — Part 4: Driverless industrial trucks and their systems (new version under development)

6.3 Appendix C – Detailed Use-Case Oriented Standardization Assessment Results

USE CASE 01	Lead: AIDI, partner: Cetto Domain: Manufacturing
Title:	**Development of Green AI-Lifecycle Management Approaches**
Standardization Focus:	Standards related to interoperability (data, system and processes), smart production IoT, machines, robots
Description (Goals/Claims from FPP/DoW)	Research and development of smart connected Engineering and Systems Engineering Approaches based on AI SoS Lifecycle Management Systems and Systems Engineering Digitalization of energy flows, energy efficiency of every injection molding machine. Continuous interoperability in a connected and synchronized intelligent production industry for SME.
USE CASE 01	Lead: AIDI, partner: Cetto Domain: Manufacturing
Title:	**Development of Green AI-Lifecycle Management Approaches**
Standardization Focus:	Standards related to interoperability (data, system and processes), smart production IoT, machines, robots
Description (Goals/Claims from FPP/DoW)	Research and development of smart connected Engineering and Systems Engineering Approaches based on AI SoS Lifecycle Management Systems and Systems Engineering Digitalization of energy flows, energy efficiency of every injection molding machine. Continuous interoperability in a connected and synchronized intelligent production industry for SME.

Standards: Topic, Committee	**USE CASE 01 Development of Green AI-Lifecycle Management Approaches**	Status	fair knowledge	used	monitored	active	Impact from AIMS5.0
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Safety of machinery	EN ISO 13849	published	yes	yes	**yes**	no	no
Safety of machinery	EN294: Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs	published	yes	yes	**yes**	no	no
Safety of machinery	EN775: Industrious robots	published	yes	yes	**yes**	no	no
Equipment standards	73 / 23 / EEC: Low Voltage Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	89 / 336 / EEC: EMC Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	89 / 392 / EEC: Machinery Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	EN61010-1: Safety of Electrical Equipment for Measurement, Control, or Laboratory Use	published	yes	yes	**yes**	no	no
Equipment standards	EN60204-1: Safety of Electrical Equipment of Industrial Machines	published	yes	yes	**yes**	no	no
Equipment standards	EN60825-1: Safety of Laser Products	published	yes	yes	**yes**	no	no
Equipment standards	EN55011: Radiated and Conducted Emissions for Industrial, Scientific and Medical products	published	yes	yes	**yes**	no	no
Equipment standards	EN61000-6-2: Immunity Standards for Industrial Equipment	published	yes	yes	**yes**	no	no

Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	yes	yes	no	no
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts	published	yes	yes	yes	no	no
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
Energy management & Sustainability standards	ISO 14001 Focus: CO_2 footprint estimation and sustainability goals align directly	published	yes	yes	yes	no	no
	ISO 14064 Focus: Quantification and reporting of greenhouse gas emissions	published	yes	yes	yes	no	no
	ISO 14644 Focus: Cleanroom classification and environmental control	published	yes	yes	yes	no	no
AI, Data & Analytics Standards	ISO/IEC 42001 Focus: Governance and management of AI systems	published	yes	yes	yes	no	no
	ISO/IEC 27001 Foucs: Data security	published	yes	yes	yes	no	no
IoT & Ind. Communication Standards	IEC 62443: Focus: Security for industrial automation and control systems	published	yes	yes	yes	no	no
	OPC UA: Interoperability between industrial systems	published	yes	yes	yes	no	no
	IEC 61850: Focus: Communication within electrical substations and power systems	published	yes	yes	yes	no	no
Energy management	ISO 50001	published	yes	yes	yes	no	no
CO_2 accounting	ISO 14064 for CO_2 accounting	published	yes	yes	yes	no	no
secure industrial IoT	IEC 62443	published	yes	yes	yes	no	no
positioning as a future-ready Industry 5.0 solution	ISO/IEC 42001	published	yes	yes	yes	no	no

USE CASE 2	Lead PCL, Task 5.1
	Domain: Consumer electronics
Title:	AI enhanced value chain
Standardization Focus:	Process quality and efficiency, Trustworthy AI
Description (Goals/Claims from FPP/DoW)	- Sustainability in manufacturing by using AI and data - AMRs with human-like approaches for higher acceptability and safety using AI

Standards: Topic, Committee	**Use case 2**	Status	fair knowledge
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes
	ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements	under development	yes
	ISO/IEC TR 20226 - Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems	under development	yes

USE CASE 3	Lead HQ, Task #: Domain: Cross Domain
Title:	Servitization and service delivery enabled by Zero administration
Standardization Focus:	IT/Communications
Description (Goals/Claims from FPP/DoW)	Developing technical solutions to support monitoring, distributed/ federated data collection, and machine learning from onboard to cloud - to reduce cost related to service delivery. Multi-party servitization, with focus on technologies needed to open new ecosystems for flexible subscription of equipment based services.

Standards: Topic, Committee	**Standards connected to Eclipse Arrowhead of direct relevance to this UC**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
OASIS	MQTT	published	yes	yes			Use for prototype/PoC implementaiton, and considered for second PoC on Arrowhead virtual cloud for multi-stakeholder collaboration
IETF	TLS (RFC 8446)	published	yes	no			Considered for second PoC on Arrowhead virtual cloud for multi-stakeholder collaboration
ISO/IEC/IEEE	ISO/IEC/IEEE 42010	published	no	no			Considered for second PoC on Arrowhead virtual cloud for multi-stakeholder collaboration
ITU-T / ISO/IEC	X.509	published	yes	no			Considered for second PoC on Arrowhead virtual cloud for multi-stakeholder collaboration

USE CASE 4	Lead: SU, T5.3 Domain: Automotive, (Robotics)
Title:	AI supporting and strengthening human and manufacturing cycles.
Standardization Focus:	Exoskeleton, Robotic, Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- Research, evaluate and demonstrate a concept for AI supported Human Assistance Exoskeleton using brain signals. - Research, evaluate and demonstrate a concept for AI supported Human Assistance Exoskeleton using brain signals. - AMRs with human-like approaches for higher acceptability and safety using AI - Sustainability in manufacturing by using AI and data - Less energy consumption for intra-logistics

Standards: Topic, Committee	**USE CASE 4 (Automotive - with Robotics and AI)**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	no			
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts		yes				
	ISO 10218-1:2025 - Robotics — Safety requirements — Part 1: Industrial robots		yes	yes			
	ISO/TS 15066:2016 - Robots and robotic devices — Collaborative robots		no	no			
	ISO 18646-1:2016 - Robotics — Performance criteria and related test methods for service robots — Part 1: Locomotion for wheeled robots		yes				
	ISO/CD 18646-7 - Robotics — Performance criteria and related test methods for service robots — Part 7: Travelling around humans	under development	yes			yes	explain type of activity and (potential) contribution from AIMS5.0 experience
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes				
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	no				
	ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements	under development	yes			yes	explain type of activity and (potential) contribution from AIMS5.0 experience
	ISO/IEC TR 20226 - Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems	under development	yes		yes		

USE CASE 5	Lead, Task #: Golmek, T5.5 Domain: Machine Tool	
Title:	AI techniques at different layers in Machine Tool Domain	
Standardization Focus:	AI, Data Interoperability, Machine Tools, Predictive Maintenance,	
Description (Goals/Claims from FPP/DoW)	(1) Design, implementation and validation of the use of AI techniques in the precision machining of large-size parts to improve efficiency, quality and reduce fault places 2) Seamless integration of AI across layers and systems in the machine tool ecosystem	

	Standards: Topic, Committee	**USE CASE 5**	Status	fair knowledge	used	monitored	active	explain type of activity	Impact from AIMS5.0
Interoperability	IEC TC 65 / SC 65E – Devices and integration in enterprise systems	IEC 62541 – OPC Unified Architecture	published	yes	yes	yes	no		no
Cibersecurity	IEC TC 65 – Industrial-process measurement, control and automation (WG 10 – Cybersecurity for IACS)	IEC 62443-3-3:2013: Industrial communication networks – Network and system security – Part 3-3: System security requirements and security levels	published	yes	yes	yes	no	the MLOps pipeline technically enforces Zones and Conduits (FR 5) by governing sensitive data flow across the Cloud, Fog, and Edge tiers. It also elevates System Integrity (FR 3) from static code verification to the continuous governance of probabilistic logic, while utilizing model-drift detection as a security trigger for Timely Response (FR 6) and automated fallback. By pre-validating the computational footprint of new models, the pipeline can ensure Resource Availability (FR 7)	no
Cibersecurity		IEC 62443-4-1:2018. Security for industrial automation and control systems - Part 4-1: Secure product development lifecycle requirements	published	yes	yes	yes	no	By utilizing a multi-tier MLOps pipeline for training and validation, the Arrowhead Framework ensures that AI / ML model updates are subject to rigorous data provenance, human-in-the-loop verification, and secure orchestration exceeding the requirements of traditional deterministic software updates.	no
Cibersecurity		IEC 62443-4-2:2019: Security for industrial automation and control systems – Part 4-2: Technical security requirements for IACS components	published	yes	yes	yes	no	AI-Gym and Edge nodes are technical components that must enforce model-specific Foundational Requirements, verifying model integrity and provenance (FR 1 & 3) before execution, ensuring resource isolation for heavy inference tasks (FR 7), and maintaining IP confidentiality via encrypted weights (FR 4). By leveraging service-level orchestration, the pipeline converts probabilistic MLOps into a series of verifiable technical gates, ensuring AI artifacts meet the "Secure by Design" requirement for industrial hardware.	no
Machine Tool, Monitoring of machines	Technical Committee ISO/TC 108, Mechanical vibration, shock and condition monitoring,	ISO 13373-1:2002 — Condition monitoring and diagnostics of machines — Vibration condition monitoring — Part 1: General procedures	published	yes	yes	yes	no	Measurement methodology	no
Machine Tool, Monitoring of machines		ISO 20816-1:2016 Mechanical vibration — Measurement and evaluation of machine vibration Part 1: General guidelines	published	yes	yes	yes	no	Measurement methodology	no
Machine Tool, Monitoring of machines	ISO/TC 39, Machine tools	ISO 17359:2018 — Condition monitoring and diagnostics of machines — General guidelines	Published	yes	no	no	no		no
Machine Tool, Monitoring of machines		ISO/TR 17243-1:2014 Machine tool spindles — Evaluation of machine tool spindle vibrations by measurements on spindle housing Part 1: Spindles with rolling element bearings and integral drives operating at speeds between 600 min-1 and 30 000 min-1	Published	yes	yes	yes	no	Measurement location	no

USE CASE 6	Lead: EDI with HUA and BME Domain: Industrial robotics / conveyor feeding / bottle handling automation
Title:	**Reconfigurable AI-based automated conveyer feeding by a robotic system**
Standardization Focus:	Industrial robot and robot-cell safety, machinery integration, guarding/interlocks, functional safety, conveyor safety, AI governance/risk management, industrial cybersecurity
Description (Goals/Claims from FPP/DoW)	- Demonstrate an AI-based robotic system that feeds randomly distributed bottles into a conveyor with high effectiveness and flexibility.
	- Handle different bottle sizes, weights and types through modular and reconfigurable cell design.
	- Develop and evaluate AI methods for machine vision, code generation and robot motion planning.
	- Support later market deployment with standards for robot cells, safeguarding, validation, electrical/control safety, governance of AI functions and secure lifecycle management.

Standards: Topic, Committee	UC6 (Reconfigurable AI-based automated conveyer feeding by a robotic system)	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
Machinery / system integration, ISO/TC 199 / IEC TC 44	**ISO 12100:2010 - Safety of machinery — General principles for design — Risk assessment and risk reduction**	**published**	**yes**	yes			**Core baseline for hazard identification and residual-risk reduction across the full UC6 cell.**
	ISO 11161:2007 - Safety of machinery — Integrated manufacturing systems — Basic requirements	published	yes	yes			Relevant because UC6 is a combined system (robot + gripper/end-effector + vision + conveyor + controls), not a standalone robot only.
	IEC 60204-1:2016+A1:2021 - Safety of machinery — Electrical equipment of machines — Part 1: General requirements	published	yes	yes			Applies to electrical equipment and machine-level integration of the robotic feeding cell.
	ISO 13849-1:2023 - Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design	published	yes	yes			Relevant for safety functions such as stop, guard monitoring, interlocks, restart prevention and safe state handling.
	ISO 13849-2:2012 - Safety of machinery — Safety-related parts of control systems — Part 2: Validation	published	yes	yes			Needed to validate the implemented safety functions and claimed performance level in the UC6 cell.
	IEC 62061:2021 - Safety of machinery — Functional safety of safety-related control systems	published	yes	yes			Alternative / complementary route to ISO 13849 for electrical/electronic/programmable safety-related control functions.
Industrial robots and robot cells, ISO/TC 299	**ISO 10218-1:2025 - Robotics — Safety requirements — Part 1: Industrial robots**	**published**	**yes**	yes			**Relevant where the robot subsystem itself is specified or selected for UC6 deployment.**
	ISO 10218-2:2025 - Robotics — Safety requirements — Part 2: Industrial robot applications and robot cells	published	yes	yes			One of the most relevant standards for UC6; covers safeguarding, integration, validation and commissioning of the robot application/cell.
	ISO/TS 15066:2016 - Robots and robotic devices — Collaborative robots	published	yes	yes			Relevant only if UC6 uses collaborative operation, manual teaching in shared space, or reduced-separation modes with operator presence.
Guarding, access prevention and stop functions, ISO/TC 199	**ISO 14120:2015 - Safety of machinery — Guards — General requirements for the design and construction of fixed and movable guards**	**published**	**yes**	yes			**Relevant for perimeter guards, covers and access protection around bottle feeding and transfer hazards.**
	ISO 14119:2024 - Safety of machinery — Interlocking devices associated with guards — Principles for design and selection	published	yes	yes			Relevant where doors, gates or movable guards are used to access the robot/conveyor cell.
	ISO 13850:2015 - Safety of machinery — Emergency stop function — Principles for design	published	yes	yes			Expected for emergency stop design unless a justified exception applies.
	ISO 13857:2019 - Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs	published	yes	yes			Relevant for fence/guard geometry and reach-prevention around robot and conveyor hazards.
	ISO 14118:2017 - Safety of machinery — Prevention of unexpected start-up	published	yes	yes			Important for maintenance, jam clearing, bottle changeover and recovery after faults.
	ISO 13855:2024 - Safety of machinery — Positioning of safeguards with respect to the approach of the human body	published	yes	yes			Relevant if light curtains, scanners, mats or other protective devices are used and their minimum distance must be calculated.
Conveyors & unit-load handling, CEN/TC 148	**EN 619:2022 - Continuous handling equipment and systems — Safety requirements for equipment for mechanical handling of unit loads**	**published**	**yes**	yes			**Directly relevant to the conveyor side of the application scenario.**
AI governance and AI-specific risk, ISO/IEC JTC 1/SC 42	**ISO/IEC 42001:2023 - Information technology — Artificial intelligence — Management system**	**published**	**yes**	yes			**Relevant for a productized UC6 solution with documented AI lifecycle governance, monitoring, responsibilities and change control.**
	ISO/IEC 23894:2023 - Information technology — Artificial intelligence — Guidance on risk management	published	yes	yes			Useful for vision-model failure modes, dataset bias/drift, unsafe edge cases and risk treatment around AI-assisted planning or code generation.
Industrial cybersecurity / connected systems, IEC TC 65	**IEC 62443-3-3:2013 - Industrial communication networks — Network and system security — Part 3-3: System security requirements and security levels**	**published**	**yes**	yes			**Relevant if the UC6 cell is networked into plant OT/IT infrastructure.**
	IEC 62443-4-2:2019 - Security for industrial automation and control systems — Part 4-2: Technical security requirements for IACS components	published	yes	yes			Relevant when controllers, HMIs, gateways, cameras or edge devices in UC6 need secure-by-design component requirements and secure update capability.

USE CASE 7	SIGNIFY, TU/e, RUG Domain: Lighting / luminaires
Title:	Digital Automated Luminaire Manufacturing platform
Standardization Focus:	AI lifecycle, machine-learning system framework, and data quality for analytics / ML in industrial computer-vision, automated data annotation and MLOps workflows.
Description (Goals/Claims from FPP/DoW)	AI-supported data annotation and MLOps workflow for the luminaire manufacturing use case. Creation of a high-quality reference dataset from production-line video/image data for training industrial AI models. Automation of annotation, model-development and iterative quality-assessment steps in a conservative, non-committal standards-monitoring context.

Standards: Topic, Committee		Status	fair knowledge	used	monitored	active standard	impact from AIMS5.0
AI / ML framework, ISO/IEC JTC 1/SC 42	ISO/IEC 23053:2022 - Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)	published	yes		yes	no	no
AI terminology, ISO/IEC JTC 1/SC 42	ISO/IEC 22989:2022 - Information technology - Artificial intelligence - Artificial intelligence concepts and terminology	published	yes		yes	no	no
AI life cycle, ISO/IEC JTC 1/SC 42	ISO/IEC 5338:2023 - Information technology - Artificial intelligence - AI system life cycle processes	published	yes		yes	no	no
Data quality for analytics / ML, ISO/IEC JTC 1/SC 42	ISO/IEC 5259-1:2024 - Artificial intelligence - Data quality for analytics and machine learning (ML) - Part 1: Overview, terminology and examples	published	yes		yes	no	no
Data quality process framework, ISO/IEC JTC 1/SC	ISO/IEC 5259-4:2024 - Artificial intelligence - Data quality for analytics and machine learning (ML) - Part 4: Data quality process framework	published	yes		yes	no	no

USE CASE 8 combin	Lead: SU, T5.3 Domain: Automotive
Title:	AI supporting and strengthening human and manufacturing cycles.
Standardization Fo	Exoskeleton, Robotic, Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- Research, evaluate and demonstrate a concept for AI supported Human Assistance Exoskeleton using brain signals. - Research, evaluate and demonstrate a concept for AI supported Human Assistance Exoskeleton using brain signals. - AMRs with human-like approaches for higher acceptability and safety using AI - Sustainability in manufacturing by using AI and data - Less energy consumption for intra-logistics

Standards: Topic, Committee	**USE CASE 4 & 8 combined (Automotive - with Robotics and AI)**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0	Explanation
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	no				
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts		yes					
	ISO 10218-1:2025 - Robotics — Safety requirements — Part 1: Industrial robots		yes	yes				
	ISO/TS 15066:2016 - Robots and robotic devices — Collaborative robots		no	no				
	ISO 18646-1:2016 - Robotics — Performance criteria and related test methods for service robots — Part 1: Locomotion for wheeled robots		yes					
							explain type of activity and (potential) contribution from AIMS5.0 experience	This standard is directly against our UC8 scope (AMR + human interaction + AI + exoskeleton). In our usecase, we are working on: (a) AMR intra-logistics (navigation, perception, task mgmt) (b) Human interaction (shared space, safety, communication) (c) EEG-controlled exoskeleton (human augmentation)
	ISO/CD 18646-7 - Robotics — Performance criteria and related test methods for service robots — Part 7: Travelling around humans	under development	yes			yes		This standard focuses on: (i) Human-aware navigation, (ii) Safe distances, (iii) Motion behavior near humans and Interaction scenarios (passing, approaching, stopping). Thus, ISO/CD 18646-7 demonstrates very high relevance to UC8, particularly in the context of AMR operation within factory environments. It directly supports the "AI-supported AMR Task & Traffic Management System" by addressing key aspects such as human-aware path planning, adaptive speed control, and collision avoidance in shared human-robot spaces. Furthermore, it aligns closely with the project's focus on human-like robot behavior and multimodal communication (visual and auditory), contributing to improved predict. Please note that this standard is behavior-focused, not AI-focused, so it doesn't cover: ML models, training sets or explainability.
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes					
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	no					
							explain type of activity and (potential) contribution from AIMS5.0 experience	This standard laddresses directly our UC8 scope (AMR + human interaction + AI + exoskeleton). It addresses functional safety in AI systems, which is highly relevant to our UC8 use case, as it focuses on the safe deployment of artificial intelligence in safety-critical environments. The standard covers key aspects such as risk assessment for AI-driven decisions, reliability and robustness of machine learning outputs, fail-safe system behavior, and the overall lifecycle management of AI systems. These elements are essential for ensuring that AI components operate predictably and safely, particularly in industrial settings where incorrect decisions may lead to operational disruptions or safety hazards. The relevance of this standard to UC8 is especially strong in the context of AI-based decision-making, which forms the core of the developed AMR Task and Traffic Management System. Our system relies heavily on AI for perception and decision-making processes. In this regard, the standard provides guidance on handling incorrect or uncertain AI outputs, managing confidence levels, and ensuring that system behavior remains safe even under ambiguity or failure conditions. The importance of ISO/IEC AWI TS 22440-1 is even more in relation to the EEG-based exoskeleton component of UC8. This system represents a human-in-the-loop application, where incorrect predictions or control actions could directly result in physical harm to the user. The standard provides a framework for mitigating such risks through the implementation of fallback strategies and validation procedures.
	ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements	under development	yes			yes		
	ISO/IEC TR 20226 - Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems	under development	yes		yes			

USE CASE 09	Lead: FuH Domain: Semiconductor
Title:	Energy-aware Scheduling of Batch processing machines in Wafer Fabs
Standardization Focus:	Machine Execution System, SECS GEM, Sensors, Energy efficiency
Description (Goals/Claims from FPP/DoW)	- Energy-aware Scheduling of Batch Processing Machines in the semiconductor factories Digitalization of energy flows Implementation of energy based scheduling rules

Standards: Topic, Committee	**USE CASE 09 Energy-aware Scheduling of Batch processing machines in Wafer Fabs**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Safety of machinery	EN ISO 13849	published	yes	yes	yes	no	no
Safety of machinery	EN294: Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs	published	yes	yes	yes	no	no
Safety of machinery	EN775: Industrious robots	published	yes	yes	yes	no	no
Equipment standards	73 / 23 / EEC: Low Voltage Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	89 / 336 / EEC: EMC Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	89 / 392 / EEC: Machinery Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	EN61010-1: Safety of Electrical Equipment for Measurement, Control, or Laboratory Use	published	yes	yes	yes	no	no
Equipment standards	EN60204-1: Safety of Electrical Equipment of Industrial Machines	published	yes	yes	yes	no	no
Equipment standards	EN60825-1: Safety of Laser Products	published	yes	yes	yes	no	no
Equipment standards	EN55011: Radiated and Conducted Emissions for Industrial, Scientific and Medical products	published	yes	yes	yes	no	no
Equipment standards	EN61000-6-2: Immunity Standards for Industrial Equipment	published	yes	yes	yes	no	no
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	yes	yes	no	no
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts	published	yes	yes	yes	no	no
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
Energy management & Sustainability standards	ISO 14001 Focus: CO_2 footprint estimation and sustainability goals align directly	published	yes	yes	yes	no	no
	ISO 14064 Focus: Quantification and reporting of greenhouse gas emissions	published	yes	yes	yes	no	no
	ISO 14644 Focus: Cleanroom classification and environmental control	published	yes	yes	yes	no	no
AI, Data & Analytics Standards	ISO/IEC 42001 Focus: Governance and management of AI systems	published	yes	yes	yes	no	no
	ISO/IEC 27001 Foucs: Data security	published	yes	yes	yes	no	no
IoT & Industrial Communication Standards	IEC 62443: Focus: Security for industrial automation and control systems	published	yes	yes	yes	no	no
	OPC UA: Interoperability between industrial systems	published	yes	yes	yes	no	no
	IEC 61850: Focus: Communication within electrical substations and power systems	published	yes	yes	yes	no	no
Energy management	ISO 50001	published	yes	yes	yes	no	no
CO_2 accounting	ISO 14064 for CO_2 accounting	published	yes	yes	yes	no	no
secure industrial IoT	IEC 62443	published	yes	yes	yes	no	no
positioning as a future-ready Industry 5.0 solution	ISO/IEC 42001	published	yes	yes	yes	no	no

USE CASE 10	Lead: Systema, IFD Domain: Semiconductor
Title:	MES concept based on AI Improving Production Cycle
Standardization Focus:	Machine Execution System, SECS GEM, Robotic, Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- New MES Software Design enabling AI based manufacturing improvement - Sustainability in manufacturing by using AI and data

Standards: Topic, Committee	**USE CASE 10 MES for Semiconductor Factories**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
IT Architecture	Referenzarchitekturmodell Industrie 4.0 (RAMI4.0)	published	yes	yes	yes	no	no
AI Lifecycle	DIN SPEC 92001 Künstliche Intelligenz - Life Cycle Prozesse	published	yes	yes	yes	no	no
AI Communicatoin	SEMI EDA (Interface A) High speed Data source	published	yes	yes	yes	no	no
AI Data Structuring	SEMI E190 / E125 Data structure / feature engineering	published	yes	yes	yes	no	no
AI Control / Decisions	SEMI GEM300 (E40, E87, E94) AI based decisions	published	yes	yes	yes	no	no
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Safety of machinery	EN ISO 13849	published	yes	yes	**yes**	no	no
Safety of machinery	EN294: Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs	published	yes	yes	**yes**	no	no
Safety of machinery	EN775: Industrious robots	published	yes	yes	**yes**	no	no
Equipment standards	73 / 23 / EEC: Low Voltage Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	89 / 336 / EEC: EMC Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	89 / 392 / EEC: Machinery Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	EN61010-1: Safety of Electrical Equipment for Measurement, Control, or Laboratory Use	published	yes	yes	**yes**	no	no
Equipment standards	EN60204-1: Safety of Electrical Equipment of Industrial Machines	published	yes	yes	**yes**	no	no
Equipment standards	EN60825-1: Safety of Laser Products	published	yes	yes	**yes**	no	no
Equipment standards	EN55011: Radiated and Conducted Emissions for Industrial, Scientific and Medical products	published	yes	yes	**yes**	no	no
Equipment standards	EN61000-6-2: Immunity Standards for Industrial Equipment	published	yes	yes	**yes**	no	no
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	yes	**yes**	no	no
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts	published	yes	yes	**yes**	no	no
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	**yes**	no	no
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	**yes**	no	no

USE CASE 11	Lead TCAG, Task 6.1.3: Domain: Indoor Farming
Title:	AI-supported Industrial IoT for Indoor Food Production
Standardization Focus:	Cybersecurity, Explanable AI, ...
Description (Goals/Claims from FPP/DoW)	- Design, implementation and validation of the IoT Framework for an Indoor Farming system - Research, evaluate and demonstrate a concept for AI-driven antenna beam switching for wireless communication optimisation - Research, evaluate and demonstrate a concept for AI-driven visual plant mass estimation - Research, evaluate and demonstrate a concept for systematic threats modelling and risk assessment vav CRA requirements

Standards: Topic, Committee	**USE CASE 11 (Indoor Farming - with IoT and AI)**	Status	fair know ledge	used	moni tored	active	impact from AIMS5.0
Cybersecurity, ISO/IEC , TC65, WG10	IEC 62443-4:2018	published	yes	yes			
	Cyber Resilience Act (CRA)	pubished	yes	yes			The Cyber Resilience Act provides the regulatory framework guiding the cybersecurity activities in the UC towards structured compliance with essential cybersecurity requirements, thereby supporting improved security maturity at the product level.
	ISO 22000 for food safety management	pubished	yes	yes			

USE CASE 12	Lead: WUW Domain: Semiconductor
Title:	Human-Centred AI for the Optimization of Robust and Competitive Semiconductor Manufacturing Networks
Standardization Focus:	Machine Execution System, SECS GEM, Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- Improvement of manufacturing using AI tools and methods, human AI interaction - Sustainability and productivity increase in manufacturing by using AI interaction

Standards: Topic, Committee	**USE CASE 12 Productivity and sustainability, human interaction with AI**	Status	fair know ledge	used	moni tored	active	impact from AIMS5.0
IT Architecture	Referenzarchitekturmodell Industrie 4.0 (RAMI4.0)	published	yes	yes	yes	no	no
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
AI	DIN SPEC 92001 Künstliche Intelligenz - Life Cycle Prozesse	published	yes	yes	yes	no	no
AI	SEMI EDA (Interface A) High speed Data source	published	yes	yes	yes	no	no
AI	SEMI E190 / E125 Data structure / feature engineering	published	yes	yes	yes	no	no
AI	SEMI GEM300 (E40, E87, E94) AI based decisions	published	yes	yes	yes	no	no
AI	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
AI	ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements	under development	yes	yes	yes	no	no
AI	ISO/IEC TR 20226 - Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems	under development	yes	yes	yes	no	no
AI	ISO/IEC 23894:2023 Information technology — Artificial intelligence — Risk management	published	yes	yes	yes	no	no
AI	ISO/IEC 42001:2023 Information technology — Artificial intelligence — Management system	published	yes	yes	yes	no	no
AI	ISO/IEC TR 24028:2020 Information technology — Artificial intelligence — Overview of trustworthiness in AI	Published	yes	yes	yes	no	no
AI	ISO/IEC 5259:2024 Artificial intelligence — Data quality for analytics and machine learning (ML)	Published	yes	yes	yes	no	no
Simulation	VDI 3633 - Simulation of systems in materials handling, logistics and production - Terms and definitions	published	yes	yes	yes	no	no
Simulation	VDI 4465 - Modelling and simulation - Building the model	published	yes	yes	yes	no	no
AI	ISO/IEC 23053:2022 Framework for Artificial Intelligence (AI) Systems Using Machine Learning (ML)	published	yes	yes	yes	no	no
AI	EU AI Act (a regulation)	published	yes	yes	yes	no	no
Quality management	ISO 9001:2015	published	yes	yes	yes	no	no
IT Architecture	IEC 62264-1:2013: Enterprise-control system integration	published	yes	yes	yes	no	no
Manufactuing	ISO 22400: Automation systems and integration — Key performance indicators (KPIs) for manufacturing operations management	published	yes	yes	yes	no	no
IT	ISO/IEC 27001:2022 Information security, cybersecurity and privacy protection — Information security management systems — Requirements	published	yes	yes	yes	no	no

USE CASE 13	Lead: HoST Domain: Semiconductor
Title:	Intelligent Sensors improving Robustness of Automated Wafer Transportation and Storage Systems
Standardization Focus:	Machine Execution System, SECS GEM, Sensors, Energy efficiency
Description (Goals/Claims from FPP/DoW)	- Intelligent Sensors improving Robustness of Automated Wafer Transportation and Storage Systems B9 Use of Sensors and Machine Learning Methods for Monitoring and Controlling of AMHS components

Standards: Topic, Committee	**USE CASE 13 Intelligent Sensors improving Robustness of Automated Wafer Transportation and Storage Systems**	Status	fair know ledge	used	moni tored	active	impact from AIMS5.0
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Safety of machinery	EN ISO 13849	published	yes	yes	**yes**	no	no
Safety of machinery	EN294: Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs	published	yes	yes	**yes**	no	no
Safety of machinery	EN775: Industrious robots	published	yes	yes	**yes**	no	no
Equipment standards	73 / 23 / EEC: Low Voltage Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	89 / 336 / EEC: EMC Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	89 / 392 / EEC: Machinery Directive (and its amending directives)	published	yes	yes	**yes**	no	no
Equipment standards	EN61010-1: Safety of Electrical Equipment for Measurement, Control, or Laboratory Use	published	yes	yes	**yes**	no	no
Equipment standards	EN60204-1: Safety of Electrical Equipment of Industrial Machines	published	yes	yes	**yes**	no	no
Equipment standards	EN60825-1: Safety of Laser Products	published	yes	yes	**yes**	no	no
Equipment standards	EN55011: Radiated and Conducted Emissions for Industrial, Scientific and Medical products	published	yes	yes	**yes**	no	no
Equipment standards	EN61000-6-2: Immunity Standards for Industrial Equipment	published	yes	yes	**yes**	no	no
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	yes	**yes**	no	no
Robotics, ISO TC299	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts	published	yes	yes	**yes**	no	no
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	**yes**	no	no
DIN	ISO 281 2010-10 Wälzlager Dynamische Tragzahlen und nominelle Lebensdauer	published	yes	yes	yes	yes	no
MCE/7	BS ISO 15243:2017 - TC Tracked Changes. Rolling bearings. Damage and failures. Terms, characteristics and causes	published	no	yes	yes	yes	no
IEC	IEC 61131-3:2025 Programmable controllers – Part 3: Programming languages	published	yes	yes	yes	yes	no

USE CASE 14	FMX, Task 6.2.2 Domain: Semiconductor
Title:	Speeding-up the Benefit of Automation by Virtual Commissioning through Digital Twins
Standardization Focus:	Driverless Transport Systems, Semiconductor Equipment, Digital Twins, Material Flow Simulation
Description (Goals/Claims from FPP/DoW)	(1) Development of next generation AI based control systems for AI enabled automation systems (2) Development of a Digital Twin of one automation system for virtual commissioning (3) AI-based control strategies for fleet management of mobile robots (4) Simulation of mobile systems

Standards: Topic, Committee		Status	fair knowledge	used	monitored	active	impact from AIMS5.0
Topic (1)	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Topic (2)	VDI Status Report (2020-02) (Simulation and digital twin for equipment life cycle)	published	yes	yes	yes	no	no
Topic (3)	VDA5050 (Communication interface for driverless transport systems)	published	yes	yes	yes	no	no
Topic (4)	VDI3633 (Simulation of logistics, material flow and production systems)	published	yes	yes	yes	no	no

USE CASE 15	Lead: IFD, UNPD Domain: Semiconductors
Title:	Productionized Machine Learning models at scale
Standardization Focus:	Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- Research, evaluate and demonstrate concepts and use cases for ML and AI within the semiconductor industry e.g. waferinspection - Research, evaluate and demonstrate concepts and methods to implement ML and AI within wafer inspection - ML methods for wafer manufacturing - improved process efficiency, quality & cost improvement - scalable, interpretable, and production-ready Machine Learning for efficient semiconductor manufacturing.

Standards: Topic, Committee	**USE CASE 15 Semiconductor Manufacturing - Machine Learning Methods**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
Topic: Artificial Intelligence (AI) Committee: ISO/IEC JTC 1/SC 42 (Artificial Intelligence)	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes		yes		UC15 validates controllability of AI systems through human-in-the-loop mechanisms and explainable models in semiconductor manufacturing. Results provide evidence on operator intervention, monitoring, and safe override strategies for production-grade AI.
Topic: Artificial Intelligence / Functional Safety Committee: ISO/IEC JTC 1/SC 42 (AI) (JWG with IEC TC 65)	ISO/IEC AWI TS 22440-1 - Artificial intelligence — Functional safety and AI systems — Part 1: Requirements	under development	no		yes		UC15 provides industrial evidence for safety-critical AI deployment, highlighting the role of human-in-the-loop, explainability, and robust model behavior in supporting functional safety requirements.
Topic: Artificial Intelligence / Sustainability Committee: ISO/IEC JTC 1/SC 42 (Artificial Intelligence)	ISO/IEC TR 20226 - Information technology — Artificial intelligence — Environmental sustainability aspects of AI systems	under development	no		yes		UC15 supports sustainability by enabling more efficient manufacturing processes (reduced waste and rework), indirectly aligning with environmental aspects of AI systems.
Topic: Artificial Intelligence / Risk Management Committee: ISO/IEC JTC 1/SC 42 (Artificial Intelligence)	ISO/IEC 23894:2023 Information technology — Artificial intelligence — Risk management	published	yes		yes		UC15 demonstrates AI risk management in production through monitoring, explainability, and human-in-the-loop, addressing model reliability, drift, and decision risks.
Topic: Artificial Intelligence / Governance / Management Systems - ISO/IEC JTC 1/SC 42 (Artificial Intelligence)	ISO/IEC 42001:2023 Information technology — Artificial intelligence — Management system	published	yes		yes		UC15 supports AI management systems by demonstrating lifecycle management, monitoring, governance, and human oversight in industrial ML deployment.
Topic: Artificial Intelligence / Trustworthy Committee: ISO/IEC JTC 1/SC 42 (Artificial Intelligence)	ISO/IEC TR 24028:2020 Information technology — Artificial intelligence — Overview of trustworthiness in AI	Published (Technical Report, 2020)	yes		yes		UC15 supports trustworthy AI through explainability, human-in-the-loop, and robust deployment in real manufacturing environments.

USE CASE 16	Lead: Thales & Forth Domain: Semiconductor
Title:	AI enhanced production and performance of RF transceivers for civilian SATCOM and radar avionic applications
Standardization Focus:	***i) MICROELECTRONICS, NANOELECTRONICS AND OPTOELECTRONICS RESEARCH and ii) DEVELOPMENT OF NANOSTRUCTURE MATERIALS AND FABRICATION PROCESSES***
Description (Goals/Claims from FPP/DoW)	***- AI methodologies for faster design optimization - Protocols for AI supported optmized use of the fabrication/characterization facilities - Reduced enviromentl footprint (as result of the above) - Support specific avionic protocols for greener and safer airports*** ***specified quality control indexes monitored/calcluated by calibrated tools after each process step to assess the quality of the processes based on pre-defined standards***

Standards: Topic, Committee	**USE CASE 16 AI enhanced production and performance of RF transceivers for civilian SATCOM and radar avionic applications**	Status	fair knowledge	used	monitored	active	Impact from AIMS5.0
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
ISO	***9001:2015 - Quality management system (TUV AUSTRIA procedures) - for i) MICROELECTRONICS, NANOELECTRONICS AND OPTOELECTRONICS RESEARCH and ii) DEVELOPMENT OF NANOSTRUCTURE MATERIALS AND FABRICATION PROCESSES***	***published***	***yes***	***yes***	***yes***	***yes***	***yes***

USE CASE 17	Lead: FhG IISB & IFD Domain: Semiconductor
Title:	Intelligent Contamination Management & Prescriptive Control Plans and Process Flows
Standardization Focus:	Machine Execution System, SECS GEM, Sensors, Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- New MES Software Design enabling AI based manufacturing improvement Sensors for monitoring & control of Cleanrooms of pilot lines and high volume semiconductor lines

Standards: Topic, Committee	**USE CASE 17 Intelligent Contamination Control**	Status	fair knowledge	used	moni tored	active	impact from AIMS5.0
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Safety of machinery	EN ISO 13849	published	yes	yes	yes	no	no
Safety of machinery	EN294: Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs	published	yes	yes	yes	no	no
Safety of machinery	EN775: Industrious robots	published	yes	yes	yes	no	no
Equipment standards	73 / 23 / EEC: C17:C25Low Voltage Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	89 / 336 / EEC: EMC Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	89 / 392 / EEC: Machinery Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	EN61010-1: Safety of Electrical Equipment for Measurement, Control, or Laboratory Use	published	yes	yes	yes	no	no
Equipment standards	EN60204-1: Safety of Electrical Equipment of Industrial Machines	published	yes	yes	yes	no	no
Equipment standards	EN60825-1: Safety of Laser Products	published	yes	yes	yes	no	no
Equipment standards	EN55011: Radiated and Conducted Emissions for Industrial, Scientific and Medical products	published	yes	yes	yes	no	no
Equipment standards	EN61000-6-2: Immunity Standards for Industrial Equipment	published	yes	yes	yes	no	no
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	yes	yes	no	no
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts	published	yes	yes	yes	no	no
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
FDA Regulations	CFR Part 11 & Part 820 (Quality Mangement System Regulations)	published	yes	yes	yes	no	no
AI, ISO/IEC	ISA-95 (IEC 62264)	published	yes	yes	yes	no	no
AI, ISO/IEC	ANSI/ISA-88	published	yes	yes	yes	no	no

USE CASE 18	IFAG, Task 6.1.5 Domain: Semiconductor
Title:	Using semantic Data Model as base for AI optimized economic & ecologic/societal supply chain improvements
Standardization Focus:	Utilization of semantic standards for the description of semiconductor concepts pertaining to the economic and ecological operating curve.
Description (Goals/Claims from FPP/DoW)	Generation of a semantic description for the economic and ecological operating curve. Application of the sematic description to the open access platform of the ecological and economic operating curve. Through simulation show economic and ecological operating curve reduction of variability of fab consumption and machine variablitly with critical energy consumption.

Standards: Topic, Committee		Status	fair knowledge	used	monitored	active standard	impact from AIMS5.0
Semantic description framework	Semantic web standards (RDF, SPARQL, JSON, OWL, SKOS) for the generation of the Digital Reference model, therefore UC models also adhere to the the standards applied.	published	yes	yes	yes	yes	no
Semantic description framework	The Digital Reference recieved a general update to the OWL2 standard within the second year of AIMS.	published	yes	yes	yes	yes	no
Semantic description framework	The UC 18 model generated for the ecological operating curve and economic operating curve uses RDF for its relationship ontology structure, and OWL for the language.	published	yes	yes	yes	yes	no

USE CASE 19	Lead: NXP, T4.5 + T6.1 Domain: Semiconductor Industry
Title:	Extension of Digital Reference Ontology for Smart Sustainable Business Planning and incident handling
Standardization Focus:	RDF, SPARQL
Description (Goals/Claims from FPP/DoW)	Improvement of existing ontologies using semantic web with regard to traceability and sustainability Demonstrator of the two application areas business planning and incident handling

Standards: Topic, Committee	**USE CASE 19**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
RDF 1.1, W3C	https://www.w3.org/TR/rdf11-primer/	published	yes	yes			
SPARQL 1.1, W3C	https://www.w3.org/TR/sparql11-query/	published	yes	yes			
E142, SEMI	SEMI E142 - Specification for Substrate Mapping	published	yes	yes			
EPCIS 2.0, GS1	EPCIS Standard	published	yes	no	yes		

USE CASE 20	Lead: IFAT Domain: Semiconductor
Title:	Harmonization of Automated Digitized Equipment Control
Standardization Focus:	Machine Execution System, SECS GEM, Sensors, Machinery Regulation, Trustworthy AI, Safety
Description (Goals/Claims from FPP/DoW)	- Harmonization of databases, business processes and workflows for testwafer harmonization ob two 300 mm production lines Harmonization of testwafer business processes Digitalization of testwaferflows

Standards: Topic, Committee	**USE CASE 20 Harmonization of Automated Digitized Equipment Control**	Status	fair knowledge	used	monitored	active	impact from AIMS5.0
SEMI standards	various SEMI standards (equipment, control software, safety)	published	yes	yes	yes	no	no
Safety of machinery	EN ISO 13849	published	yes	yes	yes	no	no
Safety of machinery	EN294: Safety of machinery - Safety distances to prevent danger zones being reached by the upper limbs	published	yes	yes	yes	no	no
Safety of machinery	EN775: Industrious robots	published	yes	yes	yes	no	no
Equipment standards	73 / 23 / EEC: Low Voltage Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	89 / 336 / EEC: EMC Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	89 / 392 / EEC: Machinery Directive (and its amending directives)	published	yes	yes	yes	no	no
Equipment standards	EN61010-1: Safety of Electrical Equipment for Measurement, Control, or Laboratory Use	published	yes	yes	yes	no	no
Equipment standards	EN60204-1: Safety of Electrical Equipment of Industrial Machines	published	yes	yes	yes	no	no
Equipment standards	EN60825-1: Safety of Laser Products	published	yes	yes	yes	no	no
Equipment standards	EN55011: Radiated and Conducted Emissions for Industrial, Scientific and Medical products	published	yes	yes	yes	no	no
Equipment standards	EN61000-6-2: Immunity Standards for Industrial Equipment	published	yes	yes	yes	no	no
Robotics, ISO TC299	ISO 5363:2024 - Robotics — Test methods for exoskeleton-type walking RACA robots	published	yes	yes	yes	no	no
	ISO/PAS 5672:2023 - Robotics — Collaborative applications — Test methods for measuring forces and pressures in human-robot contacts	published	yes	yes	yes	no	no
AI, ISO/IEC JTC1 SC42	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no
	ISO/IEC TS 8200:2024 - Information technology — Artificial intelligence — Controllability of automated artificial intelligence systems	published	yes	yes	yes	no	no

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