CP-SETIS

TOWARDS CYBER-PHYSICAL SYSTEMS
ENGINEERING TOOLS
INTEROPERABILITY STANDARDISATION

D3.1_1: IOS Success Stories and Business Plans

Document Information

Project	CP-SETIS
Grant Agreement No.	H2020 645149
Deliverable Title	IOS Success Stories and Business Plans
Deliverable No.	D3.1_1
Dissemination Level	PU
Nature	Report
Document Version	1
Date	30/11/2015
Contact	Frédéric Loiret
Organization	KTH
Phone	+46 8 790 63 01
E-Mail	loiret@kth.se

Authors Table

Name	Company/Organization	E-Mail
Frédéric Loiret	KTH	loiret@kth.se

Reviewers Table

Name	Company/Organization	E-Mail
Jürgen Niehaus	SafeTrans	Juergen.Niehaus@safetrans-de.org

Content

Figures

1 Introduction

The purpose of this deliverable is twofold. Firstly (in section 2), it provides a list of the main use cases that have been demonstrating IOS concepts (*Interoperability Specifications*[1]) in various European projects. We consider these use cases as preliminary IOS success stories since (1) they are based on technologies standardized by the IOS, and (2) they show cooperation across a large numbers of European organizations encompassing all the main stakeholders of the value chain (i.e., industrial partners, tool and integration solution providers, and universities). In this first version of the deliverable, we limited ourselves to providing a list of such use cases with short descriptions, partners' involvement, and parts of the IOS specifications supported. In the second iteration of this deliverable (to be released at the end of CP-SETIS), we will present in more details a couple of these public use cases based on the IOS.

Secondly (in section 3), this deliverable presents the main business cases to be expected by a wide adoption of the IOS standards for the stakeholders of the market value chain.

The IOS related projects that have been considered for this deliverable are the following[2].

- MBAT[3],
- CRYSTAL[4],
- EMC2[5],
- HoliDes[6],
- ASSUME[7]

Relation to other deliverables

This document is to some extent related to the CP-SETIS deliverable D2.1.1 ("*Cross-projects cartography of Interoperability Concerns and public Interoperability Scenarios"*). However, it is important to make a distinction between the so-called "public interoperability scenarios" listed out in the latter, and the IOS based use cases listed out in this document. Indeed, interoperability scenarios (in D2.1.1) elicit complete workflows (or data flows) between engineering tools by end-users. These scenarios are already implemented by these end-users, or are expected to be implemented in the future, but they are not based on any assumption or requirements on the technologies to be used for their integration, i.e., nothing is said about the IOS. On the contrary, in this deliverable (in section 2), we focus on use-cases that have been demonstrated thanks to the use of IOS technologies exclusively.

[1] http://www.crystal-artemis.eu/fileadmin/user_upload/Deliverables/CRYSTAL_D_601_022_v1.0.pdf
[2] Short descriptions of these projects can be found in the CP-SETIS deliverable D2.1.1.
[3] http://www.mbat-artemis.eu
[4] http://www.crystal-artemis.eu
[5] http://www.artemis-emc2.eu
[6] http://www.artemis-emc2.eu
[7] https://itea3.org/project/assume.html

2 IOS-Based Use Case Demonstrators

In the following sub-sections, the IOS-related use case demonstrators are briefly described according to the information provided in the table below.

1	Name of the demonstrator
2	Organization(s) involved
3	Year(s) of development
4	Short Description
5	Relation to the IOS (e.g., IOS specification supported, integration scenarios demonstrated, etc.)
6	Public links towards material (videos, public deliverables, articles, etc.)

2.1 From the MBAT Project

1	**Automated Execution (DTFsim)**
2	Austrian Institute of Technology, Volvo
3	2011-2014
4	The demonstrator intended to show case the automation aspect of the MBAT's IOS. It takes one tool used in the MBAT VOLVO's use case and activates it via the OSLC automation mechanism from a workflow tool. **Tools involved**: DTF Simulator, WEFACT (AIT).
5	OSLC Automation and Asset Domain specifications demonstrated.
6	N/A

1	**Analysis on the analysis model**
2	Mälardalen University, Volvo, Dassault
3	2011-2014
4	The main purpose of this demonstrator was to achieve traceability between requirements and analysis results. First, the requirements are made stored on Enovia Requirements Central and are imported into the analysis tool ViTAL through an adaptor supporting the OSLC-RM specification. Then, the analysis results are exposed to other tools in the RTP through another adaptor. This solution allows to link requirements with analysis results. **Tools involved**: Dassault Enovia Requirement Central, ViTAL (Mälardalen University)
5	OSLC Requirement Management and Quality Management Domain specifications demonstrated.
6	N/A

1	**Automated test-case generation based on test models**
2	Mälardalen University, Volvo
3	2011-2014
4	The main purpose of this demonstrator was to achieve traceability between the abstract test cases generated with ViTAL (a tool developed by Mälardalen University) and the concrete test cases generated in Farkle (developed by XDIN), which are be applied on Volvo's system models to obtain a PASS/FAIL verdict.

	Tools involved: ViTAL, Farkle.
5	OSLC Quality Management Domain specification demonstrated.
6	N/A

1	**Minimize dynamic tests**
2	AbsInt, BTC-ES
3	2011-2014
4	The main purpose of this demonstrator was to transport results computed by the static analysers Astrée, aiT, and StackAnalyzer (all from AbsInt) to the testing tool EmbeddedTester (from BTC-ES). **Tools involved**: Astrée, aiT, StackAnalyzer (AbsInt), EmbeddedTester (BTC)
5	OSLC Quality Management Domain specification demonstrated.
6	N/A

1	**Is a state in the model reachable?**
2	OFFIS, Daimler
3	2011-2014
4	The purpose of this scenario is automatically generating a fault tree analysis of a Matlab/Stateflow model using model checking-based methods. The analysis will process the violation of a safety requirement as a state and generates the paths that lead to this state, in case they exist. **Tools involved:** PatternEditor, DOORS, Matlab/Simulink/StateFlow, RTP Link Tool, Failure Mode Editor, VV Editor
5	MBAT IOS Formal Requirement (extending OSLC RM), MBAT IOS Architecture Management (extending OSLC AM), MBAT IOS Traceability Management
6	N/A

1	**Create requirement model / Change impact analysis**
2	OFFIS, Volvo
3	2011-2014
4	The purpose with this demonstrator was to have a seamless flow of data between the involved tools and to easily create formal requirements from natural language requirements. By utilizing associations between requirements and other model elements impacted elements are identified when modifying a requirement. This will in turn reduce the number of problems already at analysis level, which likely will reduce the needed testing effort. **Tools involved**: PatternEditor, DOORS, Matlab/Simulink/StateFlow, RTP Link Tool, Failure Mode Editor, VV Editor.
5	MBAT IOS Formal Requirement (extending OSLC RM), MBAT IOS Architecture Management (extending OSLC AM), MBAT IOS Traceability Management
6	N/A

1	**Model-based test case generation and verification**
2	Virtual Vehicle Competence Center (VIF)
3	2011-2014

4	This demonstrator presented integrated tool chain supports system modelling, test case generation, automated test execution and verification using the tools IBM Rhapsody, VIF STSTest, Matlab to model the System under Test (SUT) and VEVAT for verification.
5	OSLC Requirement Management (RM), Architecture Management (AM), Quality Management (QM)
6	N/A

1	**Analysis and test cases generation for system model validation**
2	ALES, Elvior
3	2011-2014
4	This demonstrator presented integrated tool chain supporting system modeling covered by different tools to implement different views considering functional and non-functional requirements of the system (Rhapsody for design model, TestCast for test model, Simulink BCL-FSV for analysis model), test cases generation and automated test execution using TestCast, and static analysis execution and analysis results generation using Formal Specs Verifier (FSV). In our scenario, analysis and test phases are parallel and adopted tools for these different phases are not integrated. For traceability between requirements and test cases, DOORS and TestCast will interoperate with the means of OSLC adaptors.
5	OSLC Requirement Management (RM), Quality Management (QM)
6	N/A

1	**Traceability**
2	Airbus (former EADS-IW)
3	2011-2014
4	This demonstrator showed the complete traceability from requirements to specification and test models, test cases and test reports. **Tools involved:** DOORS, AIDASS, Quality Center, Rhapsody, MBTSuite
5	OSLC Requirement Management (RM), Architecture Management (AM), Quality Management (QM)
6	Video: https://www.youtube.com/watch?v=bIfltBDCR0I

2.2 From the CRYSTAL Project

1	**Crystal Aerospace Public Use Case**
2	Airbus Group Innovations, Alenia AERMACCHI, Polito, Politecnico Di Torino
3	2013 – 2016

4	The CRYSTAL Public Aerospace Use Case has the following major objectives:
	• Describing typical aerospace engineering challenges with respect to (tool) interoperability, in order to:
	  ○ Help CRYSTAL IOS Working Groups to get a first understanding of typical aerospace (and other domain) needs,
	  ○ Help creating synergies between tools providers, academics and industry within the CRYSTAL consortium.
	• Performing a prototyping of IOS Concept, in order to:
	  ○ Refine and validate the feasibility and value of the CRYSTAL interoperability approach

	○ Show the main “idea” behind the CRYSTAL approach ○ Demonstrate CRYSTAL IOS Concept • Facilitate the presentation of CRYSTAL results in publications without facing IPR concerns, in order to support dissemination activities.
5	OSLC Requirement, Architecture, Quality Management, OSLC TRS, FMI.
6	CRYSTAL Public Deliverable about the use case: http://www.crystal-artemis.eu/fileadmin/user_upload/Deliverables/CRYSTAL_D_208_902_v1.0.pdf

1	**Crystal Automotive Public Use Case**
2	AVL, Daimler, FIAT, Volvo, Valeo
3	2013 – 2016
4	This use case can be seen as a common platform for discussions within the automotive domain. The partners share challenges and experiences from the different automotive use cases and discuss commonalities and possible collaborations. This means that the PUBLIC USE CASE AUTOMOTIVE is actually not one single use case with a clearly defined scope. Instead, it is a collection of experiences, solutions, and best practices from the automotive domain.
5	OSLC Requirement, Architecture, Quality Management, FMI, ReqIF
6	CRYSTAL Public Deliverable about the use case: http://www.crystal-artemis.eu/fileadmin/user_upload/Deliverables/CRYSTAL_D_307_902_v2.0.pdf

1	**Crystal Philips Final Demo**
2	Philips, IBM, TNO, PS-Tech, TU/e
3	2013 – 2016
4	This demonstration shows the integration of Engineering Methods throughout the product life cycle. We will integrate requirement- & test-management with safety risk management and with co-simulation. **Tools involved:** IBM DOORS NG, Quality Manager, Design Manager and Rational Team Concert, Philips XText, POOSL, TSO Simulator, Modelica, Matlab, XPoser
5	OSLC Requirement and Architecture Management, IOS Safety Management, FMI.
6	N/A

1	**Mission Support Equipment**
2	Airbus Defence and Space (Lead), Airbus Group Innovations, Fraunhofer IESE
3	2013 – 2016
4	The demonstrator deals with the landing aid function that supports helicopter pilots during the landing approach in degraded visual environments. It allows marking a landing point on ground using a head-tracked helmet mounted display. During the final landing approach it enhances the spatial awareness of flying crews by displaying 3D conformal visual cues on a helmet-mounted display. Some highlights of the demonstrator are: • Definition of product family scope and creation of variability model to support systematic reuse of lifecycle artefacts • Analysis and improvement of requirements quality based on domain ontologies • Formalization of natural-language requirements into patterns based on linear temporal logic • Automatic derivation of requirements for product variants

	• Functional analysis and simulation of state-based system behaviour • Auto-generation and execution of test cases for the functional model • Integration of functional safety analysis • End-to-end traceability and impact analysis across applications • Global configuration and change management across applications • Provision of guidance based on process model of systems engineering activities **Tools involved:** IBM RELM (advanced traceability), IBM DOORS NG, Rhapsody, Design Manager (Model-based systems engineering), TRC Requirements Quality Suite (Requirements quality analysis), Isograph Fault Tree+ (safety analysis), Pure-systems pure::variants (variability management), IBM Method Composer and Team Concert (Process automation).
5	The demonstrator supports the following IOS specifications: • OSLC Requirements Management • OSLC Architecture Management • OSLC Quality Management • OSLC Change Management • OSLC Configuration Management • OSLC Tracked Resource Set • IOS Formal Requirements Management • IOS Knowledge Management (planned) • IOS System KPIs (planned) • IOS Safety Risk Management (planned)
6	Publications related to the demonstrator: • Bogusch, R., "Towards Automatic Quality Evaluation of Natural-Language Requirements", In: M. Maurer, S.-O. Schulze (eds.), *Tag des Systems Engineering,* Bremen, November 12-14, 2014, Hanser, München, 2015, pp. 401-410. • Binder, I., "Towards seamless integration of functional safety and model-based systems engineering", In: M. Maurer, S.-O. Schulze (eds.), *Tag des Systems Engineering,* Bremen, November 12-14, 2014, Hanser, München, 2015, pp. 53-62. • Bogusch, R., S. Ehrich, R. Scherer, T. Sorg and R. Wöhler, "A Lean Systems Engineering Approach for the Development of Safety-Critical Avionic Systems", In: *Proc. of ERTS 2016*, Toulouse, January 27-29, 2016.

2.3 From the EMC2 Project

1	**Dynamic service-oriented tool chain**
2	ABB Corporate Research
3	2015
4	In its current implementation, the demonstrator integrates a design tool named HiDraw with requirements management and version control from Microsoft Team Foundation Server. The goal of the demonstrator is to show a possibility to integrate tools into a dynamic tool chain in which tools could be easily added, removed or replaced. The approach is based on OSLC, but in addition to standard OSLC integration introduces a tool named Orchestrator. Orchestrator composes OSLC services exposed by service providers of other tools into a "tool chain service provider" for a specific software project. The orchestrator also rewrites all data exchanged by the tools in order to replace tool-specific URLs into orchestrator-specific, with the aim to allow easier modification of the tool chain. The last part of the orchestrator is a Notification Log, which is a OSLC-based service allowing notifications to be

	exchanged between the tools in a publish-subscribe manner. **Tools involved**: *HiDraw* design tool, *Microsoft Team Foundation Server* (TFS) - version control and requirements management, *Orchestrator* - custom integration tool.
5	The prototypes implemented: • Custom Version Control domain partly based on Configuration Management domain draft • Custom Notification Log domain • Requirements Management (as specified by OSLC, not all details are implemented) adapter for TFS • Requirements Management client for HiDraw (Displays Req. HTML and allows editing requirements to adding links to version control items) • Version control adapter for TFS and client for HiDraw
6	N/A

2.4 From the HoliDES Project

1	**Human Views Enterprise Architecture demonstrator**
2	Airbus Group Innovations & Airbus Defence and Space
3	2014-16
4	The discipline of Human Factors (HF) involves many methods such as data collection, task analysis, cognitive task analysis, human error identification, situation awareness analysis and interface analysis techniques. The implementation of these methods and the results they produce must be orchestrated around the existing design process of a project. HF is multidisciplinary and takes place across the entire lifecycle. The implementation of methods can only be done with meaningful input from the system design and for maximum effect; the results must be fed back into that design. Today Human Factors work is often done in an isolated and disconnected manner. This is due to HF methods used being heavily based on questionnaires, surveys and text based reports, i.e., non formalised data. By the end of HoliDes, Airbus hope to demonstrate better impact from human factors by utilising linked data to demonstrate traceability from HF studies and evaluations and the engineering datasets they impact. **Tools involved**: DOORS Next Generation, Enterprise Architect, HF Filer, GreatSPN
5	The HoliDes project which this demonstration is being carried out is using OSLC for lifecycle collaboration integration. In addition, HoliDes will be creating its own IOS which to allow for integrations where OSLC does not make sense, e.g. simulation based exchanges. HoliDes has recently created a new OSLC user group for creation of human factors scenarios.
6	http://www.holides.eu/ https://www.youtube.com/watch?v=sEJBCyKgoIk - What is an RTP? An OSLC based approach to Human Factors https://youtu.be/lKSnhdj33fE - This is a video demo of the DOORS being linked with Enterprise Architect

2.5 From the ASSUME Project

1	**Traceability between requirements and detailed system models**
2	Scania, KTH

3	Started in ASSUME in 2015
4	The main goal of this demonstrator is related to requirements engineering. An engineer wants to write down a set of requirements. He/she starts the specification and requirements editor (in a Scania's in-house tool called SESAMM Specifier). He/she creates a specification document (including requirements), which is also allocated to an architecture element in the architecture of the system to build. He/she then inserts the requirement at the right place in the document. He/she chooses the requirements id and writes the requirements text. In the text he/she makes references to signals and other ports in the system architecture. Also traceability links to other requirements are included. The procedure is repeated for all requirements needed.
5	OSLC Requirement Management (RM) extended for Scania's specific needs, new Architecture Management System Models (extending the OSLC AM specification)
6	N/A

3 IOS Business Plans

In this section, we present the main business cases to be expected by a wide adoption of the IOS standards for the main stakeholders of the market value chain.

3.1 Market Value Chain and Stakeholders Analysis

Figure 1 shows the market value chain for Systems Engineering development that applies uniformly in various industrial sectors, e.g., for aerospace, automotive, rail, maritime, or healthcare sectors.

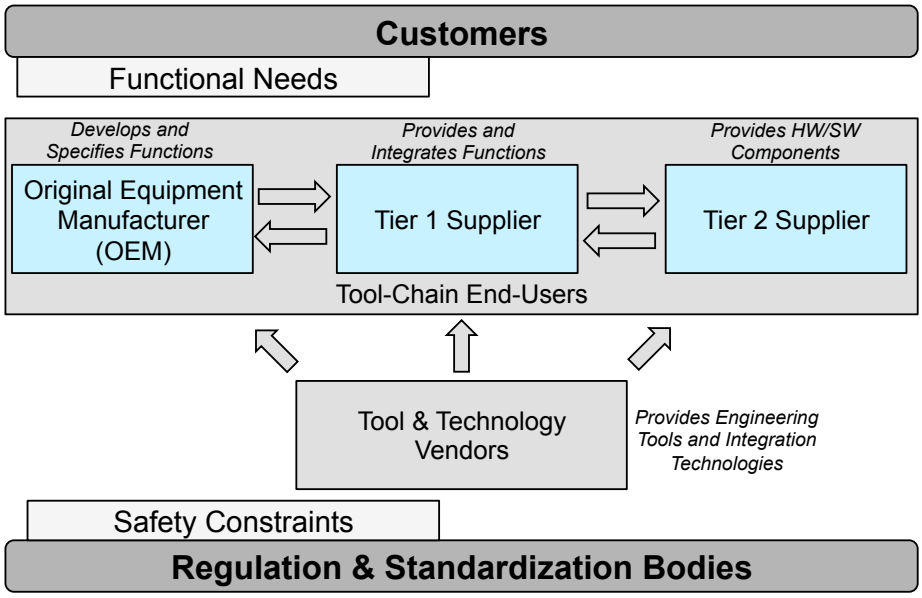

Figure 1: Market Value Chain in Systems Engineering.

Cyber-Physical Systems (CPS) products, e.g., cars, aircrafts or medical devices, are sold to customers. These customers with their functional needs are the main driving force of the technological development in these sectors. These industrial sectors are regulated within Europe and the rest of the world. These CPS products are very complex and have to integrate many components. The OEM is responsible for the complete system while suppliers develop and provide components (e.g., a specific embedded control unit). The OEM develops and specifies system functions. To realize these functions suppliers at Tier 1 implement the component requirements that are defined by the OEM. Therefore they develop hardware and software requirements. Hardware requirements for embedded devices are usually fulfilled by buying respective hardware from suppliers at Tier 2. This also holds for software components that have some generality such as operating systems or utility libraries. To support the system development from OEM to suppliers, multiple engineering tools are used and integrated into tool-chains, sold to OEMs and their suppliers by Tool and Technology vendors.

Figure 2 shows a model of stakeholders from this value chain and for which business cases based on IOS standardized tool-chains are identified.

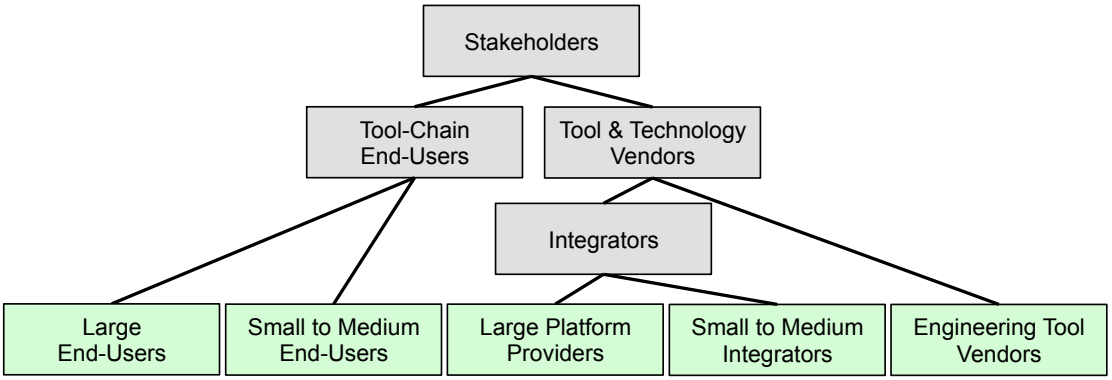

Figure 2: Stakeholders Model.

Tool-Chain End-Users are companies developing CPS products and therefore relying on tool-chains for streamlining their industrial development processes. ***Large End-Users*** (e.g., OEMs like Airbus or Volvo) are companies working with highly heterogeneous engineering environments, in terms of development & management teams and engineering tools. In some cases, the source of such heterogeneity stems from recent acquisitions of smaller companies resulting in a highly fragmented set of tools, methods and development teams. Moreover, such companies work in the context of extended enterprises, requiring exchange of information from all the stakeholders of the market value chain for system development, encompassing Tier 1 & 2 suppliers. Additionally, a very important aspect for the development of CPS is safety, ensured by standardization and regulation bodies. For example, the new ISO26262 standard from the automotive domain advocates OEMs to support full-fledge traceability across the engineering artifacts used for developing CPS. Finally, on top of these constraints, the success of nowadays CPS products depends on the OEM's abilities to deliver innovative solutions to the market just in time to satisfy demand, and to provide products with cutting-edge functionalities. ***Small to Medium End-Users*** are companies developing their own consumer CPS products, or are Tier 1 and Tier 2 suppliers working with OEMs. Their developing environments are generally much more centralized and narrowed than within large end-users, for which developing environments are much more federated.

Engineering Tool Vendors encompass a very large spectrum of tools used by end-users, e.g., for requirement engineering (e.g., Rational DOORS), model-based design (e.g., UML-based tools, Matlab), IDEs for implementation (e.g., Eclipse for Java, C#/.NET development environments), testing or analysis tools, etc. These tools are generally implemented for covering a specific engineering phase of the product development, and are not designed for being integrated with each other. In this category, we can make a distinction between well-established vendors, e.g., MathWorks with their product MATLAB, and small vendors proposing new tools on the market.

The last class of stakeholders consists of *Integrators*. On the one hand, ***Large Platform Providers*** (e.g., from the PLM or ALM domains, PTC Integrity, Siemens Team Center, IBM Jazz) provide ready-to-use integration platforms aiming at covering the whole lifecycle of CPS product development. These platforms provide basic services to tool-chain end-users for integrating their engineering tools, generally based on proprietary and monolithic interoperability buses. These stakeholders represent the current market leaders for integrated platforms. On the other hand, ***Small to Medium Integrators*** are the stakeholders that appeared the most recently on the market, and generally targeting mainstream IT applications from the ALM domain (e.g., TaskTop, fluidOps, Polarion, Sodius,

etc.). They occupy market niches for which their proprietary solutions can be applied for integrating engineering tools for small to medium end-users, or for covering specific workflow segments of large OEM processes. Both large platform providers and small to medium integrators are also proposing new lifecycle tools, providing added-value services on top of integrated tool-chains (e.g., dashboards, impact analysis tools, data warehouses, etc.).

3.2 Detailed Business Cases

In the following subsections, we analyze business opportunities arising from a wide adoption of IOS standardized tool chains for these stakeholders, and evaluate potential returns and risks.

3.2.1 Business Cases for Tool-Chain End-Users

Large Tool-Chain End-Users

Large end-users are the main stakeholders who will benefit in relying on IOS standardized tool-chains for streamlining their industrial processes and reducing their development costs.

Business Opportunities (what?)
• Innovation of CPS software-intensive products with new and high-quality features proposed to their customers, resulting in more attractive offers compared to competitors. • Reduction of development costs, especially in the context of safety-critical systems development.
Value Propositions (how?)
• **Facilitating building and maintenance of tool-chains** thanks to adoption and understanding of standardized solutions by all the stakeholders of the value chain. • **Continuous improvement of tool-chains**. The general focus of end-users is about handling system complexity and functional safety requirements. Adoption of standardized tool-chains will allow improved application functionality whilst increasing the level of functional safety of CPS products. • **Streamlining and optimization of development processes**. As described in section **Error! Reference source not found.**, the opportunities brought by big data analytics n engineering data collected throughout the lifecycle will improve decision making and will provide new inputs for improving development processes. Moreover, the IOS standards will reinforce the cooperation between the actors of the supply chain facilitating the data exchanges and reducing rework on system development. • **Overcoming tool vendors locking**. Relying on standardized solutions will ease the integration of engineering tools and tool-chain services provided by multiple tool providers and integrators.
Potential Risks and their Mitigations
• IOS standards not supported enough by tool vendors. The lack of standards support

is always a risk in the long run for end-users. Adoption of OSLC-compliant technologies slightly reduces this risk though, since it is based on Internet technologies already widely supported worldwide. • Poor management across end-user's business lines. Many end-users still expect turnkey solutions to be provided by big tool vendors for supporting their integration needs. However, in real-life and federated environments, tool-chain end-users have to organize themselves and invest internally in order to collect integration requirements from their business lines and foster cross team cooperation for deploying tool-chains standardize components. Indeed, it is most likely that multiple tool vendors will provide such components. • Lack of cooperation with IT departments. Adopting OSLC-compliant technologies imply for end-user's tool-chain architects to closely cooperate with their IT department. Indeed, such cooperation is a prerequisite for deploying tool-chains within their IT infrastructure, and in compliance with the security policies of the organization.

Small to Medium Tool-Chain End-Users

For such tool-chain end-users, even if their own development processes require design feedback loops between their developers, their integration demands are rather limited. A careful benefit/value analysis should be performed to find out whether the integration investments overweight the costs of maintaining a single-vendor ready-made tool-chain, e.g., as already sold on the market by Large Platform Providers. However, in the context of extended enterprise, such SMEs could be asked by their clients (e.g., large OEMs) to rely on IOS/OSLC compliant tools in order to streamline the exchange of information across the whole lifecycle of the value chain. Finally, since it might not be beneficial for such companies to engage into integration activities, we do not provide more detail about potential IOS/OSLC business opportunities for this stakeholder.

3.2.2 Business Cases for Integrators

Large Platform Provider

Large Platform Providers are the stakeholders that are the most reluctant in supporting interoperability standards. Indeed, their current business models are based on proprietary integration technologies, and aiming at locking in tool-chain end-users for selling them licenses and maintenance contracts in the long run. However, new business opportunities will be raised for them in a context of a wide adoption of IOS/OSLC standards. Bottom line, these large integrators could be collaborating on interoperability but compete on functionalities, stepping up the latter towards innovative added-value services.

Business Opportunities (what?)
• Getting access to new market shares thanks to higher-quality integration platforms and enhanced with new features brought by the IOS/OSLC technical innovation (see

section **Error! Reference source not found.**).
Value Propositions (how?)
• **Richer portfolio of integrated engineering tools** in their platform thanks to IOS integration interfaces implemented by third-party tool vendors. • **New added-value services** implemented on top of their integration platforms making the most of the standardized information models available across the integrated tools. These new services can be implemented by the owner of the platform itself, or by external SMEs proposing standards-compliant plug-ins on top of their platform.
Potential Risks and their Mitigations
• Loss of market shares to be occupied by competitors (either large platform providers, potentially SMEs, or communities developing IOS open-source platforms) providing higher-quality standardized integration services. It is clear that in a context of a wide adoption of IOS standards, the large platform providers will have to adapt their offers and invest on the development of new added-value services. However, big OEMs and Tier 1 suppliers will always give advantage to these large and reliable platform providers for supporting their integration needs in the long run.

Small to Medium Integrators

A wide adoption of IOS standards by the market will have a tremendous business impact on SMEs focused on integration. Indeed, for such companies, it will bring a lot of opportunities for proposing services and software on top of standardized tool-chains that will be easily reused, and then sold, to multiple end-users or to large platform providers.

Business Opportunities (what?)
• New consultancy services to be provided to tool-chain end-users. • Standardized integration bricks used within large tool-chains. • New added-value services (e.g., visualization tools, high-performance data processors, dashboards) to be provided on top of standardized interfaces, directly provided to end-users or via large platform providers. • Innovative tools for streamlining the implementation and maintenance of integration assets (e.g., standard-compliant Software Development Kits, SDKs, test suites, or modeling tools).
Value Propositions (how?)
• A lot of stakeholders will have to invest from within their organizations in order to

foster adoption of IOS standards. In order to do so, it will be required to educate these organizations and to provide support in understanding their integration needs. Such consultancy services can be easily provided by SMEs, opening-up new business opportunities directly resulting from the adoption of these standards. • The adoption of standardized interfaces and technologies for integration will allow SMEs to streamline their development processes of tool adaptors. Moreover, standardized approaches will increase the reuse potential of these adaptors, and in consequence will be potentially sold to more end-users from various industrial sectors, providing more business opportunities to these SMEs. • Once standards are widely adopted on the market, tool vendors, generally SMEs, start to provide various support tools targeting architects, designers and developers for developing these standardized assets. Among many other examples, such support tools encompass modeling tools allowing tool-chain architects to build their tool-chains based on IOS standardized information models, test suites automatically checking the compliance of tool adaptors with IOS standards, or code generators for speeding up the implementation process of standardized tool adaptors.
Potential Risks and their Mitigations
• If the IOS standards do not fly on the market, the strategy adopted by these stakeholders might put in jeopardy their business plans in the long run. However, in the case of OSLC, the main principles of the standard are to rely on Web-based technologies and Internet open standards (e.g., from the W3C). These aspects have indisputable technical benefits and business potentials for SMEs to sell their solutions.

3.2.3 Business Cases for Engineering Tool Vendors

As mentioned earlier for this category of stakeholders, we can make a distinction between small vendors proposing new engineering tools on the market and well-established ones. The former will clearly see benefits in adopting standardized IOS interfaces to promote their tools, while the latter will do so only if their clients massively request it.

Business Opportunities (what?)
• Attraction of new customers thanks to an easier integration of their engineering tools into end-users' tool-chains. • Enhance functionality of data processors and Graphical User Interfaces (GUIs) of their engineering tools based on the integrated lifecycle data available from other information silos.
Value Propositions (how?)
• **Increase chances from potential buyers** for doing business with new tool vendors.

Indeed, the support of standardized interfaces by new tool vendors will allow to seamlessly integrating their tools within large end-users' tool-chains. This will lower the barriers for potential clients, in particular for large OEMs, to adopt tools from small tool vendors.

- **Providing novel, market-relevant and emergent features**. Thanks to a wide adoption of standardized integration interfaces, tool vendors will get uniform access to engineering data provided by third-party tools. In turn, this information will be used for enhancing their own tools with added-value features in relation with the surrounding developing environment.

Potential Risks and their Mitigations

- Engineering Tool Vendors will have to implement adaptors compliant with OSLC normative specs, which might imply to support capabilities that are beyond their core businesses (e.g., capabilities related to Configuration Management). However, it is most likely that the economic benefits by the support of OSLC interfaces by their tool vendors will outweigh the initial investment of these capabilities. Moreover, the implementation of these features will be possibly outsources to SMEs, in turn creating new business opportunities for the latter.