

**Embedded multi-core systems for  
mixed criticality applications  
in dynamic and changeable real-time environments**

Project Acronym:

**EMC<sup>2</sup>**

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## Publishable executive summary

Standardization plays a key role in ARTEMIS industry-driven projects and contribution to standardization is a mandatory part of any proposal to be reviewed, as part of market impact. Further on, standardization is considered by the EC as a very important part of exploitation of results of research projects although it is a medium to long term issue compared to the duration of a research project (normally three years), whereas standardization schedules cover 5 years and more, and an immediate uptake requires a “window of opportunity”, i.e. start of a new work item within the time frame addressed by the project or of a maintenance cycle of an existing standard for an update which may take five years or more.

EMC<sup>2</sup> is quite aware of the importance of standardization. In the current Technical Annex “standardization” is referred to 178 times, most of the references concern contributions of work packages to standardization in their field of interest. Work packages cover technologies (WP 1 – WP6) as well as “Living Labs” (containers of industrial use cases) (WP 7-12). Since EMC<sup>2</sup> work packages involve a huge amount of standardization and standards related activities, the subtasks in this task are more complex than in other ARTEMIS or Framework Projects. To provide an overview over the various activities concerning standardization issues and to co-ordinate these activities in the overall frame of EMC<sup>2</sup> is a major challenge.

The task of WP 13.5, standardization, is to harmonize and motivate work packages and tasks to progress towards their standardization goals. The actual work has to be done in the technology and living labs work packages.

This deliverable combines two initial deliverables of WP 13.5:

- D13.23 - Standardization survey, collecting active (participation in standardization groups and committees) and passive (monitoring as follower or applying standards) involvement of partners in an overview (detailed tables in Annex A).
- D13.24 - Initial report about relevant standardization activities of the first year, particularly in the area of
  - Combined approaches to security issues in safety critical systems (IEC, ISO); work started 2014 and 2015; this topic is important from the “systems-of-systems” view of EMC<sup>2</sup> which is pertinent in the complex adaptive environments and systems being developed and assessed
  - Interoperability Specification – part of the efforts undertaken by the ARTEMIS-IA community towards an interoperability standard for tooling (IOS Specification), based on OSLC and forwarded to an OSLC group within OASIS; this is particularly part of WP5, a first overview was provided in D5.23 – Interoperability and Standardization, State-of-Art analysis, covering recent activities of the ARTEMIS-IA community in the small Innovation Action CP-SETIS, several ARTEMIS projects like CESAR, MBAT, SafeCer, CRYSTAL, EMC<sup>2</sup> and partially ARROWHEAD, and the ARTEMIS Standardization Working Group.
  - Domain specific standardization activities of the work packages will be covered in the upcoming annual reports and specific WP-deliverables when first results are available.

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# 1. Introduction

## 1.1 Objective and scope of the document

Scope of this document is to provide (1) a survey on active (participation in standardization groups and committees) and passive (monitoring as follower or applying standards) involvement of partners in an overview (detailed tables in Annex A), (2) report on first results on evolving, EMC<sup>2</sup> standardization activities in IEC and ISO Functional Safety Standardization on coordination of safety and security issues in an adaptive and strongly interconnected world of complex systems and systems-of-systems, and (3) Interoperability and Standardization.

Related work package deliverables are this time particularly:

Part of (2) was also discussed in WP6, System Qualification and Certification, Task 6.2, Assurance Methodologies for EMC<sup>2</sup> Systems, in D6.1, State of the Art for System Qualification and Certification.

The Interoperability issue (Part (3)) (particularly of the ARTEMIS High-Reliability project cluster) was discussed in a “State-of-Art” Deliverable D5.23 of WP5, System Design Platform, Tools, Models and Interoperability, Task T5.5, Interoperability and Standardization.

## 1.2 Structure of the document

The document consists of five parts:

1. Overview over challenges of the standardization in EMC<sup>2</sup>
2. Overview over standardization plans and activities of the work packages and tasks
3. Standardization Survey
  - a. Description of assessment method (questionnaires)
  - b. Summary of survey
4. Initial promotion of EMC<sup>2</sup> activities towards standardization organizations in IEC and ISO towards coordination of safety and security issues in functional safety standardization
5. Annex A: Detailed questionnaires of partners

## 2. Overview on Challenges of the Standardization Task in EMC<sup>2</sup>

Standardization is one of the key elements in exploiting results of research projects, therefore ARTEMIS-IA has founded an active Working Group on standards and Regulations, which has completed a Standardization Support Action “ProSE” (Promoting Standards for Embedded Systems)(lead Thales France, Technical Manager AIT) which resulted in the ARTEMIS Strategic Standardization Agenda. Further on, the Standardization task can build on experiences from many key partners who have been or are active in related projects of the ARTEMIS High-Rel Cluster of projects (iFEST, MBAT, SafeCer, R3-COP, CRYSTAL, RECOMP, Innovation Action CP-SETIS to harmonize the Interoperability Standardization activities across several ARTEMIS projects, etc.) with respect to standardization,

Since EMC<sup>2</sup> work packages involve a huge amount of standardization and standards related activities, the subtasks in this task are more complex than in other ARTEMIS or Framework Projects and to provide an overview over the various activities concerning standardization issues and to co-ordinate these activities in the overall frame of EMC<sup>2</sup> is a major challenge. Therefore, the main actual work particularly in domain-specific standardization activities has to be done in the technology WPs WP1 – WP6 and the Use Case oriented Living Labs WP7 – WP11.

Therefore, the main objective is to coordinate and harmonize the various standardization plans and activities addressed in technology WPs and LLs to gain momentum.

In EMC<sup>2</sup>, Standardization is one of the “Expected Innovations”, as cited in the Technical Annex:

### **AWP expected innovation #4: Certification and standardization**

*Projects are expected to propose an architecture to allow the investigation of the architectural design by the certification authorities as foreseen in the subject development standards of the individual industrial domains (aerospace, automotive, railway, wind-power, smart grid, medical, etc. ...).*

All EMC<sup>2</sup> use cases are strongly bound to certification and standardization. Especially living labs WP7 to WP9 have strong requirements which need to be fulfilled by any architecture (or application running hereon). Therefore, EMC<sup>2</sup> directly targets system qualification and certification through its dedicated WP6. The tool environment to be developed within the scope of WP5 as well as application models and design tools of WP2 are aware of these requirements, therefore supporting development with respect to standards and certification compliance.

The activities have to be organized strategically to achieve impact in those fields of interest where the potential and chance to succeed in a reasonable time frame are best. Therefore the so-called survey (assessment) is of key importance and aligned with the first year’s milestones of the Technology Work Packages (WP1-WP5) and Living Labs (WP7-WP12). This is to be able to include results e.g. from WP5 in a joint deliverable or reference it properly. The next step is a thorough analysis of the survey and the generation of a first standardization plan which will set priorities according to the impact of expected results on standardization and the “windows of opportunity” provided by the schedules of relevant standards (maintenance phase or new work items). Further on, joint activities by EMC<sup>2</sup> partners from different countries by support of their national committees make it easier to influence standardization.

The other deliverables can be aligned with the annual Milestones in month 24 and 36.

An additional reason for efforts towards standardization is the commitment of EMC<sup>2</sup> to contribute to the ARTEMIS CRTP, to the ARTEMIS repository and to comply with the ARTEMIS interoperability specification as started with CESAR and continued in MBAT and CRYSTAL. This interoperability specification is making use of OSLC, so the involvement in OSLC and participation in the OASIS group is an important issue.

An overview on planned WP activities with respect to standardization is provided in Section 3, an overview over the partners' involvement in Section 4.

Following activities are covered by the standardization task:

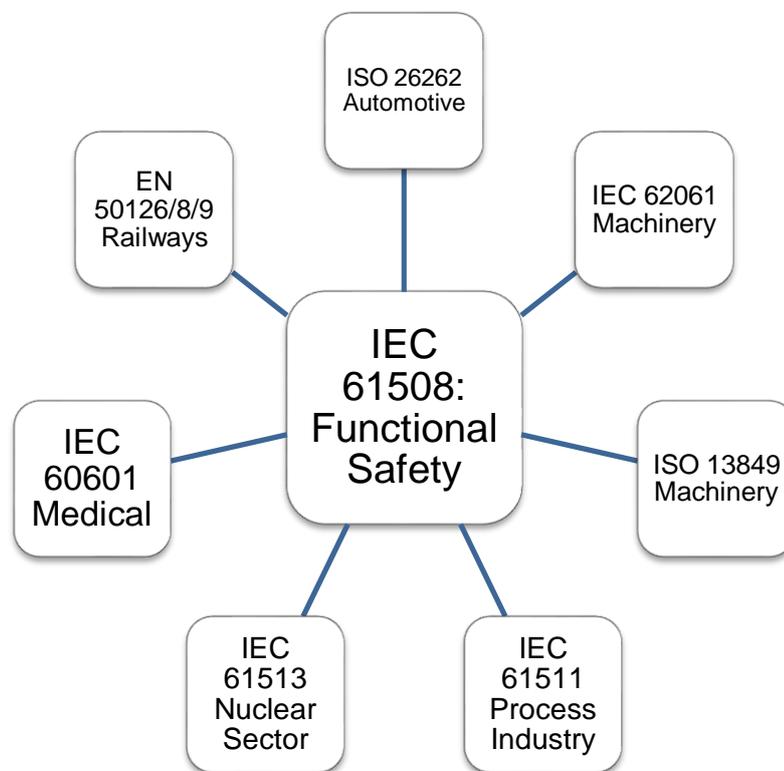
- Collect and assess standardization activities from the WPs and individual partners to provide an overview over the potential for standardization within EMC<sup>2</sup>.
- Assess partners' involvement and interest in standards and standardization activities (actively contributing or observing, or just use)
- Select promising standardization candidates
- Establish standardization plan and set up common objectives and joint activities
- Manage, plan and co-ordinate project-wide activities on standardization
- Provide annual project status reports on standardisation and updates of plans
- Co-ordinate and motivate partners to approach and/or join standardization committees or organizations / groups for active contribution and commenting/voting e.g. via national mirror groups (depending on organizational structure of the standardization committee/group).

A detailed description of standards to be addressed is to be found in the technology WP descriptions and living lab descriptions (Annexes B-M of the Technical Annex, an Overview is provided in section 3 of this report). It should be noted that much of the work for standardization is already included in the WP efforts, so that co-ordination of the activities, organization and management of the approaches to standardization organizations are the primary subtasks in T13.5.

Note: By experience from recent years, time schedules of standardization are by far longer than three years of a research project, not to forget that results of a certain maturity are normally achieved towards the end of the project. So part of the standardization activities will be to identify such "windows of opportunity" where final stages of standards development and of the project match properly (successful examples from AIT have been introducing Time-Triggered Architectures, Model-based testing and Automated Test Case Generation as results from the FP6 IP DECOS and the FP7 STREP MOGENTES in IEC 61508-3, when the third year of MOGENTES matched the final stage of IEC MT 12 activities). In the current reporting period, several standardization groups on functional safety started officially to consider for the first time or more detailed than before (IEC 61508) the impact of security attacks on safety-related and safety critical systems.

### 3. Overview over standardization plans and activities of the work packages and tasks

From the WPs, particularly WP5, System design platform, tools, models and interoperability, and WP6, system qualification and certification, with tasks on safety and security assurance methodologies, are contributors to evolving, updating or new standards and users of existing standards. One of the innovations in EMC<sup>2</sup> is the holistic approach to safety and security assurance and trust case building, and the qualification/certification of mixed-criticality, multi-core systems with resilience requirements, i.e. managing adaptability to changing environments and adaptive maintenance and enhancements during system life time under hard real-time run-time conditions in a safe and secure manner. This case is currently not considered in functional safety qualification/certification and needs not only new techniques/measures but also extensions to standards and processes, or new standards and processes. A list of standards to be addressed is to be found in section “References”.



**Figure 1: Functional Safety Standards – Security Awareness needed to be included as issue (WP6, WP13.5)**

From the other technology WPs and the Living Labs, a short overview delivers:

WP1, SP\_SoA – embedded system architecture, expects improvements of standards related to SoA (Service oriented Architecture) protocols and service semantics with focus on the critical applications to be addressed as innovation, through IRTF, IPSO and W3C.

WP2, with focus on application models and design tools for mixed criticality, multi-core embedded systems, works on clear separation of applications, optimized resource usage, code generation and offline analysis tools, with a strong safety concern. This impacts standardization and qualification considerably.

WP3, dynamic run-time environments and services, is involved in inter-core and inter-processor communication standardization, APIs and will propose results to platforms such as AUTOSAR.

WP4, multi-core hardware architectures and concepts, is interested in processor qualification and verification.

From the Living Labs, WP7 focusses on automotive standards, qualification of automotive software, ETSI standards around LDM automotive-relevant communication standards (ETSI, IEEE).

WP8 focusses on safety standards for airborne systems, e.g. SAEs ARP 4761.

WP9 focusses on aerospace systems (ECSS standards). Details on standardization in Avionics systems for space applications include

- Standardization of the basic functions and the way they interface with each other, in order to allow higher complexity within manageable and affordable limits, justify the increasing of R&D funding through the Space Agency and within all the European Industry Communities. Avionics Embedded Systems, covers avionics system aspects that cannot be adequately covered by a single discipline or technology domain in fact it covers areas from On-board Data Systems, to Space Systems Software to Space System Control.
- Within EMC<sup>2</sup>'s activities the following Areas will be covered:
  - Architectures and interfaces
  - Building Blocks (involving HW and SW)
  - Avionics on-board communications
  - Distributed avionics systems
  - Adaptive, reconfigurable avionics systems (including Fault Tolerant Architecture)
  - Development process and related methods and tools

WP10 (industrial manufacturing and logistics) have to consider, besides the functional safety standards for machinery and protective equipment, EMC standards and security challenges for smart devices integrated in large, complex assemblies (to build a chain trust on multiple roots of trust).

WP11 includes several use cases based on (mixed criticality) communications of networked EMC<sup>2</sup> nodes and systems. Many different technologies are applied and assessed – safety and security enhancements are necessary, communication profiles of several communication standards and protocols will be evaluated and the need for extensions or separate profiles for mixed criticality applications evaluated. System qualification and certification in networked environments (trust cases), system architectures and platforms from the WPs will be validated; influence on standardization activities of WPs is expected. Standardization issues are (besides others)

- TTEthernet
- IEEE 1588 group
- ETSI standards (communications, M2M, ...)
- Smart Grid related standards (many around these topics in IEC and ISO)
  - smart homes innovations with emphasis on management systems
  - autonomic algorithms and autonomic computing
  - smart home metering
  - smart home energy management

WP12 – cross domain applications - covers different application domains (control, surveillance and railways). Several standardization groups are affected (security of MPSoCs, resource management, tools, dependability, security, performance of systems, system qualification and certification etc.). Most standards addressed in WP6 are of relevance. Standards cover, mainly for use, but in a few cases like robust vision, vision based protective devices, medical imaging and railways:

- Surveillance and vision (security, privacy, robustness and reliability)
- Medical imaging (medical safety issues)
- Railways (new issue: security aware safety case evolving)

## 4. Standardization Survey

### 4.1 Description of assessment method (questionnaires)

#### 4.1.1 Introduction

The collection of standardization involvement was done via a questionnaire which was adapted from previously used questionnaires for the same purpose, with extended explanations since misinterpretations and misunderstanding of partners should be avoided. Particularly the fact that “involvement” is not only the case if partners are active members in standardization committees but also if standards evolvments are monitored just to maintain knowledge about what is going on (may be important for researchers and university institutes) (→ “followers”) or have to be taken account in their domain of work (“user”). The latter information is relevant as well since standardization is relevant in industry-driven research projects because suppliers or OEMs have to fulfill standards requirements in their products. The questionnaire contained already a few partners’ entries as example for a better understanding, besides the empty template tables.

#### 4.1.2 The Questionnaire (Template)

### Partners’ involvement in standardization

#### Notes:

*Standardization involvement means NOT ONLY personal involvement of the partners’ staff member(s) participating in EMC<sup>2</sup> but includes the whole company/institute/research organization (at least the department/division/site where the actual partners’ staff member is located). If at least one of the persons who actually work for EMC<sup>2</sup> are personally involved, please indicate this with an \* behind the role (examples in AIT table).*

**Table 1: Partner XXXX Standardization Involvement (please replace XXXX by your Acronym in the table headers and the file name!)**

**Involvement can be in different roles (column 3):** user, member, contributor, (co-) chair (or related status), (national) expert (nominated by a national mirror committee or similar), project leader or any other (**use the wording which you think best describes your role/interest/involvement**).

*Please note: Roles can be user of a standard as well!! (or follower if you are only monitoring progress or changes, but not actively work on it or comment on drafts).*

*Organisation/WG/project (column 1): Here can be either referenced a standardization committee or group, or a standardization organization (international, national, industrial association, company-type etc.) or working group, a pre-standardization group, or a (research or other) project where standardization issues are addressed.*

**Table 2: Partner XXXX Involvement in Related Research Projects and Platforms (please replace XXXX by your Acronym in the table headers and the file name!)**

*Table 2 should provide an overview on involvement of partners in current and past **related** projects (Cyber-physical Systems, Embedded Systems, critical systems) and platforms/organizations (e.g. FP6, FP7, Horizon 2020 projects, or ARTEMIS-projects CESAR, MBAT, p/nSafeCer, iFEST etc.) (except EMC<sup>2</sup> in this context, EMC<sup>2</sup> is assumed of course!). Please indicate if your organization is/has been involved in standardization WPs or activities by adding “standardization” under “Involvement/interest” and add “\*” if at least one person active in EMC<sup>2</sup> is/was involved.*

*The examples are from past surveys and incomplete, but should provide examples of the variety of data being possible.*

*It would be very nice if you could respond until October 31.*

*Please contact me in case something is unclear to you via email [erwin.schoitsch@ait.ac.at](mailto:erwin.schoitsch@ait.ac.at)*

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX

**Table 1: Partner XXX Standardization Involvement**

Project/Platform	Scope/Topic	Involvement/interest

**Table 2: Partner XXX Involvement in Related Research Projects and Platforms/Organizations**

## 4.2 Summary of survey

The detailed tables as filled in by the partners are contained in Annex A.

46 partners reported, 41 filled in the tables, which provides a good overview, some reported of no particular involvement either in standardization or in related projects and platforms or none in both.

A short summary to identify active involvement (not just user) in standards groups shows the following:

<b>Standards Group/Platform</b>	<b># of partners</b>	<b>Partners actively involved</b>
Functional Safety Standards (IEC 61508, ISO 26262, Airworthiness Stds.)	13	AIT, Alenia, AVL, CEA, CRF, EADS, FhG-IESE, IFAG, Philips, RCF, Siemens, Tecnalía, TTTech
Communications, IoT, Networks, Web	10	AIT, frequentis, IFAG, LTU, NXP, NXPGE, Quobis, SICS, Siemens, TTTech
IOS/OSLC, Interoperability		AIT, Alenia, AVL, Airbus, KTH, OFFIS, Philips, Siemens, Visure
Other Domain Standards	19	Alenia, AVL, CEA, CRF, EADS, Elektrobit, FhG-IESE, frequentis, HIB, IFAG, LTU, NXP, OFFIS, RCF, Siemens, Telvent, TTTech, Vector fabric, Visure
Modelling, Languages, Formal Methods, Systems	9	Alenia, AVL, CEA, IFAG, ISEP, OFFIS, Siemens, TVS, ViF
ARTEMIS-IA	23	AIT, Alenia, CAS, CEA, CINI, CRF, EADS, FhG-IESE, IFAG, ISEP, KTH, LTU, NXP, NXPGE, OFFIS, Philips, Quobis, Siemens, SILKAN, Tecnalía, TTTech, TUW, ViF
Other ETPs (EPoSS, SESAR,...)	7	AIT, AVL, frequentis, IFAG, NXP, NXPGE, Philips
Other Platforms	9	AIT, AVL, CINI, CRF, frequentis, IXION, Philips, Quobis, Vector fabric
High-Rel Cluster ARTEMIS		AIT, Alenia, CAS, CEA, CINI, CRF, DTU, Elektrobit, EADS, FhG-IESE, IFAG, ISEP, IXION, KTH, LTU, NXP, NXPGE, OFFIS, Philips, Quobis, RCF, SICS, Siemens, SILKAN, TASE, Tecnalía, TTTech, TU/e, TUKL, TUW, UNIVAC, UoMAN, Vector fabric, ViF, Visure
ITEA		IXION, OFFIS, TU/e, TUKL,
FP 6, 7		AIT, KTH, Philips, Siemens, SILKAN, TUKL, UNIVAC
National, others		AIT, CRF, DTU, EADS, Elektrobit, IFAG, NXP, NXPGE, OFFIS, Quobis, RCF, SICS, Siemens, TTTech, TUKL, TVS, TUW, ViF

**Table 3: Summary of partners' involvements**

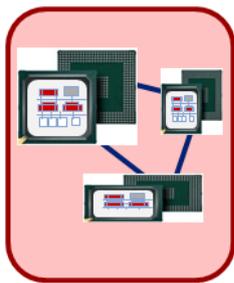
## 5. Initial promotion of EMC<sup>2</sup> activities towards standardization organizations in IEC and ISO towards coordination of safety and security issues in functional safety standardization

As explained before, promotion of research project results towards standardization requires for a rather fast exploitation a “window of opportunity”, i.e. a standardization process for a specific topic is in state that allows appropriate input at the right time.

Awareness has raised considerably that in an interconnected world where isolated systems are no longer possible the impact of security attacks on safety has to be taken into account in all life cycle stages of safety related or safety critical systems. That requires some interaction between safety and security measures and cooperation respectively coordination between the two communities which were quite separated in the past (and still are).

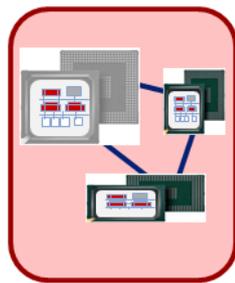
EMC<sup>2</sup> is particularly addressing highly networked adaptive systems, from internally connected multi-cores (quasi-static) to dynamically changing/adaptive closed ones to evolving dynamic open “systems-of-systems” (see Figure 2).

D1: ‘quasi statical’



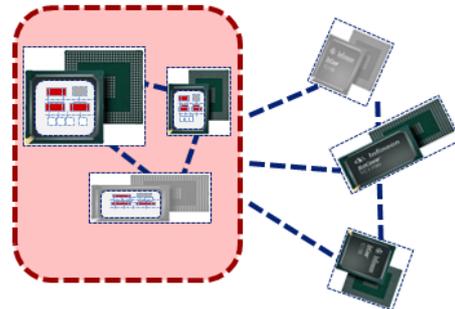
-statical scheduling  
-no dynamic changes at runtime  
-uses already the new SoA

D2: ‘dynamic changes in an *closed* system’



-known number of control units  
+applications  
-dynamic changes possible:  
e.g. reconfiguration, restart, migration

D3: ‘dynamic changes in an *open* system’



-variable number of control units  
+unknown applications possible  
-full range of dynamic changes possible

**Figure 2: EMC<sup>2</sup> - from closed to open systems**

The functional safety standards of the first generation did not tackle the challenges of highly connected “systems-of-systems”. Particularly the arising security issues were not considered at this time in context of safety. Security in an open vehicle system has become a new factor to be considered in system engineering and safety analysis.

IEC 61508 Ed. 2.0 [IEC 04], finished 2010, took as first functional safety standard into account that security may impact safety of a system. Therefore it requires consideration in the risk and hazard analysis phase, with accompanying measures to be undertaken in the following phases; particularly security has then to be reflected in the safety manual.

Although security engineering itself is excluded in the description of the scope of the standard, the standard states that it

*“...requires **malevolent and unauthorized actions** to be considered during hazard and risk analysis”.  
The scope of the analysis includes all relevant safety lifecycle phases.”*

The notes definitely address IEC 62443 [IEC 07] and ISO/IEC TR 19791 [ISO 03] (Part 1, 1.2, k). Security is mentioned in multiple requirements for the safety engineering lifecycle. Security threats need to be considered in the Hazard and Risk analysis:

*“ The hazards, hazardous events and hazardous situations of the EUC and the EUC control system shall be determined under all reasonably foreseeable circumstances (including fault conditions, reasonably foreseeable misuse and malevolent or unauthorized action). This shall include all relevant human factor issues, and shall give particular attention to abnormal or infrequent modes of operation of the EUC. If the hazard analysis identifies that malevolent or unauthorized action, constituting a security threat, as being reasonably foreseeable, then a security threats analysis should be carried out.”* (IEC 61508, Part 1, 7.4.2.3).

A security threat analysis should be conducted if a security threat is identified as a potential cause for a hazard. For guidance on security risks analysis IEC 61508 refers to the IEC 62443 series (*Industrial communication networks – Network and system security*) and to ISO/IEC/TR 19791. It is explicitly noted that malevolent or unauthorized action includes security threats. If security threats have been identified, then a vulnerability analysis should be undertaken in order to specify security requirements (IEC 61508, Part 1, 7.5.2.2).

Finally, Part 3 requires that all details about security should be included in the safety manual: *“The following shall be included in the safety manual: (...) Details of any security measures that may have been implemented against listed threats and vulnerabilities.”* (Part 3, Annex D 2.4).

Similar concepts are now evolving in IEC 61511, Ed. 2, and ISA TR 840009. Just recently, work on defining harmonized IT security requirements for railway automation was started [18], with the goal to build on the well-known safety certification processes of EN 50129, EN 50159 and integrate security requirements based on IEC 62443.

The initial concept to relate the rigor of security evaluation levels (EALs of Common Criteria) to the potential impact on safety (SIL level) did not find the necessary consensus. Now SLs (Security Levels 1 – 4) of IEC 62443 seem to be more accepted by industry than the Common Criteria EALs.

In the preparation phase of IEC 61508-3 Ed. 3.0 (Software part), which started Nov. 20-21, 2014, in Frankfurt and was continued in Toulouse March 17/18, 2015, it was decided to look at the ongoing activities in ISO and IEC with respect to “security-aware safety” and to provide more mandatory and informative guidance on a coordinated approach to security in context of functional safety.

In IEC TC65 (Industrial-process measurement, control and automation) considerable concerns arose with respect to the safety impact of security issues in industrial automation systems, since many complex systems of that kind are becoming connected “systems of systems”, particularly by interaction based on wireless connectivity from sensors/actuators to complete plants, grids etc., in maintenance and operations. An Ad-hoc Group (AHG1- “Framework towards coordination of safety and security”) was founded to look into the issue and provide recommendations how to handle the co-ordination of security issues in functional safety standards. The kick-off took place Oct. 28/29 2014 at VDE in Frankfurt. In the first meeting overviews were provided by several participants from Europe, Japan, China, US and Australia on ongoing activities and some research projects. E. Schoitsch from AIT provided an overview on several domains and the ARTEMIS projects ARROWHEAD, EMC<sup>2</sup> and SESAMO which had in-depth work

provided in the field of security-aware (security-informed) safety. The domains were not restricted to IEC standards areas but included also conceptual ideas from railways (EN 50126/28/29 and EN 50159), Airworthiness standards, Nuclear, Off-shore Platforms and Automotive (including pre-information from safety & security workshops e.g. at Fraunhofer IESE, ISSE WS at SAFECOMP 2014 Florence, ICCVE 2014 Vienna, ISSC Boston 2013 etc.).

The overall question to be discussed and recommendations to be given are: *„How to manage safety and security - in cooperation, integrated, separately? How to certify critical industrial systems taking industrial Cyber-security into account?“*

A short overview on standards' approaches discussed is provided here:

- Railways (DIN/VDE just updating EN 50129: Pre-standard DIN V 0831-104 ) – integrative approach (with IEC 62443, SL 1)
- Airworthiness Standards: 3 security standards (DO 326A (E 202A) Airworthiness Security Process Specification; DO 355 (ED 204) Information Security Guidance for Continuing Airworthiness; evolving DO YY3 Airworthiness Security Methods and Considerations) – far reaching separation
- IEC 62859: Nuclear power plants – fundamental principles defined how to include cybersecurity without impacting safety
- IEC 61511/ISA TR 840009 (draft) proposes the Cyber Security Life Cycle to be integrated with Process Safety Management
- TC44, Safety of Machinery, electro-technical aspects: separation of safety and security already at requirements level, OEM (integrator) should be the only responsible, not the machinery manufacturer - not appreciated e.g. by ISA or most of the experts.
- Example from off-shore facility: different safety and security levels at different parts of the facility assessed jointly, to be considered in allocation phase.
- IEC 62443 (security levels SL 1-4) vs. Common Criteria (ISO 15408, Evaluation Assurance Levels EAL 1-7): IEC 62443 the preferred standard for industrial automation.

A proposal from Austria (AIT) to ISO TC22 SC32 WG 08 (road vehicles – functional safety) presented at the ISO 26262 meeting at VDA in Berlin, Jan. 29/30, 2015, was set up by AIT after the AHG1 kick-off meeting, taking up ideas as well as some concerns pro and con from AHG1 members and WP6 of EMC<sup>2</sup>. The proposal left open, of course, the details which approach should be taken, although a more integrated approach was preferred by the proposer (AIT, Austria). The proposal looked like

- Cyber-security should be included as an risk factor to be considered during hazard and risk analysis
- If necessary appropriate security measures should be implemented, e.g. include recommendations for fitting security standards into ISO 26262 Ed. 2.0
- Include a requirement consolidation phase to resolve potential conflicts and coordinate safety and security requirements
- Validation of safety concept should <include>/<consider> security concept
- Security has to be considered throughout the whole (safety) life cycle – recommendations to be included where appropriate

It was decided to re-evaluate the issue in a small task group which has started to work already, with input from industry and AIT, based on WP6 intentions. In automotive this should be of great interest because of

the developments towards the “connected car”, V2V, V2I, highly automated or even autonomous driving – all trends that make security an important vulnerability and risk factor for safety [Sch01].

EMC<sup>2</sup> was presented as an example for a well-founded approach to design, assess, manage and later on be able to qualify/certify such systems at several meetings of IEC TC65 AHG1, ISO TC22 SC 32 WG08 and IEC 61508-3 preparation for Ed. 3.0.

In railways, the solution as it is planned by VDE in Germany is a more integrated one and was presented at the first Safety & Security Workshop at Fraunhofer IESE last year in September, with presentations from AIT and VDE as well.

In the railway domain, safety engineering is guided primarily by a set of four standards:

- EN 50126 Railway Applications – the specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS):
  - Part 1 – Basic Requirements and generic process (CENELEC 1999, Corr. 2010)
  - Part 2: - Guide to the application of EN 50126-1 for safety (informative) (2007)
- EN 50128 Railway Application – Communication, signaling and processing systems – Software for railway control and protection systems (IEC June 2011)
- EN 50129 Railway Applications - Communication, signaling and processing systems – Safety related electronic systems for signaling (IEC 2003, corrigenda 2010).

Security issues and unauthorized access issues are not addressed in the current version of EN 50126-1. It states

*“...this standard does not specify requirements for ensuring system security”.*

Nevertheless, similar as later was defined the relation of security to safety in IEC 61508 Ed. 2 (2010) we find:

- Under “4.3 Elements of Railway RAMS” it states (4.3.4) *“Security as an element that characterizes the resilience of a railway system to vandalism and unreasonable human behavior, can be considered as a further component of RAMS. However, consideration of security is outside the scope of this standard”.*
- Under “6.2 System definition and application conditions” *“security hazards”* are listed in the scope of the system hazard analysis.

The current version of EN 50128 (2011), although published after IEC 61508 (2010) does not refer to security at all. But in the mean-time, as railway communication systems are no longer isolated and use partially public networks even to transmit critical information and data, and wireless communication is used as well.

EN 50129 does not address security as well. But chapter B.4.6 “Protection against unauthorized access” (normative Annex B, operation with external influences, to be described in Section 4 of the Technical Safety Report of the Safety Case) takes into account different access levels guarding against unauthorized access. This focuses primarily on personal access (related to ISO 27001), but requires to define how protection is achieved against accidental and intentional unauthorized access in general. Security is one of the protection means of “external conditions”. These requirements allow to be extended to cybersecurity threats as well.

Therefore awareness has raised in the community that security issues have to be considered as potential cause of safety critical failures. An approach has started particularly in Germany (DKE) to include security requirements in EN 50129 by taking into account IEC 62443, the international group of standards for communication and network security for industrial networks. It was identified that the 41 requirements for security level 1 (SL 1) of IEC 62443 (“Protection against casual or co-incidental violation”) are mostly covered already explicitly by requirements of EN 50129 or usually fulfilled, a few are not in the scope of safety. Therefore it is recommended to include the missing SL1 requirements in the safety system’s requirements and add them in future to EN 50129. DKE in Germany plans a guideline based on IEC 62443 to address some issues, particularly of higher SLs having safety impact, in more detail. An integration of industrial Cybersecurity for Safety should be proposed, which allows separation of issues as far as possible, but without missing the context of a joint overall system certification including safety relevant security issues as part of the safety certification. This was discussed e.g. at the 1<sup>st</sup> Safety & Security Workshop at Fraunhofer IESE in Kaiserslautern on Sept. 15, 2014 (Jens Braband, Hans-Hermann Bock).

## 6. References

- [AS-NZS] AS/NZS (Australian/New Zealand Standard) 4360:2004 Risk Management
- [ECSS 01] ECSS-E-ST-40 ECSS Space Engineering Standard, Software Engineering
- [ECSS 02] ECSS-Q-ST-80 ECSS Product Assurance Standard, Software Product Assurance
- [IEC 01] IEC 31010: Risk management — Risk assessment techniques, 2009.
- [IEC 02] IEC 60812 Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA), IEC, 2006.
- [IEC 03] IEC 61025: Fault Tree Analysis, 2007.
- [IEC 04] IEC 61508: Functional Safety of Electrical / Electronic / Programmable Electronic Safety-Related Systems, Ed. 2.0, 2010
- [IEC 05] IEC 61882: Hazard and operability studies (HAZOP studies), IEC, 2001.
- [IEC 06] IEC Smart Grid Standardization Roadmap, 2010.
- [IEC 07] IEC 62443, Industrial communication networks - Network and system security - Security for industrial automation and control systems.
- [IEEE 01] IEEE Std 1012 - Standard for System and Software Verification and Validation, 2004
- [IEEE 02] IEEE Standard Glossary of Software Engineering Terminology, 1990.
- [ISO 01] ISO, 26262 Road Vehicles - Functional Safety, 2011.
- [ISO 02] ISO/IEC 15408: Common Criteria for Information Technology Security Evaluation
- [ISO 03] ISO/IEC TR 19791: Information technology -- Security techniques -- Security assessment of operational systems, 2010
- [IT-BLP] IT Baseline Protection Manual (German: IT Grundschutz-Handbuch), German Federal Office for Security in Information Technology (BSI), since 2005 “Baseline Protection Catalogues”
- [MSDL] Microsoft Security Development Lifecycle <http://www.microsoft.com/security/>
- [RTCA 01] DO-178C/EUROCAE ED-12C Software Consideration in Airborne Systems and Equipment Certification, 2012.
- [RTCA 02] DO 178C Technology Supplements:
- [DO-330](#) "Software Tool Qualification Considerations" - clarifying software tools and avionics [tool qualification](#)
  - [DO-331](#) "Model-Based Development and Verification Supplement to DO-178C and DO-278" - addressing Model-Based Development (MBD) and verification and the ability to use modeling techniques to improve development and verification while avoiding pitfalls inherent in some modeling methods
  - [DO-332](#) "Object-Oriented Technology and Related Techniques Supplement to DO-178C and DO-278A" - addressing [object-oriented software](#) and the conditions under which it can be used
  - [DO-333](#) "Formal Methods Supplement to DO-178C and DO-278A" - addressing [formal methods](#) to complement (but not replace) testing
- [RTCA 03] DO-254/ EUROCAE ED-80 “Design Assurance Guidance for Airborne Electronic Hardware”.

- [RTCA 04] DO-278 / EUROCAE ED-109 “Guidelines for Communication, Navigation, Surveillance and Air Traffic Management (CNS/ATM) Systems Software Integrity Assurance”, is the ground based complement to the DO-178B airborne standard.
- [RTCA 05] DO-178B / EUROCAE ED-12B “Software Considerations in Airborne Systems and Equipment Certification. Requirements and Technical Concepts for Aviation”
- [SAE 01] ARP-4761 System Safety Assessment, 1996.
- [Sch 01] E. Schoitsch, Ch. Schmittner, Z. Ma and T. Gruber: *The Need for Safety & Cyber-Security Co-engineering and Standardization for Highly Automated Automotive Vehicles*, paper accepted at AMAA 2015 (Advanced Microsystems for Automotive Applications), Springer Proceedings, Berlin July 7-8, 2015

## 7. Annex A: Partners' questionnaires

### 7.1 Tables 1: Partners' involvement in Standardization

Following partners reported to have no involvement in standardization (if not listed in tables): IMEC (only monitoring), evision, 15Q-ITI, fornebu Consultants, cc-ed.

#### 7.1.1 AIT Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of AIT
IEC SC65A MT12	IEC 61508 Functional safety of E/E/PE systems, maintenance team – restarted as IEC 61508-3 team and IEC 61508-31 team (2014)	Nominated Austrian expert of national mirror committee MR65*, user
IEC TC65 AHG1	Ad-hoc Group 1 of IEC TC65: “Framework towards coordination of safety and security (in industrial automation)”, (since Oct. 2014)	Nominated Austrian expert of national mirror committee MR65*
IEC SC65C WG13	IEC 61784-4 Profiles for secure communications in industrial networks	member of national mirror committee MR 65* (~TC 65)
IEC TC65 WG10	IEC 62443 Security of Industrial Process Measurement and Control – network and system security	Member of Austrian mirror committee MR 65* (~TC 65)
IEC SC65A/ IEC 61511 MT	Functional Safety: Safety of Instrumented Systems (SIS) for the process industry sector	Nominated Austrian expert of national mirror committee MR 65* (~TC 65)
IEC SC65B	IEC 61131 – 6: Programmable Controllers - Functional safety	Member of national mirror committee MR 65* (~TC 65)
ISO TC22 SC32 WG08	ISO 26262 Functional safety – road vehicles	Nominated Austrian expert of national mirror committee FA038* (~TC 22)
IEC TC44	Safety of machinery – electro-technical aspects	Starting to become member of Austrian mirror committee ÖVE TSK E08*
CENELEC TC106x	Electromagnetic Fields in the Human Environment	Nominated Austrian Expert, user as accredited lab
CENELEC C106x/ WG1	Mobile Phone and Base Stations	Nominated Austrian Expert, user as accredited lab
CENELEC TC106x/ WG4	Occupational EMF Exposure	Nominated Austrian Expert, user as accredited lab
ETSI ISG-QKD	Industrial Specification Group on Quantum Key Distribution	Chairman, founding member
ETSI MTS/MBT	ETSI Methods for Test Specifications – Model based testing	Member, monitoring

ETSI M2M	ETSI Machine-to-Machine Communication	Member, monitoring
ETSI ITS	ETSI Intelligent transport systems	Member, monitoring
EWICS TC7	involved in functional safety and medical devices safety (IEC 60601)	Active member of pre-standardization group*
ISO TC 184 SC2	Robotics, several WGs	Active member of national mirror committee FA028 (~TC 184)

### 7.1.2 Alenia Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
ISO TC/20	Alenia Aermacchi core business	Active Member
ASD-Stan	National representative for AIAD	Active Member
ASD-Cert	National representative for AIAD	Active Member
AIAD	Alenia Aermacchi core business	Active Member
IAQG/EAQG	National representative	Active Member
UNI	Chairmanship of U92 Technical Commission (Aerospace & Defense)	Active Member
UNAVIA	Chairmanship of Standardization Committee (Aerospace & Defense Standardization)	Active Member
ASD	Airworthiness Committee	Active Member
ISO-IEC-15288	Systems and software engineering - System life cycle processes	User
RTCA-DO-178B/C	Software Considerations In Airborne Systems And Equipment Certification	User
RTCA-DO-297	Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations	User
MIL-STD-498	Software Development and Documentation	User
ARINC-653	Avionics Application Software Standard Interface	User
OMG - SysML	Systems Modelling Language	User
OMG - DDS	Open, Multiplatform, Interoperable Publish-Subscribe Data-Distribution Service for Real-Time Systems	User
ISO STEP-AP233	Specify communications pipeline between Systems Engineering tools and databases	User
OMG - SPEM	Software & Systems Process Engineering Metamodel specification	User

OMG - UML	Object Modelling Language	User
OSLC	Open Services for Lifecycle Collaboration – an open specification for integrating tools	User

### 7.1.3 Articus Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of AIT
ISO TC22 SC32 WG08	ISO 26262 Functional safety – road vehicles	User

### 7.1.4 AVL Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of AVL
IEC SC65A MT12	IEC 61508 Functional safety of E/E/PE systems, maintenance team	User
ISO TC22 SC3 WG	Functional safety – road vehicles	User
AUTOSAR	Automotive Open System Architecture	Associate member
ASAM	Association for Standardisation of Automation and Measuring Systems	Active member (development and steering committee) and user
Modelica	Association for Standardisation of Automation and Measuring Systems	Active member (development and steering committee) and user

### 7.1.5 CAS Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
EASA CS25	Certification Specifications and Acceptable Means of Compliance for Large Aeroplanes	User
Airbus ABD0100 (Company standard)	Equipment - Design - General Requirements for Suppliers	User
EUROCAE ED-14/ RTCA DO-160D	Environmental Conditions and Test Procedures for Airborne Equipment	User
EUROCAE ED-79 / SAE ARP4754A	Certification Considerations for highly-integrated or complex Aircraft Systems, Revision A	User

EUROCAE ED-135 SAE ARP4761	Guidelines and Methods for conducting the safety Assessment Process on civil Airborne Systems and Equipment	User
EUROCAE ED-12C RTCA-DO-178C	Software Considerations in Airborne Systems and Equipment Certification	User
EUROCAE ED-80 RTCA-DO-254	Design Assurance Guidance for Airborne Electronic Equipment	User
FAA TSO-C194	Helicopter Terrain Awareness and Warning System (HTAWS)	User

### 7.1.6 CEA Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of CEA
OMG	UML Profile MARTE (Modeling and Analysis of Real-time and Embedded systems.	Contributor – lead of RFP
ISO 26262	Road vehicles -- Functional safety	User
AUTOSAR	Automotive Open System Architecture	Associate member
Sysml	OMG Systems Modelling Language	Participant
CEI (International Electrotechnical Commission)	SC 45A « Instrumentation and control of nuclear facilities » - WGA3 « Application of digital processors to safety in nuclear power plants »	Participant

### 7.1.7 CRF Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of CEA
ISO 26262	Road vehicles -- Functional safety	User
AUTOSAR	Automotive Open System Architecture	Associated member, User
SysML	OMG Systems Modelling Language	User

### 7.1.8 DTU Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
AS6802	Time-Triggered Ethernet	Follower

DO-178C	Software considerations in airborne systems and equipment certification	Follower
802.1Qbv	Enhancements for Scheduled Traffic	Follower

### 7.1.9 EADS Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner EADS
ARINC - NIS	Network Infrastructure & Security	Participant
AEEC / ARINC	Standardization of equipment, development and operational practices	Participant
Eurocae, RTCA	Standardization of development, certification and operational practices	Participant
ISO	Development of Security related Standards	Participant
IEEE	Technology Standards development affecting security	Participant

### 7.1.10 Elektrobit Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of AIT
AUTOSAR	Defines platforms and methodology for AUTOMOTIVE SW used in ECUs	Premium partner Lead of Software Architecture workgroup User
ISO 26262	Functional Safety	User

### 7.1.11 FhG – IESE Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of FhG IESE
ISO 26262	Edition 2. Group NA 052-01-03-16 AK	Contributor
AEF – Agricultural Industry Electronics Foundation	Agricultural domain. Review of guidelines. <a href="http://www.aef-online.org/">http://www.aef-online.org/</a>	Reviewer/Expert Member

### 7.1.12 Frequentis Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner Frequentis
EC/NEXUS	Future Satellite COM System	Active Member
EC/VOTE	VoIP Implementation and Transition Expert Group	Active Member
Eurocae/WG-67	VoIP for Air Traffic Management	Active Member
Eurocae/WG-82	New Air-Ground Data Link Technologies	Active Member
Eurocae/WG-100	Remote and Virtual Tower	Active Member
ICAO WG-I	ICAO Aeronautical Telecommunication Network over the Internet Protocol Suite	Participant
NENA	Public Safety/Next Generation 911	Active Member
EENA	Public Safety/Next Generation 112	Active Member
ETSI TCCE WG-4	Specification of mission critical broadband bearer services	Participant

### 7.1.13 HIB Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of CEA
AENOR	AEN/CTN 178 - CIUDADES INTELIGENTES (Smart Cities)	Chair of the AEN/CTN 178 committee
ISO/TC 268	Sustainable development in communities	User
CEN/CLC/SSCCCG	Smart and Sustainable Cities and Communities	User

### 7.1.14 IFAG Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Infineon
OSEK/VDX	Open systems and corresponding interfaces	Active member
AUTOSAR	Automotive Open System Architecture	Active member
FlexRay	Communication system for advanced automotive control applications	Active member
IEEE-ISTO	Industry Standards and Technology Organisation	Active member
IEEE-ISTO Nexus 5001 Forum	Standard for global embedded processor debug interface	Active member
AEC	Automotive Electronics Council	Active member

JEDEC	Joint Electron Device Engineering Council	Active member
ESDA	Electronic Discharge Association	Active member
EEMBC	embedded microprocessor benchmark consortium	Active member
ISO26262 International Semiconductor Working Groups (extension/improvement of ISO26262 standard)	Soft-IP, Analog	Active member
CAN ISO		Active member
OPEN Alliance SIG: Ethernet-based automotive communications	BroadR Reach: including but not limited to 100Mbps BroadR Reach physical layer specification and IEEE802.3bp RTPG (automotive gigabit)	Active member
Eclipse Automotive Industry Working Group: WP5: Eclipse Qualification Kit (ISO26262)	Based on the requirements of ISO26262 for the development of safety-critical applications in vehicles, a qualification / classification of tools, which are used in the development process, will be required	Inactive Member
OCP/IP Debug Working Group	Specification of generic on-chip debug support IP	Active member
MIPI Test & Debug Working Group	Specification of generic on-chip debug support IP for mobile devices	Active member
BISS Working Group	Specification of EMC tests	Active member
DKE	Emission and EMC compatibility of automotive vehicles	Active member
IEC	Integrated Circuits, Logic digital integrated circuits, EMC measurement methods	Active member
CISPR	Electromagnetic disturbances related to electrical/electronic equipment on vehicles and internal combustion engine powered devices; protection of receivers used in buildings, along the roadside, or in outdoor areas protection of on-board and adjacent vehicle receivers	Active member
ISO	Electromagnetic Compatibility (Vehicle & Components, RF Immunity, Pulse immunity, ESD)	Active member
PSI5 Consortium	Substandard Airbag, Substandard Powertrain; Further development of PSI5 specification	Associated member
SAE J2716 (SENT)	SAE J2716 (SENT)	Active member

**7.1.15 ISEP Standardization Involvement**

<b>Stds. Organisation/ WG/project</b>	<b>Scope/Topic</b>	<b>Involvement/role/interest of ISEP</b>
JTC1/SC22/WG9	Standardization of the Ada programming language	Nominated Portuguese Expert; Active member

**7.1.16 IXION Standardization Involvement**

<b>Stds. Organisation/ WG/project</b>	<b>Scope/Topic</b>	<b>Involvement/role/interest of Partner IXION</b>
ISO 26262	Road vehicles -- Functional safety	User
IEC 61508	Functional safety of electrical/electronic/ programmable electronic safety-related systems	User
MISRA	Software development guidelines to facilitate code safety, portability and reliability in the context of embedded systems	User

**7.1.17 KTH Standardization Involvement**

<b>Stds. Organisation/ WG/project</b>	<b>Scope/Topic</b>	<b>Involvement/role/interest of Partner XXX</b>
OASIS OSLC Member Section	Open Services for Lifecycle Collaboration	user & follower
OASIS	Open Standards Network	member

**7.1.18 LTU Standardization Involvement**

<b>Stds. Organisation/ WG/project</b>	<b>Scope/Topic</b>	<b>Involvement/role/interest of LTU</b>
W3C EXI	Efficient XML Interchange Working Group	Active member of standardization group
IPSO Alliance	IP Smart Objects	Active member of standardization group

### 7.1.19 NXP Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
IEEE 802.1Q	Ethernet networking	Follower
IEEE 802.1Qbu	Ethernet Frame Preemption	Follower
IEEE 802.1Qbv	Enhancements for Ethernet Scheduled Traffic	Follower
IEEE 802.1AS	Ethernet distributed synchronization	Follower
IEEE 1722	Layer 2 Transport Protocol Working Group for Time-Sensitive Streams	Follower
IEEE 802.1CB	Ethernet Frame Replication and Elimination for Reliability	Follower
AVnu alliance	Layer 2 Ethernet networking for the automotive domain	Active member
OPEN alliance	Layer 1 Ethernet networking for the automotive domain	Active member
IEEE 802.3bp	1000BASE-T1 PHY Task Force	Active member
IEEE 802.3bw	100BASE-T1 Task Force	Active member
IEEE 802.3bu	1-Pair Power over Data Lines (PoDL) Task Force	Active member
ETSI-ITS	ETSI Intelligent transport systems	Member, Monitor*
IEEE 802.11	IEEE 802.11p as PHY and MAC in car-to-car communication	Monitor
IEEE 1609	IEEE 1609 as geo-networking layer in ITS network	User

### 7.1.20 NXPGE Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner NXP
Acciel (formerly Gixel)	RFID, security & internet of things	User
CEN TC 224	RFID (Identification, signatures, cards ....)	User
Eurosmart	DRM Security	Active Member
Global Platform	DRM Security - secure and interoperable deployment and management of multiple applications on secure chip technology	Active Member
ISO-IEC-JTC1 SC3	Automatic identification and data capture techniques	Active Member
ISO-IEC-JTC1 SC1	RFID - Cards & personal identification	Active Member

### 7.1.21 OFFIS Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of OFFIS
Accellera Systems Initiative	Creation and evolution of system-level design, modeling, and verification standards for use by the worldwide electronics industry	Associate Member
Accellera SystemC Language WG (incl. TLM WG)	Definition and development of the SystemC core language	Working group chair*, maintainer of proof-of-concept implementation*
Accellera SystemC CCI WG	Configuration, Control and Inspection WG develops standards for tool/tool and tool/model interoperability	Contributing member*
Accellera SystemC Verification WG	Definition of verification extensions to the SystemC language standard	Contributing member*
IEEE-SA	IEEE Standards Association	Observer (P1801, P2416)*
IEEE-SA P1666 SystemC WG	Definition of IEEE 1666 for Standard SystemC Language Reference Manual	Contributing member*
AUTOSAR	Automotive Open System Architecture Timing extensions and Safety concept	Development partner, core contributor
IALA/IMO	Common maritime data structure (incl. S-100 extensions), E140 e-navigation architecture	Contributing member

### 7.1.22 Philips Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Philips
IEC60601-2-33	Medical electrical equipment - Part 2-33: Particular requirements for the basic safety and essential performance of magnetic resonance equipment for medical diagnosis	Active participation
IEC62464	Magnetic resonance equipment for medical imaging	Active participation
IEC60601-1-2	Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral Standard: Electromagnetic disturbances - Requirements and tests	Active participation
IEC60601-1-6	Medical electrical equipment - Part 1-6: General requirements for basic safety and essential performance - Collateral standard: Usability	Follower

IEC62366	Medical devices - Application of usability engineering to medical devices	Follower
IEC60601-1-8	Medical electrical equipment - Part 1-8: General requirements for basic safety and essential performance - Collateral Standard: General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems	Follower
IEC62926	"New Work Item: Real Time Control of Radiotherapy Equipment from Imaging - Linac related (Also need to monitor Image Guided standards developments for X-ray equipment that may affect MR)"	Active participation
ISO/IEC 10974	Assessment of the safety of magnetic resonance imaging for patients with an active implantable medical device	Active participation
ASTM F2119	IQ evaluation of Passive Implants	Follower
ASTM F2052	Magnetic Force Measurement Method	Follower
ASTM F2503	Marking of MR Conditional Items	Follower
ASTM WK34551	METAL imaging standard protocols for recommendation	Active participation
NEMA/MITA MS-8	SAR Measurement	Active participation
NEMA/MITA MS-13	NWIP: SNR Measurement Method for multi-element coils	Under discussion
NEMA/MITA MS-14	NWIP: RF Coil Thermal Safety Measurement Method	Active participation
European Commission ED 2013/35/EU	Worker Safety for EMF exposure	Active participation
China MR YY	Performance specifications for MR Systems	Under discussion

### 7.1.23 Quobis Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner Quobis
ATIS	DSI ( <a href="http://www.atis.org/dsi/">http://www.atis.org/dsi/</a> )	Contributor and member of the management committee
SIP Forum	WebRTC Task Force	Co-chair
IETF	STRAW WG	Co-chair and contributor

IETF	RTCWeb and other related WGs in the RAI area	Contributor
3GPP	WebRTC Access to IMS work item	User, follower
W3C	WebRTC WG	User, follower
IMTC	WebRTC WG	Monitoring

### 7.1.24 RCF Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner RCF
WG-72	Aeronautical Systems Security. WG-72 develops guidelines to address security concerns for aeronautical systems (airborne and ground but except land side equipment) and possibly aircraft maintenance	Active Member
MCFA	MCFA (MultiCore For Avionics) is a group of avionics industries and manufacturers that was formed to assist avionics suppliers in certification of equipment using SoC (System on Chip), and more particularly using multicore.	Active Member
ASD	The AeroSpace and Defence Industries Association of Europe (ASD) represents the aeronautics, space, defence and security industries in Europe in all matters of common interest with the objective of promoting and supporting the competitive development of the sector. It contributes to make evolving the existing regulation applicable to this sector.	Active Member
User Group	The RTCA DO-254 / Eurocae ED-80 document provides guidance for design assurance of airborne electronic hardware from conception through initial certification and subsequent post certification product improvements to ensure continued airworthiness.	Active Member
WG-63	EUROCAE WG-63 developed jointly with SAE S-18 the ED-79A (ARP 4754A), Guidelines for Development of Civil Aircraft and Systems, and is creating a new ED-135 (which will be identical to the proposed update of ARP 4761), Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment.	Active Member

### 7.1.25 SICS Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
IETF, ACE	Authentication and Authorization for Constrained Environments	Member of Working Group

### 7.1.26 Siemens Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner Siemens
OASIS	OSLC Standardization, for IOS Interoperability Specification	Active member, steering board
ETSI MTS	Standardization in Model-Based Testing / Requirements for modelling notations, Test Description Language	Active, driving member
CEN/CENELEC	CLC/CEN JPC R Programming Urban Rail / UR Survey Group	Active, driving member
CEN/CENELEC	CLC/CEN JPC R Programming Urban Rail / UR Survey Group	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 9/GK 914/GAK 914.0.3 Sichere Software	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3 Bahn- Signalanlagen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/AK 351.0.2 RAMS	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 9/GK 914 Funktionale Sicherheit von elektrischer, elektronischer und programmierbarer elektronischer Systeme (E, E, PES) zum Schutz von Personen und Umwelt	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.1 Software	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 9/GK 914/AK 914.0.5 Tagung zur IEC 61508	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.7 Security Anforderungen an signaltechnische Einrichtungen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.6 Semi-quantitative Methoden zur Risikoanalyse technischer Funktionen in der Eisenbahnsignaltechnik	Active, driving member

Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 1/K 132 Zuverlässigkeit	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3 Bahn- Signalanlagen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 1/K 132 Zuverlässigkeit	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.2 Ortsfeste Anlagen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351 Elektrische Ausrüstung für Bahnen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 7/K 767 Elektromagnetische Verträglichkeit (EMV)	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/AK 351.0.1 EMF in Bahnen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.9 Leittechnik	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/AK 351.0.2 RAMS	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.9 Leittechnik	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351 Elektrische Ausrüstung für Bahnen	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3 Bahn- Signalanlagen	Active, driving member

Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.2 Elektronische Systeme	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.4 Nahverkehr	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3/AK 351.3.3 Universelles Sicherheitsprotokoll nach EN 50159	Active, driving member
Deutsche Elektrotechnische Kommission im DIN und VDE (DKE)	DKE/FB 3/K 351/UK 351.3 Bahn- Signalanlagen	Active, driving member
DIN Deutsches Institut für Normung e.V.	DIN/NA 087-00-17 GA Gemeinschaftsarbeitsausschuss FSF/DKE: Systemaspekte in Bahnen	Active, driving member
DIN Deutsches Institut für Normung e.V.	DIN/NA 147-00-03-31 UA Inspektion (ISO/IEC 17020)	Active, driving member
Eisenbahn-Bundesamt	EBA Common Safety Methods	Active, driving member
ERA (European Railway Agency)	ERA-Safety/CSM on Risk Assessment	Active, driving member
ERA (European Railway Agency)	Common Safety Methods / Gemeinsame Sicherheitsmethoden	Active, driving member
ERA (European Railway Agency)	ERA/TSI Telematics Applications Passenger CCM	Active, driving member
ERA (European Railway Agency)	ERA-ERTMS/CG (Control Group)	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/WG 14 Working Group for safety-related standards	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/SC 9XA/WG 13 Signalling relays	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/WG 14 Working Group for safety-related standards	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/WG 12 Communication means between Safety Equipment. and MMI	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/SC 9XA/WG 4-2 Compatibility between Rolling Stock and Train Detection Systems - Additional parts to EN 50238	Active, driving member
Europäisches Komitee für elektrotechnische	CLC/TC 9X/SC 9XA Communication, signalling and processing systems	Active, driving member

Normung (CENELEC)		
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X Electrical and electronic applications for railways	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/WG 18 Railway Application - Electromagnetic Compatibility (EMC)	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X Electrical and electronic applications for railways	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/SC 9XA Communication, signalling and processing systems	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/WG 12 Communication means between Safety Equipment. and MMI	Active, driving member
Europäisches Komitee für elektrotechnische Normung (CENELEC)	CLC/TC 9X/SC 9XA/WG 13 Signalling relays	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 65/SC 65A System aspects	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 56 Dependability	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 56/WG 2 Dependability techniques	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 56/WG 2 Dependability techniques	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 56 Dependability	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/PT 62597 Railway applications - Measurement procedures of magnetic field levels	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/WG 44 Railway applications - Environmental conditions for equipment	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9 Electrical equipment and systems for railways	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/MT 62236 Railway applications - Electromagnetic Compatibility	Active, driving member
Internationale	IEC/TC 9/MT 60571 Railway applications - Electronic	Active, driving member

Elektrotechnische Kommission (IEC)	equipment used on rail vehicles	
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9 Electrical equipment and systems for railways	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/CAG Chairmen Advisory Group	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/WG 40 Railway applications-Urban Guided Transport Management and Command/Control Systems	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/WG 40 Railway applications-Urban Guided Transport Management and Command/Control Systems	Active, driving member
Internationale Elektrotechnische Kommission (IEC)	IEC/TC 9/WG 45 Railway applications - Automated urban guided transport	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/MG Safety Assurance	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/IRIS TFI (Technical Forum for Improvement)	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/MG Telematic Applications for Passengers	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/MG EMC	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	Unife ERTMS-ETCS Train Interface Unit	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/ETCS SC (Steering Committee)	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/ERTMS Marketing Group	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	Unife ERTMS-ETCS Train Interface Unit	Active, driving member
Union des Industries Ferroviares Europeennes (UNIFE)	UNIFE/IRIS Working Group 5	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Interface G und K	Active, driving member
Union Industry of	UNISIG/WG RBC Interface	Active, driving member

Signaling (UNISIG)		
Union Industry of Signaling (UNISIG)	UNISIG/WGI Eurobalise	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WGI Eurobalise	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG STM	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG RBC Interface	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Safety	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Super Group	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/ERA Change Control Management	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/Steering Group	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Safety	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Euroradio	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Keymanagement	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Test Spezifikation	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Euroradio	Active, driving member
Union Industry of Signaling (UNISIG)	UNISIG/WG Subset 76	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB FG BKI	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK Recht	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK Recht	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK Güterverkehrssysteme (GVS)	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB Ad-hoc S&T (Signaltechnik und Tk_Technik)	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	Ad-hoc Arbeitsgruppe "Neue technische Zulassung (NTZ)"	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK Regelwerke & Signaltechnik	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK Regelwerke & Signaltechnik	Active, driving member

Verband der deutschen Bahnindustrie (VDB)	VDB AK Mittelstand	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK ETCS-Schnittstellen	Active, driving member
Verband der deutschen Bahnindustrie (VDB)	VDB AK Qualitäts- und Projektmanagement	Active, driving member
Verband deutscher Eisenbahn-Ingenieure (VDEI) e.V.	Sachverständige und Fachbeauftragte	Active, driving member
Verband Deutscher Elektrotechniker (VDE) e.V.	VDE/ETG/A2 Bahnen mit elektrischen Antrieben	Active, driving member
Verband Deutscher Verkehrsunternehmen (VDV)	VDV-VDB/DURRS Deutsche Urban / Regional Rail Spiegelgruppe	Active, driving member
Verband Deutscher Verkehrsunternehmen (VDV)	VDV ATI UA SSiB Unterausschuss Systemtechnik für interoperable Bahnanwendungen	Active, driving member
Verband Deutscher Verkehrsunternehmen (VDV)	VDV-VDB/DURRS Deutsche Urban / Regional Rail Spiegelgruppe	Active, driving member

### 7.1.27 TASE Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of TASE
ECSS Standards	European Space Standards	User

### 7.1.28 Tecnalía Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of TECNALIA
ISO 26262	Road Vehicles – Functional Safety	Users
ISO 62304:2007	Health devices Software. Software life-cycle processes.	Users
ISO 14971:2012	Health products. Risk Management for health devices.	Users
ISO 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES)	Users
GSN	Goal Structuring Notation	Users
OMG: SATF	System Assurance Task Force	Members/Contributors
OMG: SACM	Structured Assurance Case Model	Members/Contributors

### 7.1.29 Telvent Standardization Involvement

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of CEA
AENOR	AEN/CTN 178 - CIUDADES INTELIGENTES (Smart Cities)	Chair of the AEN/CTN 178 committee
ISO/TC 268	Sustainable development in communities	User
CEN/CLC/SSCCCG	Smart and Sustainable Cities and Communities	User

### 7.1.30 TTTech Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner TTT
IEEE 802.1	Deterministic Ethernet / Time sensitive Networks	Voting member
RTCA DO 254	Aerospace hardware certification	Users group, member
AUTOSAR	Safety Working Group / investigate effects/interrelations of ISO26262 on/to AUTOSAR	Premium Member
SAE	The standards AS6802 & AS6003 were filed and supported by TTTech and accepted	Voting Member Standards AS6802 (TTEthernet) and AS6003 (TTP) AS6003/2 TPP Physical Layer
SAE S18	System Safety and Complex System Design Group	Liason Member, cooperation and support due aerospace industrial domain involvement
SAE AS-2	Embedded Systems Group	Liason Member, cooperation and support due aerospace industrial domain involvement

### 7.1.31 TU/e Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner TUE
ISO 26262	Road vehicles -- Functional safety	User

IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems (E/E/PE, or E/E/PES)	User
DO 178B	Software Considerations in Airborne Systems and Equipment Certification	User
OMG	Software Metric Meta-model (SMM)	User
ISO/IEC 15939	Systems and Software Engineering— Measurement Process	User
Sysml	OMG Systems Modelling Language	User

### 7.1.32 TVS Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
P1647 e Functional Verification Language	Standardisation of the e language used for functional verification of hardware	Active member leading task forces for additions to the standard
ISO 26262	Road vehicles -- Functional safety	User
DO-254	Avionics – Hardware Functional safety	User
DO-178	Avionics – Software Functional safety	User
IEC62304	Medical Devices - Functional safety	User
IEC61508	Electronic/Electrical Systems - Functional safety	User

### 7.1.33 UNIVAC Standardization Involvement

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
OMG	UML	User*
OMG	UML Profile MARTE (Modeling and Analysis of Real-time and Embedded systems)	User*
IEEE 1076	VHDL Language	User*
IEEE 1666-2011	SystemC language	User*
IEEE 802	IEEE 802 LAN/MAN Standards	User*
ANSI C	C programming language	User*

**7.1.34 UoMAN**

Organisation/ WG/project	Scope/Topic	Involvement/role/interest of AVL
AUTOSAR	Automotive Open System Architecture	User

**7.1.35 Vector Fabrics Standardization Involvement**

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Vector Fabrics
The Multicore Association	Definition and promotion of an open specifications to enable multicore product development.	Regular member

**7.1.36 ViF Standardization Involvement**

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Partner XXX
ISO 26262	ISO 26262 Road vehicles -- Functional safety	User
AUTOSAR	Automotive Open System Architecture	Associate member
ASAM	Association for Standardisation of Automation and Measuring Systems	Associate member
Eclipse	Automotive Industry Working Group	Solution member
ProSTEP iViP	Process and Product Data Management	Member
OMG	OMG Systems Modelling Language (SysML)	User
IEC 61508	IEC 61508 2 <sup>nd</sup> Ed - Functional safety of electrical/ electronic/ programmable electronic safety-related systems	User

**7.1.37 Visure Standardization Involvement**

Stds. Organisation/ WG/project	Scope/Topic	Involvement/role/interest of Visure
ReqIF Implementor Forum	Its role is to ensure interoperability between different ReqIF-based implementations (ReqIF stands for Requirements Interchange Format)	Member, User*

## 7.2 Partners' involvement in related projects and platforms

### 7.2.1 AIT – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CP-SETIS	Towards Cyber-Physical Systems Engineering Tools Interoperability Standards (H2020, Innovation Action)	Partner and WP Lead; standardization
MBAT	Combined Model-Based Analysis and Testing of Embedded Systems	Core Partner and Subproject/WP Lead; standardization
p/nSafeCer	Safety Certification of Software-intensive Systems with Reusable Components (ARTEMIS project)	Core partner; standardization
R3-COP	Resilient Reasoning Robotic Co-operating Systems (ARTEMIS project)	Core partner; WP lead; standardization
CPSoS	Cyber-physical Systems of Systems	Member of the (external) expert group
SESAMO	Security and Safety Modelling (ARTEMIS project)	Member of Expert Advisory Board
CRYSTAL	CRITICAL sYSTEM engineering AcceLeration (ARTEMIS AIPP)	Partner, WP lead
ARROWHEAD	Production and Energy System Automation – Service Interoperability based collaborative Automation (ARTEMIS AIPP)	Partner; standardization WP lead
EMC <sup>2</sup>	Embedded multi-core systems for mixed criticality applications in dynamic and changeable real - time environments	Partner, standardization WP lead
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG; E&T WG
euRobotics	European Robotics Platform, private partner of the robotics PPP	Member; Standardization WG;
EPoSS	European Technology Platform for Smart Systems Integration	Member; Automotive WG and Manufacturing & Robotics WG

### 7.2.2 Alenia – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner and WPs lead for base technologies and Use Case development
MBAT	Combined Model-Based Analysis and Testing of Embedded Systems	Partner and WP Lead concerning the Aerospace Use cases. Involvement in the IOS specification.
CRYSTAL	Critical System Engineering Acceleration - to establish an Interoperability Specification (IOS) and a Reference Technology Platform (RTP) as a European standard for safety-critical systems.	Partner and WPs Lead concerning base technologies and Use cases development. Involvement in engineering methods and IOS specification.
ASHLEY	Avionics Systems Hosted on a distributed modular electronics Large scale dEmonstrator for multiple tYpe of aircraft	Partner involved in both DDS standard application and demonstrator application development.

### 7.2.3 AVL – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Project coordinator*
CP-SETIS	Towards Cyber-Physical Systems Engineering Tools Interoperability Standards (H2020, Innovation Action)	Partner and WP lead; standardization*
CRYSTAL	CRITICAL sYSTEM engineering AccELeration	Project coordinator*
MBAT	Combined Model-based Analysis and Testing of Embedded Systems	Partner and WP lead; member of Steering board
SafeCer	Safety Certification of Software-Intensive Systems with Reusable Components	Partner and WP lead; member of Steering board
VETESS	Verification and Testing to Support Functional Safety Standards	Partner and WP lead; member of Steering board
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG chairperson*

### 7.2.4 CAS – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Project coordinator*
CRYSTAL	CRITICAL sYSTEM engineering AccELeration	Project coordinator*
MBAT	Combined Model-based Analysis and Testing of Embedded Systems	Partner and WP lead; member of Steering board
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG chairperson*

### 7.2.5 CEA – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner
CRYSTAL	CRITICAL sYSTEM engineering AccELeration	Partner
SafeCer	Safety Certification of Software-Intensive Systems with Reusable Components	Partner and WP lead; member of Steering board
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG chairperson*

### 7.2.6 CINI – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
ARTEMISIA	ARTEMIS Industrial Association	Member
NESSI	Networked European Software and Services Initiative	Member
NEXOF-RA	NESSI Open Service Framework Reference Architecture (FP7)	Member

### 7.2.7 CRF – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner
CRYSTAL	CRITICAL SYSTem Engineering AccELeration	Partner

ARTEMISIA	ARTEMIS Industrial Association	Member
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### 7.2.8 DTU – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
RECOMP	Reduced Certification Costs Using Trusted Multi-core Platforms	WP Lead
SYSMODEL	System Level Modeling Environment for SMEs	Partner
InfinIT SCSIG	InfinIT Safety-Critical Systems Interest Group	Coordinator

### 7.2.9 EADS – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
ARAMiS	Automotive, Railway and Avionics Multicore Systems (German research project)	Partner
RECOMP	REduced Certification COsts Using Trusted Multi-core Platforms	Partner
ACROSS	ARTEMIS CROSS-Domain Architecture	Partner

### 7.2.10 Elektrobit – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
ARAMiS	Automotive, Railway and Avionics Multicore Systems (German research project)	Partner
RECOMP	REduced Certification COsts Using Trusted Multi-core Platforms	Partner
ACROSS	ARTEMIS CROSS-Domain Architecture	Partner

### 7.2.11 FhG – IESE – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
MBAT	Combined Model-Based Analysis and Testing of Embedded Systems	Partner
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner and WP Lead
CRYSTAL	CRitical sYSTEM engineering AcceLeration	Partner

ARAMIS	Automotive, Railway and Avionics Multicore Systems (German BMBF)	Partner and WP Lead
SPES 2020	Software Platform Embedded Systems	Partner and WP Lead
SPES XT	Software Platform Embedded Systems “XT”	Partner and WP Lead
ARTEMISIA	ARTEMIS Industrial Association	Member

### 7.2.12 Frequentis – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
SESAR	Single European Sky ATM Research Programme	Member of SESAR Joint Undertaking. In this role we are involved in over 40 projects as project leader or industrial partner
D-MILS	Distributed MILS ( <a href="http://www.d-mils.org/">http://www.d-mils.org/</a> )	Industrial Partner

### 7.2.13 IFAG – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
EM4EM	Electromagnetic Reliability(EMR) of Electronic Systems for Electro Mobility	EMZ-specified power/nano/microelectronic components for eMobility-applications
Aramis	Automotive, Railway and Avionic Multicore Systems	SystemC modeling, virtual processing
VeTeSS	Verification and Testing to support functional Safety Standards	ISO 26262, Contribute to EU leadership in Automotive safety
SESAMO	Security and Safety Modelling	Extension of security features for automotive controllers
DESERVE	Development platform for safe and efficient drive	Development of ADAS systems
WEMUCS	Methods and Tools for interactive development and optimization of Software for embedded multicore systems	Develop contacts
eDAS	energy powered by smart Design meaningful Architecture connected Systems	Inputs for automotive designs
MACH	Massive Calculations on heterogeneous Systems	Develop contacts; learning in heterogeneous systems

**7.2.14 ISEP – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
CONCERTO	Guaranteed Component Assembly with Round Trip Analysis for Energy Efficient High-Integrity Multi-core Systems (Artemis)	Partner
P-SOCRATES	Parallel Software Framework for Time-critical Many-core Systems (FP7)	Project coordinator
Arrowhead	Cooperative automation; Internet of things; Service Oriented Architectures (Artemis AIPP)	Partner
ARTEMISIA	ARTEMIS Industrial Association	Member

**7.2.15 KTH – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
MBAT	Combined Model-Based Analysis and Testing of Embedded Systems	Partner and Subproject/WP Lead; standardization
iFEST	industrial Framework for Embedded Systems Tools	Technical coordinator, WP lead, standardization
CESAR	Cost-efficient methods and processes for safety relevant embedded systems	co-lead for architecture design WP
IIE (ICT Labs)	CPS Integrated Information Engineering	project lead and WP lead
Maenad (FP7)	Model-based Analysis & Engineering of Novel Architectures for Dependable Electric Vehicles	partner

**7.2.16 LTU – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
Arrowhead	Enable collaborative automation by networked embedded devices	Project coordinator

**7.2.17 NXP – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
ARTEMISIA	ARTEMIS Industrial Association	Member

### 7.2.18 NXPGE – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
ARTEMISIA	ARTEMIS Industrial Association	Member
euRobotics	European Robotics Platform	Member
EPoSS	European Technology Platform for Smart Systems Integration	Member

### 7.2.19 OFFIS– related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CONTREX	Design of embedded mixed-criticality CONTROL systems under consideration of EXtra-functional properties (FP7)	Project coordinator, standardization
European Mixed-Criticality Cluster	Collaboration forum between EU FP7 projects CONTREX, DREAMS and PROXIMA	Core Team Partner
ARAMiS	Automotive, Railway and Avionics Multicore Systems (German BMBF)	Partner, TP5 lead
MultiPARTES	Multi-cores Partitioning for Trusted Embedded Systems (FP7)	Member of the advisory board
SPES XT	Software Platform Embedded Systems 2020_XT (German BMBF)	Partner, Contract based design, modular safety concept, Design space exploration
MBAT	Combined Model-based Analysis and Testing of Embedded Systems (ARTEMIS)	Partner, Projectmanager, WP2.3 (Testing Tools) lead, Methodology for formal analysis and Testing
CRYSTAL	Critical System Engineering Acceleration (ARTEMIS)	Partner, Reference Technology Platform, Requirements engineering
Motorbrain	Nanoelectronics for Electric Vehicle Intelligent Failsafe PowerTrain (ENIAC)	WP2 Safety lead, development of methodology for multicore real-time analysis for automotive architecture
CPS-labs	Cyber-Physical-Systems Engineering labs	Transfer of automotive CPS approaches to maritime domain

## 7.2.20 Philips – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
AENEAS	AENEAS Industrial Association	Member
ARTEMISIA	ARTEMIS Industrial Association	Member
EPoSS	European Technology Platform for Smart Systems Integration	Member
ECSEL	ECSEL Joint Undertaking	Owner healthcare chapter
CATRENE	Cluster for Application and Technology Research in Europe on NanoElectronics	Member steering group “Applications”
ITEA3	Cluster programme supporting innovative, industry-driven, pre-competitive R&D projects in the area of Software-intensive Systems & Services (SiSS).	Board member
COCIR	European Coordination Committee of the Radiological, Electromedical and Healthcare IT Industry	Chair
Topsectoren (Dutch)	High-Tech Systemen en Materialen (HTSM)	Roadmap contribution
Topsectoren (Dutch)	Life Sciences & Health	Roadmap contribution
ARTEMIS Project	ALMARVI	Project leader
ARTEMIS Project	High Profile	Project leader
ARTEMIS Project	HoLiDeS	Monitor standardization
CATRENE Project	THOR	Project leader
ENIAC Project	CSI	Partner
ENIAC project	DeNeCor	Project leader and standardization
ITEA	COSI	Project leader
ITEA2	Care4Me	Project leader
ITEA2	HiPiP	Project leader
ITEA2	Mediate	Project leader
ITEA2	MEDUSA	Project leader
ITEA2	SoRTS	Project leader and standardization

**7.2.21 Quobis – related projects and platforms**

<b>Project/Platform</b>	<b>Scope/Topic</b>	<b>Involvement/interest</b>
THINK	Hyperties for future communications	Partner and WP Lead
ICARUS	robotic tools which can assist “human” crisis intervention teams.	Partner
NetWorld 2020	We are the European Technology Platform for communications networks and services.	Member, Steering board.
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG*
5G PPP	The 5G Infrastructure Public-Private Partnership	Member;

**7.2.22 RCF – related projects and platforms**

<b>Project/Platform</b>	<b>Scope/Topic</b>	<b>Involvement/interest</b>
MBAT	Combined Model-based Analysis and Testing of Embedded Systems – ARTEMIS	Partner
ODREA	Operational Demonstration of RPAS in European Airspace	Project coordinator

**7.2.23 SICS – related projects and platforms**

<b>Project/Platform</b>	<b>Scope/Topic</b>	<b>Involvement/interest</b>
PROSPER	Provably Secure Execution Platforms for Embedded Systems	Partner and implementation lead
HASPOC	HIGH ASSURANCE SECURITY PRODUCTS ON COTS PLATFORMS	Project lead, implementation lead
nSHIELD	Security, Privacy and Dependability (SPD) in the context of Embedded Systems	Partner

**7.2.24 Siemens – related projects and platforms**

CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner and WPs lead for base technologies and Use Case development
MBAT	Combined Model-Based Analysis and Testing of Embedded Systems	Partner and WP Lead concerning the Aerospace Use cases. Involvement in the IOS specification.
CRYSTAL	Critical System Engineering Acceleration - to establish	Partner and WPs Lead

	an Interoperability Specification (IOS) and a Reference Technology Platform (RTP) as a European standard for safety-critical systems.	concerning base technologies and Use cases development. Involvement in engineering methods and IOS specification.
CP-SETIS	Towards Cyber-Physical Systems Engineering Tools Interoperability Standards (H2020, Innovation Action)	Partner and WP Lead; standardization
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG*

### 7.2.25 SILKAN – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
ARTEMISIA	ARTEMIS Industrial Association	Member
SCARLETT	FP7 Project. “SCALable & ReconfigurabLe Electronics plaTforms & Tools”	
SMECY	ARTEMIS Project “Smart Multicore Embedded SYstems”	Multicore programming models Task leader.
SCALOPES	ARTEMIS Project. “SCALable LOw Power Embedded platformS”	Multicore code gen.
MACH	Ongoing ITEA2 Project. “MAssive Calculations on Hybrid systems”	Language embedded DSL

### 7.2.26 TASE – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
SafeCer	Safety Certification of Software-intensive Systems with Reusable Components (ARTEMIS project)	Partner

### 7.2.27 Tecnalia – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
CRYSTAL	CRitical sYSTem engineering AcceLeration	Project coordinator*
ARTEMISIA	ARTEMIS Industrial Association	Member; Standardization WG chairperson*

### 7.2.28 TTTech – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
Genesys	Development of a SoA and architectural blue print for embedded systems design	Partner/ SoA Architecture
INDEXYS	Industrial application of Genesys results in aerospace, automotive and railway domains	Coordinator/SoA Architectures
ACROSS	Development of an MPSoC based on Genesys results	Partner/ development of FPGA, software and Tools
CRYSTAL	Interoperability Specification (IOS) and a Reference Technology Platform (RTP) as a European standard for safety-critical systems	Application of results from ACROSS for automotive use in ADAS systems

### 7.2.29 TU/e – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
BENEFIC	Multi-core low power	Project participant
Flextiles	Multi-core dynamic reconfiguration	Project participant
i-GAME (Interoperable GCDC AutoMation Experience)	7th framework program (FP7-ICT-2013-10), STREP project number 612035, with the objective to develop technologies that speed-up the real-life implementation of automated driving.	Project participant
FP7-OPENCOSS	Open Platform for Evolutionary Certification Of Safety-critical Systems	Partner and WP lead; standardization*

### 7.2.30 TUKL (SEDA) – related projects and platforms

Project/Platform	Scope/Topic	Involvement/interest
SPES2020	Innovation alliance for Embedded Systems, Software Platform Embedded Systems 2020 (SPES2020)	Partner
SPES XTCore	Software Platform Embedded Systems 2020 XTCore (SPES XTCore)	Partner*
ViERforES	Virtual and Extended Reality for highest safety and reliability of Embedded Systems (ViERforES)	Partner and WP Lead*
ViERforES II	Virtual and Extended Reality for highest safety and reliability of Embedded Systems (ViERforES) - Phase 2	Partner and WP Lead*
ARAMiS	Automotive, Railway and Avionics Multicore Systems (ARAMiS)	Partner and WP Lead*

**7.2.31 TVS – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
NATEP	UK National Aerospace Technology Exploitation Programme – Requirements and Traceability Management Tool to Support Safety Standards Compliance for Avionics Systems, Hardware and Software Developments	Lead Partner; Standards Research and tool development

**7.2.32 TUW – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
ARTEMISIA	ARTEMIS Industrial Association	Member;
ECSEL JU	Electronic Components and Systems for European Leadership	Member;
MultiPARTES	Multi-cores Partitioning for Trusted Embedded Systems	Partner and WP leader;
VETESS	Verification and Testing to Support Functional Safety Standards	Partner;
AMADEOS	Architecture for Multi-criticality Agile Dependable Evolutionary Open Systems-of-Systems	Partner and WP leader;

**7.2.33 UNIVAC – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
VISION	FP7 ERC SG Project	Partner*
PRESTO	Artemis Project	Partner*
CRAFTERS	Artemis Project	Partner*
HYCON2	FP7 NoE	Partner*

**7.2.34 UoMAN – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner

**7.2.35 VECTOR Fabrics – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
Artemis Almarvi	Algorithms, Design Methods, and Many-Core Execution Platform for Low-Power Massive Data-Rate Video and Image Processing	Member

**7.2.36 ViF – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
CESAR	Cost-efficient methods and processes for safety relevant embedded systems (ARTEMIS)	Partner
ARTEMISIA	ARTEMIS Industrial Association	Member
MBAT	Combined Model-Based Analysis and Testing of Embedded Systems	Partner and Subproject/WP Lead; standardization*
p/nSafeCer	Safety Certification of Software-Intensive Systems with Reusable Components	Partner and Subproject/WP Lead;
CRYSTAL	CRITICAL SYSTEM ENGINEERING ACCELERATION	Partner and Subproject/WP Lead;
VeTeSS	Verification and Testing to Support Functional Safety Standards - ARTEMIS	Partner and Subproject/WP Lead;

**7.2.37 Visure – related projects and platforms**

Project/Platform	Scope/Topic	Involvement/interest
iFEST	industrial Framework for Embedded Systems Tools (ARTEMIS)	Partner and WP lead*; standardization