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D6.4: Dissemination and Exploitation Report – intermediate version

M24
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Executive summary

This is the second document of a series of three for reporting all WP6 activities for creating impact around the project, mainly dissemination, communication, collaboration, standardization and exploitation with the aim of ensuring the sustainability of MegaM@Rt2 results.

The document reviews and updates de dissemination and communication plan, based on the measurement of the established KPIs and presents all the activities corresponding to each of the measures.

As it happens in the previous period, the project has been very active in dissemination activities, fostering the adoption of MegaM@Rt2 results, and started to define the sustainability strategy for exploiting them. However, this is not the end of the road as the final report will include the definition of the selected path and all the activities performed for its development.

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Acronyms

BM	Business Model
D	Deliverable
T	Task
UC	Use Case
VP	Value Proposition
WP	Work Package

1. Introduction

This document presents the list of activities performed along the second project period related to maximising impact: dissemination, communication, collaboration, standardisation and exploitation.

The document is structured into five different sections documenting each of them:

Section 2. Contains an overview of the dissemination and communication plan as well as some updates on it based on the established KPIs for the project and their measurement.

Section 3. Presents all the dissemination and communication activities held during the second project period.

Section 4. Indicates the list of collaboration activities established during the period and the plans for the next one.

Section 5. Summarizes all the activities performed for contributing to most relevant project-related standards to maximise its industrial impact.

Section 6. Finally, this section contains the list of individual exploitable assets identified until this moment, as well as the different possibilities (aka. Business models) for commercializing them, finishing with partners' exploitation plans and the possibilities for a joint one based on the sustainability approach depicted in D6.3

Annexes contains the list of received individual exploitation plans, as well as the templates for collecting and analysing IPR and the joint exploitation survey.

All activities listed in this document will be further refined and updated in the final deliverable of these series, which will contain the final sustainability plan, the identified joint exploitable assets and the list of all activities performed to support it.

2. Recap and updating of Dissemination and Communication Plan

Communication aims to create awareness around the project, reaching all potential stakeholders including general public, at the same time dissemination purpose is to foster the use of MegaM@Rt2 results.

In previous deliverables (D6.2 and D6.3) a list of stakeholders was provided, as well as the objectives for reaching them. The following table summarises both, stakeholders and messages to be transmitted in order to increase the awareness around the project, aiming to attract and engage them.

Target	Message
Scientific Community	It can benefit from the novel methods and techniques for software modelling provided within the MegaM@Rt2 Toolbox.
Industry	Overall European embedded systems industry can benefit of the MegaM@Rt2 proposal, including standardisation contributions.
Civil society and general public	Although not directly addressed by the project, they can benefit of the improved services built on top of MegaM@Rt2 results.
Media	Reuse MegaM@Rt2 dissemination material to tackle technology specialists.
Investors	Who can benefit of the exploitation of certain MegaM@Rt2 results through partnerships with the consortium, even addressing specific market segments.
Customers	The can adopt MegaM@Rt2 results to enhance their offering, or even developing new services, for their final customers.

2.1. Impact Measurement

KPI for Dissemination Output	Quantitative aim (FPP)	Achieved (Feb 2019)	Planned activities (until the end of the project)
Scientific publications (and presentations) in conference proceedings	21	62	13
Presentations in conferences and events (talks, posters, etc.)	Mixed with publications in proposal	23	3
Workshops at specialized conferences	5	7	2
Videos	2	1	1
Scientific papers in peer-reviewed journals	6	10	2
White papers	4	0	2
Press releases	6	1	1 in autumn 2018; 1 in spring 2019
Website visits	15000 (50% spending over 2 minutes)	2400 unique visitors/1:47 time spent	90% of incremented users!!
Presence in social media	Twitter followers:400 LinkedIn discussions: weekly	84 followers in Twitter; no LinkedIn interactions	Plan to improve

Postgraduate courses	5	12	5

As it can be seen in the table above, the project is in an overall good shape regarding dissemination and communication activities. However, there are still some weak aspects that need to be improved, mainly related to communication activities.

For white papers, now the project results are more mature, and their benefits are being demonstrated through the real-world case studies, at least one business oriented white paper is planned to be released before the end of the year, as well as a high level one for letting a wider audience know, and understand, about the project. Technical white papers are also under discussion.

The project will write at least one more press release before the end of the project to advertise its results. However, some other will be written and printed along the project lifetime, as they have demonstrated to be useful for explaining the project during events.

Finally, regarding the project online presence new actions will be undertaken to increase the project visibility, such as:

- Regular publication of blog posts on the MegaM@Rt2 website about scientific contributions, collaborations between partners and technical solutions developed.
- Being more active on social networks (Twitter and LinkedIn) publishing relevant information about the project but also about any related topic of interest.
- Host event websites on the MegaM@Rt2 portal to increase traffic and large audience dissemination (already done for MDE@DeRun 2018 and 2019).
- Ask project partners to (re)publish captures of their presentations, tools demonstration and tutorials on the MegaM@Rt2 YouTube channel and communicate them through the project's Twitter account.
- Finally, as suggested in the Sustainability Survey (Annex III) a dedicated space will be added in the website in order to provide more industry-oriented information about the project, based on the interest of clustered potential customers.

3. Dissemination and Communication actions

The main exploitable results from MegaM@Rt2 project are described below and grouped by the type of dissemination and communication actions intended by the partners at this initial phase of the project.

The grouping is as follows:

- Publication and conferences
- Events organization and attendance
- Academic courses
- Social and online tools
- Marketing materials

3.1. Publications and Conferences

The following MegaM@Rt2 project results will be disseminated as scientific publications and presentations in conferences (such as posters, keynotes, tutorials, etc.) so that other technology vendors and industrial software development organisations are able to create tools and platforms that exploit or interoperate with MegaM@Rt2 technologies.

1. **Advanced prefetching and caching of models with PrefetchML**
   Caching and prefetching techniques have been used for decades in database engines and file systems to improve the performance of I/O-intensive applications. A prefetching algorithm typically benefits from the system's latencies by loading into main memory elements that will be needed in the future, speeding up data access. While these solutions can bring a significant improvement in terms of execution time, prefetching rules are often defined at the data level, making them hard to understand, maintain and optimize. In addition, low-level prefetching and caching components are difficult to align with scalable model persistence frameworks because they are unaware of potential optimizations relying on the analysis of metamodel-level information and are less present in NoSQL databases, a common solution to store large models. To overcome this situation, we propose PrefetchML, a framework that executes prefetching and caching strategies over models. Our solution embeds a DSL to configure precisely the prefetching rules to follow and a monitoring component providing insights on how the prefetching execution is working to help designers optimize their performance plans. Our experiments show that PrefetchML is a suitable solution to improve query execution time on top of scalable model persistence frameworks. Tool support is fully available online as an open source Eclipse plugin [Advanced prefetching and caching of models with PrefetchML, Daniel, G., Sunyé, G. & Cabot, J. Softw Syst Model (2018), https://doi.org/10.1007/s10270-018-0671-8]
2. **Gremlin-ATL: A scalable model transformation framework**
   Industrial use of Model Driven Engineering techniques has emphasized the need for efficiently store, access, and transform very large models. While scalable persistence frameworks, typically based on some kind of NoSQL database, have been proposed to solve the model storage issue, the same level of performance improvement has not been achieved for the model transformation problem. Existing model transformation tools (such as the well-known ATL) often require the input models to be loaded in memory prior to the start of the transformation and are not optimized to benefit from lazy-loading mechanisms, mainly due to their dependency on current low-level APIs offered by the most popular modeling frameworks nowadays. In this paper we present Gremlin-ATL, a scalable and efficient model-to-model transformation framework that translates ATL transformations into Gremlin, a query language supported by several NoSQL databases. With Gremlin-ATL, the transformation is computed within the database itself, bypassing the modeling framework limitations and improving its performance both in terms of execution time and memory consumption. Tool support is available online. [Gremlin-ATL: A scalable model transformation framework, Gwendal Daniel, Frédéric Jouault, Gerson Sunyé, Jordi Cabot, 2017 32nd IEEE/ACM International Conference on Automated Software Engineering (ASE), https://doi.org/10.1109/ASE.2017.8115658]
3. **Exploiting Architecture/Runtime Model-driven Traceability for Antipattern-based Performance Improvement**
   Model-Driven Engineering techniques may achieve a major support to the software development when they allow to manage relationships between a running system and its architectural model. These relationships can be exploited for different goals, such as the

software evolution due to new functional requirements. In this paper, we define and use relationships that work as support to the performance improvement of a running system. In particular, we combine: (i) a bidirectional model transformation framework tailored to define relationships between performance antipatterns and for suggesting architectural changes, aimed at removing performance problems identified on the basis of runtime in-formation. The result is an integrated approach model to derive recommended refactoring solutions for the system performance improvement. The approach has been applied to an e-commerce application based on microservices that has been designed by means of UML software models profiled with MARTE. [Exploiting Architecture/Runtime Model-driven Traceability for Antipattern-based Performance Improvement, Davide Arcelli, Vittorio Cortellessa, Daniele Di Pompeo, Romina Eramo, Michele Tucci, IEEE Int. Conference on Software Architecture (ICSA 2019), to appear].

4. **Automating Performance Antipattern Detection and Software Refactoring**

   The satisfaction of ever more stringent performance requirements is one of the main reasons for software evolution. However, it is complex to determine the primary causes of performance degradation, because they may depend on the joint combination of multiple factors (e.g. workload, software deployment, hardware utilization). With the increasing complexity of software systems, classical bottleneck analysis shows limitations in capturing complex performance problems. Hence, in the last decade, the detection of performance antipatterns has gained momentum as an effective way to identify performance degradation causes. We introduce PADRE (Performance Antipattern Detection and Refactoring), that is a tool for: (i) detecting performance antipattern in UML models, and (ii) refactoring models with the aim of removing the detected antipatterns, PADRE has been implemented within Epsilon, an open source platform for model-driven engineering. It is based on a methodology that allows performance antipattern detection and refactoring within the same implementation context. [Automating Performance Antipattern Detection and Software Refactoring, Davide Arcellin, Vittorio Cortellessa, Daniele Di Pompeo, IEEE Int. Conference on Software Analysis, Evolution and Reengineering (SANER 2019), to appear].

5. **EASIER: An Evolutionary Approach for Multi-objective Software ArchItecturE Refactoring**

   Multi-objective optimization has demonstrated, in the last years to be an effective paradigm to tackle different architectural problems, such as service selection, composition and deployment. In particular, multi-objective approaches for searching architectural configurations that optimize quality properties (such as performance, reliability and cost) have been introduced in the last decade. However, a relevant amount of complexity is introduced in this context when performance is considered, often due to expensive iterative generation of performance models and interpretation of results. In this paper we introduce EASIER (Evolutionary Approach for multi-objective Software archItecturE Refactoring), that is an approach for optimizing architecture refactoring based on performance and on the intensity of changes. We focus on the actionable aspects of architectural optimization, instead of merely searching over a set of alternatives. We also start to investigate on the potential influence of performance antipatterns on such process. We have implemented our approach on AEmilia ADL, so to carry out performance analysis and architecture refactoring within the same environment. We demonstrate the effectiveness and applicability of our approach through its experimentation on a case study. [EASIER: An Evolutionary Approach for Multi-objective Software ArchItecturE Refactoring, Davide Arcelli, Vittorio Cortellessa, Mattia D'Emidio, Daniele Di Pompeo, 2018 IEEE Int. Conference on Software Architecture (ICSA), 105-10509, 10.1109/ICSA.2018.00020]

6. **Performance-Driven Software Architecture Refactoring**

   Performance engineering of software architecture can be defined as the process of analyzing the performance of a software architecture and then reacting to problems emerging from such analysis by refactoring the software architecture in order to meet performance requirements. In the last decade, many approaches in this field have appeared, whereas the problem of reacting to problems by proposing and evaluating alternative solutions through architectural refactoring has been much less treated. Indeed, the introduction of automated support to refactoring becomes crucial to drive architectural evolutions that might lead to performance improvement. This tutorial is aimed at introducing notations, methodologies and tools that can be adopted for Performance-Driven Software Architecture Refactoring. [Performance-Driven Software Architecture Refactoring, Davide Arcelli, Vittorio Cortellessa, Daniele Di Pompeo, 2018

IEEE International Conference on Software Architecture Companion (ICSA 2018), 10.1109/ICSA-C.2018.00006]

7. **A metamodel for the specification and verification of model refactoring action**

   Refactoring has become a valuable activity during the software development lifecycle, because it can be induced by different causes, like new requirements or quality improvement. In code-based development contexts this activity has been widely studied, whereas in model-driven ones, where models are first-class development entities, there are many issues yet to be tackled. In this paper we present a metamodel that supports the specification of pre-and post-conditions of model refactoring actions, and the automated derivation and verification of such conditions in specific modeling languages. Our work is aimed at helping users to implement refactoring actions in the adopted modelling language by providing an environment for guaranteeing the feasibility of refactoring actions. Our primary focus is on the definition of applicable sequences of refactoring actions, rather than on the user-driven step-by-step application of refactoring actions. As an example, we illustrate the applicability of our metamodel for UML models refactoring. [A metamodel for the specification and verification of model refactoring action, Davide Arcelli, Vittorio Cortellessa, Daniele Di Pompeo, Proceedings of the 2nd International Workshop on Refactoring, 14--21,10.1145/3242163.3242167]

8. **Model-driven round-trip software dependability engineering**

   Supporting changes in software models is becoming increasingly important. Some of these changes are induced by non-functional analysis that is usually conducted on different models and tools. Therefore, it becomes crucial to develop methods that allow automated transformations between these two families of models throughout the development cycle. To this extent, in the last decade, a number of approaches have been introduced to generate non-functional analysis models from software models. However, when analysis models are modified to meet non-functional requirements, changes are not propagated to update the software model. Automating the identification and propagation of changes would better support a round-trip analysis process. In this PhD program, we aim at introducing automation in the model-driven assessment of dependability, and we propose to leverage bidirectional model transformations to: (i) generate dependability analysis models from software models, and (ii) automatically propagate changes, driven by dependability requirements satisfaction, from analysis models back to software models. In particular, we intend to extend JTL, that is a bidirectional model transformations framework designed for model synchronization and change propagation, to handle problems that may arise from the application of bidirectional transformations in the context of dependability assessment. [Model-driven round-trip software dependability engineering, Michele Tucci, MODELS '18 Proceedings of the 21st ACM/IEEE International Conference on Model Driven Engineering Languages and Systems: Companion Proceedings, 186-191, 10.1145/3270112.3275337]

9. **Model-Driven Engineering for Design-Runtime Interaction in Complex Systems: Scientific Challenges and Roadmap**

   This paper reports on the first Workshop on Model-Driven Engineering for Design-Runtime Interaction in Complex Systems (also called MDE@DeRun 2018) that took place during the STAF 2018 week. It explains the main objectives, content and results of the event. Based on these, the paper also proposes initial directions to explore for further research in the workshop area. [Model-Driven Engineering for Design-Runtime Interaction in Complex Systems: Scientific Challenges and Roadmap, Hugo Bruneliere, Romina Eramo, Abel Gomez, Valentin Besnard, Jean-Michel Bruel, Martin Gogolla, Andreas Kästner, Adrian Rutle, Software Technologies: Applications and Foundations. STAF 2018. Lecture Notes in Computer Science, vol 11176. Springer, Cham]

10. **TRILATERAL: Software Product Line based multidomain IoT artifact generation for Industrial CPS**

    Internet of Things (IoT) devices are usually advanced embedded systems that require functionalities monitoring and control. The design, development and validation of these devices is complex, even more when communication capabilities need to be included. In industrial environments, where safety is of critical importance, reducing this complexity can help to achieve the vision of Industry 4.0 by reducing development time and costs as well as increasing

quality. To this end, the use of Model-Driven Engineering (MDE) methodology and the Software Product Line (SPL) paradigm is becoming increasingly important as they help to accelerate and ease the development of software, while reducing bugs and errors. Thus, in this work we present TRILATERAL, a SPL Model Based tool that uses a Domain Specific Language (DSL) to allow users to graphically define the IEC 61850 information model of the Industrial Cyber-Physical System (ICPS). TRILATERAL automatically generates the source code for communicating devices with the monitoring framework, also supporting a variety of communication protocols, namely HTTP-REST, WS-SOAP and CoAP in order to control/monitor any ICPS. In addition, the solution was evaluated deploying it in different industrial domains (Wind Farm, Smart Elevator, Catenary-free Tram) from which we gained important lessons. [TRILATERAL: Software Product Line based multidomain IoT artifact generation for Industrial CPS, Aitziber Iglesias, Markel Iglesias-Urkia, Beatriz López-Davalillo, Santiago Charramendieta, Aitor Urbieta, International Conference on Model-Driven Engineering and Software Development, MODELSWARD 2019, to appear]

11. **Integrating electrical substations within the IoT using IEC 61850, CoAP and CBOR**

    Electrical substations are crucial elements of Smart Grids where they are mainly responsible for voltage transformations. However, due to the integration of distributed energy resources in the grid, substations now have to provide additional grid management capabilities which in turn require supervision and automation solutions for large low-voltage grids. A recurring challenge in such deployments are siloed systems that are due to non-interoperable communication protocols across substations: although most substations' communication is based on the International Electrotechnical Commission (IEC) 61850 standard, deployed legacy protocols lag behind modern communication technologies in terms of performance, hindering the full transition to lightweight protocols. This paper demonstrates that IEC 61850 can be fully mapped to the Constrained Application Protocol (CoAP) in combination with the Concise Binary Object Representation (CBOR) format while improving system performance compared to existing alternatives (e.g. WS-SOAP and HTTP). On average, CoAP+CBOR needs 44\% and 18\% of the message size and 71\% and 85\% of the time compared to systems based on HTTP and WS-* Web Services, respectively -- this is especially relevant for resource-constrained devices and networks in electrical grids. In addition, CoAP is based on the Representational State Transfer (REST) architectural style, which supports system integration and interoperability through uniform identification and interaction. This approach fosters the standard-compliant integration of legacy platforms with modern substations as well as current IoT systems in neighboring domains such as building management and infrastructure automation systems. [Integrating electrical substations within the IoT using IEC 61850, CoAP and CBOR, Markel Iglesias-Urkia, Diego Casado-Mansilla, Simon Mayer, Josu Bilbao, Aitor Urbieta. 2019. IEEE IoT Journal, to appear]

12. **Identifying Worst-Case User Scenarios for Performance Testing of Web Applications Using Markov-Chain Workload Models**

    The poor performance of web-based systems can negatively impact the profitability and reputation of the companies that rely on them. Finding those user scenarios which can significantly degrade the performance of a web application is very important in order to take necessary countermeasures, for instance, allocating additional resources. Furthermore, one would like to understand how the system under test performs under increased workload triggered by the worst-case user scenarios. In our previous work, we have formalized the expected behavior of the users of web applications by using probabilistic workload models and we have shown how to use such models to generate load against the system under test. As an extension, in this article, we suggest a performance space exploration approach for inferring the worst-case user scenario in a given workload model which has the potential to create the highest resource utilization on the system under test with respect to a given resource. We propose two alternative methods: one which identifies the exact worst-case user scenario of the given workload model, but it does not scale up for models with a large number of loops, and one which provides an approximate solution which, in turn, is more suitable for models with a large number of loops. We conduct several experiments to show that the identified user scenarios do provide in practice an increased resource utilization on the system under test when compared to the original models. [Tanwir Ahmad, Dragos Truscan, Ivan Porres, Identifying Worst-Case User

Scenarios for Performance Testing of Web Applications Using Markov-Chain Workload Models. Future Generation Computer Systems: The International Journal of Grid Computing: Theory Methods and Applications, Volume 87, October 2018, Pages 910-920, 2018. https://dx.doi.org/10.1016/j.future.2018.01.042]

13. The MegaM@Rt2 ECSEL project: MegaModelling at Runtime – Scalable model-based framework for continuous development and runtime validation of complex systems

A major challenge for the European electronic industry is to enhance productivity by ensuring quality of development, integration and maintenance while reducing the associated costs. Model-Driven Engineering (MDE) principles and techniques have already shown promising capabilities, but they still need to scale up to support real-world scenarios implied by the full deployment and use of complex electronic components and systems. Moreover, maintaining efficient traceability, integration, and communication between two fundamental system life cycle phases (design time and runtime) is another challenge requiring the scalability of MDE. This paper presents an overview of the ECSEL 1 project entitled “MegaModelling at runtime – Scalable model-based framework for continuous development and runtime validation of complex systems” (MegaM@Rt2), whose aim is to address the above-mentioned challenges facing MDE. Driven by both large and small industrial enterprises, with the support of research partners and technology providers, MegaM@Rt2 aims to deliver a framework of tools and methods for: 1) system engineering/design and continuous development, 2) related runtime analysis and 3) global models and traceability management. Diverse industrial use cases (covering strategic domains such as aeronautics, railway, construction and telecommunications) will integrate and demonstrate the validity of the MegaM@Rt2 solution. This paper provides an overview of the MegaM@Rt2 project with respect to its approach, mission, objectives as well as to its implementation details. It further introduces the consortium as well as describes the work packages and few already produced deliverables. [Afzal, Wasif and Bruneliere, Hugo and Di Ruscio, Davide and Sadovykh, Andrey and Mazzini, Silvia and Cariou, Eric and Truscan, Dragos and Cabot, Jordi and Gómez, Abel and Gorroñogoitia, Jesús and Pomante, Luigi and Smrz, Pavel. The MegaM@Rt2 ECSEL project: MegaModelling at Runtime – Scalable model-based framework for continuous development and runtime validation of complex systems. Microprocessors and Microsystems, Volume 61, September 2018, Pages 86-95, 2018. https://doi.org/10.1016/j.micpro.2018.05.010]

14. Vulnerability Assessment of Web Services with Model-based Mutation Testing

A major challenge for the European electronic industry is to enhance productivity by ensuring quality of development, integration and maintenance while reducing the associated costs. Model-Driven Engineering (MDE) principles and techniques have already shown promising capabilities, but they still need to scale up to support real-world scenarios implied by the full deployment and use of complex electronic components and systems. Moreover, maintaining efficient traceability, integration, and communication between two fundamental system life cycle phases (design time and runtime) is another challenge requiring the scalability of MDE. This paper presents an overview of the ECSEL 1 project entitled “MegaModelling at runtime – Scalable model-based framework for continuous development and runtime validation of complex systems” (MegaM@Rt2), whose aim is to address the above mentioned challenges facing MDE. Driven by both large and small industrial enterprises, with the support of research partners and technology providers, MegaM@Rt2 aims to deliver a framework of tools and methods for: 1) system engineering/design and continuous development, 2) related runtime analysis and 3) global models and traceability management. Diverse industrial use cases (covering strategic domains such as aeronautics, railway, construction and telecommunications) will integrate and demonstrate the validity of the MegaM@Rt2 solution. This paper provides an overview of the MegaM@Rt2 project with respect to its approach, mission, objectives as well as to its implementation details. It further introduces the consortium as well as describes the work packages and few already produced deliverables. [Afzal, Wasif and Bruneliere, Hugo and Di Ruscio, Davide and Sadovykh, Andrey and Mazzini, Silvia and Cariou, Eric and Truscan, Dragos and Cabot, Jordi and Gómez, Abel and Gorroñogoitia, Jesús and Pomante, Luigi and Smrz, Pavel. The MegaM@Rt2 ECSEL project: MegaModelling at Runtime – Scalable model-based framework for continuous development and runtime validation

of complex systems. Microprocessors and Microsystems, Volume 61, September 2018, Pages 86-95, 2018. https://doi.org/10.1016/j.micpro.2018.05.010]

15. Model-Based System Engineering in Practice: Document Generation – MegaM@Rt Project Experience

MegaM@Rt2 project is a collaborative initiative of the ECSEL Joint Undertaking under Horizon 2020 EU programme. The project regroups 26 partners from 6 different European countries who jointly address challenges of engineering modern cyber-physical systems by using model-based engineering methods. Since it is a model-based project, we adopted a similar approach for dealing with requirements analysis, architecture, design, roadmap planning and development status checking. In these tasks, document generation methods were particularly useful to create a set of "live" reference specifications and contractual reports. We believe that these methods perfectly demonstrate relevant benefits of the model-based approach and are applicable to many other contexts. Document generation has several challenges, since the produced documents should address several goals and target different audience. Hence, we describe this approach in detail in this paper in the form of an experience report. In essence, the MegaM@Rt2 project had a rather trivial task to document inception phase of the project. The challenge arises from the scale of the project, we had to deal with hundreds of requirements from completely different users, hundreds of features of 29 tools, which had to be mapped to those requirements in order to analyze a gap and devise a roadmap for a consistent tool chain. With limited resource on technical coordination we had to be extremely efficient and thus we adopted a model-based approach that we describe in this paper. The paper should be helpful to project managers and architects who wish to discuss on model-based approaches from a practical side. [Andrey Sadovykh, Alessandra Bagnato, Dragos Truscan, Pierluigi Pierini, Hugo Bruneliere, Orlando Avila-García, Atos Wasif Afzal, Adnan Ashraf. Model-Based System Engineering in Practice: Document Generation – MegaM@Rt Project Experience. Central and Eastern European Software Engineering Conference Russia (CEE-SECR), October 12-13, 2018.

https://dl.acm.org/citation.cfm?doid=3290621.3290633]

16. Reasoning about UML/OCL Class Diagrams using Constraint Logic Programming and Formula

Model Driven Engineering promotes the use of models as the main artifacts in software and system development. Verification and validation of models are key activities to ensure the quality of the system under development. This paper presents a framework to reason about the satisfiability of class models described using the Unified Modeling Language (UML). The proposed framework allows us to identify possible design flaws as early as possible in the software development cycle. More specifically, we focus on UML Class Diagrams annotated with Object Constraint Language (OCL) invariants, which are considered to be the main artifacts in Object-Oriented analysis and design for representing the static structure of a system. We use the Constraint Logic programming (CLP) paradigm to reason about UML Class Diagrams modeling foundations. In particular, we use Formula as a model-finding and design space exploration tool. We also present an experimental Eclipse plug-in, which implements our UML model to Formula translation proposal following a Model Driven Architecture (MDA) approach. The proposed framework can be used to reason, validate, and verify UML Class Diagram software designs by checking correctness properties and generating model instances using the model exploration tool Formula. [Beatriz Perez and Ivan Porres. Reasoning about UML/OCL Class Diagrams using Constraint Logic Programming and Formula. Information Systems, Volume 81, March 2019, Pages 152-177, 2019. https://doi.org/10.1016/j.is.2018.08.005]

17. A Systematic Mapping Study on API Documentation Generation Approaches

Background: Application Programming Interfaces (APIs) are key to software reuse. Software developers can link functionality and behaviour found in other software with their own software by taking an API into use. However, figuring out how an API works is usually demanding, and may require that the developers spend a notable amount of time familiarizing themselves with the API. Good API documentation is of key importance to simplify this task. Objective: To present a comprehensive, unbiased overview of the state-of-the-art on tools and approaches for API documentation generation. Method: A systematic mapping study on published tools and approaches that can be used for generating API documentation, or for assisting in the API documentation process. Results: 36 studies on API documentation generation tools

and approaches analyzed and categorized in a variety of ways. Among other things, the paper presents an overview of what kind of tools have been developed, what kind of documentation they generate, and what sources the documentation approaches require. Conclusion: Out of the identified approaches, many contribute to API documentation in the areas of natural language documentation and code examples and templates. Many of the approaches contribute to ease API users' understanding and learning of the API, but also to the maintenance and generation of API documentation. Most of the approaches are automatic, simplifying the API documentation generation notably, under the assumption that relevant sources for the generation are available. Most of the API documentation approaches are evaluated either by exercise of the approach followed by analysis of the results, or by empirical evaluation methods. [Kristian Nybom, Adnan Ashraf, Ivan Porres. A Systematic Mapping Study on API Documentation Generation Approaches. Euromicro Conference on Software Engineering and Advanced Applications (SEAA), 28-31.8.2018. https://dx.doi.org/10.1109/SEAA.2018.00081]

18. A Contract-Based Approach to Scheduling and Verification of Dynamic Dataflow Networks

Restricted dataflow models of computation have gained widespread adoption in the safety-critical and real-time domains. As more complex functionality is being incorporated in embedded systems, there is a need for more expressive languages while maintaining high analysability. We present a contract-based approach to specification, scheduling and verification of dynamic dataflow networks. The approach is based on finding static schedules based on contracts and utilising this information in the verification process to reduce the number of invariant annotations needed. Moreover, we show that contracts can be used to make compile-time scheduling decisions, hence, improving runtime performance. [Jonathan Wik, Johan Ersfolk, Marina Walden. A Contract-Based Approach to Scheduling and Verification of Dynamic Dataflow Networks. 16th ACM/IEEE International Conference on Formal Methods and Models for System Design (MEMOCODE), 2018. https://doi.org/10.1109/MEMCOD.2018.8557004]

19. Towards Scalable Model Views on Heterogeneous Model Resources

When engineering complex systems, models are used to represent various system aspects. These models are often heterogeneous in terms of modeling language, provenance, number or scale. They can be notably managed by different persistence frameworks adopted to their nature. As a result, the information relevant to engineers is usually split into several models. To be useful in practice, these models need to be integrated together to provide global views over the system under study. Model view approaches have been proposed to tackle such an issue. They provide a unification mechanism to combine and query heterogeneous models in a transparent way. These views usually target specific engineering tasks such as system design, monitoring, evolution, etc. In our present context, the MegaM@Rt2 industrially-supported European initiative defines a set of large-scale use cases where model views can be beneficial for tracing runtime and design time data. However, existing model view solutions mostly rely on in-memory constructs and low-level modeling APIs that have not been designed to scale in the context of large models stored in different kinds of sources. This paper presents the current status of our work towards a general solution to efficiently support scalable model views on heterogeneous model resources. It describes our integration approach between model view and model persistence frameworks. This notably implies the refinement of the view framework for the construction of large views from multiple model storage solutions. This also requires to study how parts of queries can be computed on the contributing models rather than on the view. Our solution has been benchmarked on a practical large-scale use case from the MegaM@Rt2 project, implementing a runtime -- design time feedback loop. The corresponding EMF-based tooling support and modeling resources are fully available online. [Hugo Bruneliere, Florent Marchand de Kerchove, Gwendal Daniel, Jordi Cabot. ACM/IEEE 21st International Conference on Model Driven Engineering Languages and Systems (MODELS 2018). https://doi.org/10.1145/3239372.3239408]

20. A Feature-based Survey of Model View Approaches

When dealing with complex systems, information is very often fragmented across many different models expressed within a variety of (modeling) languages. To provide the relevant information in an appropriate way to different kinds of stakeholders, (parts of) such models have to be combined and potentially revamped by focusing on concerns of particular interest for them. Thus, mechanisms to define and compute views over models are highly needed.

Several approaches have already been proposed to provide (semi-)automated support for dealing with such model views. This paper provides a detailed overview of the current state-of-the-art in this area. To achieve this, we relied on our own experiences of designing and applying such solutions in order to conduct a literature review on this topic. As a result, we discuss the main capabilities of existing approaches and propose a corresponding research agenda. We notable contribute a feature model describing what we believe to be the most important characteristics of the support for views on models. We expect this work to be helpful to both current and potential future users and developers of model view techniques, as well as to any person generally interested in model-based software and systems engineering. [Hugo Bruneliere, Erik Burger, Jordi Cabot, Manuel Wimmer. ACM/IEEE 21st International Conference on Model Driven Engineering Languages and Systems (MODELS 2018). https://doi.org/10.1145/3239372.3242895]

21. On the Use of Hackathons to Enhance Collaboration in Large Collaborative Projects – A Preliminary Case Study of the MegaM@Rt2 EU Project

In this paper, we present the MegaM@Rt2 ECSEL project and discuss in details our approach for fostering collaboration in this project. We choose to use an “internal hackathon” approach that focuses on technical collaboration between case study owners and tool/method providers. The novelty of the approach is that we organize the technical workshop at our regular project progress meetings as a challenge-based contest involving all partners in the project. Case study partners submit their challenges related to the project goals and their use cases in advance. These challenges are concise enough to be experimented within approximately 4 hours. Teams are then formed to address those challenges. The teams include tool/method providers, case study owners and researchers/developers from other consortium members. On the “hackathon” day, partners work together to come with results addressing the challenges that are both interesting to encourage collaboration and convincing to continue further deeper investigations. Obtained results demonstrate that the “hackathon” approach stimulated knowledge exchanges among project partners and triggered new collaborations, notably between tool providers and use case owners. [On the Use of Hackathons to Enhance Collaboration in Large Collaborative Projects - A Preliminary Case Study of the MegaM@Rt2 EU Project. Andrey Sadovykh, Dragos Truscan, Pierluigi Pierini, Gunnar Widforss, Adnan Ashraf, Hugo Bruneliere, Pavel Smrz, Alessandra Bagnato, Wasif Afzal and Alexandra Espinosa Hortelano. Design, Automation and Test in Europe (DATE) Conference, March 2019.]

22. Mechanically Proving Determinacy of Hierarchical Block Diagram Translations

Hierarchical block diagrams (HBDs) are at the heart of embedded system design tools, including Simulink. Numerous translations exist from HBDs into languages with formal semantics, amenable to formal verification. However, none of these translations has been proven correct, to our knowledge. We present in this paper the first mechanically proven HBD translation algorithm. The algorithm translates HBDs into an algebra of terms with three basic composition operations (serial, parallel, and feedback). In order to capture various translation strategies resulting in different terms achieving different tradeoffs, the algorithm is nondeterministic. Despite this, we prove its {\em semantic determinacy}: for every input HBD, all possible terms that that can be generated by the algorithm are semantically equivalent. We apply this result to show how three Simulink translation strategies introduced previously can be formalized as determinizations of the algorithm, and derive that these strategies yield semantically equivalent results (a question left open in previous work). All results are formalized and proven in the Isabelle theorem-prover and the code is publicly available. [Viorel Preoteasa, Iulia Dragomir, Stavros Tripakis. In VMCAI 2019. https://doi.org/10.1007/978-3-030-11245-5_27]

23. A generic solution for weaving business code into executable models

The separation of concerns is a fundamental principle that allows to build a software with separate parts, thereby improving their maintainability and evolutivity. Executable models are good potential representatives of this principle since they capture the behavior of a software-intensive system, that is, when, why and how calling business operations, while the latter are specified apart. EMF is de facto framework used to create and executable DSL (xDSL) but a solution to weave business operations into it is still missing. This is compounded by the fact that such business operations can be tied to specific technological platforms that stand outside the

EMF world (e.g. Android SDK). To that purpose, in this paper we describe a solution for managing business operations both at design-time (creation of executable models with EMF) and at runtime (operation call from the deployed execution engine). This solution is generic enough to be integrated into any Java-based environment and for any xDSL. [Eric Cariou, Olivier Le Goaer, Léa Brunschwig, Franck Barbier, in 4th International Workshop on Executable Modeling at MoDELS (EXE 2018), October 2018]

3.1.1. PhD and Master thesis

1. **Generic Model-based Approaches for Software Reverse Engineering and Comprehension**

   [Generic Model-based Approaches for Software Reverse Engineering and Comprehension, PhD Thesis, Hugo Bruneliere]

   Nowadays, companies face more and more the problem of managing, maintaining, evolving or replacing their existing software systems. Reverse Engineering is the required phase of obtaining various representations of these systems to provide a better comprehension of their purposes / states. Model Driven Engineering (MDE) is a Software Engineering paradigm relying on intensive model creation, manipulation and use within design, development, deployment, integration, maintenance and evolution tasks. Model Driven Reverse Engineering (MDRE) has been proposed to enhance traditional Reverse Engineering approaches via the application of MDE. It aims at obtaining models from an existing system according to various aspects, and then possibly federating them via coherent views for further comprehension. However, existing solutions are limited as they quite often rely on case-specific integrations of different tools. Moreover, they can sometimes be (very) heterogeneous which may hinder their practical deployments. Generic and extensible solutions are still missing for MDRE to be combined with model view / federation capabilities. In this thesis, we propose to rely on two complementary, generic and extensible model-based approaches and their Eclipse/EMF-based implementations in open source: (i) To facilitate the elaboration of MDRE solutions in many different contexts, by obtaining different kinds of models from existing systems (e.g. their source code, data). (ii) To specify, build and manipulate views federating different models (e.g. resulting from MDRE) according to comprehension objectives (e.g. for different stakeholders).

   Defended on 2018-12-20, current available link (final publication process is still ongoing) - http://www.theses.fr/en/s215450

2. **3D web visualization of continuous integration big data**

   The purpose of this thesis is to explore the use of 3D data visualization that could help the CI system users of a beneficiary organization in interpreting and exploring CI system data. The study focuses on designing and creating a 3D user interface for providing a more effective and usable system for CI data exploration. Design science research framework is chosen as a suitable research method to conduct the study. This study identifies the advantages of applying 3D visualization to a software system data and then proceeds to explore how 3D visualization could help users in exploring the software data through visualization and its features. The results of the study reveal that the 3D visualization help the beneficiary organization to view and compare multiple datasets in a single screen space, and to see the holistic view of large datasets, as well as focused details of multiple datasets of various categories in a single screen space. Also, it can be said from the results that the 3D visualization help the beneficiary organization CI team to better represent big data in 3D than in 2D. [3D web visualization of continuous integration big data, Rubini Mattasantharam, Master's thesis, 2018, http://urn.fi/URN:NBN:fi:oulu-201812063239]

3. **Multivariate data analysis for visualization and process control**

   [Multivariate data analysis for visualization and process control, Jarmo Niemi, http://jultika.oulu.fi/Record/nbnfioulu-201902121197]

4. **Code Change Based Selective Testing in Continuous Integration Environment**

   The purpose of this thesis is to analyze existing test selection methods, and to implement an initial continuous test selection method in CI environment that reduces duration of integration testing stage and provides faster feedback. The method is aimed to be safe that no additional faults are let through the testing. The test selection is based on changes submitted to version control system (VCS), which are compared with source code file coverages of different hardware variants reported by compilers. In addition, other possible dependencies

between variants and code changes are investigated. Those are related to test codes and interfaces. Now the testing of change independent variants can be ignored, and only testing change dependent variants is conducted. At the beginning the implemented test selection method was used in a single software development branch for testing purposes. The results indicate that utilizing the method accomplished slight but statistically significant reduction of integration testing duration with significance level of 0.05. The mean of the testing duration was decreased by 15.2% and the median by 22.2%. However, the implementation still has some inaccuracies in dependency detection, and further improvements are needed to make the test selection method more efficient.

[Code change based selective testing in continuous integration environment, Wilén, Juhani, Master Thesis, 2018, http://jultika.oulu.fi/Record/nbnfioulu-201806062460]

5. **Test Case Selection and Prioritization in Continuous Integration Environment**

It is beneficial for continuous integration (CI), that building and testing a software happens as quickly as possible. Sometimes, when test suite grows large during the lifecycle of the software, testing becomes slow and inefficient. It is a good idea to parallelize test executions to speed up testing, but in addition to that, test case selection and prioritization can be used. In this case study, we use incremental machine learning techniques to predict failing and passing tests in the test suite of an existing software from space industry, and execute only test cases that are predicted failing. We apply such test case selection techniques to 35 source code modifying commits of the software, and compare their performance to traditional coverage based selection techniques and other heuristics. Secondly, we apply different incremental machine learning techniques in test case prioritization, and compare their performance to traditional coverage based prioritization techniques. We combine features that have been used successfully in previous studies, such as code coverage, test history, test durations and text similarity to separate passing and failing tests with machine learning. The results suggest, that certain test case selection and prioritization techniques can enhance testing remarkably, providing significantly better results compared to random selection and prioritization. Additionally, incremental machine learning techniques require a learning period of approximately 20 source code modifying commits to produce equal or better results than the comparison techniques in test case selection. Test case prioritization techniques with incremental machine learning perform significantly better than the traditional coverage based techniques, and they can outweigh the traditional techniques in weighted average of faults detected (APFD) values immediately after initial training. We show that machine learning does not need rigorous amount of training to outperform traditional approaches in test case selection and prioritization. Therefore, incremental machine learning suits test case selection and prioritization well, when initial training data does not exist. [Markus Mulkahainen, Master Thesis. Tampere University of Technology. March 2019]

6. **Xmodeling Studio: An Eclipse plug-in for defining executable DSL**

Xmodeling Studio is a tool enabling a simple integration of executable models in any Java environment chosen by software developers. By proposing specific meta-classes, this Eclipse plug-in assists software engineers in the design and the implementation of executable DSL (xDSL) and their execution engine taking into account the business operations and their data flow. At design time, Xmodeling studio enables to attach the definition of business operation to any executable elements of a xDSL. At runtime, once the execution engine for a given xDSL implemented, it automatically calls these business operations and manages the data flow among calls. [Léa Brunschwig, Master thesis, University of Pau, September 2018]

3.1.2. Posters and presentations

1. Poster presentation: Poster presentation of the project and overall project idea, Project presentation, ECSEL Symposium, 2017, (ABO, MDH)
2. Round table: Participation in a round table called "A vision of the future of MDE" to provide the vision and experience of MegaM@Rt2 project to attendants to the conference JISBD 2017, Project presentation and advocacy of the project approach to ensuring the future impact of MDE in the industry, https://fg.ull.es/sistedes2017/jisbd/, (ATOS)
3. Paper presentation: Presentation of the paper on Reconstructing Timed Symbolic Traces from Rtioco-Based Timed Test Sequences Using Backward-Induction, Fifth European Conference

on the Engineering of Computer-Based Systems (ECBS 2017) Paper presentation, http://www.cyprusconferences.org/ecbs2017/programme.html, (ABO)

4. Position Paper & Poster presentation: Julio L. Medina and Eugenio Villar: Towards MARTE++: an enhanced UML-based language to Model and Analyse Real-Time and Embedded Systems for the IoT age FDL 2017, Standardization of the UML profile for MARTE, http://fdl17.di.univr.it/, (UCAN)
5. Tutorial organization: Rafik Henia; Beyond the deadline: New interfaces between control and scheduling for the design and analysis of critical embedded systems, ESWEEK 2017, Model-based timing verification for system with "less than hard" timing constraints, http://esweek.org/tutorials, (TRT)
6. Keynote: Franck Barbier: After 30 years, it is reasonably time to look critically at model-driven software development (MSDE). Who may nowadays claim that MSDE has been massively adopted by the software industry? Who may show numbers demonstrating that MSDE allowed/allows massive cost savings in daily software development, but, above all, software evolution? This keynote aims at showing that MSDE failed in some cases while it successes in others: "embedded models", a "composite" overview of "executable models" and "models at run-time". The keynote weakly discusses the idea and power of "embedded models" in a theoretical way. Instead, it provides feedbacks and lessons learned from the use of "embedded models" for designing a professional mobile 3D video game. Models rely on the State Chart XML W3C standard and related libraries. As concrete illustration, the keynote includes demonstrations of the game. MODELSWARD 2018, Designing 3D Video Games with Models at Run-time, http://www.modelsward.org/, (UPAU)
7. EU Project Space: Andrey SADOVYKH: Both, Poster and Presentation of the project and overall project idea, MODELSWARD 2018, Project presentation, (SOFT)
8. Poster & demo: A Feedback monitoring infrastructure for OpenMP on embedded systems, DAC 2017, Project demo, (UAQ)
9. Tutorial: HEPSYCODE: HW/SW Co-Design of Heterogeneous Parallel Dedicated Systems, HIPEAC 2018, Tutorial organization at HIPEAC18 - High Performance and Embedded Architecture and Compilation, (UAQ)
10. Poster presentation: Project poster, roll ups, folder and prints of newsletter and HiPEAC article. Networking, ECSEL JU Symposium 2018, Event for ECSEL projects, (MDH)
11. Exhibition: Project posters and eventually demonstration of intermediate project results, INTERTRAFFIC Amsterdam 2018, Traffic surveillance systems, https://www.intertraffic.com/amsterdam/, (CAM)
12. Workshop presentation: Eugenio Villar: Model-Driven Analysis and design of IoT Systems, DATE Workshop W06: Embedded Software for Industrial IoTs (ESIIT 2018, Presentation of the goals of the S3D IoT system modeling methodology, https://www.date-conference.com/conference/workshop-w06, (UCAN)
13. Workshop presentation, Eugenio Villar: Model-Driven Analysis of Security, Reliability, Test, Privacy, Safety and Trust of IoE Services, Surrealist Workshop of the IEEE European Test Symposium, Presentation of the S3D capability to model and analyze NFPs in IoT systems, http://www.lirmm.fr/surrealist18/, (UCAN)
14. Panel: Safety, trust, privacy, security, reliability and test, Surrealist Workshop of the IEEE European Test Symposium, 2018, Discussion on how to guarantee NFPs in future devices with the advance of new research directions such as IoT, Wearable Devices, Cyber Physical Systems, and Autonomous driving, http://www.lirmm.fr/surrealist18/, (UCAN)
15. Tutorial: Vittorio Cortellessa, Performance-Driven Software Architecture Refactoring, ICSA 2018, http://icsa-conferences.org/2018/, (UAQ)
16. Presentation: Eugenio Villar: Model-Driven Analysis and Design of Distributed, Heterogeneous Systems, Kick-Off Meeting of the ECSEL Fitoptivis project, S3D improvements in MegaMart and its potential role in multi-video modeling & design, https://fitoptivis.eu/, (UCAN)

17. Approach presentation: Andrey SADOVYKH: We presented the Architecture management approach adopted in MegaM@Rt as written the paper for SEDA. REVAMP project plenary, (SOFT, TRT)
18. Presentation: Model-Based approach and Data Model for Life Cycle Management in Aerospace&Defence industries, Military Metrology for AeroSpace, Presentation of MegaM@Rt approach and demonstrators to conference participants, http://www.metroaerospace.org/, (RO)
19. Presentation: Pitch of the MegaM@Rt2 project to an audience of regional and national actors in the Industry 4.0 domain, PERFORM Seminar of the IRT Jules Verne, Pitch of the MegaM@Rt2 project to an audience of regional actors on the Industry 4.0 domain, https://www.irt-jules-verne.fr/industrial-research-institute/, (ARM)
20. Presentation: Aitor Urbieta: IKER's experiences on Verification and Validation of IoT Systems, First Int. Workshop on Verification and Validation of Internet of Things co-located with ICST 2018, Challenges in Cybersecure Internet-of-Things: a Basque Industry 4.0 Perspective, https://web.fe.up.pt/~vviot2018/, (IKER)
21. Poster: Dragos Truscan: we presented the MegaM@Rt2 project in a annual symposium, The Annual Symposium of Computer Science in Finland 2018, http://tucs.fi/tkt-paivat-2018/, (ABO)
22. Presentation: Presentation of the MEgaM@Rt2 project to the Spanish Software Engineering community, XXIII Jornadas de Ingeniería del Software y Bases de Datos (JISBD 2018) Software Engineering (Model-driven Engieering track) https://congreso.us.es/sistedes2018, https://whova.com/embedded/event/siste_201809/, (UOC)
23. Tutorial: HEPSYCODE: HW/SW Co-Design of Heterogeneous Parallel Dedicated Systems (2nd Edition), HIPEAC 2019, Tutorial organization at HIPEAC19 - High Performance and Embedded Architecture and Compilation, (UAQ)
24. Tool demo: Automating Performance Antipattern Detection and Software Refactoring, 26th IEEE International, Conference on Software Analysis, Evolution and Reengineering (SANER) tool demo presentation, https://saner2019.github.io/program/sessionList.html#Energy,%20Performance,%20and%20OSS, (UAQ)
25. Journal first session conference presentation: Performance-driven software model refactoring, 26th IEEE International Conference on Software Analysis, Evolution and Reengineering (SANER), tool demo presentation Academiics & Industrials, https://saner2019.github.io/program/sessionList.html#Refactoring%20and%20Design%20Pattern, (UAQ)
26. Paper presentation: Siavashi, Faezeh and Truscan, Dragos and Vain, Jüri. Vulnerability Assessment of Web Services with Model-based Mutation Testing. IEEE International Conference on Software Quality, Reliability and Security, Lisbon, Portugal, July 2018. https://doi.org/10.1109/QRS.2018.00043
27. Paper presentation: Kristian Nybom, Adnan Ashraf, Ivan Porres. A Systematic Mapping Study on API Documentation Generation Approaches. Euromicro Conference on Software Engineering and Advanced Applications (SEAA), Prague, Czech Republic, 28-31.8.2018. https://dx.doi.org/10.1109/SEAA.2018.00081
28. Paper presentation: Jonathan Wik, Johan Ersfolk, Marina Walden. A Contract-Based Approach to Scheduling and Verification of Dynamic Dataflow Networks. 16th ACM/IEEE International Conference on Formal Methods and Models for System Design (MEMOCODE), Beijing, China, 2018. https://doi.org/10.1109/MEMCOD.2018.8557004
29. Paper presentation and journal: Alain Girault, Christophe Prévot, Sophie Quinton, Rafik Henia, and Nicolas Sordon. Improving and Estimating the Precision of Bounds on the Worst-Case Latency of Task Chains. August 2018, IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems PP(99):1-1. DOI: 10.1109/TCAD.2018.2861016

30. Poster presentation: Rafik Henia, Laurent Rioux. Integrating Temporal Performance Verification in your Engineering Practices. RTSS@Work in IEEE Real-Time Systems Symposium (RTSS). December 2018.
31. Presentation: L. Napoletani, International Conference of Electrical and Electronic Technologies for Automotive, Milano 9-11, July 2018.
32. Presentation: V. Preoteasa. VMCAI 2019 – 20th International Conference on Verification, Model Checking, and Abstract Interpretation. 13 – 19 January 2019 Cascais, Portugal.
33. Presentation: Eric Cariou, paper "A generic solution for weaving business code into executable models" at 4th International Workshop on Executable Modeling at MoDELS (EXE 2018), October 2018, Copenhagen, Denmark.
34. Tool demo: Eric Cariou, presentation of the Pauware tool at 4th International Workshop on Executable Modeling at MoDELS (EXE 2018), October 2018, Copenhagen, Denmark.

3.2. Events organization and attendance

The following MegaM@Rt2 project results consists of organization of events and attendance with the aim to disseminate MegaM@Rt2 technologies and solutions.

1. Workshop: Variability and Evolution of Software-intensive Systems (VariVolution 2018) colocated with SPLC 2018, https://sites.google.com/softeam-rd.eu/varivolution2018/, 10 - 1 Sep 2018 (SOFTEAM)
2. Thematic session: Design and runtime tools for embedded systems in CWS HIPEAC 2018, https://www.hipeac.net/csw/2018/heraklion/#/schedule/ (UAQ)
3. Workshop:MegaM@Rt2: The devops for embedded systems colocated with HIPEAC 2019, https://www.hipeac.net/2019/valencia/#/schedule/sessions/7625/, 22 Jan 2019 (ATOS, ABO, SOFT, IKER, MDH)
4. Brokerage Event: MegaM@Rt2 booth at EFECS Brokerage Event in Lisbon, 20-22 Nov 2018.
5. Brokerage Event: L. Bozzi, attendance at ECS Brokerage Event in Bruxelles, 15-16 Jan 2019.

3.3. Academic courses

The following courses have been implemented by the academic partners of the consortium:

- Advanced Models for Software Engineering (Feb 2018 – Jun 2018), Master Degree in Computer Science, UAQ. Dissemination of results to students of the Computer Science Department.
- Embedded Systems (Sep 2017 – Dec 2017 and yearly), Master Degree in ICT, UAQ. Dissemination of results to students of the Computer Science Department.
- Software testing course (Mar-Apr-May 2018), Master Degree in IT, ABO. Testing course with focus with MBT and MB- monitoring.
- Development of Autonomous Systems (Jun 2018), Master Degree in IT, ABO. Development course with focus on model, driven engineering, modeling, code generation.
- Quality Assurance of Autonomous Systems (Aug 2018), Mater Degree in IT, ABO. QA course with focus on model-based testing, verification, online monitoring, etc.
- System and Software Engineering (Oct 2017, Mar 2018), Training Courses, INT. MDE training courses.
- Process, methodology and patterns for the development of Real Time Systems (Nov 2018 – Jan 2019), Master Degree in Informatics, UCAN. Master Course where the student will know how to design real-time software over the basis of a sufficient set of patterns suitable to predict its timing behavior and will know how to extract its corresponding schedulability analysis models.
- Quality Assurance – Model based testing in practice (Nov 2018 – Mar 2019), Graduate, MDH. Master course for industrial professionals to apply model-based testing in practice.
- Quality Assurance – Regression testing and fault prediction (Sep 2018 – Mar 2019), Graduate, MDH. Master course for industrial professionals to apply regression testing and fault prediction in practice.
- Software testing course (March – May 2019), Graduate, ABO. Mater course on test design techniques.

- Model-based development of Autonomous Systems (Aug 2019), Graduate, ABO. Master course for both students and industrial professionals on using modeling, verification and test generation for developing high quality autonomous systems.

3.4. Social and online tools

3.4.1. Project website

The project website https://megamart2-ecsel.eu/ is the open window of the project to the outsiders and the unique access point to all project information. It is constantly updated with new information generated from the MegaM@Rt² progresses.

The structure of the website described in D6.3 has been extended to integrate the following contents:

- The *Home* page now contains a video presenting an overview of the project
- *Use Cases* page presenting the MegaM@Rt2 use cases to the general audience, and showing how the project helps solving these challenges.
- *MegaM@Rt² Catalog* page presenting the set of tools integrated in the project, and providing an uniformized way to download, navigate the documentation, and contact the tool providers.
- *Publication - Scientific Results* page gathering all the scientific publications related to the project

In addition, the MegaM@Rt² blog is continuously updated with summaries of new publications and results related to the project. Each post draft is reviewed by UOC and adapted if necessary before its final publication on the website. Specifically, the following 21 blog posts have been published since the last deliverable:

- Towards MARTE++: an enhanced UML-based language for the IoT age
- Can Pairwise Testing Perform Comparably to Manually Handcrafted Testing Carried Out by Industrial Engineers?
- 3rd MegaM@Rt2 Plenary Meeting took place on March 13-15, 2018 in Helsinki, Finland
- Architectural models for testing the energy consumption of embedded systems using mutation analysis
- Reconstructing Timed Symbolic Traces
- Foundations for Model-based Runtime Analysis Methods
- Challenges in Automating Performance Tool Support – Panel
- Adopting a Modelling Environment at Volvo to Enhance Systems Engineering, Testing, and Function Development Process
- Tool-supported Approach for Building the Architecture and Roadmap in MegaM@Rt2 project
- HepsyCode Tutorial: Hardware / Software CO-DEsign of HEterogeneous Parallel dedicated SYstems
- What the F-OMP is going on in OpenMP?
- Survey of Existing Model View Approaches
- Youtube channel for the MegaM@rt2 project
- Availability-driven Architectural Change Propagation through Bidirectional Model Transformations
- Towards Scalable Model Views on Heterogeneous Model Resources
- Reasoning about UML/OCL Class Diagrams using Constraint Logic Programming and Formula
- Vulnerability Assessment of Web Services with Model-based Mutation Testing
- A Systematic Mapping Study on API Documentation Generation Approaches
- Model-Driven Engineering for Design-Runtime Interaction in Complex Systems

- A Contract-Based Approach to Scheduling and Verification of Dynamic Dataflow Networks
- MDE@DeRun 2019 – 2nd Int. Workshop on Model-Driven Engineering for Design-Runtime Interaction in Complex Systems

The website averages 210 unique visitors per month with average session duration of 1m 05s.The numbers of visitors has grown since the last deliverable (+40%), mostly because of the continuous update of the blog, as well as the hosting of the landing pages of MegaM@Rt²-related events. Visitors come mostly from participant European countries but the area of influence of the project goes beyond the national clusters, as shown in the following map. Note that since the last report the project website audience significantly grew in the United States.

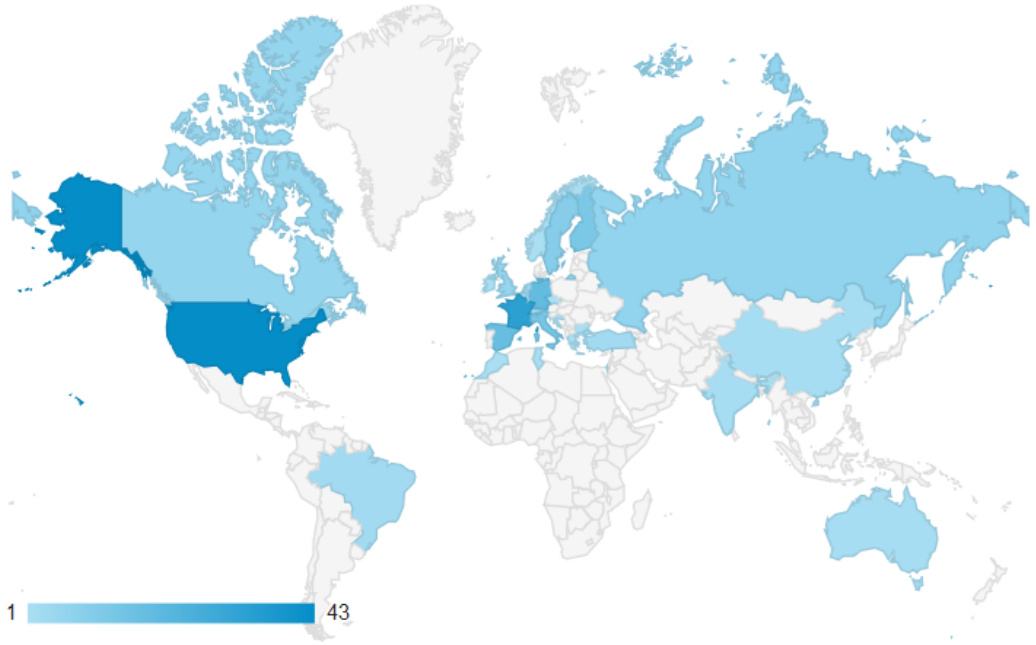


Figure 1: Influence area map for the project web site

3.4.2. Social media

The Twitter account of the project (@MegaMart2_ECSEL) continuously tweets relevant project information, especially new blog posts and major events attended or organized by the project. In addition, we monitor a set of hashtags in order to retweet technological content relevant to the project, and the account follows other related projects and initiatives in order to spread new results to a wider audience. These investments have gathered 48 new followers at the time of writing this deliverable (+138%).

3.5. Marketing Material

The project aims to build a branding recognition around its communication material, making it easily distinguishable from competitors. For this reason, marketing material is periodically released to let audience stay tuned of latest news and releases.

3.5.1. Project video

In order to make the project understandable for a wider audience, a video with latest project results has been produced in the middle of Y2. The video is available in the front page of the website, but the project has also created a YouTube channel (Megamart2 ECSEL) to make it easily reachable. The video can be found here: https://www.youtube.com/watch?v=-Esy3BS436w

3.5.2. Flyer and poster

The project has updated its flyer and poster in order to keep them aligned with latest results.

The new flyer contains an overview of the project, summarising objectives and impact, as well as its value proposition and the proposed solution to let any potential stakeholder what the project is about and why it is useful for. The flyer is available on the website: https://megamart2-ecsel.eu/wp-content/uploads/2018/06/flyer.pdf

A new version of the poster is also available, containing the same information as the flyer. This poster will be used in the project's booths to raise attention around MegaM@Rt2. The poster is also available on the website: https://megamart2-ecsel.eu/wp-content/uploads/2018/06/poster.pdf

3.5.3. Press Releases

The project periodically releases (twice a year) press notes in order to let others know about the latest news, including events and software releases. These press releases are published on the website, but also printed and taken to events to be given as companion documentation of flyers.

One of the latest press releases is available on the website: https://megamart2-ecsel.eu/wp-content/uploads/2018/06/MegaM@Rt2-on-the-road.pdf

The last one for 2018 will be uploaded soon. The project also plans to release a new one before the summer in order to advertise MegaM@Rt2 catalog.

4. Collaboration actions and future plans

The project aims to establish liaisons with other projects and related initiatives in order to maximise its impact through knowledge-sharing, co-organised events and joint publications.

Collaboration activities also seem to be a good opportunity to reach a wider audience, benefiting from the communities of awareness created by other projects, allowing MegaM@Rt2 to reach a wider set of stakeholders.

4.1. Ongoing and realized efforts according to the proposed plan

MegaM@Rt2 has already increased the list of projects for collaboration, going from the 11 identified in Y1 to 16 identified in Y2.

The list of projects is as follows:

- INTO-CPS
- CPSWarm
- AQUAS
- CERBERO
- CROSSMINER
- ENABLE S3
- COMPACT
- MODELS
- AMASS
- SafeCOP
- Q-Rapids
- Platform4CPS
- REVAMP
- FitopTiVis
- MINEStrA
- XIVT

For each of these projects, a representative from the project has been identified and a representative from MegaM@Rt2 has been appointed in order to be the main contact points for communication. Due to the different nature of the projects and their expectations it is not possible to establish a single collaboration plan for all of them. Instead, the project has established a collaboration framework where projects are categorised based on their area of interest and the common points for potential collaboration. Individual collaboration activities are developed for each of them.

Other collaboration activities included the participation in events organized by clusters and communities:

- ECSEL Symposiums
  - Attended part events in Malta, June 2017; in Brussels, June 2018; in Lisbon, November 2018.
- HIPEAC, www.hipeac.net
  - MegaM@Rt2 is an active participant in organized events, organising its own workshops to spread the word about latest project results and achievements. A representative example is the workshop organized in Valencia, assisted by the Spanish cluster participants. https://www.hipeac.net/2019/valencia/#/schedule/
- Se4Sa, cluster of DG CONNECT
  - As depicted in D6.3, the project is member of the Software Engineering for Services and Applications cluster (https://eucloudclusters.wordpress.com/software-engineering-for-services-and-applications/), participating in its periodic meetings in order to collaborate with other projects aiming to influence the European future research on software engineering topics.

4.2. Future plans

D6.3 established three pillars for the collaboration activities:

Organize joint seminars with relevant collaborative projects

Within these activities, the project will participate in the Summer School on Cyber-Physical Systems and Internet-of-Things (CPS&IoT'2019), collocated with ECYPS 2019 (7th EUROMICRO/IEEE Workshop on Embedded and Cyber-Physical Systems) and MECO 2019 (8th Mediterranean Conference on Embedded Computing), that will be held in Montenegro in June 2019. MegaM@Rt2 will have a tutorial session there to present their latest results on software modeling.

Organize webinars with selected projects

MegaM@Rt2 will analyse the possibilities to organise joint events with related projects in order to maximise its impact.

Participation in communities and clusters

MegaM@Rt2 will continue its participation with HIPEAC and Se4Sa in order to disseminate results and achievements in these two communities.

5. Standardization actions and future plans

Along this second period (M12-M24), MegaM@Rt2 activities on standardization have been concentrated on MARTE and SysML OMG standards, though some efforts have also been invested on observing the recent evolution of UTP2.0.

5.1. Ongoing and realized efforts according to the proposed plan

In summary, MegaM@Rt2 have participated in the SysML related weekly meetings. The project attended to the OMG technical meeting in Reston (19-23 March 2018), where it issued a new 1.2 version of MARTE and a call for Request for Information towards MARTE 2.0. Besides, it have continued efforts following the various standards related to the executable UML group, as well as the UML Testing Profile version 2.0 (UTPv2).

5.1.1. Activities related to MARTE

A Request for Information (RFI) was prepared and finally approved by OMG. Responses were initially due on February 15th, 2019 but the deadline for submissions have been recently extended until August 26th, 2019.

The technical content related to MegaM@Rt2 that was required by the reviewers will be added as requests into the responses that our partners shall produce in response to the RFI.

Besides the collective response from MegaM@Rt2 consortium, which is still under preparation, an initial response has been prepared and issued by Thales (https://www.omg.org/cgi-bin/doc?ad/2019-02-01). Other partners are also working towards the formalization of individual responses. A template to facilitate their responses have been produced and is available in the project repository (https://drive.google.com/open?id=1OiiCbEXecihfqdyHIhzZDcdp8e2tckiZ).

In addition, along this period, following the OMG procedures, the final report for the Revision Task Force for MARTE 1.2 has been already approved by the Architecture Board of OMG (https://www.omg.org/cgi-bin/doc?ptc/18-17-03).

5.1.2. Activities related to SysML

In the context of the Revision Task Force for SysML 1.6, MegaM@Rt2 contribute to the Semantics Group in order to prepare version 1.7 with its semantic formalized as a testbench in an annex.

Efforts were dedicated to automating the production of this specification by producing SysML version 1.5.1. It has addressed mostly editorial issues and assemble the specification using a modelling tool and a collaborative model-based visual editor (https://mms.openmbee.org).

Several partners are involved in a team for the submission of a response to the current Request for Proposals (RFP) for SysML version 2.0. So far, the group target the semantics of the language in order to produce its UML profile so that it results backward compatible to versions 1.6 and 1.7 (under preparation).

5.1.3. Other related standardization efforts

As a contribution to UTPv2, UCAN hosted a face-to-face meeting of the UTP 2.0 Finalization Task Force in April 2018, to prepare resolutions for its last pending issues. These efforts were approved by OMG and lead to the current UTP 2.0 specification (https://www.omg.org/spec/UTP2/).

5.2. Future plans

Plans for contributions to MARTE standards.

The Request for Information (RFI) was approved at the last OMG meeting. Responses are formally due on August 26th, 2019. MegaM@Rt2 main goal is to formalize the partners' proposals presented in the initial survey, being it improved proposals or new ones.

Proposals must follow rules in the RFI document, which can be downloaded from https://www.omg.org/schedule/MARTE_2.0_RFI.html

The plan for contributions to MARTE in the near future is:

- Partners involved se4nd their request for the standard to UCAN and TRT (julio.medina@unican.es & laurent.rioux@thalesgroup.fr) before June 14th.

- MegaM@Rt2 responsible of standardization will harmonize them and send comments back to the partners.
- Then, responses shall be formalized either by the partners conforming to the FRI document or collectively in a joint response from the consortium.
- In case of any doubt, partners will get support in order to integrate all requests, in particular if they have interest but do not plan to send a formal response to OMG.

The current approach for contributions to SysML standard involves the identification and creation of spaces in the standard to insert technical results from MegaM@Rt2 and include texts that expose the semantics of behaviours in SysML and define traces as a mean for conformance.

This is consistent with the idea of making “executable models” ala fUML in SysML. This brings expectations that MegaM@Rt2 partners involved in SysML would be able to match planned or simulated execution traces, taken from the models’ behaviours, with those taken at runtime from the actual system. It is important to highlight here that SysML models are not meant for software only, but for the complete deployment and operation of complex systems.

MegaM@Rt2 plans include:

- Interested partners may trigger internal discussions among the consortium and eventually raise formal issues to the current version of the standard.
- Organization of a telco by the end of May 2019 to disseminate/propose spaces in the standard where MegaM@Rt2 identifies potential impact and ask the interested partners for feedback and/or additional proposals.
- Present and defend resulting proposals or issues in a next OMG technical meeting. It shall be the one in June or in September, trying to align it with the time when most responses to MARTE RFI are accounted and processed.

6. Exploitation and sustainability

During this second year of the project, the work has been concentrated on identifying all the potential exploitable assets that can be commercialized after the end of the project, their ownership and their license in order to determine the most suitable strategy for each of them.

At the same time, a preliminary set of potential business models for commercializing these assets has been identified and validate taking into consideration individual partners' expectations and figures extracted from the thorough market analysis performed during the first year of the project.

Finally, individual exploitation intentions from most of the partners have been collected, and a survey has been conducted to identify opportunities for joint exploitation plans.

The information presented here will be updated during the last year of the project in order to i) present a sustainability plan adequate to partners' commitment, ii) develop the most suitable business models for commercializing project results, and iii) propose mitigation actions for any incompatibility issue that may rise from IPR considerations.

6.1. Market Overview

D6.3 provided a detailed market analysis, including competitors and related solutions, focusing on the overall software market.

Focusing on latest trends, digitisation and digitalisation suppose a change on the business culture. Software-defined anything (SDx) solutions are being widely adopted by different organisations in order to reduce costs and automate processes. Technavio [1] estimates this trend as a CAGR of 32% by 2020.

Battery Ventures [2] predicts that global software market will grow until USD 1 trillion by 2030, what represents a 10% of the American economy. While in Europe software and software-based services are expected to reach €290 billion by 2020, according to Digital Single Market [3].

The same report [3] states that "*Software can significantly increase Europe's industrial competitiveness and largely contribute to Europe's growth. Software offers new opportunities but brings also a lot of challenges that software companies that the European industry must meet*".

Following these trends, MegaM@Rt2 results seem to be in a good shape for succeeding into the market. Further analysis are provided in the following subsections, and a review of market trends will be provided in the final deliverable of the series.

6.1.1. Updated SWOT analysis

As explained in D6.3 there are several factors that need to be taken into account for the correct positioning of MegaM@Rt2 in the current market context.

First of all, it is important to distinguish between those internal factors, the ones that are inside the project and can be controlled and improved (Strengths, Weaknesses) and the external ones where the project doesn't have any influence (Opportunities, Threats). The second categorization corresponds to those that are helpful and need to be potentiated (Strengths, Opportunities) and the harmful ones, which need the development of contingency plans (Weaknesses, Threats).

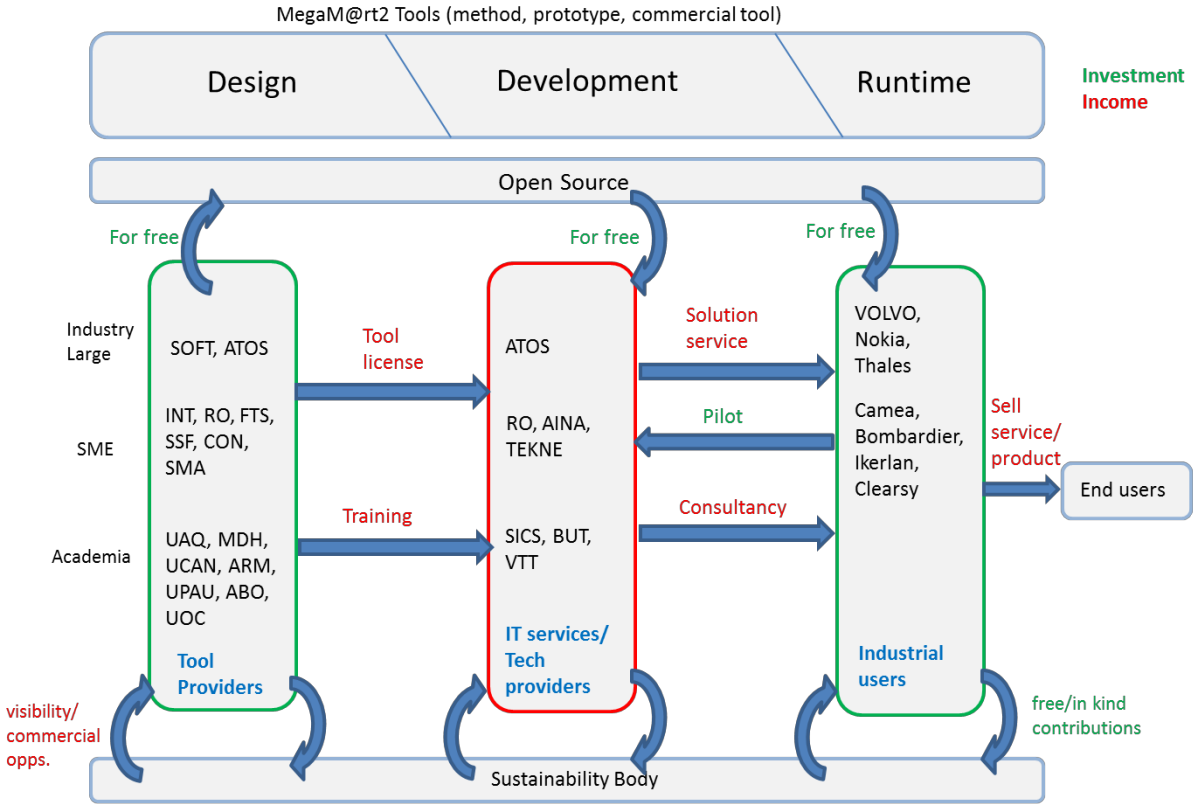
Based on the previous market overview and the inputs received from partners, the project has identified the following factors, extending the list presented in D6.3:

STRENGHTS	**WEAKNESSES**
• Capability and knowledge of the consortium to support the uptake of MegaM@Rt2 developments. • Benefits of adoption demonstrated through project case studies. • Domain independency to be applied in different verticals.	• Too many potential combinations of non-integrated tools to solve customer needs. • Weak communication campaign.

• Contributions to standards maximising the industrial impact.	
OPPORTUNITIES • Increased demand of embedded applications in different domains. • Digitalisation is pushing for new solutions.	**THREATS** • Big number of competitors. • Immaturity of the solution. • Lack of an integrated solution.

6.1.2. Updated value chain

D6.3 presented the generic value chain for the project, while in this document it has been updated to include all the actors represented by MegaM@Rt2 participants.



As it can be seen in the figure above, the own consortium represents all the possibilities for the commercialization of MegaM@Rt2 results. In principle, the underlying idea was to follow an open source approach. However, as shown in the following section, there are several tools with a commercial license who cannot be offered in the same way. For this reason, several business models have been identified and can be adopted and developed as part of the Sustainability Body strategy.

6.2. Exploitable assets

MegaM@Rt2 identified assets consists in a set of tools, available in a downloadable catalog [4]. Due to the open nature of project results, the tools can be combined based on specific user needs, thus, without the need of installing the whole Toolbox. The following subsections contains the key value proposition of each of the available tools, their owner and their license.

6.2.1. Value proposition

In order to understand the value of each of the MegaM@Rt2 tools, each partner has identified the specific value proposition per each of them, grouping them based on their functionalities, with the objective to show the distinguishing factor of each of them.

Tool	Value Proposition
Model and Traceability Management	
EMF Views	Brings the concept of views (such as in databases) to the modeling world.
JTL	Allows designing and manipulating models, maintaining consistency and synchronizing software artifacts, while keeping traceability during design.
Modelio Constellation	Organizes and manages collaborative (distributed) worldwide modeling projects.
NeoEMF	Aims at handling large EMF models in an efficient and scalable way.
Runtime Analysis	
AIPHS	Supports designers on the development of OCMSs able to satisfy given monitorability requirements.
DBCAE	Assess the clusterability of a given dataset and performs clustering based on the results obtained from a previous evaluation.
CompleteTest	Automatic test generation for function block diagrams.
Convex Hull	Tool for finding novelties, anomalies and outliers in the data using supervised and semi-supervised paradigms.
LIME Testbench	Runtime monitoring of model-based properties and test case generation.
MATERA2	Model-based monitoring and performance testing tool.
PADRE	Performance-driven software model refactoring framework.
PauWare	Set of Java classes and interfaces for making up and execution engine for State Chart XML and UML state machine diagrams.
VeriATL	Provides fine-grained incremental deductive verification support for model transformations.
System Engineering	
CertifyIt	Model-based test generation tool enabling end-to-end testing.
CHESS	Specialization of the MARTE profile for various dependability analysis.
Collaboro	Makes language development processes collaborative.
Conformiq Designer	Automate testing and speed up development of embedded software in various industries.
EMFtoCSP	Automatic verification of UML or EMF models annotated with OCL constraints.
Hepsy Code	A system-level methodology for HW/SW co-design of heterogeneous parallel dedicated systems.
MbeeTle	On-the-fly testing tool for runtime testing.

Modelio	Open source modeling environment.
Moka Extensions	Provides plugins for extending the functionality of Papyrus Moka engine for UML simulations.
Papyrus extensions	Plugins that extend the functionality of Papyrus UML for Aspect Oriented Modeling.
RCRS	Compositional reasoning framework
S3D	Single-source design approach based on UML-MARTE
Xamber	Configuration and real-time analysis tool for partitioned systems based on the hypervisor XtratuM.
XPM	Eclipse-cased plugin to automatically generate the deployment for a target partitioned system based on XtratuM hypervisor.

6.2.2. IPR

As it can be seen in the table below, each tool has its own license. At this moment, there is no foreseen severe incompatibility issue between them. However, a thorough analysis with the potential combinations of tools and its corresponding assessment on licensing and joint IPR will be provided in the final exploitation deliverable.

Tool	Owner	License
Model and Traceability Mangement		
EMF Views	ARMINES	Dual: EPL 2.0 – GPLv3
JTL	UAQ	ELP 2.0
Modelio Constellation	SOFT	Commercial
NeoEMF	ARMINES + UOC	EPL 2.0
Runtime Analysis		
AIPHS	UAQ	Apache 2.0
DBCAE	VTT	Commercial
CompleteTest	MDH	Dual: Commercial or Free for academia non-profit applications
Convex Hull	VTT	Commercial
LIME Testbench	SSF	GPL
MATERA2	ABO	Dual: Commercial or Free for academia non-profit applications
PADRE	UAQ	EPL 2.0
PauWare	UPAU	LGPLv3

VeriATL	ARMINES	EPL 2.0
System Engineering		
CertifyIt	SMARTESTING	Commercial
CHESS	INTECS	EPL 2.0
Collaboro	UOC	EPL 2.0
Conformiq Designer	CONFORMIQ	Commercial
EMFtoCSP	UOC	EPL 2.0
Hepsy Code	UAQ	GPLv2
MbeeTIe	SMARTESTIGN	Commercial
Modelio	SOFT	Dual: GPL – Apache 2.0
Moka Extensions	ATOS	EPL 2.0
Papyrus extensions	ATOS	EPL 2.0
RCRS	SSF	MIT
S3D	UCAN	Free for academia non-profit applications
Xamber	FENTISS	Commercial
XPM	FENTISS	Commercial

6.3. Benefits of adopting MegaM@Rt2 tools

MegaM@Rt2 considers its nine use cases as flagships for showing the benefits of adopting its tools. During the last period of the project these benefits will be collected as "success stories" to be promoted through different marketing material, such as the project website or press releases, to attract potential adopters to the solution offered by the project.

As a starting point, three use cases have been selected as the more mature ones to show the benefits that MegaM@Rt2 tools can bring to their businesses:

IKERLAN

With MegaM@Rt2, IKERLAN aims to continuously improve the different phases of the lifecycle of the projects it carries out for companies in various sectors. The final aim is to improve both the efficiency of project development and the quality of the projects. Particularly, MegaM@Rt2 Toolbox will have an impact on IKERLAN's business in four key aspects:

1. Market Exposure: Continuous lessons learning due to runtime verification and model refactoring will allow to adapt faster to future market trends.
2. Improved Portfolio: Time saved due to automation, both in development and testing, could be used to tackle unexplored businesses and industries. Furthermore, model reusability will allow a faster adaptation to these new clients' needs.
3. Client Satisfaction: On the one hand, clients will directly benefit from a cheaper, faster development. On the other hand, client needs will be better verified due to runtime verification benefits.
4. Enhanced Client Support: Model maintenance and continuous runtime verification will allow to supervise and improve/upgrade already deployed systems.

THALES

We expect that the industrial SW development processes of critical embedded systems in Thales and especially in avionics, will benefit from the MegaM@Rt2 Toolbox. Thales' expectation is that the verification activity effort for the system real-time behaviour will be reduced by 30% leading to 15% improvement in productivity costs. Similarly, we expect achieving 40% less time for model modifications and corrections to ensure correct system real-time behaviour. Another benefit from adopting the MegaM@Rt2 Toolbox will be to reduce the time and effort required to select the most appropriate hardware platform for the execution of the applications. We also expect reducing the costs for maintenance and upgrades of our systems.

VOLVO

In MegaM@Rt2, Volvo Construction Equipment strives to build capacity with regards to model-based systems engineering and, in the end, reduce the development lead time of its products. The MegaM@Rt2 toolbox allows Volvo CE to improve its testing procedures. It is expected that the improvement in the test procedures will help to reduce the testing efforts while maintaining its high-quality standards. In addition to testing, the MegaM@Rt2 Toolbox directly affects the development lead time by providing means for managing variability within the model-based systems engineering context. Due to the variability modeling mechanisms provided by the MegaM@Rt2 Toolbox, Volvo CE expects a reduction in specification time up to 20%.

6.4. Business models

At this stage of the project, several business models have been identified for commercializing the abovementioned exploitable assets. These models will be further elaborated during the last year of the project, explicitly mentioning which partner will support them, what assets they apply to, and what happen with the commercialization of joint IPR.

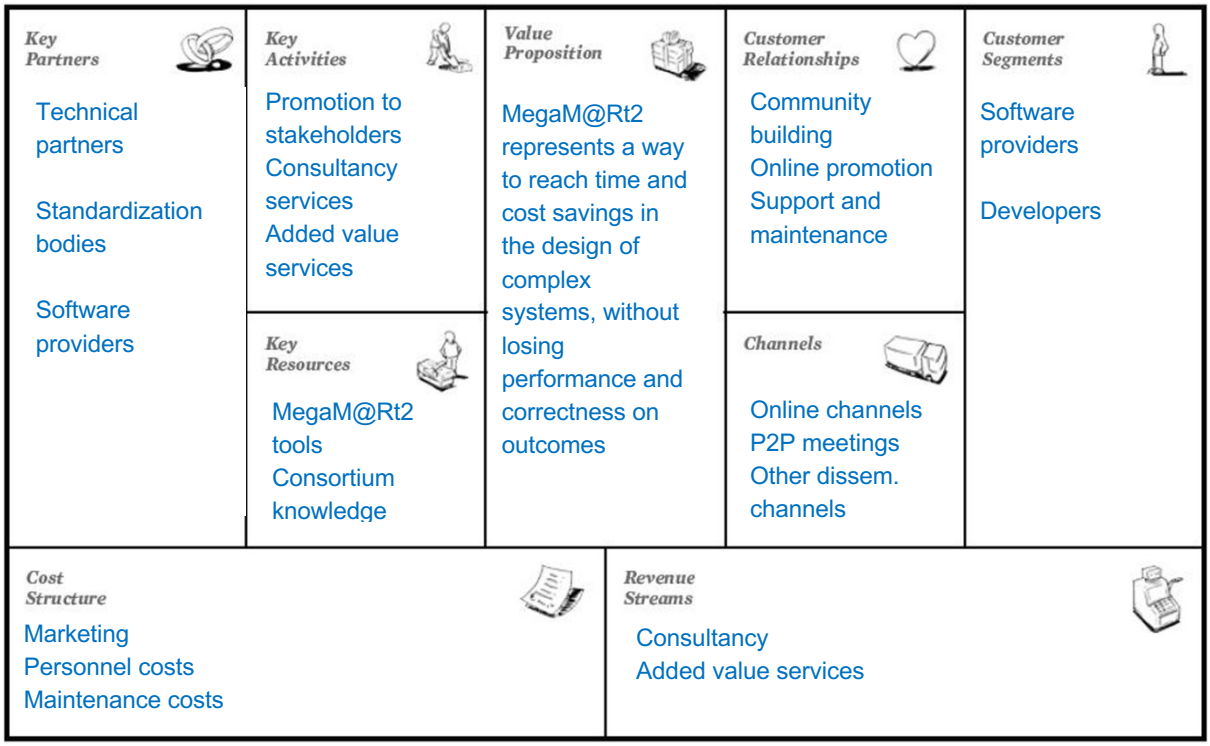
6.4.1. Initial business models

In order to present the identified business models, the canvas invented by Alex Osterwalder [5] has been chosen as the tool to present them. This tool is well recognized by different industries as it supports the development of specific business plans.

The Canvas consists of nine blocks for identifying i) the value proposition highlighting the difference with competitors, ii) identify customers and ways to reach and engage them, iii) define the offering, iv) identify costs, and v) identify ways for monetizing the product.

6.4.1.1. Open Source model

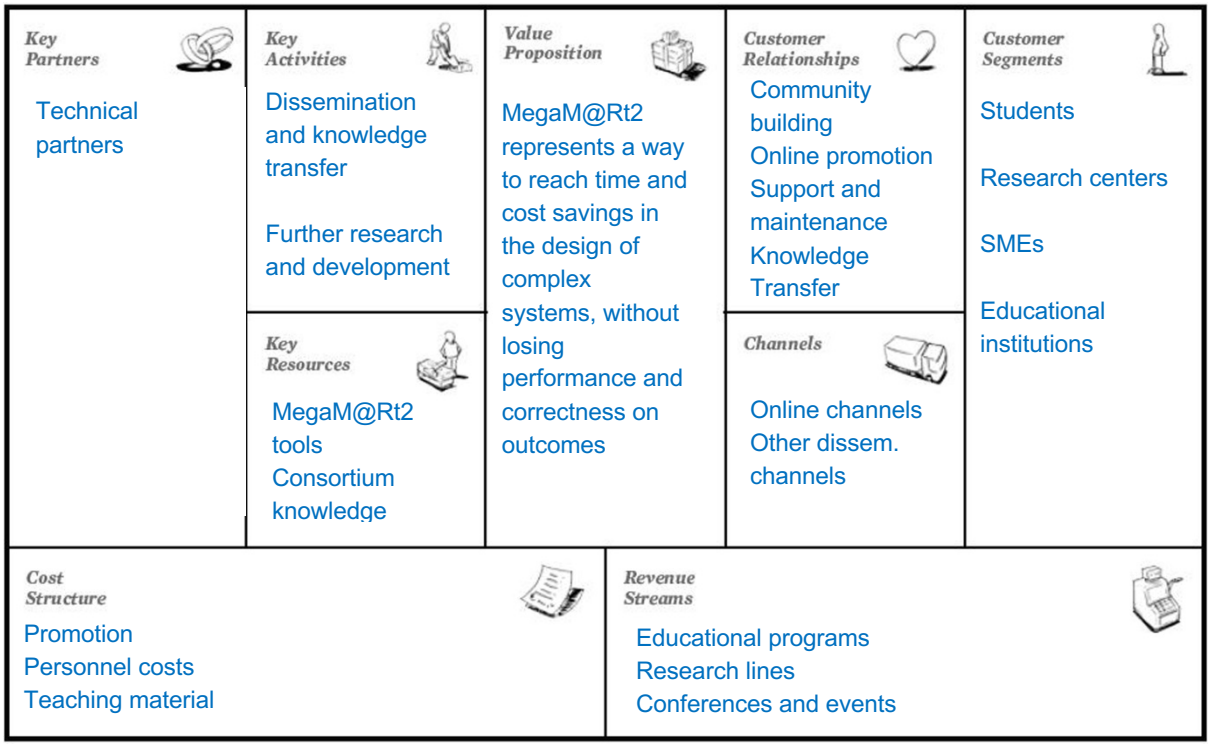
This is the traditional model for commercializing software under an open source licensing scheme. It is based on the monetization of services built on top of public and distributed code.



Within this model, as part of the Open Source strategy of the project, the tools are offered for free, with the minimum required documentation to accomplish with the license requirements. Benefits of this models come from consultancy services, to help organisations to choose the most adequate tools for their needs, and the so-called added value services, which refer to installation, maintenance or integration among others.

6.4.1.2. Knowledge Transfer model

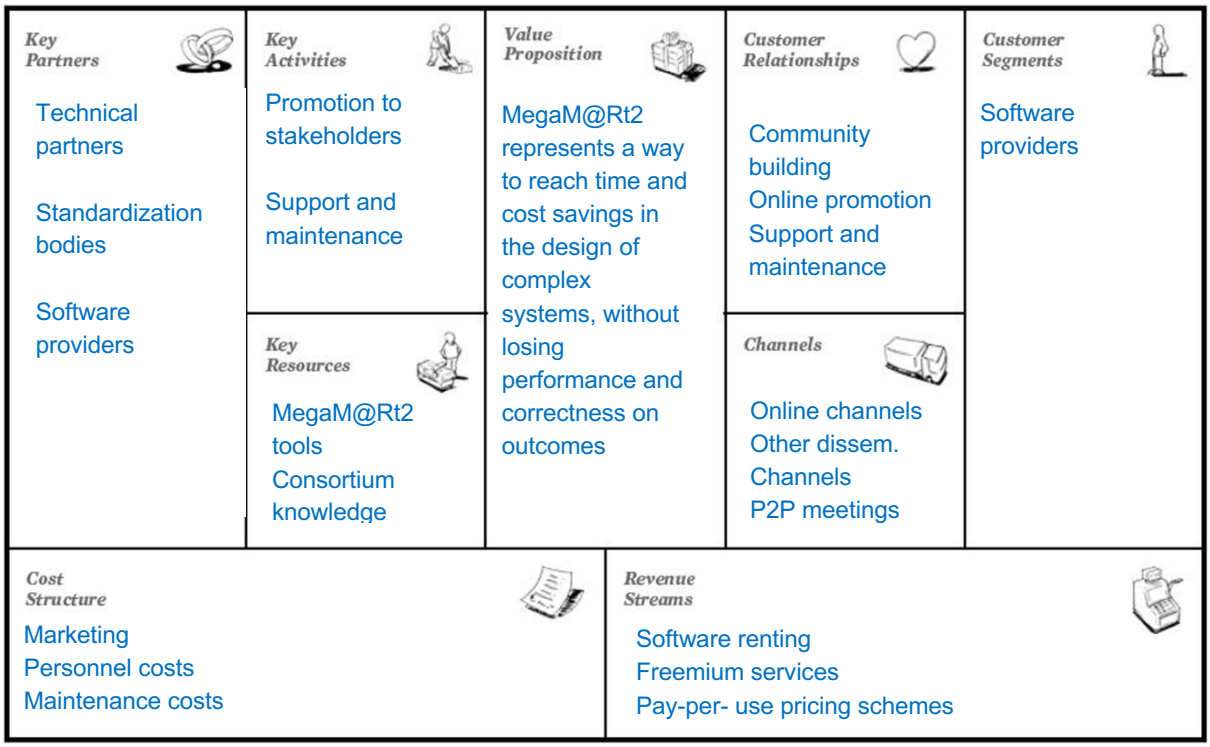
Although this model is widely adopted by educational institutions, it can be applied to any organisation who is willing to perform any knowledge transfer activity.



This model is not based on the direct commercialization of project results, but on those educational services that can be built around them. The objective of the model is not only to increase revenue, but also the reputation of the involved organisations offering innovative courses or publishing in high-ranked conferences among others.

6.4.1.3. XaaS model

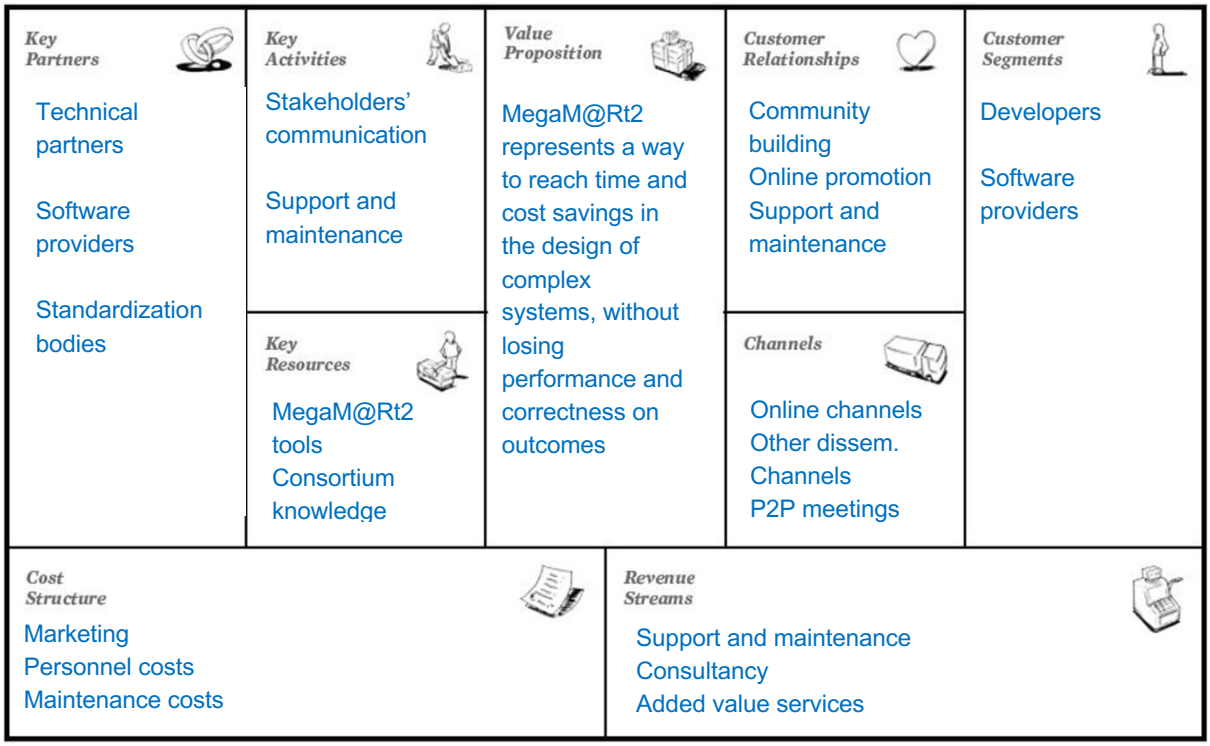
This model applies to any tool, or set of tools, offered as a service to a third party.



In this model the tool owner keeps the ownership of the tool, that can contain more functionalities than the one published online, offering services around it to a third party.

6.4.1.4. Direct Commercialization model

Finally, this is the model to be applied whenever a tool, or set of tools, are sold to a third party who will be in charge of operating them.



Although many of the tools are licensed under open source schemes, this doesn't affect the potential commercialization of them in i.e. software packages specially developed to cover clients' unique needs.

6.4.2. Validation

In order to validate these initial models, MegaM@Rt2 has applied a validation methodology that has been proved in several research projects to determine the strongest points of the offering. For this initial validation inputs from partners exploitation intentions and the market analysis performed during the first year have been taken into consideration. These qualitative inputs have been converted into quantitative measures to support the commercialization strategy.

The following table shows the criteria to be applied per model:

	Criterion	**Value**
		[0-1] lower, [1-2] low, [2-3] medium, [3-4] high, [4-5] higher
Impact	**Revenue potential**	Value of the revenue potential
	Customer acceptance	Value the need of the customers for the product
	Differentiation	Value the novelty on the market
	Impact on critical mass	Value the number of partners and customers participating
	Visibility	Value the potential to raise attention without explicit marketing campaigns
Ease of Implementation	**Investment costs**	Value the investment costs
	Time required	Value the time required until the first service is sold

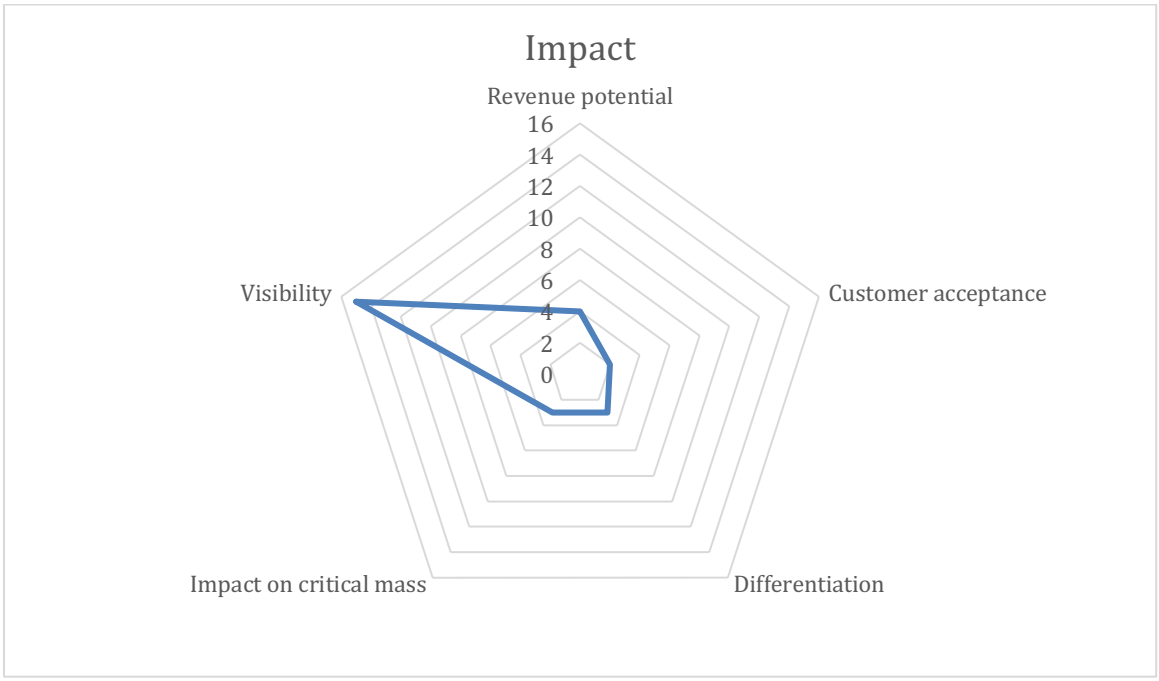
	Risks	Value the objective technical feasibility with today's knowledge
	Transparency	Value how detailed is the info provided to the customers

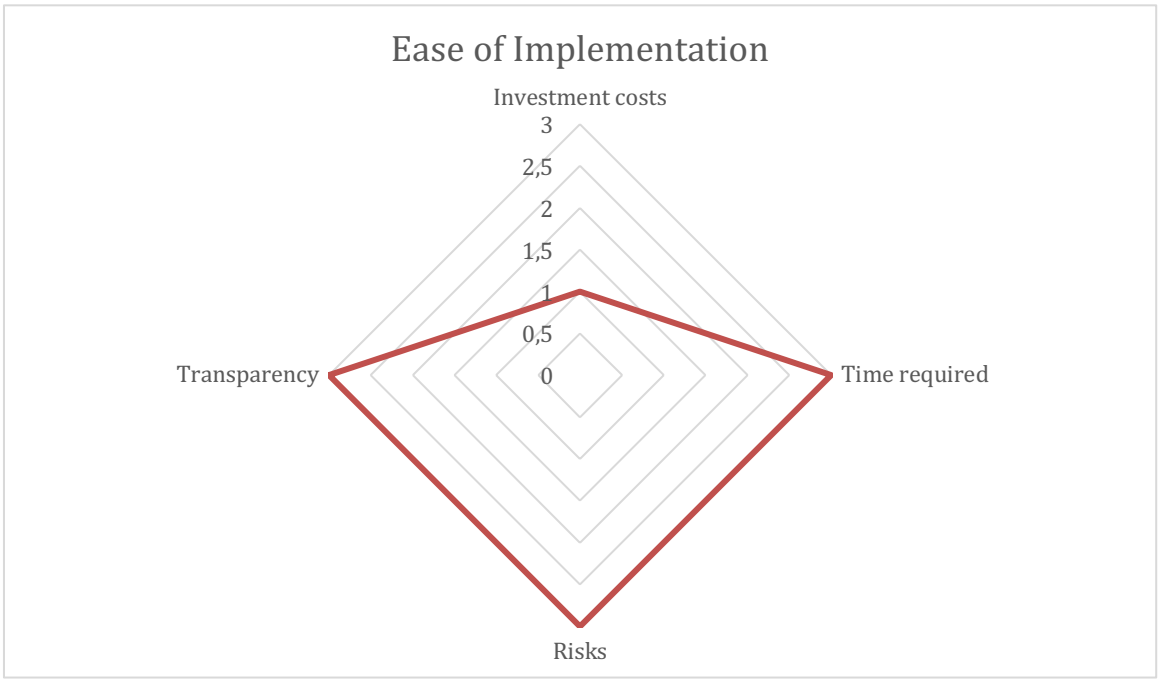
6.4.2.1. Open Source model

	Criterion	Value
Impact	**Revenue potential**	4
	Customer acceptance	2
	Differentiation	3
	Impact on critical mass	3
	Visibility	2
Ease of Implementation	**Investment costs**	1
	Time required	3
	Risks	3
	Transparency	3

Investment costs is the key criterion of this model taking into account that they are expected to be lower than in commercial solutions. Revenue potential is also high due to the services offered around tools.

In order to make the evaluation more visible and easier comparable with the second iteration of the business models, it can be also represented in a graphical way:



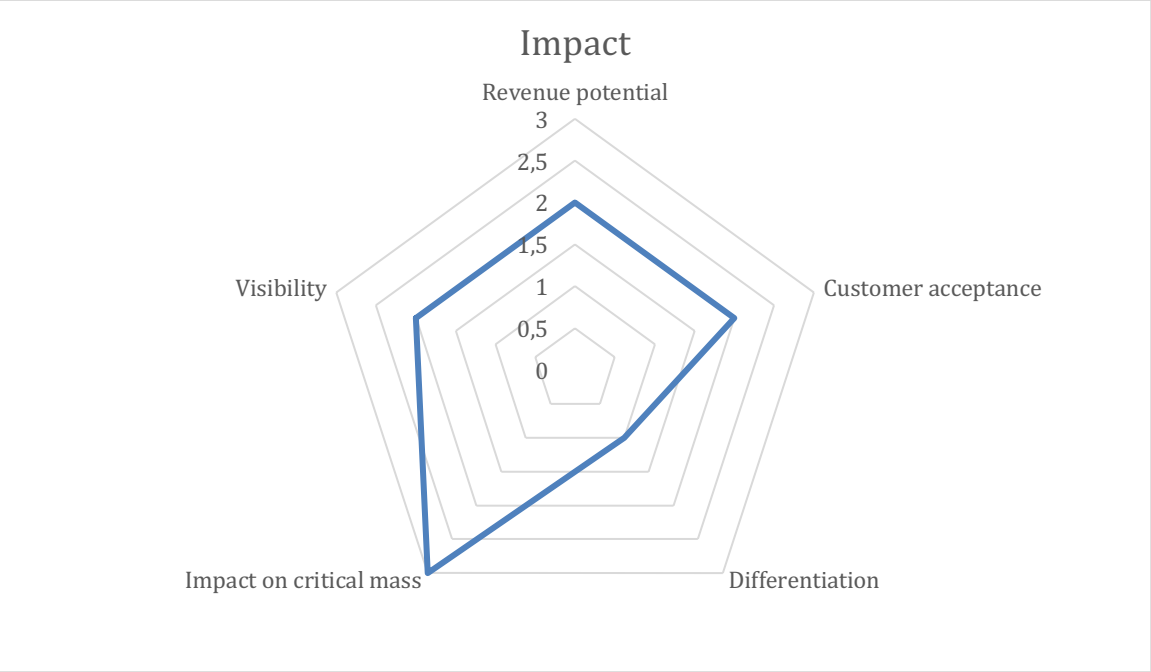


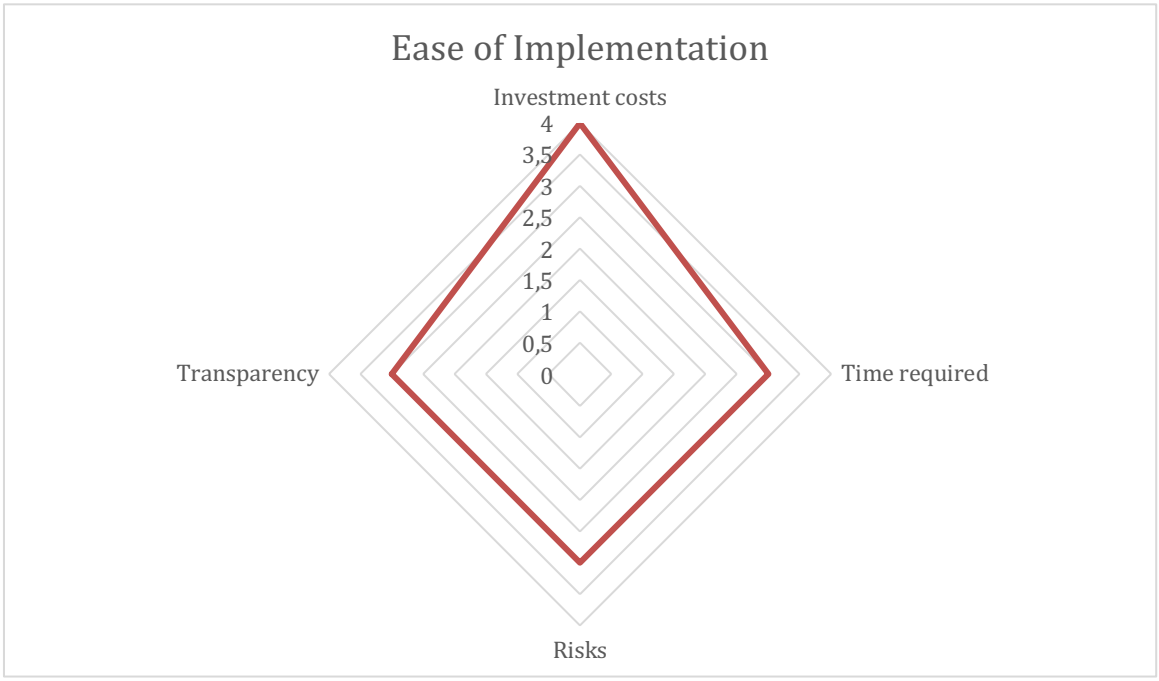
6.4.2.2. Knowledge Transfer model

	Criterion	Value
Impact	**Revenue potential**	2
	Customer acceptance	2
	Differentiation	1

	Impact on critical mass	3
	Visibility	2
Ease of Implementation	**Investment costs**	4
	Time required	3
	Risks	3
	Transparency	3

Due to prestige of academia itself, value proposition is the key factor of the proposed model. Moving to the evaluation, investment costs are of special relevance due to the time needed to train personnel to reach the minimum level of expertise.

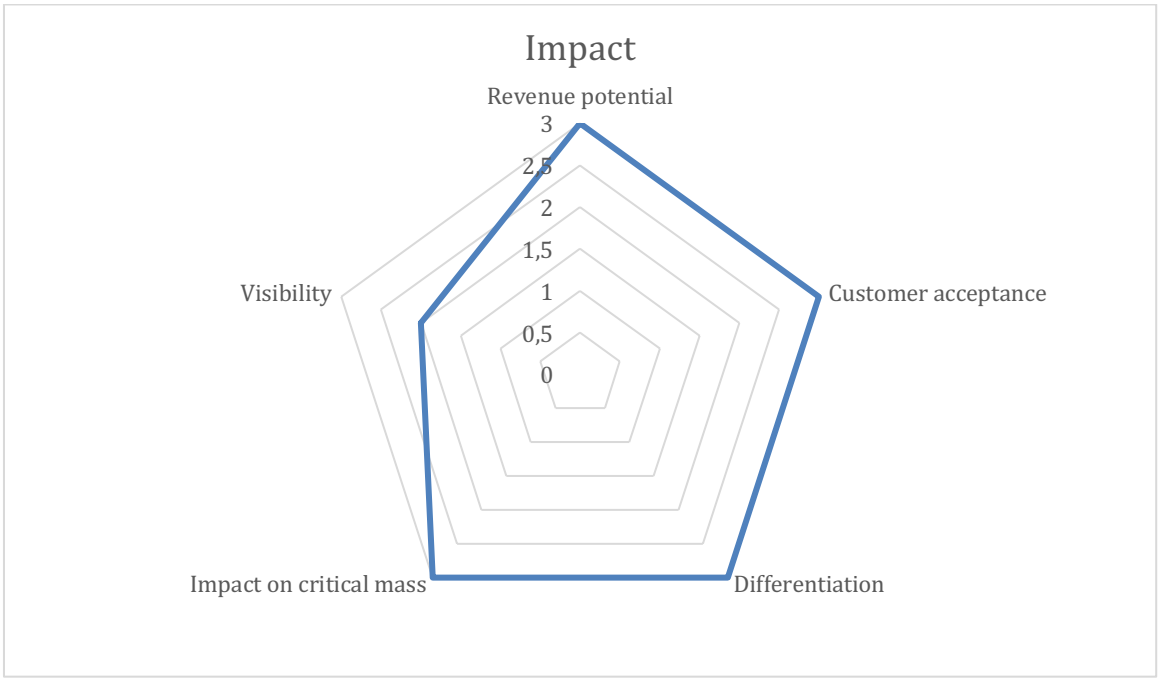


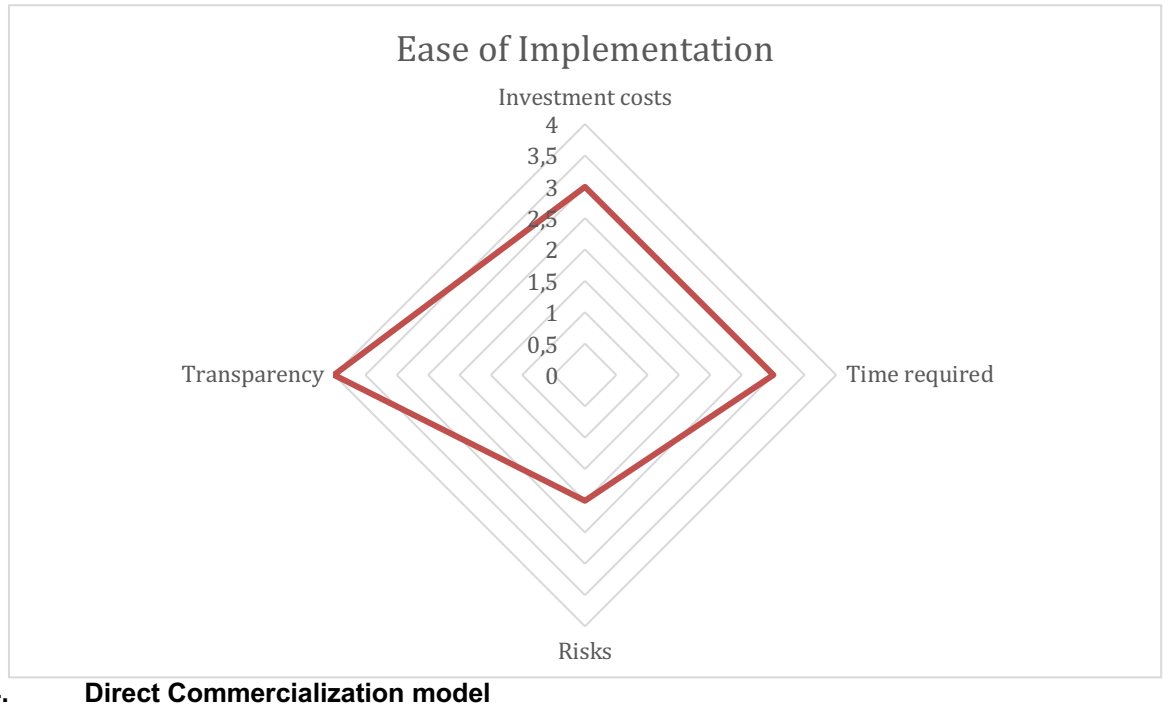


6.4.2.3. XaaS model

	Criterion	Value
Impact	**Revenue potential**	3
	Customer acceptance	3
	Differentiation	3
	Impact on critical mass	3
	Visibility	2
Ease of Implementation	**Investment costs**	3
	Time required	3
	Risks	2
	Transparency	4

In this model most of the criteria has a similar value while transparency for the customer, as it should rely on a third party operating the tool, its highlighted.



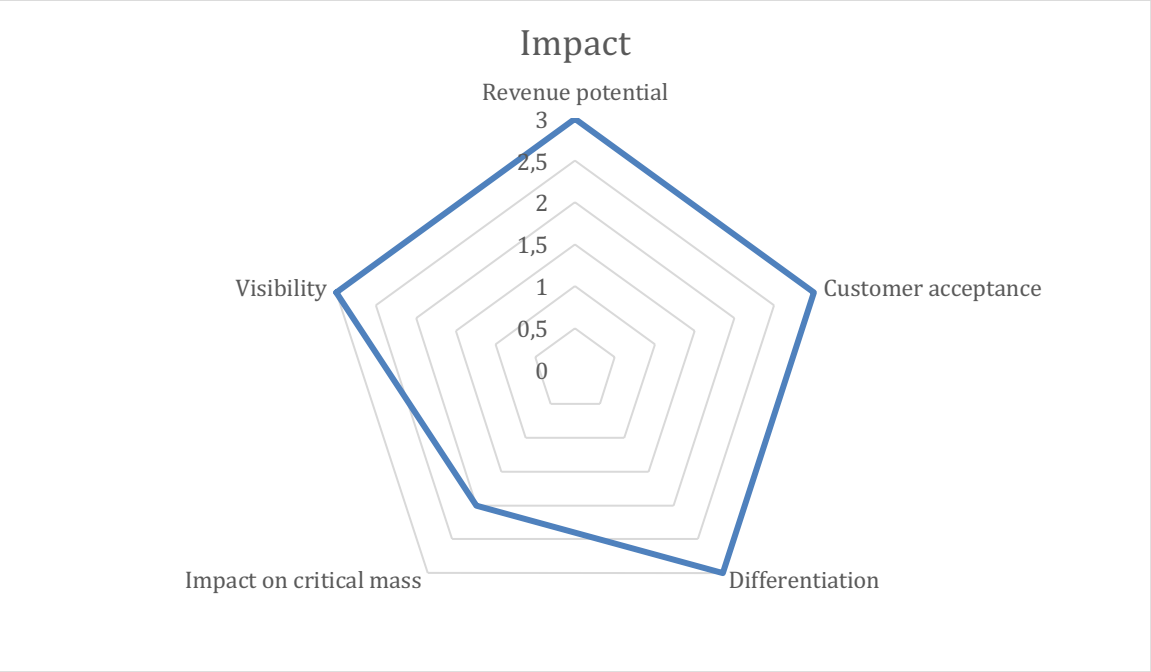


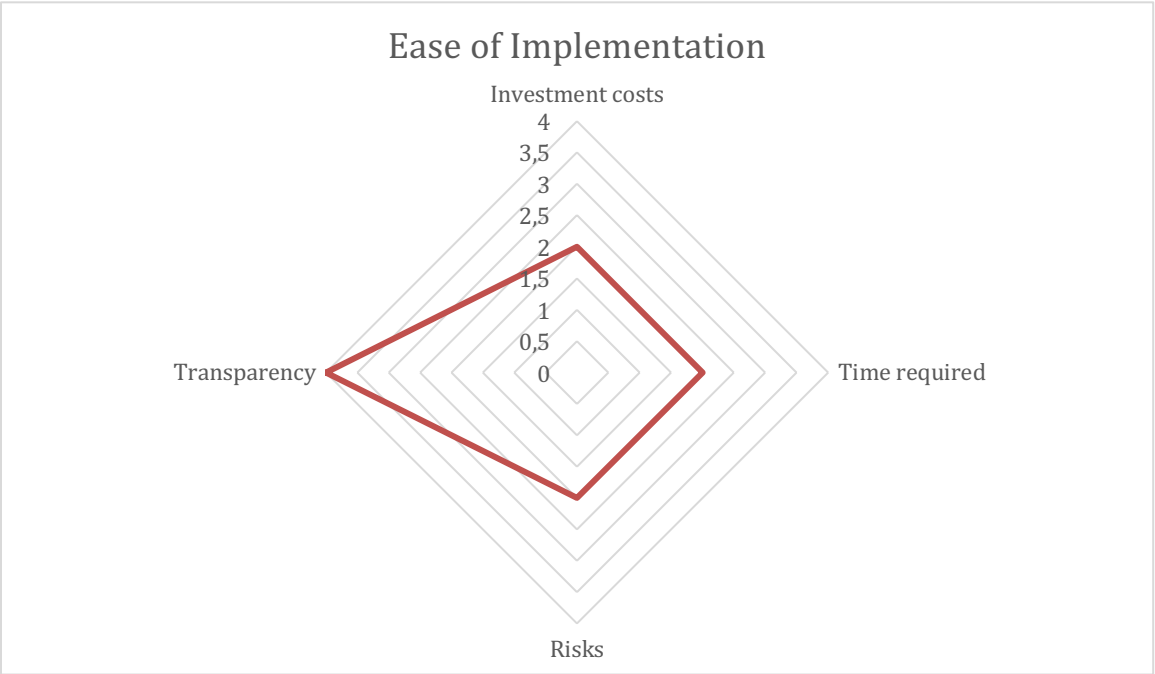
6.4.2.4. Direct Commercialization model

	Criterion	Value
Impact	**Revenue potential**	3
	Customer acceptance	3
	Differentiation	3

	Impact on critical mass	2
	Visibility	3
Ease of Implementation	**Investment costs**	2
	Time required	2
	Risks	2
	Transparency	4

Differentiation is a key factor for succeeding into the market and this can be achieved being transparent to the customer, providing all the requested information, and trying to engage them with further improvements as the basis for future commercial contracts.





6.5. Sustainability path

There are two options for exploiting project results: at individual or at joint level. Individual intentions are gathered in the individual exploitation plans developed by partners. While there are several possibilities for the joint exploitation of project results as explained in the corresponding subsection.

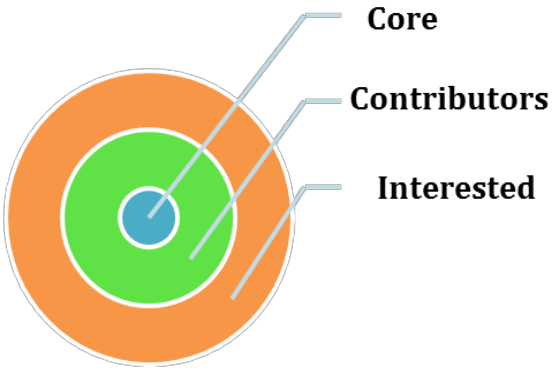
6.5.1. Individual exploitation plans

By the time this document was written, not all individual exploitation plans were available and many of them need to be updated. In order to present a clear path for the final exploitation report dedicated sessions with all partner will be kept, including at individual level, to support the consortium on achieving the sustainability of their results once the project ends.

Already available plans can be seen in Annex I.

6.5.2. Joint exploitation plan

The last step for the development of the sustainability plan presented in D6.3 is the definition of the sustainability body, who will be in charge of creating a community around project results. In this first iteration, the willingness from all partners have been collected and the governance model who will run it will be presented in the final report on exploitation.



According to the project definition, the sustainability body is considered the main instrument to support the project after its end. It has the following objectives:

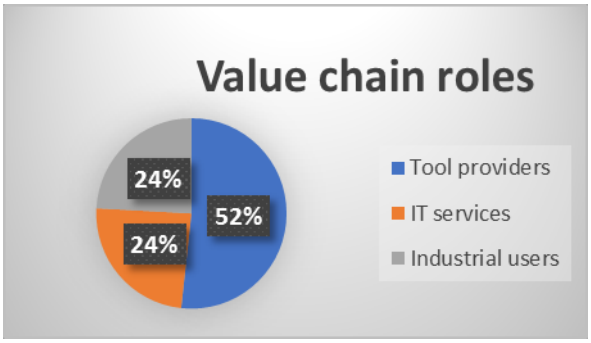
- Explore new domains of applications.
- Continue the dissemination of results.
- Maintain the project results, mainly those open source ones.
- Establish networks to identify commercial opportunities.
- Keep the branding to easily identify MegaM@Rt2.
- Investigate any potential opportunity for the project.

The body is structured into 3 levels, according to the level of commitment of participants:

- Core group: those participants with a commercial interest on developing businesses on top of the proposed solution.
- Contributors: those in charge of maintaining project results, contributing to the developments and interested in further research of the project topics.
- Interested parties: those who will create awareness around the project, disseminating and promoting project results without a direct implication on the development of results.

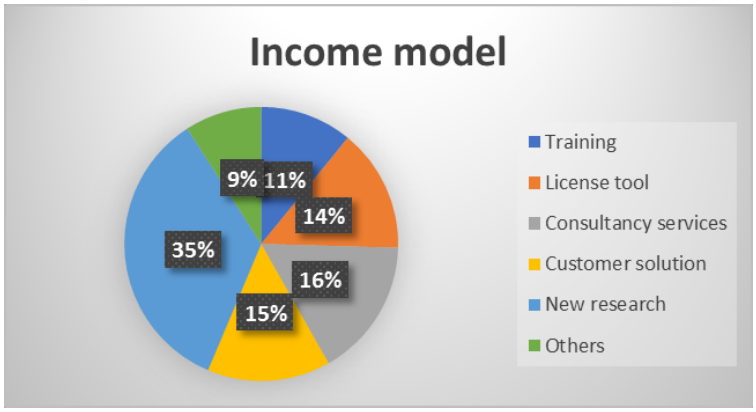
In order to determine the composition of the sustainability body, a survey was conducted to gather partners' feedback as it can be seen in Annex III.

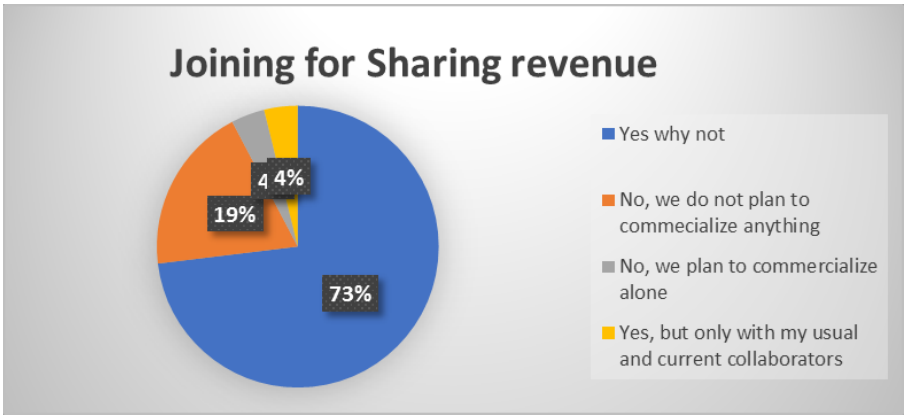
The results of the survey, in a graphical manner can be seen below:



26 partners answered to the survey specifying the roles they are playing, as identified in the project value chain (Section 6.1.2).
Some of the partners play more than one role within their daily activity, although not directly linked to MegaM@Rt2.

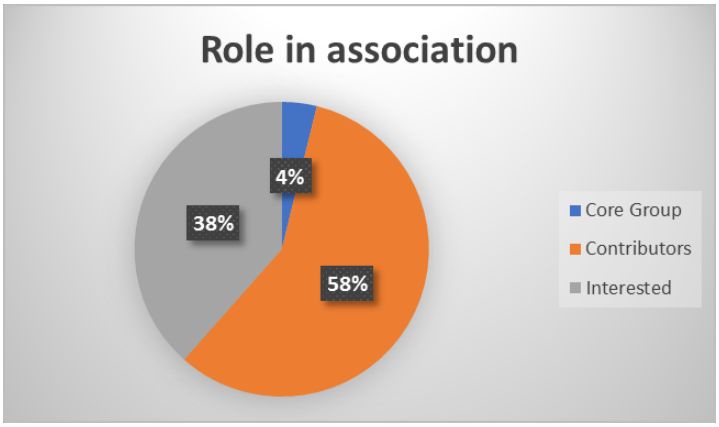
There are many options in the income model where getting revenues from exploiting project results, mainly based on the type of organization (academia or industry). However, the predominant option is to find new funding mechanisms for continuing the research in order to have a higher TRL and more mature solutions ready-to-market.

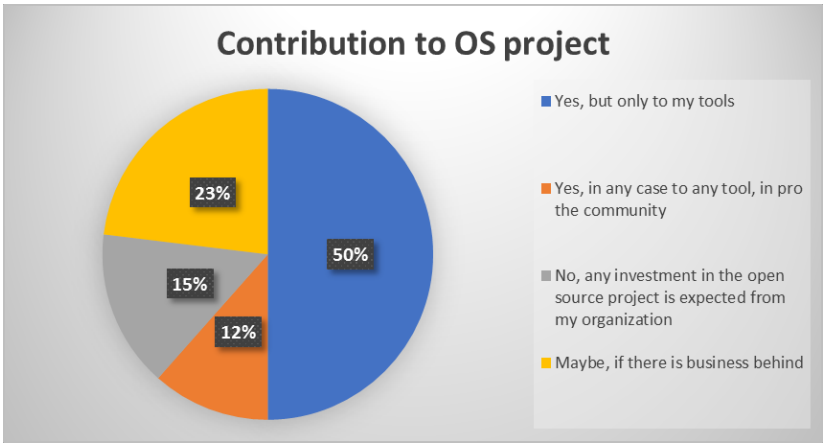




The majority of partners agree with a joint exploitation of MegaM@Rt2 results in order to find more opportunities for exploitation. Universities are those ones who are not planning a direct commercialization of their results.

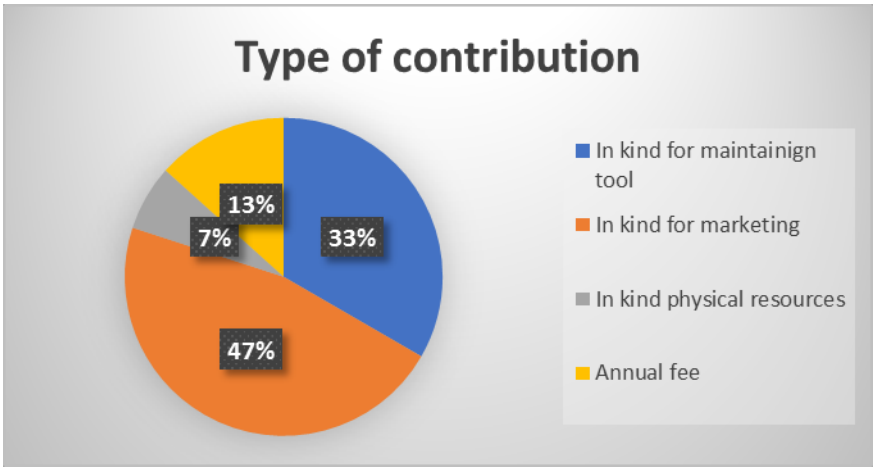
Most of the partners are interested on contributing to the planned MegaM@Rt2 association as tools' providers. The other big percentage corresponds to the project case studies that will remain as interested parties on future evolutions of MegaM@Rt2.





As it can be seen in the figure, most of the partners agree with the Open Source approach proposed in D6.3 for their own tools, while a few of them will contribute supporting others' tools. As expected, industrial partners need a business behind the association for committing resources. Those tools' providers under commercial licenses, don't consider contributing to an open source community.

Finally, partners are committed to contribute with some resources (not only monetary) to ensure the sustainability of MegaM@Rt2 creating news business opportunities and attracting, and engaging, potential customers.



7. Conclusions

MegaM@Rt2 is an ambitious project who will deliver a wide catalog of tools for the development and runtime validation of complex systems. Due to the different nature of all project participants is complicated to define a single plan for ensuring its sustainability. For this reason, as a first step the intentions from all partners have been collected and analysed in order to identify the different possibilities and select those more promising ones.

This intermediate report develops the initial thoughts presented in the first deliverable of the series and sets the basis for setting the sustainability path to be reported in the last one.

In this sense, the project considers crucial all activities related to dissemination, communication, standardization and exploitation to ensure the impact of the project. Thus, all activities will be continued along the project lifetime and increased in the last year of the project. Furthermore, all weakness identified will have their companion contingency plans in order to ensure their viability.

References

[1] Technavio, "Global Software-defined Anything (SDx) Market 2016-2020," [Online]. Available: https://www.technavio.com/report/global-it-professional-services-software-defined-anything-sdx-market.

[2] N. A. L. Bartlett, "Software 2017: Where are we now and where are we going?," Battery Ventures, [Online]. Available: https://www.slideshare.net/Battery_Ventures/software-2017.

[3] D. S. Market, "The Economic and Social Impact of Software and Service on Competitiveness and Innovation," [Online]. Available: https://ec.europa.eu/digital-single-market/en/news/economic-and-social-impact-software-and-services-competitiveness-and-innovation.

[4] M. Toolbox. [Online]. Available: http://toolbox.megamart2-ecsel.eu/toolbox?.

[5] A. Osterwalder, “Business Model Canvas,” [Online]. Available: https://strategyzer.com/canvas.

Annex I: Individual Exploitation Plans

Brno University of Technology

Brno University of Technology (BUT) is the second largest technical university in the Czech Republic. It comprises 8 faculties with more than 23,000 students and 3,000 staff members. The Faculty of Information Technology (FIT) provides education in the Bachelor and Master Study programs in Computer Science and Engineering and the Doctoral study program in Information Technology. Research activities include embedded intelligence, runtime analysis, cyber physical systems, model-based validation, hardware-accelerated image and video processing, human-computer interaction, distributed and parallel systems, and knowledge technologies.

FIT is involved in the international cooperation with more than 30 research and education centres in Europe, USA, India and China. It has a strong support from leading industrial companies involved in the IT development (NVidia, Honeywell, IBM, Intel, Siemens, Microsoft, etc.).

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

BUT will exploit project results in knowledge transfer, to improve the quality of teaching, and to contribute to the state of the art. Various presentations at research and scientific as well as non-academic events will help us increase visibility of our team to the community and stabilize our position as a regional leader of academic research in the cyber-physical and embedded domains. We will primarily target students, research and development teams in companies as well as in other academic institutions, general public, R&D industrial groups, etc. MegaM@Rt topics will extend academic courses and Bachelor, Mater, and PhD thesis will be published linked to our contribution to the MegaM@Rt project. Project results will also contribute to an increased participation of our team in future industrial as well as RTD projects.

In addition to the standard exploitation channels mentioned above, BUT will also follow specific steps to increase impact by means of cooperation with the university spin-off company Cognitechna which focuses on innovative applications of cyber-physical systems. System designers from the company will learn about the project progress in annual meetings (the first was in M8 of the project) and will explore the market potential of specific products developed by the project in which BUT has taken place. The results of the project will be also discussed with members of the Industrial Board of the Faculty of Information Technology, BUT.

Early Stage Innovation & Exploitation Paths

The first two years of our participation in the MegaM@Rt project has already showed some clear exploitation paths to identify market opportunities that benefit from using project results. We have defined clear objectives and goals for our cooperation with relevant industrial partners. We continued and further intensified our interaction with Camea, Softeam, and other partners to secure the exploitation of code generation modules developed by our team. Camea will employ the modules in the evolution of their current traffic monitoring system (see their exploitation plans).

BUT also defined an ambitious roadmap on the exploitation paths linked to profiling-based feedback generation to the generation model. It opened a new exploitation channel – the cooperation with Codasip – a local company developing specialized processors. The company experts are involved in the discussion on the suggestion integration process and will help us to find a proper way to commercialize the results.

CAMEA, spol. s r.o

CAMEA, spol. s r.o. (Ltd.) (CAM), is the Czech market leader in the development and production of embedded systems for specialised applications in traffic monitoring and industrial quality control. The company was founded in 1995 as a private company with Czech ownership. It currently employs over 40 people out of whom over 30 are working in the research and development areas. The company is active in the development of automated code generation for the particular domain of image processing and computer vision and model-based runtime methods for sensors and signal processing devices, hardware-accelerated high-performance computing, and their large-scale deployment in traffic monitoring and enforcement.

The industrial applications include mass electronics component manufacturing quality control and inspection over 1.000 video cameras were manufactured and installed in industrial applications, both in the Czech Republic and abroad. Traffic applications include video-based red-light and section speed

enforcement systems, and traffic monitoring installed in several cities in the Czech Republic (over 400 cameras in use at the moment) as well as Slovakia, Poland, Ukraine, Russia, etc.

CAMEA has an extensive experience in developing model-based industrial solutions dealing with high performance image and video processing, usually embedded in cameras and other devices. Recent installations include industrial video-inspection system for electronic components MODICAM – AVX Lanskroun, Czech Republic – reliable application of video processing in industrial environment (>1.000 PCs), section speed enforcement and red light enforcement system suitable also for monitoring UNICAM – Czech police and municipalities (>400 places in Czech Republic and abroad, including new contract in Poland 2014), Nonwowen textile quality inspection systems – Pegas Bucovice, Czech Republic – industrial quality inspection system being installed on most of the production lines nowadays (>50 PCs), traffic monitoring and bicycles counting system – Municipality of Prague, the system is intended for traffic monitoring and bicycle in particular, various updates being continuously performed, signal processing equipment development for Ministry of Inferior, Czech Republic (over 20 years of collaboration and >50 sets delivered).

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

In case of CAMEA, MegaM@Rt2 project can help with product development process in terms of speeding-up (and thus reducing time-to-market) and reducing development cost. The potentially most problematic parts of the development process are distributing parts of the system over the target platform(s) including selection of suitable HW itself. As well runtime analysis with subsequent priority scheduling is valuable as well. With MegaM@Rt2 framework workload and demand on knowledge of engineers can be significantly reduced. This makes our traffic monitoring systems cheaper (with some level of modularity) and more competitive.

Early Stage Innovation & Exploitation Paths

In CAMEA, development of traffic monitoring system use case using MegaM@Rt2 tools was planned. During the first year, available tools were tested and analyzed. During the second year, new tools (or their features) are being proposed and consulted with tool providers. During the last year, all suitable tools will be tested and evaluated in terms of speeding-up and reducing cost of the development of traffic monitoring system. For the future development MegaM@Rt2 tools could be used and help us to gain competitive advantage. Especially when new system evolved from older platform is developed.

Atos Spain S.A

Atos SE (Societas Europaea) is a leader in digital transformation with circa 100,000 employees in 72 countries and pro forma annual revenue of circa € 12 billion. Serving a global client base, the Group is the European leader in Big Data, Cybersecurity, Digital Workplace and provides Cloud services, Infrastructure & Data Management, Business & Platform solutions, as well as transactional services through Worldline, the European leader in the payment industry. With its cutting edge technology expertise and industry knowledge, the Group supports the digital transformation of its clients across different business sectors: Defense, Financial Services, Health, Manufacturing, Media, Utilities, Public sector, Retail, Telecommunications, and Transportation. The Group is the Worldwide Information Technology Partner for the Olympic & Paralympic Games and is listed on the Euronext Paris market. Atos operates under the brands Atos, Atos Consulting, Atos Worldgrid, Bull, Canopy, Unify and Worldline.

Atos' objective is to empower its clients on their digital journey by applying its in-depth market knowledge and extensive portfolio of services. Pursuing this objective, Atos identified four key challenges that its customers face, whatever their industry sector and whatever their geography: Business Reinvention, Customer Experience, Operational Excellence, Trust & Compliance. Atos has the resources, the scale and the expertise to help its customers meet all the challenges of their transformation.

Thanks to the large expertise of the Atos Research and Innovation group in research, development and innovation projects, we are able to bring new solutions and innovative elements to customers' business. Atos participates in this project through this group. Through the innovation mechanisms deployed in the company, this group transfers the project results to the business units through business development managers who will support this group in identifying which potential solutions developed or to be developed for customers would ideal for using MegaM@Rt2 tooling and methods in commercial projects.

By the nature of company's activity, we have to face frequently large and complex projects where the solution is formed by integration of plethora of individual components or solutions from different providers, and where the business goals required by the customer are complex, numerous and many time changing. The modelling of the solutions by applying MDE techniques becomes then an interesting and potential useful framework to develop under quality, correctness and reliability conditions our software. This is main reason why Atos was interested in participating in a project like MegaM@Rt2. Apart from the increment of the quality of our software, we think that MegaM@Rt2 may also provide us a way to be more productive and then reduce the developing and maintenance costs.

The introduction of agile methodologies for software development is already a reality in many IT companies, and the interaction and feedback between design and runtime phases is more and more intensive and fruitful, what usually is call devops. But there is still a room for improvement in really take advantage of the runtime metrics to feed and re-design the code, in the most automatic manner. And here is where Atos is interested. If there would be a really effective and efficient tool that covered this functionality, there would be a nice new!

As technology provider we are, Atos is also bringing to the project its experience in software engineering and modelling both in commercial and research projects in the past, enriching the project tooling with our industrial solutions in the context of MDE.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

Atos does not have large percentage of projects in embedded domain, our software is mainly for users' applications or services. In our experience the MDE techniques are not much adopted by this kind of software but they have a chance in embedded applications, so we foresee to be focused on transferring the project results to those of our business units which are working in embedded domain (mainly Worldgrid and Worldline brands). We expect to identify at least 3 applications (or customers) that could fit into MegaMart target users and make a workshop with them to explain them the benefits of results into their software.

Early Stage Innovation & Exploitation Paths

Year 1

Goals: reduce effort and cost in development and re-design of our SW for embedded; find a concrete domain where to apply our research on modelling.

Roadmap: find an Atos commercial project for embedded domain to present them the project results and transfer the results; apply to the Innovation Board at ATOS to get the internal support for technology transfer and business development

Year 2

Goals: demonstration, taking the project case studies as success stories, of the benefits that the extensions developed for Papyrus and Moka can bring to the software development. Atos has identified different domains where MegaM@Rt2 can be applied and found that HPC and Cloud domains can benefit of improved software modelling tools that can allow faster developments, easier deployments and even taking new considerations (such as energy efficiency) into account.

Roadmap: the business development team has identified some gaps where MegaM@Rt2 results can be applied. A first internal meeting with the representatives of labs (Internet of Everything, HPC) and research lines (Software Engineering) has been held in order to identify needs and find potential synergies. As a second step, a meeting with the University of Cantabria has been also held early this year to find common points for future collaborations in order to promote MegaM@Rt2 joint results.

University of Cantabria

The University of Cantabria (UC) is a modern public institution with an overall budget in 2016 of 105.97M€, whose main purpose is to contribute to social progress through teaching, technology transfer and scientific excellence. This allowed UC to confirm the "International Campus of Excellence" label in December 2014 with the highest score.

Although UC is the 44th in terms of size within the Spanish University System, it is positioned among top 5 Spanish universities in terms of world impact and excellence of its scientific publications (SCIMAGO 2015 Ranking). Moreover, it is the 4th Spanish university in research quality (ISSUE-BBVA 2015 Ranking) and the 3rd Spanish university in funds obtained per professor per projects with the

private sector (INUE 2015 Ranking). In 2013, UC entered the Shanghai International Ranking for the first time (positioning the Physics area among the 150-200 best universities in the world).

The contribution of the University of Cantabria to MegaMart is being carried out by the Microelectronics Engineering and the Computers and Real-Time Systems Groups.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The main results from the MegaMart project for the UC will be a design verification methodology and SW synthesis for run-time verification and associated tools (i.e. VIPPE, eSSYN and Forest) inside the single-source system design framework, S3D (umlmarte.teisa.unican.es).

UC bases its exploitation on the nature of project results, particularly the UML/SysML/MARTE MDA single-source system modeling and verification methodology. UC will provide documentation, tutorials and training as part of its educational remit. Results will be used to improve and update post-graduate courses, maintaining the university's well regarded stature.

Early Stage Innovation & Exploitation Paths

Improved versions of VIPPE, eSSYN and Forest as part of the S3D framework, will be made accessible through their respective web pages. These are dual licensed, depending on whether the user is commercial or academic. UC will explore the potential to extend the OMG UML Testing Profile (UTP) standard. The university has a solid technology transfer program with local and national companies, especially SMEs. In particular opportunities will be sought with companies such as TST, CIC, Ambar and Setelsa, where a good working relationship already exists.

Thanks to the support of the Government of the Autonomous Region of Cantabria, a specific innovation and technology transfer laboratory may be set-up with the mission of ensuring the widest exploitation of MegaMart results to the companies in Cantabria, provided that the Regional Government approves its contribution to MegaMart through ESIF funds.

Goals:

1. Improve the Megamodeling capabilities of S3D,
2. Improve the simulation, performance analysis, SW synthesis and system verification tools of S3D,
3. Enrich the technical content of the courses on embedded systems in both the Informatics Engineering and the Telecom Engineering syllabus,
4. Promote the technology transfer to industry.

Roadmap:

Following the phases and timeline of the MegaMart project, the roadmap for innovation and exploitation of the project results is divided in three steps:

1. in a first step, the mega-modeling methodology will be defined. A first improvement of the design and verification tools, VIPE, eSSYN and Forest will be delivered and a preliminary evaluation on the industrial and own use cases will be performed.
2. In a second step, based on the evaluation results in the first step, an improved version of the tools will be made available. These results could serve to start its promotion to potentially interested companies,
3. Finally, the definitive version of the tools will be made available. The new technology skills gained will improve the content of the related courses under the responsibility of the Microelectronics Engineering and the Computers and Real-Time Systems Groups.

Universitat Oberta de Catalunya

A state-of-the art technological university with a highly innovative learning model, providing a benchmark for quality in both teaching and R&D. This is the philosophy of the Universitat Oberta de Catalunya (UOC, Open University of Catalonia), created in 1994 as one of the world's very first completely online higher education establishments and that currently has more than 50,000 students. The UOC's core goal is to be the university of the knowledge society, promoting innovative education, personalised learning, technological leadership, R&D work on the information society and e-learning and the dissemination of knowledge.

The UOC promotes R&D activities via 44 groups linked to a study or to one of the university's two research centres: the eLearn Center, which studies e-learning, ; and the Internet Interdisciplinary Institute (IN3), specialising in the study of the networked society and the knowledge economy, network technologies, and specific software areas. In total, more than 400 people work in R&D at the UOC. Over the last five years, the UOC has participated in more than 260 R&D projects, either national or European. What is more, the UOC works to promote knowledge transfer and has, over the last four years, signed more than 1000 agreements to this end over the last four years. The UOC forms part of more than 30 international networks, including the European University Association (EUA), the International Council for Open and Distance Education (ICDE), and the IMS Global Learning Consortium.

The UOC research team directly involved in the project (, the Systems and Software Lab: http://som-research.uoc.edu/), has a high-level expertise in Software Engineering and in particular in the Model Driven Engineering (MDE) paradigm, which is the core paradigm behind the MegaM@Rt2 project. Therefore, there is a clear benefit for UOC in participating in the project as a way to expand and consolidate its MDE knowledge, skills, and international positioning in the MDE field.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

UOC exploits MegaM@Rt2 for scientific research but also for technology transfer and teaching purposes.

From a research perspective, MegaM@Rt2 allows UOC to mature and scale its current techniques and prototypes on, mainly, model verification and collaboration. Moreover, UOC plans to conduct innovative research on new fields, like topics life-cycle/continuous traceability and holistic systems engineering. In general, the strong collaboration with industrial partners throughout the project offers a much more practical view of the actual industrial problems in the area, which will result in much more targeted (and therefore useful) research to be conducted by UOC.

From a teaching perspective, UOC offers several degrees related to computer science plus some masters (e.g., on computer engineering, free software, information security, …), and one PhD programme in this area. Results of the project are continuously integrated in the course contents, specially at the master level.

Early Stage Innovation & Exploitation Paths

In year 1, UOC focused on identifying potential collaborations with MegaM@Rt2 partners working in its areas of interest (especially regarding scalable model management and model verification). A secondary goal of this first year has been to visualize the participation of UOC in the consortium to external actors (other research groups and companies) as a way to engage with other parties that could be interested in following (and potentially reusing) UOC's results in the consortium.

In year 2, UOC has as main goal to start publishing the results of its work in the consortium in a number of international conferences either alone or, most typically, in combination with other research partners of the consortium. Inspiration and requirements to be addressed by these research works are derived from the contacts in Year 1. This "early results" should allow UOC to define a clear path to the consolidation and exploitation at the industrial level of its improved model collaboration, scalability, and verification techniques.

- UOC has published conference and journal papers both individually and in collaboration with academic and industrial partners of the project. UOC also participated in joint papers on the overall project, and co-organized events related to MegaM@RT2 (e.g. MDERun and IPEAC workshops).
- We have worked on improving our NeoEMF tool (large model persistence) in collaboration with ARM to efficiently persist and query views over a combination of large models. The outputs of this collaboration have been published in an A-level conference.

In year 3, the focus will be on the industrial exploitation of UOC's results, (preparing also the path to future collaborations with MegaMart MegaM@Rt2 partners once the project is over). Early results published in year 2 should now be empirically validated with the industrial partners and transformed into mature results to be published in journals. Improvements in our tools should derive in technologies ready to be transferred as well to the industrial partners for commercial use as part of collaboration

agreements. These experiences will be also transferred to the teaching courses (e.g., as full case studies) as a way to highlight the benefits of applying model-driven technologies in industry.

IKERLAN S. Coop.

IK4-IKERLAN is a leading knowledge transfer technological centre providing competitive value to companies, and the key research and technological development actor within the industrial corporation Mondragon Group.

The ICT area of IK4-IKERLAN is specialized in developing cyber-secure and safety-critical software solutions, with special focus on software development processes, for complex systems in a wide range of sectors: automotive, railway, smart warehouses, smart metering, etc. One of the industrial domains that IK4-IKERLAN is currently focused is on providing digital platforms for monitoring, control and supervision of remote IoT devices in any of these sectors.

As a use case provider, the involvement of IK4-IKERLAN in the MegaM@RT2 focuses on infusing development and testing teams of model-based systems engineering, testing tools and methodologies; in order to reduce development and exploitation costs while ensuring quality and safety of our software.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The adoption of MegaM@Rt2 framework will enable to radically improve the engineering of real-time monitoring systems across the whole lifecycle, mainly during design, commissioning, operation and maintenance phases.

We envision that modelling techniques could be applied to the management of component dependencies at runtime as well as data execution monitoring, gathering and analysis; which will help to reduce system downtime times when failures are detected. Predictive analysis and online reconfiguration techniques are also a very promising way to avoid system failures.

This will have an impact on IK4-IKERLAN's operations, both internally and externally. Internally, MegaM@Rt2 outcomes will provide the basis for revisiting the current engineering processes and tools capabilities, in order to maximize productivity and minimize costs while ensuring safety and quality of the developed software. As a result, our customers will benefit from improved software meeting high quality standards and ensuring safe operation, which will increase the availability of this kind of systems, reducing costly commissioning and maintenance actions.

Based on all of this and considering the variety of industrial companies (different domains and applications) with different functional and extra-functional requirements, IK4-IKERLAN is developing a generic and adaptable systems that can be accessible to many industrial domains, having a set of core technologies reused in every of them.

In this context, it is vitally important to have a platform lifecycle process (embedded devices and the cloud) that guarantees product quality, security and reliability. In this way, IK4-IKERLAN is going to improve their IoT device ecosystem lifecycle process: focusing on the relation between the design time and runtime, also taking into account the verification and validation processes in a continuous way, reducing costs without losing quality. As part of this continuous development process, the following should be achieved as part of MegaM@RT2's framework:

- ➢ Ease the maintenance and reusability of models in other application domains.
- ➢ Automatic generation of model-based code, both for development and testing purposes.
- ➢ Runtime verification, i.e. observation, detection and reaction to system behaviours.
- ➢ Iterative application of lessons learned from multiple independent projects in currently deployed environments as well as systems that are going to be developed.

Early Stage Innovation & Exploitation Paths

With MegaM@Rt, IK4-IKERLAN aims to improve the different phases of the life cycle of the projects it carries out for companies regardless the application sector, covering the whole lifecycle, from the requirements to the runtime, including design and testing phases. The final aim is to improve both the efficiency of project development and the quality of the projects, focusing mainly on:

- ➢ New stakeholders on the early phases of the life cycle.

- Internally, the involvement of the testing team will be greater through the whole design process, from system design (with the incorporation of improvements based on results) to system maintenance (with an easier design validation).
- Externally, the requirements and needs from multiple stakeholders, even not directly project related, will be added to system design, as the reduction on development costs and time-to-market will allow greater innovation in product and services.

➢ New markets' entrance.

- Easily extension of the designed platforms to domains where they have not been previously deployed, as the modelling framework can be tailored to adopt needs not gathered and automatically re-validated.
- Feasibility study of licensing/patenting of a generic validation tool, possibly with different partners of MegM@RT2, which allows an automated acceptance of end-to-end systems in different contexts.

➢ Enhanced value proposition.

- Productivity will be increased due to the automation of several crucial task for the success of every project, such as system testing and validation.
- Effort could be redirected to focus on enhancing the performance of the business logic, as well as adding value not previously contemplated improving the portfolio of different customers.

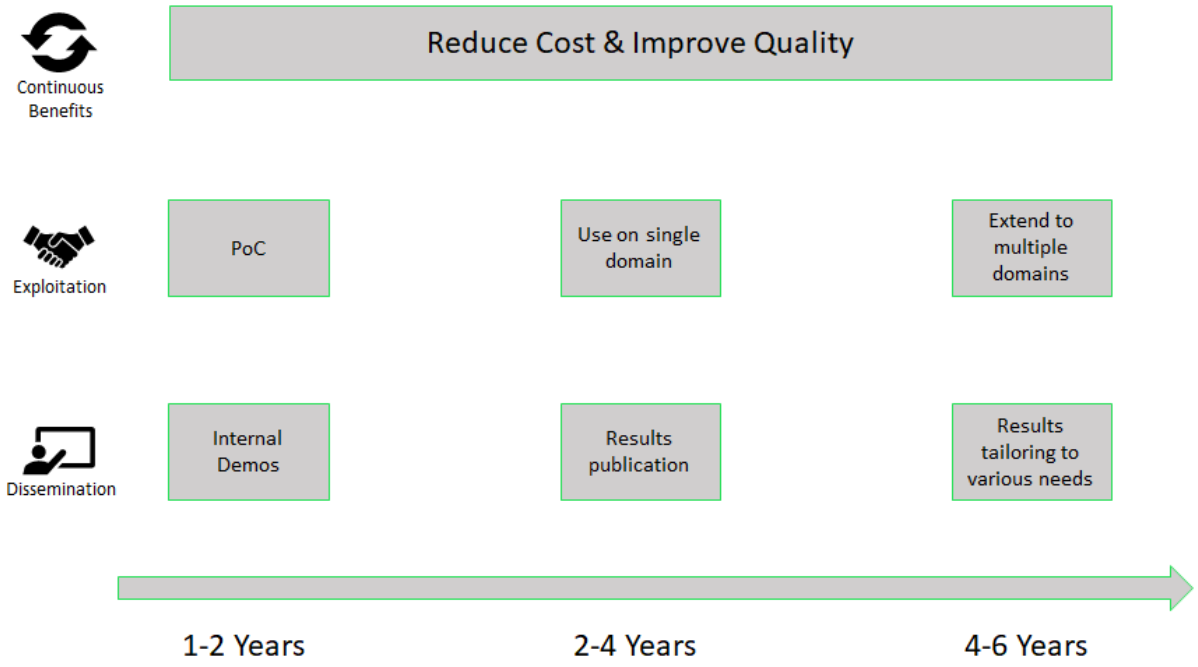
In order to achieve all this objectives, the following actions need to be undertaken according to the specified roadmap:

➢ Firstly, internal dissemination via presentations, seminars and demos will continue to create new efficient processes to apply in current and future developments. This will facilitate the incorporation of the learned knowledge and good practices in IK4-IKERLAN.

➢ Secondly, contribute to the dissemination of the MegaM@RT2 framework in relevant technical and industrial conferences, in professional social networks and publishing in highly-rated technical journals.

➢ In parallel to this, some social media actions could be taken to promote the project scope to different customers and leverage their expectations to improve IK4-IKERLAN´s approach.

➢ Finally, historic results and benefit will be presented to various potential customers in order to engage with them and wider the portfolio of IK4-IKERLAN.



Fent Innovative Software Solutions

FentISS (Fent Innovative Software Solutions) is a technological company experienced in partitioned systems, for real-time and critical embedded applications. The main company product is the hypervisor XtratuM which supports the processors used in the aerospace market, notably the rad-hard Sparc-LEON family of processors used in spacecrafts and the ARM-Cortex family which is increasingly used in new space applications (e.g. microsatellites, minis satellite constellations), the aviation industry, and other safety critical markets such as railways and automotive.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

Although XtratuM compares very favorably with competitors in terms of performance, however FentISS customer's feedback shows that it is still considered a product difficult to use by engineers with little expertise in real-time systems. Moreover, customers report a lack of integration of the product with their complete software development lifecycle. MegaM@Rt2 will improve on this situation by integrating XtratuM and its supporting scheduling and configuration tools in project toolchain thus enabling real-time requirements of XtratuM-based systems to be considered early in the development lifecycle.

Early Stage Innovation & Exploitation Paths

The work developed in MegaM@Rt2 will open the door to other markets featuring more complex real-time embedded systems but using more sophisticated software development lifecycles. FentISS expectes to use the project result to penetrate the following markets:

- *Aviation.* This sector has been the originator of the IMA architecture and several successful aircrafts such as Airbus A340M, A380, Boeing 787 (Autonomous Aerial Vehicles), fully electrical aircrafts and HAPS (high altitude platform stations), all having severe Size, Weight and Power constraints (SwaPs) which will favour the adoption of an IMA-based architecture using XtratuM as a base.
- *Railway signalling.* The need to reduce cabling in railway signalling together with the safety critical requirements of signalling controllers can be covered by using XtratuM as a basis to build signalling controllers.
- *Automotive.* The improvements in the software development environment support of XtratuM resulting from MegaM@Rt2 will have a positive impact in the perception of the hypervisor for automotive applications in particular regarding the forthcoming autonomous vehicle market with strong mixed critically and safety requirements.

Thales

Thales is a world leader for mission critical information systems, with activities in five core businesses: aerospace (with all major aircraft manufacturers as customers), space domain, ground transportation, defence, and security. It employs 68000 people worldwide (50 countries).

Aerospace:

No. 1 worldwide in air traffic management

No. 2 worldwide in in-flight entertainment

No. 3 worldwide AND No. 1 in Europe in commercial avionics

Thales is the only company in the world with leadership positions in both onboard equipment – for the cockpit and the cabin – and ground equipment (radar, air traffic management systems, etc.).

Market leadership in avionics, air traffic management and space systems make Thales the world's only company with the capacity to provide a comprehensive end-to-end response to the challenges of air transport.

Thales contributes to the future prosperity of the civil aerospace sector by providing equipment, systems and services - both in the air and on the ground - to support aircraft manufacturers, airlines, air traffic controllers, airports and civil aviation authorities in meeting the challenges of growth, safety, economic and environmental performance, security and passenger comfort.

Space Domain:

No. 1 worldwide in payloads for telecommunication satellites

No. 3 worldwide in commercial/civil satellites

European leader in satellite systems and a major player in orbital infrastructure

Space systems play a vital role in modern societies, particularly for Telecommunications, Earth observation (radar and optical), satellite navigation and deep-space exploration. Thales continues to set the global standard in each of these areas through two joint ventures with Leonardo of Italy: Thales Alenia Space and Telespazio.

Thales provides commercial, institutional and military customers with an exceptional combination of expertise spanning the entire value chain: equipment, payloads, satellites, systems and services. Thales's space businesses complement the Group's other activities, and vice-versa, and represent a distinct competitive advantage by enabling Thales to offer customers complete end-to-end solutions and play a central role in major civil and military programmes. In defence, for example, space systems are a key component of C4ISTAR (Command, Control, Communications, Computers, Intelligence, Surveillance, Target Acquisition and Reconnaissance). The space component is also prominent in most of the programmes now defining the future of air traffic management as well as in rail and road traffic projects around the world.

Ground Transport:

No. 2 worldwide in rail signaling

Thales helps transport operators and infrastructure managers to get the most out of their investments by optimising their operational performance, offering better passenger services and managing the growing complexity of their networks. Thales systems and services make it possible to operate transport infrastructures at higher capacity and to carry passengers and goods to their destinations more quickly, more safely and at lower cost.

The Group is one of the world's foremost players in rail signaling systems and control and surveillance systems for urban and mainline rail networks.

Most of the other players in the transportation sector have traditionally been rolling stock providers. In contrast, the Thales systems approach enables us to develop innovative solutions based on state-of-the-art technologies. Our solutions can be integrated and interfaced with most existing solutions, so that infrastructure operators and managers have more freedom and flexibility in their choice of

rolling stock and other equipment in a transportation project. The Group is one of the pioneers in the definition of the de facto standards that are structuring the rail transport sector today: CBTC systems (Communications-Based Train Control) for metros, ETCS systems (European Train Control System) for mainline rail, integrated supervision systems, etc.

Defence:

No. 1 worldwide in dipping sonars

No. 1 in Europe in defence electronics

No. 2 worldwide in military radio communications

No. 3 worldwide AND No. 1 IN EUROPE in surface radars for land and naval defence forces

Thales is a long-standing partner of defence forces worldwide, working with them to provide the best possible protection in the field and helping them operate more effectively and more efficiently.

Thales supports the armed forces in accomplishing their missions in the traditional defence environments – land, air, sea and space – and the emerging environments of urban operations and cyberspace. These systems detect and assess threats, manage information, support rapid command decisions and the implementation of suitable responses (including threat neutralisation), with maximum reliability. Furthermore, by facilitating the coordination of joint or coalition operations, they contribute to the decision-making superiority of these forces.

From system design to through-life support and personnel training, Thales support services ensure that the Company's solutions continue to perform optimally, now and in the future.

Security:
No. 1 worldwide in interbank transaction security

No. 1 in Europe in cybersecurity

With the emergence of threats such as terrorism, organised crime, trafficking and cyberattacks, defence organisations alone are not fully equipped to contend with the changing risk environment. This convergence between defence and security is driving demand for new solutions and technologies that enable organisations to share existing information and communication systems while protecting their networks and infrastructure from attack.

Drawing on its experience in the defence sector, Thales works with government agencies, local authorities and civil operators to develop and deploy integrated, resilient solutions to protect citizens, sensitive data and infrastructure. The Group has developed unrivalled expertise in cybersecurity, telecom network security, urban security, airport security, border protection and infrastructure security.

The Group's distinctive strengths include the ability to integrate large-scale, complex systems and leverage the legacy solutions of each customer. In addition, Thales systems are built around key components and technologies in which the Company has expertise: sensors, secure networks and information systems, 4G, secure cloud computing, data processing algorithms, data fusion, big data and management of large volumes of video, voice, text and data.

Thales is involved in MegaM@RT2 through its corporate research center, Thales Research & Technology, bringing both advanced skills regarding critical embedded systems computing architectures, and meaningful use cases to assess the project innovations. Thales Research & Technology monitors the latest advances, develops disruptive technologies and expertise in new areas, attracts talented science graduates and provides a platform for innovation and knowledge sharing to support company-wide projects.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The main exploitation objective for THALES will be to transfer the MegaM@RT2 results into industrial use, i.e. mainly into the industrial SW development processes and tool flows. The documented KPI's already stress that MEGAM@RT2 should provide empirical benefits for real-world software and especially in avionics. Therefore, it is planned that THALES performs early evaluation on the basis of a representing THALES product in terms of complexity and timing performance issues. After the project, evaluation results will be validated by broadening the exploitation scope to other THALES divisions and products. Additional industrial experimentations will prove whether the benefits hold for other SW ecosystems as well. Having demonstrated the MegaM@RT2 benefits on a broad scope, and two years

after the project ends, a broad introduction into development tool landscapes and processes is planned. However, it is required that the MegaM@RT2 advancements are successful streamlined into existing product lines by the participating tool vendors. THALES's expectation is that the verification activity effort will be reduced by 30%, leading to 15% improvement in productivity costs. Similarly, we expect achieving 40% less time for model modifications and corrections.

Early Stage Innovation & Exploitation Paths

Goals & Roadmap:

Year 1:

In the first year of the MegaM@Rt2 project, THALES will get an overview of the modelling and verification solutions and tools brought by the project partners. This will allow challenging the tools currently used at the different Thales units and promote internal discussions.

Year 2:

In the second year of the MegaM@Rt2 project, it is planned that THALES performs a first evaluation of the project solutions on the basis of a representing THALES product in terms of complexity and timing performance issues. The objective here is to challenge and complement the current practices in THALES for performance design and verification of real-time embedded systems.

Year 3:

In the third year of the MegaM@Rt2 project, evaluation results will be validated and promoted internally (workshops, meetings, videos and demonstrations) in order to broaden the exploitation scope to other THALES divisions and products. We will also initiate the elaboration of an industrialization path related to the identified solutions.

ClearSy System Engineering

Established in January 2001 CLEARSY System Engineering (CLEARSY) is a SME specialised in the development of safety critical software and systems mainly in the railways. CLEARSY has developed or contributed to a number of CASE and engineering format tools and also provides dedicated tools like supervision (SCADA), simulation and diagnosis software. Engineering activities include:

- The realisation of worldwide projects committed to achieving results in the design and/or validation of systems and software.
- A technical support activity in the field of formal methods and operational safety.

CLEARSY engineers are skilled in various engineering domains (systems, mechanics, electronics, software, operational safety) and apply IT tools and an electronic laboratory to create prototypes and conduct trials. Collaborations with laboratories and industrial partnerships ensure the production of the various systems components (sensors and interfaces).

The current staff is around 130. CLEARSY headquarters are located in Aix in Provence (France) with business locations in Paris and Lyon.

CLEARSY develops railways safety critical systems, ranging from SIL2 to SIL4, that are installed worldwide and maintained remotely. CLEARSY has a huge experience in designing, developing and maintaining embedded systems that perform safety critical functions (a failure could lead to injuries or deaths). These systems are mostly designed specifically for a project with little reuse and usually detection-based (relying on a smart combination of diverse sensors).

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

CLEARSY is facing fierce international competitors in new markets across the globe. CLEARSY expects the adoption of MegaM@Rt2 technologies to improve its industrial practices and strengthen its whole safety critical systems development cycle, CLEARSY plans to lower development costs, time-to-market and risks. Increased competitiveness is expected to result in an additional contract (ranging from 2M€ to 6M€) won every year after the end of the project.

In particular, CLEARSY plans to use Megamart tools to ease the analysis of existing systems' execution logs and provide updates to those systems.

Early Stage Innovation & Exploitation Paths

Year 1 (past)

During Y1, CLEARSY performed a study of the baseline tools of the Megamart project that could be used in a standard development of a new CLEARSY system. The development effort needed for different scenario has been estimated using the legacy tools of the company and the baseline tools for new topics.

Year 2

During Y2, CLEARSY has recreated some of the scenario with new versions of Megamart tools and measured the improvement in term of effort. In parallel, new methods have been tried, making possible to explore new kind of analysis. Traceability and information representation greatly lowered the efforts for log exploitation by gathering all information relevant to a failure in a single view.

Year 3

During Y3, CLEARSY plans to exploit the megamodeling through the connection between models of the system and models of logs. This mega-modeling should permit to automatize the major part of the log refinement leaving only interpretation to the system analyst. We also plan to develop simulations of the whole system and play scenarios on those system in order to recreate and understand phenomenons that can be observed in logs.

ARMINES

ARMINES is a private non-profit research and technological organization having common research centers with engineering schools from the Institut Mines-Telecom (IMT) group. In MegaM@Rt2, the ARMINES/IMT Atlantique – Nantes Campus common research center “Automation, Production and Computer Sciences department” is involved via its NaoMod research team (formerly AtlanMod team). This team is the result of a long term experience and research expertise on Model Driven Engineering (MDE)/Modeling in different areas (which is the core paradigm behind the MegaM@Rt2 project). Specialized in advanced MDE/Modeling and its concrete applications to various domains, the team activity is visible and recognized worldwide in terms of research results (scientific publications), contributions to open source communities (via the Eclipse Foundation), but also technology transfers and industrial collaborations. Within MegaM@Rt2, NaoMod is notably interested in extending, (re)using and applying in the context of Cyber-Physical Systems (CPSs) their existing solutions for model management and views as well as verification and validation.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

As a research team working on Modeling/MDE, our main objective in such a European collaborative project is to advance the scientific state-of-the-art in this area. As said before, we are particularly interested in the application/adaptation of modeling principles and techniques, coming from the Software Engineering world, to the world of Cyber-Physical Systems. Thanks to the project, we are also interested in being able to validate our research on real case studies from the industry. This is perfectly in phase with the overall strategy of our organization that targets more and more topics related to Industry 4.0 and CPSs, and intends to progressively gain more visibility in these research domains in the coming years (i.e. during and after the MegaM@Rt2 project).

In the project proposal and in the initial version of our exploitation plan, we already mentioned EMF Views, VeriATL and NeoEMF (in collaboration with UOC) as our research solutions/prototypes we are pushing further in the context of MegaM@Rt2. Expected results can take different forms:

- Good scientific publications in international journals and conferences in our domain, or in application domains from our case study providers;
- Related improvements in our modelling solutions/prototypes as previously mentioned;
- Related initiatives in common with other partners from the project, e.g. joint organization and/or participation in scientific/industrial events;
- Transfer/usages of the developed principles or techniques to/by our use case partners.

From our side, the degree of innovation at the end of the project could be evaluated by looking to the number (and importance/relevance) of realizations of the different items mentioned before. The creation of other initiative(s), in which we would be involved, as the result of the project (e.g. a new

consortium proposing a European project being a follow-up of MegaM@Rt2) could be considered as an additional criteria of success.

Early Stage Innovation & Exploitation Paths

As mentioned before, our core "business" is about producing new knowledge in the scientific area. Thus, the main target ("market") of our work is the research community as composed of both academic and industrial researchers. However, we also pay a particular attention to show that our conceptual approaches and corresponding technical solutions are actually applicable in the context of the industry. This is a key motivation for participating in a large international collaborative project such as MegaM@Rt2.

Our current roadmap and exploitation results are the following:

Year 1 (past)

- Perform a deep analysis of the state-of-the-art in the scientific domains previously mentioned (i.e. some Modeling principles and techniques as well as their applications in the scope of the project).
- Identify key problems / challenges (in these abovementioned areas) to be then studied further during Year 2 & 3 - Disseminate the main research findings to both the scientific and industrial communities in Modeling and CPSs via good-level publications (from ARM and/or in collaboration with other partners of the project)
    - We have already published conference and journal papers on both the overall project itself and its related scientific challenges, in collaboration with project partners. We have also published an A-level journal paper about the state-of-the-art in a particular scientific domain of interest for us (model views).

Year 2 (ongoing)

- Study, design, implement and experiment on significant improvements of the solutions/prototypes previously mentioned (both scientifically and technically) - Disseminate first results to both the scientific and industrial community in Modeling and CPSs via good-level publications (from ARM and/or in collaboration with other partners of the project) + new versions of corresponding tooling.
    - We have already published conference and journal papers on the overall project solution/framework, in collaboration with project partners. We have also published an A-level conference paper about conceptual and technical improvements of a couple of our tools (model views + mode storage).
    - We have worked a lot on improving our EMF Views (model views) solution. A new version has been released with a new website, upgraded documentation and resources, etc.

Year 3 (to come)

- Study, design, implement and experiment on significant improvements of the solutions/prototypes previously mentioned (both scientifically and technically).
- Deploy and validate these research solutions/prototypes in the context of industrial case studies (at least one) from the project - Disseminate the results to both the scientific and industrial community in Modeling and CPSs via good-level publications (from ARM and/or in collaboration with other partners of the project) + new versions of corresponding tooling.

Université de Pau et des Pays de l'Adour

The "University of Pau and the Adour Region" is a multi-site university localized in the south west of France where more than 11 000 students are studying various disciplines. Its computer science laboratory, the LIUPPA, is composed of 33 permanent researchers and teachers. The LIUPPA, mainly through its MOVIES team, has a strong experience on Software Engineering and Model-Driven Engineering. Its areas of research notably deal with software architecture, software adaptation, software

requirements, system engineering or model-based software development. The MOVIES team has led these last years research on model at runtime and model execution.

The MOVIES team conducts academic researches but also in collaboration with the industry through various projects, consulting or PhD supervisions. It is member of the Aerospace Valley World Competitiveness Cluster of the South-West region of France.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

As an academic institution, UPAU will primarily disseminate the results of the MegaM@RT project via scientific publications in software engineering workshops, conferences and journals. Model execution is an important challenge in model-driven engineering field as it enables to get a full or partial running system directly from design models, filling in this way the gap between design and implementation. Scientific results obtained during the project will make evolving the state of the art on this domain.

Secondly, UPAU will provide open source tools. The PauWare execution engine will be enhanced with trace and verification features. An EMF-based tool will be developed to make these features available for any executable DSML and to help in implementing such executable DSML. The usage of PauWare in complex and concrete industrial use cases of the project partners will validate the strongness and the scalability of PauWare.

Finally, UPAU is providing a MDE course for its master students. The experience gained on model execution during the project will enable to enhance this course.

Early Stage Innovation & Exploitation Paths

The first year UPAU will study scientific state of the art on verification and trace for model execution in a MDE context. UPAU will interact with the use case providers of the project to present the PauWare tool, what is planned to be developed and to know what they can expect from UPAU.

The second year, new developments around PauWare and an EMF-based tool dedicated to executable DSML have been developed. Two tools have been released:

- Xmodeling studio which is an Eclipse plugin enabling at design to generically associate business operations with executable elements of an xDSL and to automatically execute them at runtime with the management of the data flow among operations.
- Code generator for Pauware: it is available through a website on which one can download a XMI/UML file containing the definition of an UML state machine and it generates the Java code for the Pauware API enabling to execute in any Java environment this state machine.

First scientific publications were also published at this stage.

The third year, UPAU will provide new tools to manage traces and verification features for Pauware. These tools will be presented to project partners for developing their use cases and integrate these tools within the global MegaM@RT framework.

Smartesting Solutions & Services

Smartesting Solutions & Services SAS (SMA) is a model-based testing technology provider and vendor focused on technical areas such as embedded systems and distributed systems (e.g., industrial systems), IT systems, electronic transactions and security components. Smartesting develops the CertifyIt technology that allows automatic test generation from requirements to test using a model-driven approach.

Within the MegaM@Rt2 project Smartesting evolves the CertifyIt technology for offline testing and adapts it to specific features dedicated to continuous online verification. One major asset from the project is the MegaM@Rt2 Framework dedicated to continuous development of complex CPS systems including the integration of runtime and design time system levels, supported by guidelines for integration in any testbed.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The exploitable assets from MegaM@Rt2 will be composed of two elements extending CertifyIt:

- The first asset is related to the modelling for verification and validation (V&V).

- The second asset is related to the runtime toolset with an online testing tool.

The first extension will allow modelling for V&V. The second represents a new toolset for testing at runtime. Both of these exploitable assets will be part of the MegaM@Rt2 framework. These results will be furthermore integrated in the Smartesting product offer and training services on testing embedded systems.

Early Stage Innovation & Exploitation Paths

Goals/Roadmap:

Year 1:

Within the first year, Smartesting analysed the requirements for online testing (at runtime) of MegaM@Rt2 use case providers. This helped to refine the R&D objectives of the developed toolset for runtime testing. This produced a first version of the tooling. No exploitation was planned for the first stage of the project.

Year 2:

In the second year, Smartesting focused on the evaluation of the toolset providing guidelines and tutorials for this usage, providing a tutorial adapted for online training using web conferences. Based on experiments conducted by MegaM@Rt2 use case providers, Smartesting gathers in year two valuable inputs to mature its technology and make it exploitable at the end of the project.

Year 3:

With the final results in year three and the toolset integrated in the framework, Smartesting expects to have solid feedback from use case providers that can be used as part of the exploitation material and pre-sale activities on the new offer. Smartesting expects that the new offer on continuous modelling and testing will generate new customers on national and European level, as contacts would have been already established with some European partners.

Tekne

TEKNE is a medium size enterprise, present in Italy with around 100 employees in the sites of Chieti (CH), Ortona (CH), Guastalla (RE), and Poggiofiorito (CH). TEKNE is a reliable and qualified partner in design and production of custom electronic systems, advanced technological solutions and systems, and military and industrial vehicles. Founded in 1990, TEKNE offers his clients a 20-year-experience in the field along with the passion of young and prepared technicians.

TEKNE provides technological solutions designed for several markets:

- Civil security, mobility and terrestrial transports.
- Protection and surveillance of critical infrastructures.
- Defence systems and solutions (design, production, modernization and maintenance of electronic systems, devices and accessories to be installed or already installed on naval or aerial vehicles, and/or in their logistic or operative bases).
- Special purpose military and industrial vehicles.
- Lifting machineries.
- Wire harnesses, patch boards and electromechanical systems.
- Research, training and consulting services.

TEKNE is strongly oriented to innovation and keeps many and useful cooperation agreements with highly qualified Universities and Research Centres in Italy.

TEKNE specialized in applications for harsh environments. In every field of application TEKNE's experience and adaptability permits to produce both small and big lots of the highest quality. That is why important companies (such as Thales Italia, and IVECO-ASTRA) have chosen TEKNE as their preferential partner.

The competences gained on the most competitive international markets and the continuous effort to innovate have allowed TEKNE to export its solutions and to have a presence in many countries with the completion of complex projects in several sectors.

TEKNE technological areas of expertise are the following:

- Radio Frequency and spectrum management.

- Ultra-Wideband technology.
- Indoor localization technologies for fire brigades and robots.
- Wireless and MANET technologies.
- Sensor networks for defence and security applications.
- Remote monitoring and WSN.
- Local communications, CAN-BUS, in-vehicle networks.
- Vehicle smart boxes.
- Software security.
- Embedded software development.
- Firmware and FPGA development.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The first innovation that Tekne expects from MegaM@RT really is a 'meta-innovation' because discloses the way to all the others: to switch from sporadic (in some project-phases of some projects) to established model based engineering practices. The difficulties derive from the cost and time required to gain expertise and introduce them in the industrial development process, as well as from the tools themselves (academic, not well integrated). We expect that MegaM@RT will provide better tools, and offer the opportunity to familiarize with and experiment them.

The second innovation that we expect is a relevant step toward an asymptotic null-time value for the (post)integration verification. We imagine a mechanism that is applied at design and/or coding/code-generation time, and that produces (or helps in producing) the counterpart of each module/component/sub-system. Such counterpart can go from a (simple) traces analyser to a (complex) simulator of the rest of the world. Designers/developers carry out independently the component test. After that, if interfaces and function are full verified, then the component continues to work when integrated with other components. This approach is not new, but we expect that model based techniques can take it beyond the current limits of complexity and cost.

We are aware that this vision needs the support of a previous clear statement of requirements and interfaces, and the complement of a successive non-functional test. The latter, more broadly intended as run-time monitoring for verification, fault detection and adaptivity, is the third innovation we expect from MegaM@RT.

TEKNE foresees that the model based approach will improve considerably the requirement management and the design—time and effort reduction up to 40%. Moreover, we are confident in a 30% reduction of verification activities. Overall, for the case study we expect to demonstrate at least a 25% improvement in productivity.

Early Stage Innovation & Exploitation Paths

Goals and Roadmap:

Year 1

For the first year, TEKNE expectation is to gain a broad knowledge of model based techniques for the development (requirements, design, verification and integration) of embedded software.

The goals are: (a) to have a clear picture of areas that model based technologies and tools can benefit, through the so called *baseline development* of the Tekne case study—for this tools that other partners made available at the beginning of the project are employed—and through internal confrontation and reviews with TEKNE personnel; (b) to plan the courses that TEKNE technicians not directly participating in the project will attend in the following; and (c) to establish a positive feedback with the tool-provider partners of MegaM@RT.

Year 2

For the second year, TEKNE expectation is to assess the effectiveness of the model based approach, by mean of the so called *first phase development* of its case study—for this tools that other partners will be going to improve during the project are employed.

The goals are: (a) to gain expertise on the use of the tools—directly from the participation in the project, and indirectly from the courses—and to evaluate them; (b) to continue a fruitful collaboration with tool-provider partners; and, as an appreciated side effect (d) to contribute to the development of the Ultra-Wideband system proposed as case study.

Year 3

For the third year, TEKNE expectation is to globally assess the efficiency of the model based approach, by mean of the so called *second phase development* of its case study—for this the MegaM@RT tools final version are employed—and by bringing in the activities as many technicians as possible.

The goals are: (a) to analyse (at what extend, how, when), plan and begin the application of the model based approach in the Tekne industrial development cycle; and (b) finish the project with a firm relationship with all the other partners.

Università degli Studi dell'Aquila

The Department of Information Engineering Computer Science and Mathematics (DISIM) at University of L'Aquila (UAQ) has developed a solid research and development experience in software engineering. The main focus of the research activities are synthesis and analysis of complex systems, software architectures, model-driven development, component-based programming, internet- based programming, mobile and adaptable applications development, security and verification issues. UDA collaborates with different companies in the telecommunication area and is/has been involved in several national and international projects. Its centre of excellence for research "Architectures and Design Methodologies for Embedded Controllers, Wireless Interconnect and System-on-Chip" (DEWS) has developed an interdisciplinary research program in the field of embedded systems and it has participated to several European research projects, has received several grants from Italian research institutions and has a long list of contracts with private companies. DEWS is currently a member of the Network of Excellence HYCON2 (Highly-complex and networked control systems). DEWS expect to improve its EDA-ESL approaches by means of the exploitation of model-driven technologies. The results of this project will allow to update the contents of our academic courses and they will strengthen its position in the field of the research in the embedded systems domain. Moreover, it will enrich its contacts network by enabling several international collaboration opportunities.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

UAQ is interested in exploiting the outcomes of MegaMart in several different ways:

- *Scientific publications*: there are interesting results in MegaMart in terms of domain analysis, model management and mega-modelling, traceability over multi-disciplines models, methods for inference of system deviations and affected design elements. UAQ is very much involved in such research areas and consequently it wants to propose to the attention of corresponding scientific communities the results obtained in MegaMart (e.g., the tools that have been developed for the traceability support). Moreover, UAQ is interested on exploiting MegaMart outcomes to better automate automatic monitoring system generation, in order to evaluate at runtime the system behaviour, with or without the introduction of applications overhead.
- *Teaching*: Among the courses offered by the DISIM department of UAQ to master students, the courses of Software Engineering for Autonomous Systems, Model Driven Engineering, Advanced Software Engineering have been identified. In that courses, showing concrete applications of model-driven and model-based techniques in the context of European projects is for sure of interest for students that if properly motivated might even play an active role in the creation of user communities around the MegaMart technologies. Moreover, the course of Embedded systems is offered by DISIM department at UAQ, where the development of embedded systems is explained, and two main outcomes are exploited from MegaMart:
    - Methods to extract monitoring information at runtime without introducing SW overhead.
    - Methods to produce suitable systems starting from requirements in automated ways. The main activities are related to modelling framework and tools (i.e., EDA solutions for embedded system design at system-level entry), to model-driven approaches to reduce time-to-market and design time, and design space exploration techniques to analyse different implementation alternatives in the context of the HW/SW Co-Design domain. Simulation, validation and verification activities are also treated in the embedded system course to offer a complete overview of the product development process needed for the realization of such kind of systems in different industrial and academic domains.

In all exploitation areas described above, UAQ is already committed and has the required expertise to achieve substantial impact. In particular, concerning *scientific publications* UAQ regularly

publishes in international journals and presents works in international conferences and workshops. The works that are typically published are related to results developed in the context of European and Italian projects, and also to scientific collaborations established with national and international researchers. Concerning *teaching* activities, UAQ runs the above-mentioned courses for master students for several years and further than theoretical and foundational notions, a number of concrete applications of software engineering techniques have always been explained. A number of projects related to these techniques have been proposed and developed by some of the students.

Early Stage Innovation & Exploitation Paths

During the project lifetime, UAQ plans to carry out the following actions:

- Academic and Research
    - Participation in scientific conferences, events and forums.
        - UAQ will participate and present Megamart2 outcomes and results in scientific conferences and events (posters, papers, tutorial, etc.). Moreover, the results will be disseminated during the MDE@DeRun (Model-driven engineering for design-runtime interaction in complex systems) workshops co-located with the STAF conferences.
    - Dissemination of research results.
        - UAQ will present outcomes from Megamart2, in the context of runtime monitoring systems, with posters at Cyber-Physical System summer schools and during poster sessions in relevant conferences. In the context of modelling and development of embedded systems, UAQ will contribute in several conferences and summer schools, presenting results taken from Megamart work related to framework, methodology and tool improvements, with focus on tool and use case provider collaborations.
    - Creation of new courses, seminars, etc.
        - UAQ will exploit the project results by updating the contents of academic courses (Degree in Computer Science and Information Engineering), strengthening its position in the field of the research in software engineering and embedded systems.
    - Collaboration with standardization bodies or other research institutions.
        - UAQ will adopt monitoring systems mechanisms developed in Megamart2 within FITOPTIVIS European project, in collaboration with European partners.
        - UAQ will use the Megamart2 research knowledge (in terms of modelling, framework development and collaboration activities) within AQUAS and FITOPTIVIS European projects.
    - Publishing papers, articles, etc. in scientific journals and/or magazines.
        - UAQ will present work outcomes from Megamart2. In the context of runtime monitoring systems, UAQ aims at publishing in relevant embedded systems conferences (DATE, FPL) and in relevant journal (ACM Transactions on Architecture and Code Optimization (TACO)). In the context of embedded systems co-design, modelling and framework development, UAQ will submit papers in several embedded system conferences (DSD, DATE, ESWEEK) and to international journal (TACO, Microprocessors and Microsystems, MICPRO, Journal of Aerospace Information Systems, JAIS). In the context of model-based software engineering, UAQ aims in publishing in relevant conferences the context of model-driven engineering (MODELS), Applications and Foundations of Software Technologies (STAF), software architectures (ICSA), automated software engineering (ASE), and in relevant journal (such as SOSYM, TSE, JIST, etc.).

Intecs Solutions SpA

Intecs SpA (www.intecs.it), founded in 1974, provides innovative software & hardware technology, engineering services and products for dependable safety- and mission-critical electronic systems. Intecs Solutions is a company part of the Intecs Group which addresses activities related to the design and development of applications, tools, software, hardware components and products for Aerospace, Defense, Transportation, Telecommunication and Smart Systems markets in cooperation with major European and Italian Industries, Organizations, Universities and Research Centers.

Intecs' capabilities in the field of System and Software Engineering represent one of its main competitive assets. Intecs has developed a broad range of experience in methods and tools for system and software model-based development, in all relevant safety-critical domains. Such experience has been acquired through a well-established and longtime co-operation with most of the major Italian and European electronic industries, the development of products, and the participation in several research projects and other European or national organizations.

Intecs has deep experience in solutions for the development of embedded software, in particular, component and model based development for high integrity, safety-related embedded systems, and development of tools. The unit has outstanding and long-time experience in the development of proprietary and open source solutions. Intecs contributes to the PolarSys Industry Working Group of Eclipse (http://www.polarsys.org) created in 2012 for the development and maturation of industrial tools for the engineering of embedded systems.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

INT will exploit the MegaM@Rt mega-modelling results and the acquired knowledge for increasing its technical lead and competitive edge in its core domains, and for opening up domains where modelling is essential for the development of trusted and reliable systems. Intecs will therefore expand and integrate its development and consultancy portfolio in relation with best practices and standards improved within MegaM@Rt .

Intecs has delivered already the CHESS toolset as open source under the Eclipse Polarsys working group (http://www.polarsys.org/), the new open source industry collaboration created at the Eclipse Foundation to focus on tools for safety critical and embedded system development.

In MegaM@RT, Intecs plans to extend the CHESS framework to cover mega-modelling, to support requirement engineering, integrate with new analyses (e. g. enhancements of the MOSES tool for performance analysis), and support for traceability techniques between design and runtime.

Early Stage Innovation & Exploitation Paths

Goals:

The extensions developed for CHESS in MegaM@Rt will be delivered under Polarsys, as extensions to the existing CHESS Project. The open source distribution of the MegaM@Rt products, specifically addressing markets of interest for Intecs, is expected to increase the company visibility, competitiveness and the returns in terms of support, training, consultancy and customization services. In addition Intecs can exploit the participation to other EU projects sharing valuable results.

Roadmap:

Year 1:

Intecs, in the WP2 leader role (MegaM@Rt System Engineering), coordinate and participate to the Tasks T2.2 and T2.4 and the Deliverables D2.1 and D2.2, D2.3, D2.4 and D2.5. The Intecs contribution focus on the coordination, investigation and definition of system modeling and verification framework architecture. It also contribute to all the other work packages, notably to WP1, WP4, WP5 and WP6. Possible participation to article and scientific publication

Year 2:

Intecs is involved in a WP2 leading role, it focus on the implementation of the foreseen solution for MegaM@Rt framework. The results can be disseminated through training courses and commercial material. New CHESS functionalities can be delivered under Polarsys updating and enhancing the CHESS project. Possible participation to article and scientific publication.

Year 3:

Intecs in in charge to support the industrial partners to develop the demonstrator and to validate the framework. Significant results can support the Intecs business development and the application to commercial projects.

Ro Technology srl

The main Ro Technology's expertise gained are in the fields of advanced design, development and V&V Techniques (Model-based Approach, Component based architecture, powerful validation and verification technologies), Requirements Engineering (Capturing, analysis, verification and validation, traceability, consistency and completeness from concepts to products, requirements variability management), High level architecture (HLA - the preparedness and response of the system with respect to an event accident, natural disaster etc.). Ro Technology will exploit advanced design, development and V&V Techniques for requirements modeling and model based verification in the field of model-driven engineering, embedded systems design and wireless communications.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

After this first year of MegaM@rt project, we are starting to understand how and when exploit our planned and desired results. As we provide development and maintenance services to IT Large Enterprise like HP, Ericsson, Leonardo, Reply and so on, we would exploit our MegaM@Rt2 results using the Business Model Canvas methodology (BMC) among these customers. We could also reach new customers by improving our Value Propositions both for the aforementioned consultant services and the new ones such as WSNs developing.

By using MegaM@Rt2 results, we would be able to save time during the requirements analysis, offering at the same time a quicker and better service from the QoS point of view.

Taking into account that during the software life-cycle development, the requirements analysis phase could be between 15 and 20% of the total amount, and considering a development process of about 1 year, the average duration of the test phase could be about 1 month or more. Thanks to MegaM@rt results, our hypothesis now is that we could improve the saving time during the requirements phase. At this stage it is too early to say how much time it could be saved, and we can only image a range between 30 and 40%.

As indirect benefit, at the end of the project, thanks to the collaboration with the MegaM@rt partners, we would improve our skills and expertise in the machine-learning sector, in order to enhance our products in cyber security.

Early Stage Innovation & Exploitation Paths

As we identified our actions in the task early in the project related to V&V Techniques for requirements modeling, after the first year we started the integration process of the CMA tool within MegaM@Rt framework especially related to TEKNE use case. In parallel we are studying and understanding how the market works, the potential customer segments and the related value proposition. In particular we are analyzing and building-up a taxonomy regarding the market composition.

Goals:

- Provide contribution in development/implementation/integration of the Italian demonstrator within the MegaM@Rt framework.
- Develop a business plan helpful to exploit our results in business oriented way.

Roadmap:

- First year: Contribution to design and integration of tools within MegaM@Rt framework.
- Second year: Contribution to development phase of MegaM@Rt tool sets.
- Third year: Contribution to verification and validation activities. We slightly modified our work in the Demonstrator as also described in D2.4 related to CMA tool improvement initially planned. We then decided, accordingly with UC leader and partners involved in UC04-TEK, to address tracing mechanisms available at runtime to then perform runtime validation (i.e. on ARM processor in the context of UC04-TEK).

Abo Akademi University

Åbo Akademi University has an acknowledged position at the forefront of research in such areas as biosciences, computer science and engineering, democracy, human rights, material sciences, process chemistry and psychology. The research project will be carried out within the Computer Engineering (CE) (https://research.it.abo.fi) subject at the Faculty of Science and Technology and the Turku Centre for Computer Science (TUCS, https://www.tucs.fi) which is a joint research institute of University of Turku and Åbo Akademi University. TUCS conducts basic and applied research in computer science and engineering, and has a long history of high-level achievements of its affiliated researchers, in terms of articles in high-level journals and conferences, high number of citations, invitations to speak in the most important conferences in the field, and memberships in editorial boards of many high-level international journals.

Åbo Akademi University has collaborated in the past with Space Systems Finland and Conformiq within the LIME LightwEight formal Methods for testing Embedded systems project (2007-2009) and with VTT, AINA and Nokia in the PAM (Practical Applications of Model-based TEchnologies to Continuous Integration and Testing Methodologies, 2012-2015), Cloud Software (2010-2013) and Need for Speed (N4S, 2014-2017) projects. At European level, Åbo Akademi University has participated together with Nokia, VTT and Conformiq in the ITEA2 D-Mint-- Deployment of Model-Based Technologies to Industrial Testing (2007-2009) and together with Space Systems Finland in the ARTEMIS RECOMP -- Reduced Certification Costs Using Trusted Multi-core Platforms (2010-2013). These past collaborations gave rise to new research topics which are now pursued in the MegaM@Rt2 project.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

Via this project Åbo Akademi University will strengthen its expertise in model-driven development and V&V activities with new methods and technologies applicable to industrial settings and thus establish itself as a competence center at Finnish and European level on these topics. The results of the project will be disseminated to our local and European industrial partners not present in the project via bilateral research cooperation and research publications. The methods and tool prototypes developed will be made available to project partners and to the community. Throughout the project, and the results of the work will be published in the form of master theses, as part of doctoral theses and in renown forums and periodicals. New course content and training materials will be developed based on the results of the project and provided not only to students but also to national companies.

Early Stage Innovation & Exploitation Paths

Goals/Roadmap:

Year 1:

Perform survey of the state of the art and state of practice on different WPs of the project.

Collaborate with the Finnish case study providers on case study requirements specification, and planning for case study demonstrators.

Publish preliminary research results.

Year 2:

Continuously evaluate and improve our research methods and tools by performing early experiments and case study evaluations on the industrial case studies.

Year 3:

Apply the devised methods in pilot projects and industrial partners and collect KPIs and suggestions of improval.

AinaCom Oy

AinaCom Oy is a Finnish company providing ICT-services and solutions for corporate customers, mainly to SME-segment with national focus. The service portfolio covers all types of telecom services, data connections & networks, cloud based solutions and data center services. The focus is to provide our customers easy to acquire, use and modify types of services that improve the productivity of businesses and drive the possibilities to adapt new ways of working (e.g. time and place becomes irrelevant). The

service creation is heading towards a direction where efficient model based software generation and automated testing methodologies will be increasingly important.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The MegaM@Rt2 will support AinaCom's business development towards more efficient, effective and higher quality productization process. The results in MegaM@art will most likely have a positive impact; especially MegaM@Rt2 results will directly affect the SMS-gateway product its usability, error handling and autonomous error recovery & reporting.

Early Stage Innovation & Exploitation Paths

Goals/Roadmap:

Year 1:

The immediate benefits of MegaM@Rt2 for the first year is in developing the SMS-Gataway''s service functionality and being able to provide to the market V3.0 of the service. With MegaM@rt partners we will be able to utilize new testing tools while releasing new features. This is expected to increase the quality of service and customer satisfaction.

Year 2:

In year two we expect to be able to test end to end process covering a larger scale of usability and redundancy of services with data analytics related to the real-time activities and traceability issues. Even though the SMS-Gateway acts as a case study for the project we expect the results to materialize also in a larger scale of product development within AinaCom. The MergaM@rt and the methodologies will also increase the competency of our employees and thus bring value to the company.

Year 3:

With the results AinaCom expects to shorten its product development cycle, improve significantly the transparency and automation of processes within the SMS Gateway service. The improved quality will be measured by higher customer satisfaction figures. With the continuous modeling and testing practice we will also create new more efficient working culture within our development team.

Space Systems Finland Ltd.

Space Systems Finland Ltd. (SSF) is a systems engineering, software development and data science company located in Espoo, Finland and Prague, Czech Republic. SSF supports customers in designing and developing complex industrial applications such as data processing applications, control systems and test automation solutions. SSF provides services for leading customers in a wide variety of industries. SSF is especially prominent in industries where lifecycle and quality management, safety and security as well as data are critical.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

MegaM@Rt2 will support SSF in developing new tools for testing and developing software as well as collaborating with the MegaM@Rt2 partners. The results and the tools of the project will be used by SSF and they will be made available to the project partners. The results will also be disseminated via scientific publications, and master thesis.

Early Stage Innovation & Exploitation Paths

Goals/Roadmap:

In the first year we identified the features for the tools to be developed, and we also identified possible collaborations with the project partners. We decided to work and improve tools that were previously developed by SSF together with Abo Akademi and other partners in previous projects and we also identified problems in our continuous integration software processes that we seek to improve.

Nokia Networks

We create the technology to connect the world. Powered by the research and innovation of Nokia Bell Labs, we serve communications service providers, governments, large enterprises and consumers, with the industry's most complete, end-to-end portfolio of products, services and licensing.

Nokia is enabling the infrastructure for 5G and the Internet of Things, and shaping the future of technology to transform the human experience.

Through our six business groups, we have a global presence with operations in Europe, the Middle East & Africa, Greater China, North America, Asia-Pacific, India, and Latin America. We also have research and development ("R&D") facilities in Europe, North America and Asia, and at the end of 2017, we employed approximately 103 000 people.

We closed 2017 delivering net sales of EUR 23.1 billion. We continued to make significant targeted R&D investments, a bedrock of our success in innovation, with R&D expenditures equaling EUR 4.9 billion in 2017.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

For Nokia, the objectives of the adoption of MBSD (Model Based System Design) to practical, industrial integration and testing are following: 1) seamless integration, including tool chains 2) comprehensive, optimized and intelligent test automation, 3) provision and utilization of reusable artifacts for both modern and legacy systems to facilitate the automated adaptations, 4) model-based analysis and diagnostics, and 5) incorporation of these methodologies to both continuous and long-term integration and testing activities.

Nokia wants to improve process flow for R&D. This improvement starts from Acceptance criteria specification phase and takes a critical look at its contents. It must be verified that SW Design domain model contains the information that is needed in testing as an input for automated test generation. That information does not necessarily include testing specific data, which is typically modelled in test phase domain models. From the process flow point of view possible automated transformations shall be developed towards automated transformation when regarded feasible. The focus is in testing and traceability, because the requirements information is needed in automated test result analysis. Nokia is expecting a creation of efficient Model Based System Design (MBSD) Way-of-Working (WoW), which enables Executable Acceptance Test Driven Development (EATDD) for Lean SW development.

Second expectation is a contribution to produce methods of proper information for test case generation in varying practices of product lines. Then we model testing specific information with the design data in order to be able to automatically generate test cases and other definitions needed in automated test case execution. Such information is e.g. how to move the system under testing (SUT) into specific state, from which the test cases are designed to start the execution.

Thirdly Nokia expects to find and produce algorithms for automated test result and root cause analysis. Nokia's assumption is that 30% less time (efficiency gain) is needed during modelling, leading to 40% improvement in productivity. Similarly, 60% less time (efficiency gain) for model changes/updates, leading to 50 % improvement in productivity.

Early Stage Innovation & Exploitation Paths

Nokia believes that products could get out to our customers in 15 months after product content decision instead of 3-4 years.

Having Modeling & Simulation as a de-facto design technique as a part of Nokia R&D process, we could achieve this. That would need totally new and different approach – Nokia calls it as virtual platform initiative or modeling and simulation platform for both SW and HW.

Desired state:

- The core of the modeling and simulation is not the models and simulation themselves but 'Problem Statement' i.e. we have a problem (or requirement) and we want to solve it early enough by modeling and simulating and analyzing the results.
- We have created a process framework for modeling and simulation with tight interlock with operation research (discipline that deals with the application of advanced analytical methods to help make better technical and management decisions.
- Interoperability across different HW/SW simulation tools.
- We have defined the specific phases horizontally/vertically when tools can be and must be used with expected results and data for decision making. The usage of the tools is then mandatory.
- Designers have been well trained to use the tools.
- Key users are in place for the support and maintenance.

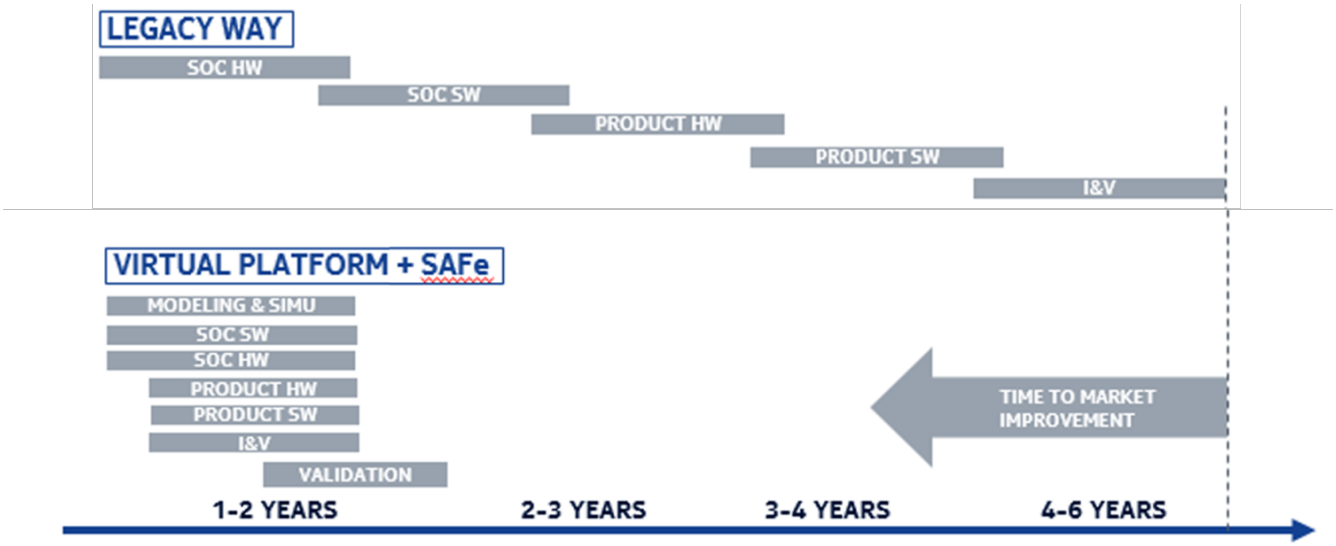


Figure 2: Time to market improvement using modeling, simulation and virtualisation

VTT Technical Research Centre of Finland

Technical Research Centre of Finland Ltd is one of the leading research and technology organisations in Europe. We use our research and knowledge to provide expert services for our domestic and international customers and partners.

In MegaM@RT2, VTT will develop methods and technologies related to machine learning, this includes new smart technologies, profitable solutions and innovation services. This includes the telecommunications sector for anomaly detection and root cause analysis.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The areas of potential exploitation of the results of MegaM@RT2 are broad, including sport analytics, the energy sector, home security, and automation. Machine-learning technologies which include basic functionalities, such as anomaly detection and root cause analysis, are in high demand in sectors where electronically readable time-series data is utilized.

The developed machine-learning technologies will be exploited indirectly in future customer projects (as the competences of researchers) and directly in future research projects (further development of prototypes.)

VTT will publish the results of the developed research in conferences and journals. The impact and quality of these outlets will serve as the KPIs to indicate the degree of research achieved in MegaM@RT2 by VTT.

Early Stage Innovation & Exploitation Paths

First version of convex hull structure (1st year)

First version of multidimensional clusterability identification (1st year)

Deep learning publications (1st year)

Conformiq Software Oy

Conformiq is a leading software technology company, focused on test automation, functional testing and software quality. With Conformiq's products the end user will be able to improve software development efficiency, decrease costs and achieve higher quality in software development organization. Conformiq has taken unique approach to model based testing technology, which enables end-to-end test automation in software development lifecycle. With high level of test automation and low test maintenance, Conformiq solutions enable in-sprint test automation in agile software development. Conformiq's competitive edge is based on our leadership in model based technology, automated test

generation algorithms, integration between software development tools, and the bright and intelligent people behind these innovations.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

Conformiq is a commercial company whose business model is based on licensing model-based testing technology. Conformiq will use to any applicable extent the results of MegaM@Rt to promote model-based testing in the industry and to support its own model-based testing tools business. Based on the company's long experience in the model-based testing domain, Conformiq will make contributions to the creation of presentation and productizing material. Furthermore, Conformiq aims to

- Demonstrate the state-of-the-art model-based testing technology available from Conformiq to create and boost markets for commercial model-based testing tools,
- Gain new research and technology insights and exploit these insights in the company's commercial offering to gain competitive edge
- Employ the informational and marketing material to get an increased marketing efficiency
- Capitalize the increased awareness of model-based development and testing enabled by MegaM@Rt to result in increased sales volume of Conformiq tools, and
- Publish academic and/or industrial research papers on international forums in order to gain credibility as the global technology leader in model-based testing and as such establish a defendable position as market leader

Early Stage Innovation & Exploitation Paths

SICS Swedish ICT Västeras AB

RISE SICS is a leading research institute for applied information and communication technology in Sweden, founded in 1985. RISE SICS is non-profit and carries out advanced and focused research in strategic areas of computer science, in close collaboration with Swedish and international industry and academia. The research creates cutting-edge technology, invigorating companies beyond their own R&D.

RISE SICS consists of a flexible group of researchers with a very strong knowledge in several areas including; embedded systems, the future of internet and services, industrial efficiency, optimisation, systems and software engineering, future energy, innovation and product realisation. RISE SICS conducts solution-oriented research in close collaboration with industry, and has a proven record of disseminating and promoting industrial deployment of research findings. Transferring research findings to industry is central to RISE SICS' mission, and also a natural activity given our strategic position as a research institute between academia and industry. Among difference research areas, RISE SICS also has a software testing group which is the team involved in MegaM@Rt. In addition, the people involved in MegaM@RT from SICS have also been involved in the CHESS and MBAT EU projects which are two of the related projects to MegaM@Rt. Therefore, it matches the research profile and direction of SICS and helps to build upon previous knowledge and achievements.

New knowledge obtained in the project will be disseminated through presentation of results at ndustry-relevant events and publications geared toward software testing professionals, as well as through other projects and collaborations we have with various industrial partners such as ABB, Volvo, Ericsson, MälarEnergi, Atlas Copco - to name a few.

Moreover, RISE SICS also holds annual events and workshops where projects and research results are showcased and presented such as SICS Open House and SICS Software Week where many professionals, academics and practitioners participate.

RISE SICS has established and is also the main organizer of the ITEQS international workshop which focuses on testing quality attributes, and also is involved in other software testing events, conferences, and journals which will be used as additional channels for RISE SICS to disseminate the project results.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The results from MegaM@Rt will strengthen the profile of SICS in model-driven engineering and in particular, model-based testing. This, in turn, will lead to more and stronger presence and contributions in future projects, both with our industrial partners as well as pure research projects. In the area of runtime verification & validation and online testing, SICS already has several solutions for test process optimization, test case selection and prioritization. SICS will not only bring these solutions into

MegaM@Rt but also intends to extend and tailor them as part of a holistic model-based solutions and using models@runtime. Additionally, development of new techniques to complement our existing solutions and offering, such as model-based test case generation, will be another way for exploiting the results of SICS's involvement in MegaM@Rt, and adding to the expertise profile of the team.

Early Stage Innovation & Exploitation Paths

Goals/Roadmap:

Year 1:

Performing state-of-the- art and practice studies and surveys, identifying the gaps and possibilities for extensions together with the Swedish industrial partners and helping them also to refine their use-case requirements, and better define their use-case demonstrators.

Publishing on preliminary results of the project

Year 2:

Providing tailored solutions and prototypes for our industrial partners; and extending our existing solutions by adding and implementing new features

Year 3:

Working together with industrial partners to develop final use-case demonstrators, and apply and evaluate the developed solutions against the industrial use-cases, helping disseminate the results in our industrial partners' organizations

Mälardalen University

Mälardalen University (MDH) is well known for its successful co-production with industrial partners. In particular, the Embedded Systems (ES) research environment at MDH is the most prominent and is recognized as the university's only center of excellence. There are six cooperating research directions in ES and MegaM@Rt2 will be conducted in the research direction of verification and validation where the Software Testing Laboratory (STL) will host it. STL builds on ES' reputation of excellence in co-production with industrial partners. Two large companies participating in MegaM@Rt2 (Bombardier Transportation (BT) and Volvo Construction Equipment (VCE)) have closely cooperated with STL on mutually benefiting projects. MegaM@Rt2 also builds on and extends STL prior participation in EU funded ATAC and MBAT projects. Nationally, MegaM@Rt2 will further enhance and use the results from IMPRINT project where both BT and VCE have participated. In MegaM@Rt2, MDH is active in multiple WPs, mostly active in the areas of model-based testing and model-based systems engineering in general.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The direct benefit of MegaM@Rt2 for Mälardalen University (MDH) is in the further competency development of STL (Software Testing Lab) as a progressive and a collaborative research group in the area of modelbased verification and validation. STL will strive for a 50% per year increase in conference papers and journal articles published in the domain. STL gets to maintain its existing cooperation and collaboration with Volvo Construction Equipment (VCE) and Bombardier Transportation (BT). MDH and particularly STL, in active collaboration with its industrial partners, will strive to meet the set key performance indicators for the project. MegaM@Rt2 results are expected to reach out to several other companies that cooperate with STL; several of these companies are interested in gaining lessons learnt from MegaM@Rt2 and will thus benefit indirectly. Participation in MegaM@Rt2 will establish new contacts with European industrial and academic partners such as in France, Spain, Italy and Finland. MDH already has a strong network of Europewide collaborators and MegaM@Rt2 will only improve its current standing as a leading embedded systems research university. MDH has several strategies to exploit and disseminate MegaM@Rt2 results:

- Several courses at MDH will get lessons learnt and useful case study results from MegaM@Rt2. These courses include both oncampus courses ("Software Verification and Validation") and distancecourses offered through the PROMPT (KKS) (http://www.promptedu.se/) initiative ("Software Testing", "ModelBased Testing").

- MDH will integrate MegaM@Rt2's test, designtime and runtime validation results with our previous ATAC and MBAT deliverables to improve generalizability of results for Volvo and BT.

Early Stage Innovation & Exploitation Paths

MDH's detailed plan for all the years is given below. Please note that the Swedish consortium members meet regularly for meetings (participated by all four Swedish members of MegaM@Rt2) which has been a primary venue for dissemination and sharing of results within the Swedish consortium. Until March 2019, 11 such meetings have already been taken place with the 12th planned for 10th May 2019.

Also note that all the scientific output and dissemination happening is listed on the MDH project website: http://www.es.mdh.se/projects/457-MegaMaRt2_Megamodelling_at_Runtime_ECSEL_Vinnova

Goals/Roadmap:

Year 1:

Study state of the art with respect to MDH commitment in several work packages.

In collaboration with Swedish industrial partners, plan for experimental and case study evaluation of model driven initiatives.

Start publishing initial results.

Year 2:

Build on the early experimental and case study evaluation to provide more in-depth results for the industrial partners and the research community by large.

Year 3:

Start transferring results in the actual practices at the industrial partners, while continuing with experiments and case studies.

Volvo Construction Equipment AB

Volvo Construction Equipment (VCE) develops, manufactures and markets equipment for the construction and related industries. The vast product range of VCE includes different types of loaders, excavators, trucks, forestry machinery and demolition machinery. VCE is facing a dramatic increase in complexity related to the increased demand for advanced functionality in their machines. VCE products are increasingly technology driven with more focus on electronics and software. Consequently, the impact of software on the customer, and hence on market shares and competition, is and will be enormous. This establishes software as one of VCE's key technologies. However, with growing competition in the market, there is high demand on reducing the lead time (time-to-market). In this context, there is increasing need for development to support a continuous engineering process with focus on early and continuous verification and validation as well as virtual integration. VCE is a use case provider in MegaM@Rt2 where its scenarios deal with variability management as well as model-driven systems engineering in general.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

The MegaM@Rt2 results will support VCE's current push towards an efficient and effective end-end model-based system engineering lifecycle. Especially, MegaM@Rt2 results are expected to have an impact on early verification, and the successful coexistence of different types of models at various abstraction levels of system integration and the seamless working of variety of tooling mechanisms for continuous development.

The model-based methods developed and evaluated within MegaM@Rt2 will increase VCE's efficiency when it comes to developing advanced vehicular systems. The matching of design time and runtime aspects in MegaM@Rt2 are particularly in line with VCE's strategy towards an end to end model-based system engineering lifecycle. Therefore, VCE is interested in the results of both design methods and tools as well as runtime methods and tools developed in MegaM@Rt2.

Early Stage Innovation & Exploitation Paths

VCE's detailed plan for all the years is given below. Please note that the Swedish consortium members meet regularly for meetings (participated by all four Swedish members of MegaM@Rt2) which has been

a primary venue for dissemination and sharing of results within the Swedish consortium. Until March 2019, 11 such meetings have already been taken place with the 12th planned for 10th May 2019.

Also note that, similar to the other Swedish industrial partner (Bombardier), VCE's participation in MegaM@Rt2 is primarily driven by efficiency and effectiveness gains in the internal development process. As such it is difficult to provided exact details of presentations to specific departments since this happens on need basis and cannot be planned upfront. As an example, if there is a new thesis project starting that is funded by MegaM@Rt2, a meeting is called with relevant stakeholders inmediately to clarify the scope.

Goals/Roadmap:

Year 1:

The immediate benefits of MegaM@Rt2 for VCE is in accelerating the take-up of end-end model driven engineering practices in its development process. MegaM@Rt2 will add positive energy to model-driven engineering practices in VCE. The initial results in MegaM@Rt2 are expected to help motivate employees to adopt new value-adding methods.

Year 2:

Since the scope of work in MegaM@Rt2 spans the wide spectrum, from modeling to automatic code generation to verification and validation, there will be plenty of opportunities to share best practices and lessons learnt from MegaM@Rt2 results. MegaM@Rt2 will be an important contributor in keeping and building key competence in VCE. In addition, the knowledge built in the project will be available to Volvo Group in general, and to some extent also to Volvo subcontractors. MegaM@Rt2 results will also help VCE to stay current and informed of the latest innovation happening in model-driven systems engineering and especially those targeting integration of design and runtime aspects. Therefore MegaM@Rt2 results will also affect how VCE provide trainings to its employees. Given that MegaM@Rt2 has diverse industrial and academic partners, there will be plenty of chances for VCE to increase its collaboration network and to start new EU wide partnerships.

Year 3:

With the project results, VCE aims to shorten its lead-time and therefore decrease time to market (productivity improvement in the range of 10%50%). VCE also, with the help of MegaM@Rt2 results, aims to boost quality improvement in the range of 10%30%. These targets will be achieved by meeting specific KPIs, such as reduction of time/efforts for requirements validation in the range of 10%50% and reduction of 10%50% in time/effort required for managing and handling models. Starting with the evaluations undertaken in the MegaM@Rt2 VCE use case, VCE plans to continuously adopt and integrate knowledge gained from the project in the existing system development processes.

Bombardier Transportation Sweden AB

The company participating in the MegaM@Rt2 project, Bombardier Transportation Sweden AB (shortly abbreviated as BT), is the Scandinavian part of the train designing division Mainlines and Metros within Bombardier Transportation (the division represents about 70% of Bombardier Transportation's turn over). The Scandinavian software developing department within division Mainlines and Metros contains roughly 25 SW developers and 25 test engineers. An increased number of functionalities, within a complex largescale and safety-critical system, are implemented today as a pure software solution often on a more general-purpose hardware. However, this does not change the fact that the system as a whole has to be thoroughly tested and verified for its correct functioning. When building a train, this is in specific a challenging task considering all the safety regulations that had to be fulfilled and the amount of time one need to spend on a real train performing testing and retesting of the build in safety functions. BT is a use case provider in MegaM@Rt2 in the railway domain, focusing on model-based testing and mode-based systems engineering in general.

Identification of individual innovation & exploitation possibilities for MegaM@Rt2

BT has invested a large effort, over the last decade, in developing a toolchain support system ranging from requirements modeling to software testing of their Train Control Management System (TCMS), all done in a simulated/lab environment. However, commissioning phase of each train project in BT still requires a significant effort spent in executing and re-executing test case scenarios on the real train, resulting in a rather high overall cost for the project. In order to reduce the time spent on the real train when performing testing, safety certification agencies are requiring from BT to provide

convincing evidence that their TCMS software is verified from a model point of view and accordingly tested in a simulated environment, removing the need to be retested again on the real train.

The MegaM@Rt2 results are expected to provide BT with insights into the overall model-based system engineering process, ranging from the requirements modeling to runtime execution models and the interconnections between them. In specific, Bombardier is paying close attention to the traceability of system requirements and the runtime system from the verification point of view. Methods and tools, proposed within the MegaM@Rt2, will be empirically evaluated in the Bombardier's case study, for their efficiency and effectiveness in the context of a safety critical software development within the railway domain.

Early Stage Innovation & Exploitation Paths

BT's detailed plan for all the years is given below. Please note that the Swedish consortium members meet regularly for meetings (participated by all four Swedish members of MegaM@Rt2) which has been a primary venue for dissemination and sharing of results within the Swedish consortium. Until March 2019, 11 such meetings have already been taken place with the 12th planned for 10th May 2019.

Also note that BT's participation in MegaM@Rt2 is primarily driven by efficiency and effectiveness gains in the internal development process. As such it is difficult to provide exact details of presentations to specific departments since this happens on need basis and cannot be planned upfront. As an example, if there is a new thesis project starting that is funded by MegaM@Rt2, a meeting is called with relevant stakeholders immediately to clarify the scope.

Goals/Roadmap:

Year 1:

Upon the start of the MegaM@Rt2 project, BT will immediately get a firsthand insight into the current modelling opportunities and the toolset surrounding it. This will create an open forum for discussions with engineers, were the benefits of the existing process and the toolchain at BT will be challenged.

Year 2:

BT always strives to improve their development and testing processes such that the productivity of the engineers, but also their effectiveness, would increase. There are several possibilities within the MegaM@Rt2 were this could be achieved, ranging from scalable modeling, automated test generation, automated trace analysis, continuous testing, etc. The knowledge and the best practices that exists within the MegaM@Rt2 consortium could easily complement existing approaches within the BT, thus creating a plethora of possibilities for the improvement both on a personal level of an engineer but also on a global companywide level.

Year 3:

One of the main challenges, BT aims to address with the results from the MegaM@Rt2, is the possibility of shortening its time-to-market. This will be achieved by striving to confirm several KPI targets defined for the BT. Mainly, having productivity improvement in the range of 10%50% and quality improvement in the range of 10%-30%.

Annex II: IPR collection template

The following table contains the inputs received by MegaM@Rt2 tools' providers with respect to each of the project components. The original table contains more columns, including copyright holder or license URL among others. Most relevant information is listed in the table.

Component	Owner	Technology	License	Exploitation ways
Modelio	SOFTEAM	Tool for modeling systems and software	EPL	Open Source
Modelio Constellation	SOFTEAM	Tool for Model governance		Commercial
EMF Views	ARM		EPL 2.0 + GPLv3	Open Source
Collaboro	UOC	Collaborative DSL Development	EPL	Open Source
emfToCSP	UOC	Bounded verification of UML/OCL models	EPL	Open Source
CompleteTest	MDH	Test case generation	Free for non-commercial applications in academia only	Open Source
S3D	UCAN			
CHESS	INT	Design, verification and implementation of critical software systems	EPL	Open Source
Papyrus extension	ATOS	Editing or any type of EMF model, particularly UML and related standard modeling languages such as SysML and MARTE	EPL	Open Source
Moka	ATOS	Execution of UML models using a rich and extensible animation and simulation framework	EPL	Open Source
XPM	FTS	Project manager for developing partitioned systems based on XtratuM hypervisor	Commercial	Commercial
Xamber	FTS	Design and configuration of partitioned systems	Commercial	Commercial
CMA	RO	Consistency, completeness, correctness of requirements		Open Source
VeriATL	ARM		EPL	Open Source
NeoEMF	ARM/UOC		EPL	Open Source
AIPHS	UAQ		Apache 2.0	
HepsyCode	UAQ		Apache 2.0	
JTL	UAQ	Traceability and bidirectional model transformations	EPL	Open Source
LIME TestBench	SSF	Java, C, C++ instrumentation for monitoring and test generation	LGPL v3	Open Source
Confirmiq Designer	CON	Automated test design / test case generation	Commercial	
PauWare	UPAU	Execution engine for UML state machines	LGPL v3	Open Source
CertifyIt	SMA			
CertifyIt Mbeetle	SMA			
Capella	TRT	Tool for modelling systems and software	EPL	Open Source
MATERA2	ABO	Model validation and verification, model-based testing and monitoring	Free for non-commercial applications in academia only	Open Source
RCRS Toolset	SSF	Modeling and verification of reactive systems	MIT	Open Source

Annex III: Sustainability Survey

The project has conducted an online internal survey in order to gather the commitment from all partners regarding the creation of a sustainability body for maintaining the project results. Below the list of questions asked and the figures collected from the received answers:

1. *Look at the proposed value chain: Which roles do you expect to play on it? Select all wished.*
    a. *Tools providers* - 15
    b. *IT services* - 7
    c. *Industrial user*- 7

2. *Which income model from the listed below would fit into your usual business?*
    a. *Training* - 6
    b. *License tool* - 8
    c. *Consultancy services* - 9
    d. *Customer solution* - 8
    e. *New research* - 19
    f. *Others* - 5
    g. *Publishing* - 1
    h. *Selling products* - 2
    i. *Internal R&D* - 1
    j. *Student intake* - 1

3. *Would you be in favor of joining other partners to approach together commercial opportunities and sharing revenue?*
    a. *Yes, why not* - 19
    b. *No, we don't plan to commercialize anything* - 5
    c. *No, we plan to commercialize alone* - 1
    d. *Yes, but only with my usual and current collaborators* - 1

4. *Do you foresee to contribute and maintain the MegaM@Rt2 open source repository with project results?*
    a. *Yes, but only to my tools* - 13
    b. *Yes, in case of any tool, in pro the community* - 3
    c. *No, any investment in the open source project is not expected from my organization* - 4
    d. *Maybe if there is a business behind* - 6

5. *Do you plan to contribute or extend tools from existing open source projects? If your answer is Yes, please indicate which ones.*
    - Projects from the Eclipse Modeling Project (possibly, depending on opportunities and relevance)
    - JTL, PADRE, AIPHS, HEPSYCODE
    - Papyrus
    - We may develop our own new prototypes, maybe building on other open source tools and services
    - PapyrusRT
    - CHESS
    - Lime

6. *For warrantying the future sustainability of the project results, we are creating an association where you could play one of these roles (see schema). Which one would you like to play?*
    a. *Core Group* - 1
    b. *Contributors* - 15
    c. *Interested* - 10

7. *Which kind of contributions would you bring to this association once the project was finalized?*
    a. *In kind for maintaining tool* - 15
    b. *In kind for marketing* - 21
    c. *In kind physical resources* - 3
    d. *Annual fee* - 6

8. *Please, tell us any suggestion or comment about project sustainability.*
   - The MegaMart mega-modeling and design framework has the potential to become a dissemination and exploitation platform for the project results.
   - The proposed approach is solid and appropriate.
   - I have already seen associations/clubs created out of EU projects, but few of them really appeared to be active and/or visible after project endings. I guess it requires a strong/support commitment from industrial partners and also to rely on an already existing community/infrastructure.
   - A new future EU project would be a good opportunity to consolidate the consortium and enhance the MegaM@Rt2 products.
   - Future research project(s).
   - Creating new project proposals and future consortiums based on MegaM@rt collaborations and results.
   - Right now, it's difficult for an external potential client to really understand what MegaMart can do for him/her. There's an obvious reason for this: MegaMart is a very big consortium. I guess we should highlight the most promising applications / benefits for a limited number of external user profiles so that people visiting the megamart website can recognizes himself in one of them and easily assess whether megamart is something useful for his company.
   - A follow up project would make sense to sustain the results of MegaMart2.
   - The MegaM@Rt2 sustainability is well planned and managed.
   - I am wondering on the ability to integrate so much tools as we have and then to maintain the global framework of MegaM@Rt2 in time.
   - Try to improve the project through new EC proposals with the aim to reach a robust framework at commercial quality level. When significant results will be available, we should try to promote the project to new industrial companies.
   - Our results from the project contain logs or models of existing products which are mostly confidential. We can produce simplified or degraded versions for research use in publication or in public case studies.
   - The association should not be limited to MegaM@RT partners. It should create a community around MegaM@RT.
   - Project sustainability will strongly depend on solving real customers' problems from the start and iterating with customers to shape project tools.
   - Value analysis for end users is an important element of the MegaM@Rt valorisation strategy.
   - Maintaining a repository with the project results (software and documents).