MADES

Model-based methods and tools for Avionics and surveillance embeddeD SystEmS

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D1.2 Standards Survey

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Executive Summary

This deliverable provides a survey of the various standards defining organisations in the ICT industry along with the identification of specific standards that are related to the requirements specified by the MADES industrial user partners. As the use of model driven engineering for critical embedded systems development is still in the early stages of industry acceptance, emerging specifications with potential to become *de facto* standards are also identified. The purpose of this deliverable is to ensure the project partners are aware of existing standards that could be utilised as a basis for further research and development. A mapping of the industrial user requirements to relevant standards is provided along with a summary of project partners' involvement in standards organisations relevant to MADES.

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1   Introduction

Standardisation is a consensus-driven activity, carried out by – and for – the interested parties themselves. Standardisation is based on openness and transparency within independent organisations, and its aims are to establish the voluntary adoption of, and compliance with standards. Despite its voluntary character, standardisation however many times has an effect on a number of areas affecting industry, such as competitiveness, choice of products and suppliers, and interoperability of products from different suppliers.

MADES will establish a standardisation strategy because of the expected benefits standardisation can provide to the project in addressing the needs of industrial organisations in the aerospace, surveillance and other industries. For example, standardisation strongly supports the dissemination and upgrading of project results, it widens the exploitation potential of MADES results, and it provides MADES with access to a large pool of external expertise. Moreover, developing new standards can help to build a strong position in the market for MADES and enable the exploitation of MADES results by the project partners and third party commercial organisations. In addition, MADES expects that the standardisation processes will bring higher international recognition and new opportunities for cooperation.

MADES is intended to be largely based on existing standards available from a range of standards organisations. Some of these interfaces or specifications will likely be extended within MADES to realise the innovations targeted by the project and to address advanced functionalities that were not considered at the times the standards were established. The extensions developed by MADES will be submitted to the appropriate standards organisations for consideration and the project partners will collaborate with other industrial organisations to eventually reach a consensus on new or extended standards driven by the MADES project technologies.

1.1 Types of standards

There are several definitions for standards and standardisation. For the purpose of this document, standardisation is understood to be the process aiming to define common and mutually agreed technical solutions between relevant stakeholders for the benefit of all involved. The primary aim of standardisation for MADES is to remove technical barriers, open up new markets, and enable new innovations for collaborative work to be built upon the project results. Standardisation should also help create economies of scale while at the same time increasing opportunities for product differentiation and competition as well as services.

Within the standards making communities around the globe, four major categories of standards can be identified:

- **Fundamental standards** - concerning terminology, conventions, signs and symbols, etc;

- **Test methods and analysis standards** - measuring characteristics such as traceability, correctness, security, or other attributes of a system;

- **Specification standards** - defining the characteristics of a product or service and their performance thresholds, e.g. interchangeability, expected actions, requirements to be satisfied;

- **Organisation or process standards** - describing the functions and relationships within an organisation, as well as elements such as quality assurance, maintenance, software development procedures, etc.

A key benefit from the standardisation process is the additional validation activities that occur in the standards making process by a wider expert audience that are often close to the market. These experts well understand standards' key role in encouraging innovation, improving markets and creating competitive opportunities. This outside expertise provides additional value in providing feedback and perhaps improving the original proposed solutions (technologies, services, guidelines, etc.), and thus increasing the benefits provided by the new or modified standard to the target industrial domains.

1.2   Standards survey scope

There are hundreds of organisations that position themselves as originators of standards ranging from government sponsored formal standards bodies, to industry associations that address standards for specific application domains. For this deliverable the survey scope is centred on standards setting organisations and standards that are potentially relevant to the MDE research and development topics being addressed within the MADES project.

The motivation for this deliverable is to ensure the project partners are aware of existing standards that could be utilised as a basis for further research and development and to also be aware of potentially conflicting or competing standards. As the use of MDE for critical embedded systems is still in the early stages of industry acceptance, emerging specifications with potential to become *de facto* standards are also considered.

1.3   Role of this deliverable

This deliverable focuses on describing the current landscape of standards relevant to MADES at the early stages of the project workplan. The role of this deliverable is to create awareness amongst the project partners of existing standards that could be utilised as a basis for further research and development in the project, and to identify existing standards that may address one or more of the industrial user requirements for the project. A further role of this deliverable is to assist external organisations within industry in identifying standards defining organisations and specific standards and emerging specifications related to model driven engineering for embedded systems.

1.4   Structure of this document

This deliverable is structured in six parts starting with an overview in Section 2 of the standardisation processes utilised by standards defining organisations of various types and forms and the different types of results that are achieved. Section 3 provides a survey of the various standards defining organisations within the ICT industry including a summary of the organisation and links to the respective websites where more details are available. Sections 4 and 5 identify the specific standards from the various standards defining organisations that may be relevant to MADES research and development, where both well established and emerging potential standards are identified. Sections 6 provides a mapping of the industrial user requirements set out in *D1.1 – Requirements Specification* to the specific standards that may address each requirement. Section 7 indicates the standards defining organisations relevant to MADES where project partners are active and where new or extended standards developed in the project are likely to be submitted for industry consensus.

1.5   Relationship to other MADES deliverables

This deliverable is closely related to *D1.1 – Requirements Specification* as the industrial user requirements, along with the workplan and initial technology vision established within the project, have helped focus the scope of the survey towards specific standards and emerging standards that are relevant to MADES requirements and research objectives.

The results of this deliverable will provide important inputs for the specification work to be carried out in each of the development workpackages and in particular the preparation of deliverables:

- D2.1   MADES Modelling Language Specification
- D2.2   MADES Modelling Tools Architecture
- D3.1   Domain-specific and user-centred verification
- D4.1   Model Transformation and Code Generation Tools Specification

Conformance to standards is also expected to be part of the evaluation criteria that will be developed and specified in *D5.1 – Specification of the evaluation criteria of the technical WPs,* and this deliverable is expected to contribute towards the definition of standards related evaluation criteria for the later stages of the project.

1.6   Contributors

The Open Group has been a major contributor to this deliverable as well as acting as editor in the preparation of the various versions of the document. Politecnico di Milano and University of York have made significant contributions, while Softeam and TXT e-solutions have acted as reviewers for the deliverable providing valuable suggestions for final editing and refinements.

2   Standardisation processes

ICT standardisation processes are carried out in many different organisations on a national, European or global level, by many different types of organisations. In most of these organisations, standardisation is conducted following a number of identical process steps. Despite these general process characteristics there are also differences between organisations, for example in the approach they take, or with respect to the results they seek to achieve.

Standards bodies do not always have the same objectives and therefore do not always produce the same type of output. Some organisations may for example pursue results more fit for legislative purposes, e.g. through emphasizing the thoroughness of their formal and public approval processes, while others seek to produce guidelines addressing immanent market needs, e.g. through consensus amongst their participants.

2.1   General process characteristics

Although not all standardisation processes follow exactly the same steps, in exactly the same order, a number of commonalities can be identified that characterise a 'typical' standardisation process:

- First, a market need for a new standard or standardisation activity has to be identified and recognised amongst a sufficient number of members of an existing standards organisation, or sufficient interests exists to form a new grouping;

- Subsequently, a set of requirements has to be drafted, underlying the actual technical specification work (usually referred to as 'commercial', 'user' or 'functional' requirements);

- Based on consensus reached amongst the organisation's members on these requirements, a specification is drafted by a group of technical experts;

- Once the draft specification is finalised, a formal approval process is conducted; this may be limited to the organisation and its participants, but may also invite a wider audience, e.g. to broaden the support for, or impact of the future standard;

- After its approval, arrangements are made for testing or (self-) certification by the industry, in order to guarantee interoperability between different implementations; this may also encompass developing reference implementations or implementation guidelines;

- Finally, a maintenance or periodic review and possibly update process will be embedded in the organisations procedures to ensure the standard will remain in sync with market requirements.

The technologies resulting form the MADES project that will be candidates for standardisation will need to follow a similar set of steps. Some of these steps will occur during the operation of the project, while others will be undertaken after the MADES contract is completed.

2.2   Different organisations, different approaches & different results

Many standardisation processes in principle follow the same sequential steps, but they do not necessarily generate the same results. This may be due to differences between the nature of organisations, or due to a specific approach (e.g. formal or non-formal) towards standardisation processes. Also, it can be a result of an organisation's participants aiming at specific standardisation deliverables (e.g. guidelines documents or test specifications).

When considering the various standards involved in MADES related software development we must consider the differences between types of standards bodies, as well as differences between the standardisation processes they support, and between standardisation deliverables they produce.

2.2.1 Different types of standards bodies

On a European level, there are three formal standards organisations: CEN[1], CENELEC[2] and ETSI[3]. These are recognised by the European Commission and meet the World Trade Organisation criteria for standards setting. All three have cooperation arrangements in place with their global counterparts: ISO, IEC and ITU. In addition, there are several formal standards bodies working at a national level, which also have wider impact (e.g. DIN[4], ANSI[5] or BSI[6]).

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[1] European Committee for Standardization

[2] European Committee for Electrotechnical Standardization

[3] European Telecommunications Standards Institute

[4] German Institute for Standardization

[5] American National Standards Institute

As the MADES project partners are not aiming to address standards that ultimately should have a more legal (or even mandatory) character, choosing one of these formal standards body for establishing new standards based on the project results is not the best path. Formal standardisation processes require relatively long periods for formal approval processes which could substantially lessen the desired impact of the MADES project results.

Many aspects of ICT standardisation are however covered by industry consortia and trade organisations rather than by formal standards bodies. Industry consortia do not primarily aim at producing formal standards, and many times set out to address or resolve only a limited number of specific issues. Usually they have a lifespan between 5 and 15 years, as their activities tend to terminate once their original standardisation goals have been accomplished.

Despite the less formal character of the industry standards they produce, their strong focus on specific market segments often proves to be an efficient way for generating critical mass among stakeholders, necessary for successfully completing standardisation processes.

2.2.2 Different types of standardisation results

The ICT standardisation environment is characterised by a large number of standards bodies, generating an even larger number of standardisation activities. Even with these differences however, the deliverables resulting from these activities can be grouped as follows:

- **Formal standards**, sometimes also referred to as *de jure* standards, are normative documents from formal standards bodies and have passed through a full and open consensus process. They are implemented on a national level and there is strong pressure to apply them; formal standards have a legal basis and can be made mandatory but considerable time (up to 4 years) is needed for completing the full approval process.

- **Technical or industry specifications** are based on consensus among members of standards bodies, consortia or trade organisations and do not have a formal character or legal basis; they are recommendations and require less time to produce (1-3 years) but when widely accepted and used in practice by relevant market players they can become *de facto* standards.

- **Workshop Agreements** are industry recommendations developed by interested stakeholders through a short-track process (6-12 months) often facilitated by several formal standards bodies; workshop agreements serve as industrial consensus documents between participating individuals and organisations, and can be revised relatively easily.

- **Conformance, test applications, reference implementations** and guidelines aim to support interoperability between and easy rollout by market players of products and services based on formal standards or industry specifications. They have an informative character and are usually produced in a relatively short timeframe (6-12 months).

- **Technical reports** are informative documents supporting further standardisation work, e.g. by identifying the need for additional technical clarifications in – or between – existing specifications, standards, or guideline documents.

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[6] British Standards Institute

Both formal standards and industry specifications that are developed in an open process and are publicly available under so called Fair, Reasonable and Non-Discriminatory (FRaND) terms, can be regarded as 'open standards'. Nevertheless, there can be a trade-off between the formal impact of a standard, and the amount of time (and in some cases also resources) it takes to produce.

The MADES project will most likely have as its eventual goal for standardisation the establishment of a new or revised industry specification.

2.3   Emerging standards

The MADES project is addressing state-of-the-art technologies in MDE for embedded systems, which is a relatively new field of software development. Many of the industry technologies and specifications related to MADES topics are *de facto* standards that are recognised more for their widespread usage or acceptance, rather than having passed through a process of industry review and consensus or formal approvals.

These emerging standards often have associated communities of users who create momentum for industry acceptance and adoption even though the standards development process is often no more structured than a website for downloading a specification or an open source reference implementation, and a discussion board where the main contributors to the specifications and industrial and academic users can interact. Nonetheless, there are several examples of successful industry standards that were established through very similar arrangements (e.g. Linux).

A natural progression for many of these emerging standards is that alternative implementations or specifications appear which are driven by different application domain specific requirements. When this occurs and the emerging standards reach a level of maturity, efforts to converge the various alternatives are undertaken. This convergence process functions quite similarly to the consensus process utilised by member based standards bodies, consortia or trade organisations.

The project partners expect that many of the specifications and technologies that will eventually be considered as established MBE standards for embedded systems will follow similar informal paths to industry acceptance and *de facto* standardisation. For this reason the relevant emerging standards have been included in this survey deliverable.

3   Standards defining organisations

The following provides a listing of standards defining organisations (SDOs) addressing standards that potentially have relevance to MADES. The SDOs are listed alphabetically with a short description taken directly from their websites. The type of standardisation results they generally achieve are noted as one of the following:

- IND – Technical or industry specifications

- FRM – Formal standards having a legal or regulatory basis for enforcement

- RI – Reference implementation establishing a de facto standard by usage

A link to each SDO website is provided for obtaining further details.

Organisation	Description	Type	Link

Organisation	Description	Type	Link
ACCELLERA	Drive worldwide development description and use of standards required by systems, semiconductor and design tools companies, which enhance a language-based design automation process.	IND	www.accellera.org
AEEC	Delivers benefits to airlines and aviation industry by promoting competition, providing interchangeability, and reducing life-cycle costs for avionics and cabin systems. Over 3500 engineers and scientists representing nearly 2000 organisations participate in the development of ARINC Standards. These standards define key elements of equipment and systems installed in more than 10,000 aircraft around the world.	IND	www.aviation-ia.com
AFEI	The Association for Enterprise Integration goal is to advance enterprise integration, network centric operations and world-class electronic business practices for industries and governments	IND	www.afei.org
AIM	Association for Automatic Identification and Mobility is a global trade association comprising providers of components, networks, systems, and services that manage the collection and integration of data with information management systems. AIM's core value is to accelerate the growth and use of AIDC technologies and services.	IND	www.aimglobal.org
ATA	ARCNET Trade Association maintains the ARCNET standard ATA 878.1-1999 a high-speed local area network (LAN) well-suited for real-time control applications which is available for free to the public by download.	IND	www.arcnet.com
ATIS	Alliance for Telecommunications Industry Solutions is a US based body that is committed to rapidly developing and promoting technical and operations standards for the communications and related information technologies industry.	IND	www.atis.org
AUTOSAR	Automotive Open System Architecture Partnership objective is the establishment of an open standard for automotive electrics/electronics architecture. It serves as a basic infrastructure for the management of functions within both future applications and standard software modules.	IND	www.autosar.org
BioAPI	The BioAPI Consortium was founded to develop a biometric Application Programming Interface that brings platform and device independence to application programmers and biometric service providers.	IND	www.bioapi.org

Organisation	Description	Type	Link
BSF	The Broadband Services Forum is an international industry resource that provides a forum for dialogue and development, along with the tools and information to address the fundamental business and technology issues vital to the growth and health of the broadband industry. The Broadband Services Forum fosters collaboration across the broadband value chain including content, service and technology providers.	IND	www.broad-bandservicesforum.org
CDG	CDMA Development Group is an international consortium of companies who have joined together to lead the adoption and evolution of 3G CDMA wireless systems around the world. The CDG is comprised of CDMA service providers and manufacturers, application developers and content providers.	IND	www.cdg.org
CELF	Consumer Electronics Linux Forum is focused on the advancement of Linux as an open source platform for consumer electronics (CE) devices.	IND	www.celinuxforum.org
CEN	European Committee for Standardization mission is to foster the European economy in global trading, the welfare of European citizens and the environment. Through its services it provides a platform for the development of European Standards and other technical specifications. CEN is a major provider of European Standards and technical specifications. It is the only recognized European organization according to Directive 98/34/EC for the planning, drafting and adoption of European Standards in all areas of economic activity with the exception of electrotechnology (see CENELEC) and telecommunication (see ETSI).	FRM	www.cen.eu
CENELEC	European Committee for Electrotechnical Standardization is a technical organization composed of the National Electrotechnical Committees of 31 European countries. In addition, 11 National Committees from neighbouring countries are participating in CENELEC work with an Affiliate status. CENELEC's mission is to prepare voluntary electrotechnical standards that help develop the Single European Market/European Economic Area for electrical and electronic goods and services.	FRM	www.cenelec.eu
CompTIA	Computing Technology Industry Association supports and leads the global IT industry through educational programs, market research, networking events, professional certifications, and political advocacy.	IND	www.comptia.org

Organisation	Description	Type	Link
CVC	Component Vendor Consortium is dedicated to building highly reliable and secure reusable software components for sale. Our mission is to actively promote how secure, functionally rich and useful our members products are to commercial software developers around the world.	IND	www.components.org
DCMI	Dublin Core Metadata Initiative is an open organization engaged in the development of interoperable online metadata standards that support a broad range of purposes and business models.	IND	www.dublincore.org
DDWG	The Digital Display Working Group is an open industry group lead by Intel, Compaq, Fujitsu, Hewlett Packard, IBM, NEC and Silicon Image. The objective of the Digital Display Working Group is to address the industry's requirements for a digital connectivity specification for high-performance PCs and digital displays.	IND	www.ddwg.org
DISA	The Data Interchange Standards Association advances the foundation of electronic trade and commerce by supporting and promoting standards used for business-to-business data exchange.	IND	www.disa.org
DMTF	Distributed Management Task Force brings together key technology vendors, government organizations and end users for the development, adoption, and interoperability of management standards and initiatives for enterprise and Internet environments.	IND	www.dmtf.org
EASA	The European Aviation Safety Agency promotes the highest common standards of safety and environmental protection in civil aviation in Europe and worldwide. It is the centrepiece of a new regulatory system which provides for a single European market in the aviation industry.	FRM	www.easa.europa.eu
ECA	Electronic Components Association represents designers, manufacturers and suppliers of passive and electromechanical electronic components, connectors, wire and cable, component arrays and assemblies, and materials and support services.	IND	www.ecaus.org
Eclipse Foundation	Eclipse is an open source community, whose projects are focused on building an open development platform comprised of extensible frameworks, tools and runtimes for building, deploying and managing software across the lifecycle.	RI	www.eclipse.org
ECMA	An international Europe-based industry asso-	IND	www.ecma-

Organisation	Description	Type	Link
	ciation facilitates the creation of a wide range of global ICT and consumer electronics standards		international.org
ECSS	The European Cooperation for Space Standardization is an initiative established to develop a coherent, single set of user-friendly standards for use in all European space activities.	IND	www.ecss.nl
EEMBC	Embedded Microprocessor Benchmark Consortium develops performance benchmarks for the hardware and software used in embedded systems. EEMBC benchmarks have become an industry standard for evaluating the capabilities of embedded processors, compilers, and Java implementations according to objective, clearly defined, application-based criteria.	IND	www.eembc.org
ERTICO	Intelligence Transport System and Services Europe is a multi-sector, public/private partnership pursuing the development and deployment of Intelligent Transport Systems and Services.	IND	www.ertico.com
ETSI	European Telecommunications Standards Institute produces globally-applicable standards for ICT, including fixed, mobile, radio, converged, broadcast and internet technologies. ETSI is officially recognized by the European Union as a European Standards Organization.	FRM	www.etsi.org
EUROCAE	The European Organization for Civil Aviation Equipment membership exclusively comprises aviation stakeholders made up of Manufacturers (aircraft, airborne equipment, ATM systems and ground equipment), Services Providers, National and International Aviation Authorities and Users (Airlines, Airports, and operators) from Europe and elsewhere. EUROCAE has developed performance specifications and other documents exclusively dedicated to the Aviation community that are widely referenced as a means of compliance to European Technical Standard Orders and other regulatory documents.	FRM	www.eurocae.net
EUROSMART	European Smart Card Industry Association is committed to expanding the world's smart secure devices market, developing smart security standards and continuously improving quality and security applications.	IND	www.eurosmart.com
FIPA	FIPA is an IEEE Computer Society standards organization that promotes agent-based technology and the interoperability of its standards with other technologies.	FRM	www.fipa.org

Organisation	Description	Type	Link
FlexRay	The FlexRay Consortium was formed to drive the adoption of the FlexRay communication system as the de facto industry standard for high-speed communication networks for automotive applications.	IND	www.flexray.com
GlobalPlatform	GlobalPlatform is leads smart card infrastructure development through interoperable technical specifications for cards, devices and systems for achieving interoperable, sustainable and flexible smart card deployments that support multi-application, multi-actor and multi-business model implementations.	IND	www.globalplatform.org
Globus Alliance	The Globus Alliance is a community of organizations and individuals developing fundamental technologies behind the "Grid," which lets people share computing power, databases, instruments, and other on-line tools securely across corporate, institutional, and geographic boundaries without sacrificing local autonomy.	IND	www.globus.org
IBTA	InfiniBand Trade Association chartered with maintaining and furthering the InfiniBand specification. The IBTA is led by a steering committee that includes IBM, Intel, Mellanox, Oracle, QLogic, and Voltaire. Other members of the IBTA represent leading enterprise IT vendors who are actively contributing to the advancement of the InfiniBand™ specification.	IND	www.infinibandta.org
IEC	International Electrotechnical Commission is the world's leading organization that prepares and publishes international standards for all electrical, electronic and related technologies. The IEC also manages conformity assessment systems that certify that equipment, systems or components conform to its international standards.	FRM	www.iec.ch
IEEE	Institute of Electrical and Electronic Engineers is the world's largest professional association dedicated to advancing technological innovation and excellence. IEEE and its members inspire a global community through IEEE's highly cited publications, conferences, technology standards, and professional and educational activities.	FRM	www.ieee.org
IETF	Internet Engineering Task Force is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.	FRM	www.ietf.org
INCITS	The International Committee for Information Technology Standards is the forum of choice	FRM	www.incits.org

Organisation	Description	Type	Link
	for information technology developers, producers and users for the creation and maintenance of formal de jure IT standards.		
ISA	The Instrumentation, Systems, and Automation Society is setting the standard for automation by helping over 30,000 worldwide members and other professionals solve difficult problems. ISA develops standards; certifies industry professionals; provides education and training; publishes books and technical articles; and hosts the largest conference and exhibition for automation professionals in the Western Hemisphere.	IND	www.isa.org
ISC	Internet Systems Consortium is the producer and distributor of commercial quality Open Source software for the Internet Community. ISC has led the industry with the most complete reference standard implementation of DNS software using a Managed Open Source model. ISC also provides production-quality reference implementations for other core protocols such as DHCP, and distributes other open source software.	IND	www.isc.org
ISO	International Organization for Standardization is the world's largest developer and publisher of International Standards. ISO is a network of the national standards institutes of 161 countries, one member per country, with a Central Secretariat that coordinates the system. ISO is a non-governmental organization that forms a bridge between the public and private sectors.	FRM	www.iso.org
IVIF	Interchangeable Virtual Instruments Foundation is an open consortium founded to promote specifications for programming test instruments that simplify interchangeability, provide better performance, and reduce the cost of program development and maintenance.	IND	www.ivifoundation.org
JCP	The Java Community Process is the mechanism for developing standard technical specifications for Java technology. Anyone can register for the site and participate in reviewing and providing feedback for the Java Specification Requests (JSRs), and anyone can sign up to become a JCP Member and then participate on the Expert Group of a JSR or even submit their own JSR Proposal.	IND	www.jcp.org
JEDEC	The leading developer of standards for the solid-state industry. Almost 2400 participants, appointed by some 270 companies work together in 50 JEDEC committees meet the needs of every segment of the industry, manufacturers and consumers alike. The publications and standards that they generate are	IND	www.jedec.org

Organisation	Description	Type	Link
	accepted throughout the world.		
Liberty Alliance Project	The vision of Liberty Alliance is to enable a networked world based on open standards where consumers, citizens, businesses and governments can more easily conduct online transactions while protecting the privacy and security of identity information using Liberty's open identity standards, business and deployment guidelines and best practices for managing privacy.	IND	www.projectliberty.org
Linux Foundation	The Linux Foundation is a non-profit consortium dedicated to fostering the growth of Linux. The Linux Foundation sponsors the work of Linux creator Linus Torvalds and is supported by leading Linux and open source companies and developers from around the world. The Linux Foundation promotes, protects and standardizes Linux by hosting important workgroups, events and online resources such as Linux.com.	IND	www.linuxfoundation.org
LXI	LXI Consortium is an industry consortium that maintains the LXI specification, promotes the IEEE LXI Standard, and ensures interoperability. LXI is widely used by test and measurement companies worldwide.	IND	www.lxistandard.org
MIPI	The Mobile Industry Processor Interface Alliance is an open membership organization that includes over 60 leading companies in the mobile industry that share the objective of defining and promoting open specifications for interfaces to mobile application processors. The MIPI Alliance intends to speed deployment of new services to mobile users by establishing specifications for standard hardware and software interfaces to mobile application processors.	IND	www.mipi.org
MISRA	The Motor Industry Software Reliability Association is a collaboration between vehicle manufacturers, component suppliers and engineering consultancies which seeks to promote best practice in developing safety-related electronic systems in road vehicles and other embedded systems.	IND	www.misra-c2.com
Modelica Association	The Modelica Association aims at developing and promoting the Modelica modeling language for modelling, simulation and programming of physical and technical systems and processes. The Modelica Association owns and administrates incorporeal rights related to Modelica, which should be generally available for the promotion of industrial development and research.	IND	www.modelica.org

Organisation	Description	Type	Link
NCOIC	Network Centric Operations Industry Consortium is a collaboration of premier leaders in the aerospace, defence, information technology, large-scale integrator and services industries. The Consortium works in tandem with customers from around the world, each with a specific mission, to provide a set of tools that enable the development of network centric capabilities and products.	IND	www.ncoic.org
NISO	National Information Standards Organization identifies, develops, maintains, and publishes technical standards to manage information in our changing and ever-more digital environment. NISO standards apply both traditional and new technologies to the full range of information-related needs, including retrieval, re-purposing, storage, metadata, and preservation.	FRM	www.niso.org
OAG	The Open Applications Group is a not-for-profit open standards group building process-based XML standards for both B2B and A2A integration. The OAGi's unique, technology neutral approach to building the OAGIS® standard ensures that both end-users and solution providers have the most robust XML standard in the world that can be deployed using ebXML, Web Services, or the Framework of their choice.	IND	www.open-applications.org
OASIS	Organization for the Advancement of Structured Information Standards is an international consortium that drives the development, convergence, and adoption of e-business standards. The consortium produces more Web services standards than any other organization along with standards for security, e-business, and standardization efforts in the public sector and for application-specific markets.	IND	www.oasis-open.org
OCP-IP	Open Core Protocol International Partnership supports OCP as the socket standard that ensures rapid creation and integration of interoperable virtual components. OCP-IP's mission is to promote and support OCP as the complete socket standard that ensures rapid creation and integration of interoperable virtual components.	IND	www.ocpip.org
ODVA	Open DeviceNet Vendor Association and its members support network technologies based on the Common Industrial Protocol (CIP). These currently include DeviceNet, EtherNet/IP, CompoNet, ControlNet and the major extensions to CIP — CIP Safety, CIP Sync, and CIP Motion.	IND	www.odva.org

Organisation	Description	Type	Link
OMG	Object Management Group develop enterprise integration standards for a wide range of technologies, including: Real-time, Embedded and Specialized Systems, Analysis & Design, Architecture-Driven Modernization and Middleware and an even wider range of industries, including: Business Modelling and Integration, C4I, Finance, Government, Healthcare, Legal Compliance, Life Sciences Research, Manufacturing Technology, Robotics, Software-Based Communications and Space.	IND	www.omg.org
OpenAjax Alliance	The OpenAjax Alliance is an organization of vendors, open-source initiatives and Web developers dedicated to the successful adoption of open and interoperable Ajax-based Web technologies. The alliance's prime objective is to accelerate customer success with Ajax by improving the customer's ability to mix and match solutions from Ajax technology providers and helping to drive the future of the Ajax ecosystem.	IND	www.openajax.org
OSCI	The Open SystemC Initiative (OSCI) is composed of a broad range of organisations dedicated to defining and advancing SystemC as an open industry standard for system-level modelling, design and verification. SystemC is a language built in C++ that spans from concept to implementation in hardware and software. IEEE Standards Association approved the standard for the SystemC library as IEEE 1666-2005.	IND	www.systemc.org
OSGi	Open Services Gateway Initiative mission is to specify, create, advance, and promote an open service platform for the delivery and management of multiple applications and services to all types of networked devices in home, vehicle, mobile and other environments.	IND	www.osgi.org
OSI	The Open Source Initiative maintains the Open Source Definition for the good of the community. The Open Source Initiative Approved License trademark and program creates a nexus of trust around which developers, users, corporations and governments can organize open-source cooperation.	IND	www.opensource.org
OW2	OW2 Consortium is a global open-source software community which goal is the development of open-source distributed middleware, in the form of flexible and adaptable components. These components range from specific software frameworks and protocols to integrated platforms. OW2 developments follow a component-based approach.	IND	www.ow2.org

Organisation	Description	Type	Link
PC104 Consortium	Over 75 members worldwide who have joined together to establish and maintain standards and disseminate information about PC/104 and other small form factors to manufacturers and users, as well as to provide a liaison function between the PC/104 community and other standard organizations.	IND	www.pc104.org
PICMG	PICMG is a consortium of companies who collaboratively develop open specifications for high performance telecommunications and industrial computing applications including CompactPCI, AdvancedTCA, AdvancedMC, CompactPCI Express, COM Express and SHB Express.	IND	www.picmg.org
Power.org	Power.org's mission is to develop, enable and promote Power Architecture technology as the preferred open standard hardware development platform for the electronics industry and to administer qualification programs that optimize interoperability and accelerate innovation.	IND	www.power.org
RapidIO Trade Association	The RapidIO Trade Association and its global members drive the RapidIO interconnect architecture. This ISO and ANSI-certified, open-standard seamlessly enables the chip-to-chip, board-to-board, control, backplane and data plane interconnections needed in high-performance networking, communications and embedded systems.	IND	www.rapidio.org
RTCA	Radio Technical Commission for Aeronautics develops guidance documents related to the FAA and often in association with EUROCAE. RTCA is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a US Federal Advisory Committee and develops consensus-based recommendations on contemporary aviation issues.	FRM	www.rtca.org/
SA Forum	The Service Availability Forum is a consortium of industry-leading communications and computing companies working together to foster an ecosystem that enables the use of commercial off-the-shelf building blocks in the creation of high availability network infrastructure products, systems and services.	IND	www.saforum.org
SAE	SAE International has more than 121,000 members who share information and exchange ideas for advancing the engineering of mobility systems. SAE addresses standards development used in designing, building, maintaining, and operating self-propelled vehi-	IND	www.sae.org

Organisation	Description	Type	Link
	cles for use on land or sea, in air or space.		
SISO	The Simulation Interoperability Standards Organization focuses on facilitating simulation interoperability and component reuse across the government and non-government applications.	IND	www.sisostds.org
SPIRIT Consortium	The SPIRIT Consortium provides a unified set of specifications based on IP meta-data, the IP-XACT specifications, for importing complex IP bundles into SoC design tool sets, and exchanging design descriptions between tools. An API for querying and writing to IP-XACT data-bases is also provided as part of the IP-XACT specifications.	IND	www.spiritconsortium.org
SSCI	The Systems and Software Consortium is structured to allow industry and government to co-invest in the development of systems and software processes that improve business performance and to share the lessons learned in the use of those processes.	IND	www.software.org
TCG	The Trusted Computing Group (TCG) is a not-for-profit organization formed to develop, define, and promote open standards for hardware-enabled trusted computing and security technologies, including hardware building blocks and software interfaces, across multiple platforms, peripherals, and devices.	IND	www.trustedcomputing-group.org
The Open Group	The Open Group is a vendor- and technology-neutral consortium, whose vision of Boundary-less Information Flow will enable access to integrated information within and between enterprises based on open standards and global interoperability.	IND	www.opengroup.org
Unicode Consortium	The Unicode Consortium enables people around the world to use computers in any language. Members develop the Unicode Standard, Unicode Locales (CLDR), and other standards. These specifications form the foundation for software internationalization in all major operating systems, search engines, applications, and the web.	IND	www.unicode.org
W3C	The World Wide Web Consortium is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is: To lead the World Wide Web to its full potential by developing protocols and guidelines that ensure long-term growth for the Web.	IND	www.w3.org
Workflow Management	Workflow Management Coalition is a global organization of adopters, developers, consult-	IND	www.wfmc.org

Organisation	Description	Type	Link
Coalition	ants, analysts, as well as university and research groups engaged in workflow and BPM. The organisation creates and contributes to process related standards, educates the market on related issues, and is the only standards organization that concentrates purely on process. The WfMC created Wf-XML and XPDL widely used to store and exchange process models.		

4   Relevant standards

The following standards have been identified as being relevant to the MADES project research and development based on the industrial user requirements that have been defined in *D1.1 – Requirements Specification*. These standards originate from the SDO's identified in Section 3 - Standards defining organisations and address the research and development topics in each of the technical workpackages.

Standard	Summary	Organisation
AADL	The SAE AADL is an extensible architecture analysis and design language for embedded and real-time systems. The core language provides a precise semantic specification for modelling task and communication architectures and their mapping onto distributed execution platforms.	SAE www.sae.org
ARINC 653	ARINC 653 (Avionics Application Standard Software Interface) is a software specification for space and time partitioning in Safety-critical avionics Real-time operating systems. It allows hosting multiple applications of different software levels on the same hardware in the context of a Integrated Modular Avionics architecture.	AEEC www.aviation-ia.com
BPEL	Business Process Execution Language is an OASIS standard executable language for specifying interactions with Web Services. Processes in Business Process Execution Language export and import information by using Web Service interfaces exclusively. BPEL is an orchestration language that specifies an executable process that involves message exchanges with other systems, such that the message exchange sequences are controlled by the orchestration designer.	OASIS www.oasis-open.org
CORBA CCM	CORBA Component Model (CCM) is an addition to the family of CORBA definitions. It was introduced with CORBA 3 and it describes a standard application framework for CORBA components. It is a	OMG www.omg.org

Standard	Summary	Organisation
	more general form of EJB (Enterprise Java Beans), providing four component types instead of the two that EJB defines. It provides an abstraction of entities that can provide and accept services through well-defined named interfaces called ports.	
DO-178B	Software Considerations in Airborne Systems and Equipment Certification is published by RTCA and is the standard applied by the FAA for guidance to determine if software will perform safely and reliably in an airborne environment.	RTCA www.rtca.org
DO-178C	DO-178C updated DO-178B with respect to current software development and verification technologies and addresses software modelling and the ability to use modelling to supplant some of the verification techniques required in DO-178B, Object-oriented software and the conditions under which it can be used, and clarifies software tools and avionics tool qualification.	RTCA www.rtca.org
DO-254	DO-254 specifies compliance for the design of complex electronic hardware in airborne systems. Complex electronic hardware includes devices like FPGAs, PLDs, and ASICs. The DO-254 standard is the hardware counterpart to the well-established software standard DO-178B.	RTCA www.rtca.org
IEC 60812	Standard for reliability analysis it describes Failure Mode and Effects Analysis (FMEA) and Failure Mode, Effects and Criticality Analysis (FMECA), and gives guidance as to how they may be applied to achieve various objectives by providing the procedural steps necessary to perform an analysis; identifying appropriate terms, assumptions, criticality measures, failure modes; defining basic principles; and providing examples of the necessary worksheets or other tabular forms.	IEC www.iec.ch
IEC 61508	IEC 61508 is intended to be a basic functional safety standard applicable to all kinds of industry. It defines functional safety as: "part of the overall safety relating to the EUC (Equipment Under Control) and the EUC control system which depends on the correct functioning of the E/E/PE safety-related systems, other technology safety-related systems and external risk reduction facilities." The standard covers the complete safety life cycle, and may need interpretation to develop sector specific standards. It has its origins in the process control industry sector.	IEC www.iec.ch
IEC 61511	IEC 61511 is a technical standard which sets out practices in the engineering of systems that ensure the safety of an industrial process through the use of instrumentation. Such systems are referred to as Safety Instrumented Systems. It covers the design	IEC www.iec.ch

Standard	Summary	Organisation
	and management requirements for Safety Instrumented Systems from cradle to grave. Its scope includes: initial concept, design, implementation, operation, and maintenance through to decommissioning.	
IP-XACT IEEE 1685-2009	IP-XACT is an XML format that defines and describes electronic components and their designs. The standard ensures delivery of compatible component descriptions from multiple component vendors, enables exchanging complex component libraries between electronic design automation (EDA) tools for SoC design (design environments), describes configurable components using metadata, and enables the provision of EDA vendor-neutral scripts for component creation and configuration (generators, configurators).	SPIRIT Consortium www.spiritconsortium.org
ISO 26262	An adaptation of the Functional Safety standard IEC 61508 for Automotive Electric/Electronic Systems specifically for road vehicles functional safety. This standard aims to bring development of automotive safety-critical systems up to date by focusing on the specific needs of road vehicles and encompassing state-of-the-art design processes such as model-based control system development.	ISO www.iso.org
ISO C, C++, Java, Ada	Standard programming languages commonly used for the development of embedded systems. C, C++ and ADA are ISO approved standards, while the Java Community Process (JCP) is responsible for the standardisation of the Java language.	ISO www.iso.org JCP www.jcp.org
ISO/IEC 12207	Establishes a common framework for software life cycle processes, with well-defined terminology, that can be referenced by the software industry. It contains processes, activities, and tasks that are to be applied during the acquisition of a system that contains software, a stand-alone software product, and software service and during the supply, development, operation, and maintenance of software products. Also provides a process that can be employed for defining, controlling, and improving software life cycle processes.	ISO www.iso.org
ISO/IEC P42010 IEEE 1471	Addresses the creation, analysis and sustainment of architectures of systems through the use of architecture descriptions. A conceptual model of architecture description is established. The required contents of an architecture description are specified. Architecture frameworks are introduced for codifying conventions and common practices of architecture description within a community. The content of an architecture framework is specified. Annexes provide the motivation and background for key concepts and terminology and examples.	ISO www.iso.org IEEE www.ieee.org

Standard	Summary	Organisation
ISO/IEC15288	Establishes a common framework for describing the life cycle of systems and defines a set of processes and associated terminology. These processes can be applied at any level in the hierarchy of a system's structure. Also provides processes that support the definition, control and improvement of the life cycle processes used within an organisation or a project.	ISO www.iso.org
JMI	The Java Metadata Interface specification enables the implementation of a dynamic, platform-independent infrastructure to manage the creation, storage, access, discovery, and exchange of metadata. JMI is based on MOF from the Object OMG and defines the standard Java interfaces to these modelling components, and thus enables platform-independent discovery and access of metadata. JMI allows for the discovery, query, access, and manipulation of metadata, either at design time or runtime.	JCP www.jcp.org
LwCCM	The Lightweight CCM is a profile based on CORBA Component specification that aims to support constraints of embedded environments like small code size, and limited processing overhead for performance conservative applications. Its goal is to simplify as much as possible the use of and implementation of CCM for embedded applications.	OMG www.omg.org
MARTE	MARTE (Modelling and Analysis of Real-Time and Embedded systems) is a specification of a UML profile that aims to replace UML capabilities for model-driven development of Real-Time and Embedded Systems (RTES), and for analyzing schedulability and performance of UML specifications. It provides capabilities such as the support for specification, design, and verification/validation stages, the definition of non-functional properties, time and time related concepts and analysis frameworks.	OMG www.omg.org
MISRA C, MISRA C++	MISRA C is a software development standard for the C programming language developed by MISRA (Motor Industry Software Reliability Association). Its aims are to facilitate code safety, portability and reliability in the context of embedded systems, specifically those systems programmed in ISO C. There is also a set of guidelines for MISRA C++.	MISRA www.misra-c2.com
Modelica	Modelica is a non-proprietary, object-oriented, equation based language to conveniently model complex physical systems containing, e.g., mechanical, electrical, electronic, hydraulic, thermal, control, electric power or process-oriented sub-components.	Modelica Association www.modelica.org

Standard	Summary	Organisation
MOF	The MetaObject Facility Specification is the foundation of OMG's industry-standard environment where models can be exported from one application, imported into another, transported across a network, stored in a repository and then retrieved, rendered into different formats, transformed, and used to generate application code. These functions are not restricted to structural models, or even to models defined in UML.	OMG www.omg.org
OCL	The Object Constraint Language is a declarative language for describing rules that apply to UML models and is a precise text language that provides constraint and object query expressions on any MOF model or meta-model that cannot otherwise be expressed by diagrammatic notation. OCL is a key component of OMG's QVT specification.	OMG www.omg.org
QoS & FT	UML Profile for Modelling Quality of Service and Fault Tolerance Characteristics and mechanisms. QoS & FT profile pays special attention to risk analysis methods and defines general notation for the identification of safety risks in UML models, and for the representation of mitigations means in software architectures that reduce the probability of hazard occurrence.	OMG www.omg.org
QVT	QVT defines a standard way to transform source models into target models. Under QVT source and target models may conform to arbitrary MOF metamodels and the transformation program is considered itself as a model, and as a consequence also conforms to a MOF metamodel. QVT only addresses model to model transformations, and not model to text or text to model.	OMG www.omg.org
Ravenscar profile	The Ravenscar profile is a subset of the Ada tasking features designed for safety-critical hard real-time systems. It was defined by a separate technical report in Ada 95 and is now part of the Ada 2005 Standard.	ISO www.iso.org
RTSJ	The Real-Time Specification for Java (RTSJ) is a set of interfaces and behavioural specifications that allow for real-time programming in the Java programming language. RTSJ 1.0 was developed as JSR 1 under the Java Community Process, which approved the new standard in November, 2001. An updated RTSJ 1.1 is being developed under JSR 282.	JCP www.jcp.org
SDL	Specification and Description Language is widely used in the telecommunications field, it is also now being applied to a diverse number of other areas ranging over aircraft, train control, medical and packaging systems. It is a general purpose description language for communicating systems.	ITU www.sdl-forum.org

Standard	Summary	Organisation
	The basis for description of behaviour is communicating Extended State Machines that are represented by processes.	
SoaML	SoaML (Service oriented architecture Modelling Language) is an open source specification project describing a UML profile and metamodel for the modelling and design of services within a service-oriented architecture.	OMG www.omg.org
SPEM	The Software and Systems Process Engineering Meta-model is a process engineering meta-model as well as conceptual framework, which can provide the necessary concepts for modelling, documenting, presenting, managing, interchanging, and enacting development methods and processes. An implementation of this meta-model would be targeted at process engineers, project leads, project and program managers who are responsible for maintaining and implementing processes for their development organizations or individual projects.	OMG www.omg.org
SysML	SysML is a UML Profile for System Engineering intended to support modelling of a broad range of systems, which may include hardware, software, data, personnel, procedures, and facilities. Its main purpose is to assist in the system requirements engineering and design processes, having as background the reference system processes and principles defined in the ISO System Engineering – System Life Cycle Processes [ISO15288], as well as industrial practices.	SysML.org www.sysml.org
SystemC	SystemC is a set of C++ classes and macros which provide an event-driven simulation kernel in C++. These facilities enable a designer to simulate concurrent processes, each described using plain C++ syntax. SystemC processes can communicate in a simulated real-time environment, using signals of all the data types offered by C++, some additional ones offered by the SystemC library, as well as user defined. In certain respects, SystemC deliberately mimics the hardware description languages VHDL and Verilog, but is more aptly described as a system-level modelling language.	OSCI www.systemc.org
SystemRDL	Specifically designed to describe and implement a wide variety of control status registers. Developers can automatically generate and synchronize register views for specification, hardware design, software development, verification, and documentation.	SPIRIT Consortium www.spiritconsortium.org
UML	Unified Modelling Language is a general-purpose modelling language used to specify, visualize, modify, construct and document the artefacts of an object-oriented software intensive system under	OMG www.omg.org

Standard	Summary	Organisation
	development. UML offers a standard way to visualize a system's architectural blueprints, including elements such as actors, business processes, components, activities, programming language statements, database schemas, and reusable software components.	
UPDM	The Unified Profile for DoDAF/MODAF provides a modelling standard that supports both the USA Department of Defense Architecture Framework (DoDAF) and the UK Ministry of Defence Architecture Framework (MODAF). UPDM is expected to be able to support other frameworks as well, such as the NATO Architecture Framework (NAF) which has an identical meta-model to MODAF.	OMG www.omg.org
UT2P	The UT2P provides extensions to UML2 to support the design, visualization, specification, analysis, construction, and documentation of the artefacts involved in testing. It is independent of implementation languages and technologies, and can be applied in a variety of domains of development.	OMG www.omg.org
Verilog	Verilog is a hardware description language used to model electronic systems. Verilog is most commonly used in the design, verification, and implementation of digital logic chips at the register transfer level (RTL) of abstraction. It is also used in the verification of analogue and mixed-signal circuits.	IEEE www.ieee.org
VHDL	VHDL is a hardware description language used in electronic design automation to describe digital and mixed-signal systems such as field-programmable gate arrays and integrated circuits, and has constructs to handle the parallelism inherent in hardware designs.	IEEE www.ieee.org
Wf-XML	Wf-XML offers a standard way for a BPM engine to invoke a process in another BPM engine, and to wait for it to complete. This allows a user to match the best process definition tool with the best process execution engine for their needs. Wf-XML completes the job by giving a standard way to pass the process definition between the design tool and the execution engine.	Workflow Management Coalition www.wfmc.org
XMI	The XML Metadata Interchange (XMI) is a standard for exchanging metadata information via Extensible Markup Language (XML). It can be used for any metadata whose metamodel can be expressed in Meta-Object Facility (MOF). The most common use of XMI is as an interchange format for UML models, although it can also be used for serialization of models of other languages (metamodels).	OMG www.omg.org
XML	XML (Extensible Markup Language) is a set of	W3C

Standard	Summary	Organisation
	rules for encoding documents in machine-readable form. It is defined in the XML 1.0 Specification produced by the W3C, and several other related specifications. It is a textual data format, with strong support via Unicode for the languages of the world. Although XML's design focuses on documents, it is widely used for the representation of arbitrary data structures.	www.w3.org
XPDL	The XML Process Definition Language allows the interchange of business process definitions between different workflow products, i.e. between different modelling tools and management suites. XPDL defines an XML schema for specifying the declarative part of workflow / business process. XPDL is designed to exchange the process definition, both the graphics and the semantics of a workflow business process.	Workflow Management Coalition www.wfmc.org

5   Emerging standards

The following emerging standards have been identified as being relevant to the MADES project research and development based on the industrial user requirements that have been defined in *D1.1 – Requirements Specification*. These standards are generally less formalised and often have associated communities of users who create momentum for industry acceptance and adoption.

Standard	Summary	Source
AltaRica	AltaRica is a high-level language designed for the modelling of systems. The well-defined semantics of AltaRica is based on the Arnold-Nivat model but applied to Constraint Automata. Synchronisation of constraint automata is made up of: the Arnold-Nivat strong synchronization of events; boolean constraints on variables shared by automata; a weakest synchronization mechanism of events that is similar to a broadcast mechanism.	www.labri.fr
ATL	ATLAS Transformation Language is a model transformation language and toolkit. In the field of Model-Driven Engineering (MDE), ATL provides ways to produce a set of target models from a set of source models. Developed on top of the Eclipse platform, the ATL Integrated Environment (IDE) provides a number of standard development tools (syntax highlighting, debugger, etc.) that aims to ease development of ATL transformations. ATL is a QVT-like transformation language and engine with a large user community and an open source library of transformations.	www.eclipse.org/m2m/atl/
COAL	COAL (Component-Oriented Architecture Language), extending OMG IDL with constructions coming from OMG D&C specification, AADL and others.	myccm-hi.sf.net

Standard	Summary	Source
DAM	The Dependability Analysis Modelling profile aims at defining a MARTE-compliant dependability profile. For this purpose, it defines stereotypes as specializations of stereotypes included in MARTE. The DAM profile is derived from a conceptual model, the DAM Domain Model, which consists of four sub-packages. The "Core" sub-package provides means to describe the structure of the system to be analyzed; "Redundancy" contains some concepts related to fault tolerance mechanisms; "Threats" takes into account errors and error propagation; "Maintenance" is related to maintenance tasks in repairable systems. The actual implementation of the DAM Domain Model as an UML profile consists of a model library, the DAM_Library, and a single package, DAM_UML_Extensions.	portal.acm.org/citation. cfm?id=1434728
EAST-ADL2	EAST-ADL2 is an architecture description language, intended for modelling automotive embedded systems. It provides means to handle complexity and improve safety, reliability, cost, and development efficiency through model-based development. EAST-ADL2 is aligned to AUTOSAR.	www.atesst.org
Eclipse IDE	Eclipse is a multi-language software development environment comprising an integrated development environment (IDE) and an extensible plug-in system. Users can extend its capabilities by installing plug-ins written for the Eclipse software framework, such as development toolkits or modelling tools, and can write and contribute their own plug-in modules.	www.eclipse.org
Epsilon	Epsilon is a family of consistent and interoperable task-specific programming languages which you can use to interact with your EMF models to perform common Model Driven Engineering tasks such as code generation, model-to-model transformation, model validation, comparison, migration, merging and refactoring.	www.eclipse.org/gmt/e psilon/
HRT-UML/RCM	HRT-UML/RCM stands for "Hard Real-Time UML for the Ravenscar Computational Model", was one of the major results of the ASSERT (Automated proof based System and Software Engineering for Real-Time Applications) project. Rooted in the conceptual basis of the OMG MOF, HRT-UML/RCM defines a formal domain specific language that promotes the separation of functional modelling from the design of the real-time architecture in which those functional models are to be incorporated, and also allows the automated derivation of a consistent platform-specific model that preserves the properties stipulated in the modelling space provided to the user. It enables static analysis with round-trip on the model, as well as automatic code generation.	www.assert-project.net
JML	The Java Modelling Language is a behavioural interface specification language that can be used to specify the behaviour of Java modules. It combines the design by contract approach of Eiffel and the model-based specification approach of the Larch family of interface specification languages, with some elements of the refinement calculus.	www.jmlspecs.org

Standard	Summary	Source
Kermeta	Kermeta is a modelling and programming language for metamodel engineering. Kermeta is a modelling and aspect oriented programming language. Its underlying metamodel conforms to the EMOF standard. It is designed to write programs which are also models, to write transformations of models (programs that transform a model into another), to write constraints on these models, and to execute them. The goal of this model approach is to bring an additional level of abstraction on top of the "object" level and thus to see a given system like a set of concepts (and instances of concepts) that form an explicitly coherent whole, which one will call a model.	www.kermeta.org
MAST	MAST is an open source set of tools that enables modelling real-time applications and performing timing analysis of those applications. The MAST model can be used in a UML design environment to design real-time applications, representing the real-time behaviour and requirements together with the design information, and allowing an automatic schedulability analysis.	mast.unican.es
MyCCM	MyCCM-HI is component framework for critical, distributed, real time and embedded software. MyCCM-HI is a (very) custom implementation in C language of the OMG Lightweight CCM (LwCCM) specification, with add-ons and limitations, designed so that Lightweight CCM-compliant C component implementations can be quickly adapted for MyCCM-HI.	myccm-hi.sf.net
oAW	Open Architecture Ware is an Eclipse based model driven development framework, which is supported by a large developer community. The framework integrates different languages (Xtend and Xpand) for specifying Model–to-Model or Model-to-Text transformations. The models can be defined as EMF models or models generated with other UML2 tools. Moreover the oAW framework contains an automated parser and editor generator through the integration of a GMF-Adapter and the Xtext framework. GMF is the Eclipse Graphical Modelling Framework, which forms the base for generating graphical editors for Eclipse. Based on the specification of a DSL, oAW can generate a syntax-aware editor.	www.openarchitecture ware.org
UAL	UAL is short for UML Action Language and it defines a textual language for defining UML behaviour that can be mapped to the subset of UML actions that are specified in the fUML specification from OMG. The scope of UAL is to be a textual surface language for the computational completion of UML models specified by the supported subset of UML elements and actions in fUML. The rational for UAL is to allow models to be complete and directly executable in a simulator or on a target platform through translation.	www.omg.org
UML-MAST	UML-MAST is a methodology and a set of tools for modelling and analysing object oriented real-time systems expressed in UML. It is based on the concept of the "Mast RT View" of the system, which describes in a qualitative and	mast.unican.es/umlma st

Standard	Summary	Source
	quantitative way the timing behaviour, the real-time performance constraints and relevant implementation parameters from the real-time perspective. The use of a real-time view allows the designer building the real-time system model gradually according to the evolution of the development process, feeding the analysis tools, and bringing back into the model the relevant timing responses. Therefore UML-MAST follows the model processing paradigm.	
UPPAAL	Uppaal is an integrated tool environment for modelling, validation and verification of real-time systems modelled as networks of timed automata, extended with data types (bounded integers, arrays, etc.). Uppaal consists of three main parts: a description language, a simulator and a model-checker. The description language is a non-deterministic guarded command language with data types (e.g. bounded integers, arrays, etc.). It serves as a modelling or design language to describe system behaviour as networks of automata extended with clock and data variables. The simulator is a validation tool which enables examination of possible dynamic executions of a system during early design (or modelling) stages and thus provides an inexpensive mean of fault detection prior to verification by the model-checker which covers the exhaustive dynamic behaviour of the system. The model-checker can check invariant and reachability properties by exploring the state-space of a system, i.e. reachability analysis in terms of symbolic states represented by constraints.	www.uppaal.com

6   Requirements and standards

The industrial user partners in collaboration with the development partners have defined in deliverable *D1.1 – Requirements Specification*, a set of requirements to be addressed by the tools foreseen in the MADES technical workpackages. The following table provides a mapping of these requirements to the relevant standards that may provide a basis for the research and development of MADES technologies and tools. In some cases there are no specific standards that address a requirement or the requirement defines behaviour rather than technology, which are noted as not applicable (NA).

6.1   Requirements related to Integrated Environment

Req ID	Title	Description	Related Standard(s)
R 1.1	Introduction in Toolset	There shall be a Guide explaining how to use the Integrated Environment with a small example project.	NA

Req ID	Title	Description	Related Standard(s)
R 1.2	Integration of Toolset	Modelling and Verification shall be integrated in a single framework (the user should not perceive change of environment).	Eclipse IDE
R 1.3	Applicability of Toolset	TXT and EADS workflows shall be supported.	ISO/IEC 12207 IEC 61511 ISO/IEC15288 XPDL BPEL SPEM

1.1   Requirements related to Component Repository

Req ID	Title	Description	Related Standard(s)
R 2.1	Introduction in Component Repository	There shall be a Guide explaining how to do search for MARTE Components inside the MADES Component Repository.	NA
R 2.2	Component Repository API specification	An API for external modelling tool connection shall be defined.	XMI MOF Eclipse IDE SoaML
R 2.3	Provision of Components	The Component Repository shall provide previously stored components to modelling tools.	NA
R 2.4	Provision of Components Library	The Component Repository shall provide previously stored sets of components to modelling tools.	NA
R 2.5	Storage of Components	The Component Repository shall provide means to modelling tools to store components.	XMI MOF
R 2.6	Storage of Components Library	The Component Repository shall provide means to modelling tools to store sets of components.	XMI XML MOF
R 2.7	Search for Components	The Component Repository shall provide means to modelling tools to search for components.	MOF

1.2   Requirements related to Modeling Tool

Req ID	Title	Description	Related Standard(s)
R 3.1	Domain Support	The Modelling Tool shall support developers in creation and analysis of models for avionics and surveillance systems.	DO-178C DO-254
R 3.2	Support for software design standard constraints	The Modelling Tool shall provide means to formulate software design constraints and verify their fulfilment.	MARTE OCL QoS & FT AltaRica UPPAAL
R 3.3	Support for different stakeholders	Depending on the role of the user, different parts of the model shall be editable / viewable.	NA
R 3.4	Top-Down Engineering	The Modelling Tool shall provide a model structure which supports different abstraction levels.	UML
R 3.5	Navigation	It shall be easy to navigate through different abstraction levels (zoom in and zoom out).	NA
R 3.6	Refinement of Elements	The Modelling Tool shall provide means to create multiple refinements of model elements. E.g. a Use Case will be refined for external and internal view.	NA
R 3.7	Navigation through refinements	It shall be easy to find and navigate to different refinements of a model element.	NA
R 3.8	Classification of refinements	It shall be possible to classify elements or refinements as approved or rejected.	NA
R 3.9	Status of requirements	It shall be possible to model the life-cycle state of a requirement.	SPEM UT2P
R 3.10	Creation and Maintenance of components	The Modelling Tool shall support the creation and maintenance of components to be used in system models.	MyCCM LwCCM
R 3.11	Usage of components	The Modelling Tool shall support the developer to compose an avionic and surveillance system model using previously stored components.	UML

Req ID	Title	Description	Related Standard(s)
R 3.12	User friendly notation	The modeling notation shall be understandable also by users which are not experts in Avionic and Surveillance domain.	UML
R 3.13	UML subset	The subset of UML2 shall be supported.	UML
R 3.14	UML extensions	There shall be suitable elements for modelling system interfaces with their properties (logical & physical).	MARTE HRT-UML/RCM UML-MAST
R 3.15	Interface Delegation	Delegation from Component Interface to Composite Interface or Activity Parameter shall be supported.	NA
R 3.16	Data Modelling	Means shall be provided to model exact (bitwise) data description.	UML SystemRDL
R 3.17	Resource Modelling	The Modelling Tool shall allow to specify information about timing budget and resource usage.	MARTE AADL SDL
R 3.18	Dependency Awareness	The Modelling Tool shall be able to detect dependencies between behaviours (Components involved in several scenarios).	NA
R 3.19	Time Modeling	The Modelling Tool shall be able to model time using MARTE	MARTE
R 3.20	Processes Types	The Modeling Tool shall be able to model processes type and duration (periodic or statistic) and communications mechanisms between different entities (e.g. synchronous or asynchronous).	UML MARTE SDL SystemC AltaRica
R 3.21	Processing Capacity	Modeling capacity of components (e.g. how many requests can be received).	MARTE

1.3   Requirements related to Verification Tool

Req ID	Title	Description	Related Standard(s)
D 4.1	Usability	The developers can easily interact with the tool and can select the properties of interest.	NA
D 4.2	Properties	Developers can define the properties to be verified and receive a response.	UML-MAST
D 4.3	Dependencies	Verification tool should be able to interpret dependencies specified at modelling level and verify timing properties (e.g. scheduling properties).	MARTE UML-MAST UPPAAL

1.4   Requirements related to Simulation Tool

Req ID	Title	Description	Related Standard(s)
D 5.1	Usability	The developers have suitable interfaces to launch the simulation of their model.	NA
D 5.2	Behaviour	The simulation of the behaviour of the system should be possible.	Modelica SystemC

1.5   Requirements related to Transformations Tool

Req ID	Title	Description	Related Standard(s)
R 6.1	Tracking of requirements' changes	Track on each requirement change in the baselines.	SysML
R 6.2	Documentation of re-quirements' changes	Requirement change should be documented saying which object and requirements it has affected (ECR= Engineering change request).	SysML
R 6.3	Implementation Tracing	Each requirement must allow to trace operations that implement that re-quirement and its use cases (and vice versa).	SysML ATL Epsilon
R 6.4	Trace Verification	A verification procedure to control that each requirement is linked to at least one operation (low level design) and one use case (high level design).	SysML ATL Epsilon
R 6.5	Test Tracing	Each test sequence must be traced versus one or more requirements.	UT2P
R 6.6	Code Generation	The code generated should be 'readable' (otherwise code is not cer-tifiable).	MISRA C MISRA C++

7   Partner involvement in SDOs

Some of the MADES project partners have substantial experience and are currently active in standards defining organisations (SDOs). One project partner, The Open Group, is itself an SDO. These project partners provide to the project additional insight into the state of various standards activities and the maturity of specifications through their first-hand knowledge. In the later phases of the project, these partners will be key in ensuring project results which extend existing standards or are new standards will be submitted to the appropriate SDO and that the industry consensus building process will go forward.

The following provides a summary of the involvement of the MADES project partners in SDOs.

7.1   SOFTEAM

Organisation / WG / Project	Scope / Topic	Involvement / Interest
OMG	Analysis & Design Task Force	Contributing member
OMG	Revision Task Force	Contributing member

Organisation / WG / Project	Scope / Topic	Involvement / Interest
OMG	Finalization Task Force	Contributing member
OMG	UML2.0	Contributing member, Revision
OMG	UML2 Profiles	Contributing member, Revision
OMG	SPEM – Software Process Engineering Metamodel	Contributing member, Revision
OMG	SysML – System Modelling Language	Contributing member, Revision
OMG	SoaML – SOA Modelling Language	Contributing member, Finalization
OMG	MARTE – Modeling and Analysis of Real-time and Embedded Systems	Contributing member, Revision
OMG	U2TP – UML2 Testing Profile	Contributing member, Revision
OMG	UPDM – UML Profile for DoDAF/MoDAF	Integration with SOFTEAM UML Profiles.
OMG	MIWG – Model Interchange Working Group	Contributing member
OMG	BPMN – Business Process Modelling Notation	Integration with SoaML and UPDM

7.2 University of York

Organisation / WG / Project	Scope / Topic	Involvement / Interest
OMG	Software Assurance SIG	Member, providing contributions to Evidence Metamodel.
RTCA	DO-178C Revisions	Contributor and monitoring the development of new DO-178C standard for certification of software-intensive airborne systems.
Eclipse Foundation	Eclipse Modelling Project and Generative Modelling Technologies	Contributor to Eclipse GMT project via Epsilon subproject. Soon Epsilon will move elsewhere under the Eclipse Modeling Project umbrella, and Epsilon will continue to be a contributed project.
Java Community Process	JSR-302 Safety-Critical Java Specification	Members of JSR-302 working group, publishing SC Java specification in July 2010

7.3 The Open Group

The Open Group is itself an SDO addressing standards for system software, systems management, security, real-time and embedded systems, IT architecture, and many others. The following summarises the involvement with other SDOs related to real-time and embedded systems.

Organisation / WG / Project	Scope / Topic	Involvement / Interest
IEEE and ISO	IEEE Std 1003.1-2008 / ISO 9945 and extensions	Chairman of POSIX Committee addressing operating system standards.
OMG	Service Oriented Architecture SIG	Member, providing contributions to SoaML extensions to UML for services modelling. OMG is also a member of The Open Group.
Java Community Process	JSR-302 Safety-Critical Java Specification	Chairman of JSR-302 working group, publishing SC Java specification in July 2010
NCOIC	Network Centred Services Framework Version 2.1	The operation and administration of the NCOIC Consortium is contracted to The Open Group and we contribute to several standards and interoperability committees.
AEEC	ARINC 653 APEX Working Group	Member and coordinating updates with platform standards
CELF	Linux specification	Member, coordinating RT Linux Profiles and Certification
SAE	Real-time standards for automotive	Member, coordinating of RTOS standards and certification

8   Conclusions

The project partners have identified a wide range of organisations that are establishing ICT standards for industry and government. Specific standards that are well-established as well as those emerging as new standards related to the planned research and technology development in MADES have also been identified. These will provide a basis for the new innovations in model driven development technologies for critical embedded systems that will be realised by the project partners.

The project partners are active in many standards organisations and have experience with the processes for establishing consensus and acceptance of new technology standards. In particular, the project partners have already identified initial improvements to the MARTE standard related to diagram support that will be submitted at an upcoming meeting of the OMG in December 2010. Further enhancements to the MARTE standard are expected to be specified from the project research activities in the later stages of the project related to support for veri-

fication and code generation. The project partners believe the experiences of the partners and the contacts already established in SDOs will be important assets when initiating the standardisation processes for MADES results.