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1 Introduction

For a large project like MBAT with 38 partners, dissemination is of key importance to promote widespread take-up and use of results and thus to justify the effort and budgets spent outside the consortium. Therefore, according to the ARTEMIS work program, it is mandatory to describe very well the planned dissemination activities in a proposal, and it is one of the indicators for evaluators.

Education and Training are an important part of Dissemination because it plays an important part in creating the ARTEMIS Sustainable Innovation Ecosystem, particularly by taking care that results can be transferred effectively via training material and an “experience package” as defined in the MBAT Technical Annex to students and professionals for future use in practice. Large projects with many partners from research and universities should invest a certain amount of effort into creating such training material, guidelines, presentations and small demonstrators to show the importance of MBAT innovations, e.g. the MBAT RTP approach and the impact of combining (Model-based) Analysis and Test.

The Deliverable “Training Material” (month 24 and 36) anticipates that training material based on results of the technical and innovation work packages is rather expected in the last period of the project. So the first deliverable at month 24 will rather summarize the motivation based on the seven pillars of the ARTEMIS concept for a Sustainable Innovation Ecosystem (which includes Standardization and Education & Training) and show a few preliminary examples of existing and starting activities of partners towards inclusion of MBAT ideas and results in their training materials. These materials include:

- Materials to be used in university lectures and courses resp. lab exercises, which in the end will partially become available to the public
- Materials for training of in-house staff in partner companies (OEMs, tool providers, training organizations etc.), which in most cases will for IPR reasons stay confidential.

The training material as such will not be produced by the Dissemination WP. This WP will assess what will be available, will motivate technical work packages to generate versions of their tools, guidelines etc. for E&T purposes which in the end can become available to the public (particularly slides and training manuals, or computer guided visualization of the underlying methodologies and technologies), and try to co-ordinate the production of an “Experience Package” describing Use Case results for the interested public. This has to be planned and discussed carefully since IPR issues in many Use Cases may hinder direct publication. This is similar to the so-called “Publishable Results” issue of EU research projects.

As mentioned just before, the Deliverables “Training Material” will be accompanied later (M30, M36) by an evolving “Experience Package”. The first version will describe the assessment of what is to be expected to be publicly available in the end. The final version will provide some concluding set of information and training material.

This will be achieved by monitoring the provision of training material and an experience package describing the use cases and other outcomes of the project by the dissemination WP partners, which may result in an educational subset of the Technology Platform (AIT holding the chair of the E&T WG of ARTEMIS). An important goal of ARTEMIS is the creation of an ARTEMIS Reference Technology Platform, as started by the ARTEMIS project CESAR. MBAT has developed its own agenda to contribute to this platform and follow the idea of an interoperability standard (OSLC (Open Services for Life Cycle Collaboration)).
2 Motivation for generation of MBAT related E&T Material

2.1 The Importance of Training for the ARTEMIS Sustainable Innovation Eco-Systems

ARTEMIS does not want “to be just another funding programme”, but aims in the medium/long term at a sustainable innovation eco-system around the achievements of the projects. The ARTEMIS SRA (Strategic Research Agenda [ARTEMIS 2011, 2013]) respectively MASP (Multi-Annual Strategic Plan and Research Agenda) describes seven pillars of the intended ARTEMIS Sustainable Ecosystems visualized in the following graphics (Figure 1).

![Figure 1: Conceptual model of an ARTEMIS eco-system for (open) innovation](image)

Education & Training is one of these pillars, besides standardization. To put results of ARTEMIS projects into practice can be achieved in the long term by including them in teaching, education and training programs at universities, universities of applied sciences and professional education in industrial and technology transfer organizations. The latter is a means not to address only students but also industrial professionals. This is additionally a very effective means of dissemination with medium to long-term impact since persons trained in courses on the use of a certain methodology or tools during their studies tend to apply their knowledge later on during their professional career.
2.2 ARTEMIS Approach: The E&T Working Group

With the ARTEMIS aim of creating an innovation eco-system, in part through a community and shared scientific vision, the mission of the WG E&T is to enable the long-term sustainability of these innovation eco-systems by:

- Building an infrastructure for E&T that facilitates the introduction of new content and curricula.
- Strengthening links between industry and academia,
- Building on and integrating the results of recent and on-going European activities, networks and projects
- Raising business awareness and facilitating short-term exchange and training in both directions (industry and academia), complementary to long-term basic research.

Cooperation with other initiatives and groups working on E&T related topics (EWICS TC7, ARTIST 2 and ARTIST Design, ReSIST, COSINE2 and others) resulted in a recommendation to include an E&T section in each ARTEMIS project proposal as a mandatory requirement.

The importance of the WG E&T to the ARTEMIS strategy is clear in the statement of intent in the SRA 2011 to “facilitate the productive engagement of industry and academia to match the pace of evolution of educational systems and curricula to the rapid evolution in technologies.”

Not only will ARTEMIS break down the present distinctions between system architects, hardware and software engineers, and promote a more holistic approach to system design, covering all levels of industrial groups (OEMs, suppliers, end-users) but it will also use EIT ICT Labs of the European Institute of Innovation and Technology (EIT) to get ARTEMIS results quickly to the curricula of students, to the knowledge of SMEs and to the products of European industry.

The primary question discussed at the ARTEMIS E&T WG is “What can the ARTEMIS E&T Working Group contribute to better match the innovation needs in this fast evolving technological world?” This was broken down into several sub-topics, the results of the discussions are summarized under each bullet point [ARTEMIS 2011, 2013]:

- **Ideas & priorities for future activities of the WG:**
  - Although E&T plans are now addressed in the ARTEMIS Work Programme, the evaluation criteria should include concrete E&T target values.
  - A new approach was discussed at length and included as target for next year’s activities: The whole chain for professionals has to be addressed in the field, not only academic and professionals, but also at school level (e.g. project courses 15-18 years, e.g. in manufacturing environment, and specific training for teachers in E.S. area)! There is a shortage in engineering staff on all levels, which has become a problem for industry, and it is too late in curricula to start at academic level.
  - Complementary funding to explore innovation etc. is unfortunately not possible in current ARTEMIS projects: Target for “Next Generation Joint Undertaking”? NOTE: In the evolving JTI ECSEL, such support actions (CSA) will be possible as bi-partite projects (only EC funding and partners).

- **Co-operation with other initiatives or programmes:**
  - Co-operation with EIT-ICT Labs will be fruitful for both sides
  - The E&T WG will follow the firm request for co-operation with Prof. Hannu Tenhunen (hannu@kth.se), who is in charge of EIT ICT Lab’s Embedded Systems M.Sc. Program (besides some other contacts)
  - Co-operation with KET has to be looked into (high-level group)
• Link with and tap into projects and their innovation activities?
  o Examples from recent ARTEMIS projects: in R3-COP, pSafeCer and nSafeCer as well as in MBAT Dissemination E&T activities (development of training material, workshops) are planned.
  o Contribution to future MASP: strengthen E&T as Work Program requirement.
  o Pupils/girls days (like in the FP6 IP DECOS project) (companies, research organizations)
  o Short internships for students and schools: Can we train companies to take this into account as part of ARTEMIS projects? (ARTEMIS challenge and possibility for ARTEMIS companies!)

• “Make it happen” chapter of the new SRA 2011- Implications for the WG:
  o SRA: “Sustaining the Artemis innovation environment”– E&T has an important role! (p. 16, p. 95/96)
  o ARTEMIS organizers: Invite local students, their teachers and local industrial community to ARTEMIS/ITEA2 Co-Summit exhibition etc.: (potential partners: EIT ICT Labs)
  o ARTEMIS Centres of Innovation Excellence (CoE): E&T should be an important criterion (EICOSE, Process-IT). The discussion revealed that at the moment E&T is not an issue – to be changed!!

Since the ARTEMIS E&T WG should differentiate from similar groups: the involvement of industry would be a key requirement (chambers A and C, SMEs and large industries).

2.3 MBAT Training Material and “Experience Package” concept

To implement some ideas of the ARTEMIS E&T Working Group on how to promote E&T activities within ARTEMIS projects (the ARTEMIS E&T Working Group even wanted to make this a mandatory requirement for ARTEMIS projects, but did not succeed), MBAT did a first approach beyond the usual E&T activities of universities and research organizations including ideas and project results into their lectures and courses, industrial seminars and so on, which is already reported in the Dissemination Deliverable D_WP_0.3_4_1 and 2. MBAT defines a separate task for E&T (T 0.3.6) containing two specific items besides the usual:

  • Education and Training Material Promotion: Monitoring of and Facilitation of production of dissemination and training material as outcome of the respective technical work packages (for future users/trainees of the tool platform)
  • “Experience package” describing the use cases and other outcomes of the project (particularly the MBAT RTP).

MBAT refers to the ARTEMIS “sustainable innovation eco-systems” and the E&T Working Group, stating:

“The objectives of education & training activities are:

• To achieve long term impact towards a self-sustaining innovation ecosystem (ARTEMIS MASP and SRA, requirement of Work Program 2010)
• To support especially the second and third dissemination objective (close relation to dissemination)
• Monitoring the provision of training material and an educational subset of the Technology Platform (AIT holding the chair of the E&T WG of ARTEMIS).”

The Training Material and Experience Package to be provided takes inputs (and relies on them!) from technology work packages. This material will be re-used to write parts of the training material, of course in the required style as universities or training organisations need it. This will be part of a rather
generic guideline (paper-based, or computer-based) or “cook book” for the MBAT methodology and approach.

Partner specific knowledge about E&T material and a possible MBAT RTP training subset are required from the E&T point of view. It has to be clarified, that these material tools will be available to the public as an educational subset (not to be in conflict with IPRs).

The approach taken for selection of the Training Material and Experience Package contents is the following:

- Assess (questionnaire) availability and potential of MBAT tools and processes for facilitating production of training material,
- Assess possibility to produce educational versions of tools and RTP implementation,
- Collect and define training guidelines (universities!)
- Assess availability especially with respect to a training guidelines, support material and training environment, and based on results of sufficient matureness,
- Collect a set of training material and experience package content with sufficient coverage of MBAT technology and innovation, provided by the technical work packages and motivated/coordinated by the dissemination WP partners.

This was reported on the Euromicro/SEAA Workshop Session in Santander [SEAA, 2013].

2.4 Role of partners in E&T and Technology Transfer (derived from the dissemination roles)

2.4.1 AIT

AIT is chair of the ARTEMIS E&T WG. AIT organized e.g. a Special EWICS/ERCIM/ARTEMIS Workshop Session on “Teaching, Education and Training for Dependable Embedded/Cyber-physical Systems” at Euromicro SEAA 2013 in Santander, Spain (Sept. 4 – 6, 2013).

AIT will in co-operation with Universities provide themes for academic studies (Master, PhD) (Education and Training role), and especially in its role as technology transfer organization between research and industry or SMEs, respectively. The MBAT topic is a strategic key topic of the Safety and Security Department of AIT and in particular for its SAS business unit (Safe and Autonomous Systems).

- AIT will make use of the experiences gained from the MBAT project for industrial technology transfer seminars provided in context of several organisations involved in this area in Austria.
- AIT will further use the experiences for the ARTEMIS E&T Working Group by taking them into account for E&T concerns with regard to embedded systems education and professional training curricula.

2.4.2 AAU

Education and AAU: The Danish Government has recently (2009) approved that the AAU researchers may offer a special Study Program on Embedded Systems for Elite Students, and the MBAT results will be integrated in the program on a regular basis. It is expected that 20-25 M.Sc. students per year will graduate having an expertise on embedded systems including knowledge within model based testing and analysis.

AAU is coordinating a National industrial innovation network, InfinIT. Results from MBAT will be disseminated to Danish industry through this network. In particular we plan to initiate a yearly series on software testing - including model based testing and analysis.
2.4.3 CEA LIST
CEA List personnel regularly teach advanced university courses on the latest test and analysis techniques so that newly qualified engineers are familiar with their use. MBAT will provide an example for the students of how such techniques can be integrated and used in an industrial context. LMeASI is greatly involved in the COMASIC master of Ecole Polytechnique. This Master program is dedicated to the analysis and modelling of complex industrial systems. It is thus a perfect place for the dissemination of MBAT results among students. Also, LSL and LISE laboratories are responsible for the teaching of the Software Test module at Polytech’ Paris-UPMC and will therefore be able to disseminate the results of MBAT to future students.

2.4.4 ENEA
Enea is involved in several other European research projects. MBAT and its results are also introduced in those projects to strengthen the synergy and collaboration between such research projects, and possible adoption of MBAT methodologies in the future in E&T and industry.

The company offers several master and bachelor thesis work opportunities which are supervised and performed in collaboration with universities such as KTH, Uppsala and Mälardalen University. The master students get, this way, introduced to our research activities and projects.

Enea is also a member of Innovative Center for Embedded Systems (ICES: http://www.ices.kth.se/). The center consists of different academic and industrial partners such as: KTH, ABB, Ericsson, MathWorks, Prevas, Scania, Stoneridge, ÅF. This center provides another opportunity to disseminate the results and provide information and training.

2.4.5 ENS
The ENS partner members are involved in teaching various courses at undergraduate and graduate levels, in particular, a course on abstract interpretation and applications within the Parisian research master in computer science (MPRI). MBAT technologies will be introduced within these courses.

Collaboration with industrial partners will help ENS focus on their relevant needs. The results within the project will be used in tutorials and workshops.

2.4.6 Fraunhofer IESE
Intermediate and final results will be directly transferred to the industry within and outside the MBAT project by developing tools, supporting the MBAT RTP, and systematic coaching and training of partners.

Fraunhofer IESE has a close relation to the computer science department of the Technical University of Kaiserslautern. Scientists of the institute have given lectures and seminars at the university covering different software engineering topics including safety analysis, quality assurance, and process improvement. Based on the results of MBAT the institute will elaborate on advanced Bachelor’s and Master’s courses in the field of risk-based testing, model-based testing and combined analysis and testing by using models. The IESE contributions to SP2 are directly mapped to dissertation topics of 3 researchers. The validation of their thesis will be done in the MBAT case studies. During the project duration the institute will also provide Bachelor’s and Master’s thesis as well as internships to computer science and software engineering students.

2.4.7 KTH
The connection to ICES (www.ices.kth.se), the KTH based centre for embedded systems, provides even further opportunities for dissemination of MBAT results. ICES coordinate research and educational activities at KTH. ICES encompasses more than 10 KTH research groups, spanning four of KTH’s 11 schools and involves close cooperation with industrial partners facilitating technology
transfer including ABB, ENEA, Ericsson, FreeScale, Mathworks, Scania, Stoneridge and ÅF. KTH is also a partner of the ArtistDesign network of excellence on embedded systems design.

For KTH, the work in MBAT will lead to dissemination along the following dimensions:

- Incorporation of MBAT results and RTP, including theory, methods, and tools, into embedded systems education at KTH, at the levels of Master, PhD, and continued industrial education for industry.
- Industrial evaluation and deployment of MBAT techniques in collaboration with industrial partners, e.g., Volvo, ABB, SCania, and ENEA.
- Integration of MBAT analysis and testing techniques with popular tools so that the new approaches are accessible and easy for evaluation to the potential user.
- Dissemination of MBAT achievements through national initiatives such as ICES (www.ices.kth.se), Swedsoft (www.swedsoft.se) and through high quality publications of innovative techniques or novel applications of present techniques accomplished in the area of model-based analysis and testing.

2.4.8 MDU (Mälardalen University)
The plan for dissemination of MBAT results at MDU is threefold.

- Technology transfer to other projects and research units: the results will be integrated with the research results from other research projects at MDU. A concrete goal is to complement the component-based analysis techniques and tools developed in the PROGRESS strategic research centre for Predictable Development of Embedded Systems, with the results of MBAT.
- Education/Teaching: The results of MBAT will be used in our master and graduate education in the fields of intelligent embedded systems, industrial software engineering, and robotics. We intend to integrate MBAT main topics and solutions into our Advanced Verification and Validation course, given at MRTC as a graduate course.
- Technology transfer to industry: MDU has extensive collaboration with many Swedish and international companies, including e.g., Ericsson, ABB, and Volvo, which already have great interest in model-based development, analysis, and testing. The results will be validated in different industrial settings and deployed in the development environments used within these companies.

2.4.9 OFFIS
OFFIS is dedicated to technology transfer, and is organized in three R&D Divisions, focusing on IT in Transportation, Health, and Energy.

- Education/Teaching: As a so called „An-Institut“ there is a strong relationship to the University of Oldenburg. The Departement of Computer Science offers for its Bachelor degree a specialisation course on embedded systems and has a dedicated Master course on Embedded Systems and Microrobotics. These courses offer excellent oppurtunities to teach topics addressed within MBAT.
- Technology Transfer: As an application oriented research institute our aim is provide solutions applicable in industry and to transfer research results to industry. The results of MBAT will be used to extend our consultancy offer on the efficient transfer of research results to industry applications.

2.4.10 TU Graz
TU Graz will exploit the results in their lectures, lab exercises and perform PhD and Master Thesis work, as well as in technology transfer.
• Education/Teaching: The results of MBAT will be used in TU Graz’s courses, research and industrial collaborations by means of tool development and integration into the framework. A number of bachelor, master and PhD thesis projects are envisaged on the MBAT topic. Hence, young researchers will be trained in the theories and tools resulting from MBAT.

• Technology Transfer: TU Graz has a strong collaboration with the automotive industrial cluster in Graz (Magna, AVL, KTM etc.). The integration of its test case generator into the common framework will be of mutual benefit, fostering the transfer of the new MBAT technologies to our local industrial partners.

• Networks: TU Graz has a number of local research projects on model-based testing. The biggest is the SoftNet Austria Competence Network which is coordinated by TU Graz. The results of MBAT, especially the new insights in combining testing and analysis techniques will be used in these projects.

2.4.11 TU Munich

TU Munich is active in the following areas of dissemination:

• Education/Teaching: “Introduction to Computer Science” courses are held each year for over 350 students every year, and several advanced courses on compiler technologies. These offer excellent opportunities to introduce future software engineers to the MBAT technologies.

• Technology Transfer/Collaboration with Industry:
  o Saarland University collaborates with AbsInt. The mode analysis work is expected to improve their worst case execution time analyser aIT. The race detection work developed in TUM is based on the open source Goblint analyser. Adapting the aIT analyser to the Autosar/OSEK platform is conducted in collaboration with Daimler Research.

2.4.12 ViF

VIRTUAL VEHICLE Competence Centre (ViF) has positioned itself as an independent, international platform for research and development in the automotive industry.

• Conferences, Publications: The know-how gained in MBAT will be presented to students during industry presentations (e.g. at the Graz or Vienna University of Technology).

• Education/Training: Additionally, master theses on this topic will be proposed in order to train young scientists.

• Technology Transfer: ViF addresses the gap between academic research and the needs of industrial research and development departments. Depending on the interest on the market, ViF might propose consulting services on MBAT topics.
3 MBAT Training Material: Promoting project results towards the “Life-Long Learning Community”

3.1 Training Material to experience the ARTEMIS (MBAT) RTP and Interoperability Standard (concept)

To create an ARTEMIS interoperability standard is a declared goal of the ARTEMIS cluster of projects focusing on safety and high reliability, namely CESAR, MBAT, SafeCer, iFEST, R3-COP, RECOMP and, since 2013, CRYSTAL, besides others.

At the 2013 ARTEMIS Spring Event in March 13 & 14 in Brussels, the first day was a dedicated ARTEMIS JU Information and Networking Day. EICOSE organize a small exhibition of example Tool Platform Projects where the basic concepts and processes what a RTP is and how to create the required subset of tool chains based on the IOS (Interoperability Specification) for a specific domain and application were explained (to be more precise: visualized) on posters. The MBAT poster is shown below.

![Example Tool Platform Projects](image)

Figure 2: MBAT RTP Poster at ARTEMIS Spring Event 2013

For the Training Material, the MBAT RTP subset building process should be demonstrated with a smaller subset of available tools (may be in a down-graded demo version) to fulfil a set of different requirements in different configurations for training purposes. This is the intention for the final phase of generating training material. It could be arranged in the first run as computerized visualization of the
3.2 AIT Example of a Computer Aided Visualization Tool Supporting Training

AIT has developed a tool to visualize the concepts behind mutation testing and mutation-based test-case generation. Notice that the latter technology is used in AIT’s MoMuT family of test-case generators. The tool itself, shown in Figure 3, has already been used on conferences and will be used in upcoming lectures to give the audience an intuitive feeling about mutation testing.

As can be seen in the figure, the tool lets the user take control of a car alarm system specified as an UML state machine (top right). Several inputs to the car alarm system are available: On the one hand the user can send signals that stimulate the closing/opening or locking/unlocking of the doors of the car. On the other hand the user is able to control the simulated time by the action of waiting. The current active state in the state machine is highlighted, as well as the transitions taken.

In the lower left part of the tool a set of about 80 red/green coloured tiles show how many mutated, i.e. faulty, versions of the car alarm system the user’s input sequence was able to detect. Undetected mutants remain red while detected, i.e. killed, ones change to green. Clicking on one of the tiles displays a test-case (bottom right, computed by MoMuT::UML) that is able to detect the mutant.

Figure 3: Visual Animation of a Car Alarm System
This tool was used at the ETSI User Conference UCAAT on Advanced Automated Testing. This conference had strong MBAT presence: the organizers were All4Tec and Cassidian (with papers and presentations), Siemens and AIT were active (presentation, booth). AIT had a small showcase visualizing model-based mutation testing, which is one of the AIT and TUG contributions in MBAT for automated test case generation. This is of course a first step for a MBAT training material since it shows the approach to be used when completed to a full MBAT demo case. In the MBAT process shown in Figure 4 it represents this time the test path, but the approach will be extended to show more MBAT features how to simplify test case generation.

![Figure 4: MBAT process flow](image)

### 3.3 TU Munich Tutorial for the Marktoberdorf Summer School 2013

Helmut Seidl prepared a tutorial for the 2013 Summer School in Marktoberdorf in Bavaria, Germany. The topic was "A Generic Infra-structure for Interprocedural Analysis of Concurrent C". This tutorial summarizes joint work with Kalmer Apinis and Vesal Vojdani done within the EU project MBAT.

**Abstract:**

This tutorial is about infra-structures for general-purpose inter-procedural analyses. It consists of two parts. The first part argues that side-effecting constraint systems may serve as kind of a Swiss army knife for specifying analyses, while the second part provides an overview on solving techniques for such systems.

Side-effecting constraint systems were originally introduced for the analysis of multi-threaded code by Müller-Olm, Seidl and Vene (2003).

Here, we show how this formalism provides a unified framework for realizing efficient inter-procedural analyses of programs, possibly with dynamic function calls, where the amount of context-sensitivity can be tweaked and where the context-sensitive analyses of local properties can be combined with flow-insensitive analyses of global properties, e.g., about the heap.
One infrastructure realizing this intermediate format is the analyzer generator Goblint which is developed within the EU project MBAT and practically evaluated on use cases provided by the industrial partners of this project.

The second part reports on techniques for solving side-effecting constraint systems. One major issue here is that non-trivial analysis problems require complete lattices with infinite ascending and descending chains. In order to compute reasonably precise post-fix points of the resulting systems of equations, Cousot and Cousot have suggested accelerated fix point iteration by means of widening and narrowing (Cousot and Cousot, 1977, 1992).

The strict separation into phases, however, may unnecessarily give up precision that cannot be recovered later. While widening is also applicable if equations are non-monotonic, this is no longer the case for narrowing. A narrowing iteration to improve a given post-fix point, additionally, must assume that all right-hand sides are monotonic.

The latter assumption, though, is not met in presence of widening. It is also not met by constraint systems corresponding to context-sensitive inter-procedural analysis, possibly combining context-sensitive analysis of local information with flow-insensitive analysis of globals.

As a remedy, we present a novel operator that combines a given widening operator with a given narrowing operator. We present adapted versions of round-robin as well as of work-list iteration, local, and side-effecting solving algorithms for the combined operator and prove that the resulting solvers always return sound results and are guaranteed to terminate for monotonic systems whenever only finitely many unknowns (constraint variables) are encountered.

3.4 Industrial Training Material

Some industrial partners have already provided training material and guidelines to train their staff or to perform external training (e.g. tool suppliers). This material is in most cases confidential because it contains company-specific know-how (IPR), but nevertheless the examples show directions to go for if material has to be produced for industrial practice.

An internal assessment is planned what could be made available to learn from their experience.

3.4.1 RICARDO

RICARDO produces training material to train its engineers. The material is tailored to fit with our approach (existing practices & MBAT approaches).

The training material consists of the following types of documents:

- Guidance documents
  - For example, a guidance document about requirements formalisation that gives concrete guidance based on the notations, method & tools we are using
  - These act as a reference for engineers using the techniques after they've had training
- Work-instructions
  - These are typically tool-specific
  - These act as a reference for engineers
- 2-day training course that is not currently written but planned
  - We plan, for our own engineers, a training course to get them up to speed from requirements writing through requirements formalisation through to analysis & test derived from formal requirements
This course is not yet written, but it will be based on our Brussels demonstrator and we will use a lot of slides from our existing internal dissemination material.

The plan is to write this in January.

Basically, providing the support required to our MBAT work is a major focus in RICARDO’s team. For example, the diagram below shows all the guidance etc. documents we planned related to the task of requirements formalisation and related T&A:

![Diagram showing planning for training documents for RICARDO engineers](image)

Figure 5: RICARDO’s plans for training documents for their engineers

Many of the above already exist in first draft form. A rather comprehensive list what is planned and what is available (although contents are confidential) is provided by Darren Sexton from RICARDO.

### Table 1: RICARDO Internal training / guidance new for MBAT approaches

<table>
<thead>
<tr>
<th>Title</th>
<th>Description</th>
<th>MBAT relevance</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricardo internal 2-day training course &amp; work-shop: Requirements formalisation and derived verification</td>
<td>Hands-on training &amp; work-shops for internal Ricardo use to train engineers in formalising requirements so that we can then derive analysis and test objectives from them and then performing that A&amp;T.</td>
<td>Training in one of our MBAT streams of work.</td>
<td>This is planned to be created in next few months; at time of writing does not e4xist. However, will use a hand-on example based on Brussels demonstrator (which exists) and re-use a lot of our internal dissemination material.</td>
</tr>
<tr>
<td>Ricardo internal guidance on boilerplates for natural language requirements</td>
<td>Reference document for Ricardo engineers for using simple boilerplates to help ensure natural language requirements are written in a style that supports later efficient formalisation (i.e. “write for formalisation”.</td>
<td>Reference for preparing for a key-step in our MBAT work-flow; link to suggested MBAT method topic “Write requirements for formalisation”</td>
<td>First draft written, currently being updated as boilerplates are trialled further.</td>
</tr>
</tbody>
</table>

---

© MBAT Consortium
<table>
<thead>
<tr>
<th>Work Instruction: DOORS infrastructure for boilerplates</th>
<th>Describes some tool infrastructure in DOORS that helps with an MBAT task.</th>
<th>Support for a key-step in our MBAT workflow; link to suggested MBAT method topic “Write requirements for formalisation”</th>
<th>Not yet written, planned for early 2014.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricardo internal guidance on requirements formalisation</td>
<td>Reference document for Ricardo engineers on the task of formalising requirements.</td>
<td>Reference for a key-step in our MBAT workflow; link to MBAT method of “joint input constraints for analysis &amp; test”</td>
<td>First draft written, currently being updated</td>
</tr>
<tr>
<td>Ricardo internal guidance on analysis of implementation with respect to robustness</td>
<td>Reference document for Ricardo engineers on the task of model checking an implementation for requirement independent health / robustness properties.</td>
<td>Reference for a key-step in our MBAT workflow; link to MBAT method “analysis first, then test” / “model and analyse early”.</td>
<td>Not yet written, planned for early 2014. May be a single document or may be two separate ones.</td>
</tr>
<tr>
<td>Ricardo internal guidance on analysis of implementation with respect to requirements</td>
<td>Reference document for Ricardo engineers on the task of model checking an implementation against formal requirements.</td>
<td>Reference for a key-step in our MBAT workflow; link to MBAT method “analysis first, then test” / “model and analyse early”.</td>
<td>First draft written</td>
</tr>
<tr>
<td>Ricardo internal guidance on back-to-back testing</td>
<td>Reference document for Ricardo engineers on the task of assuring generated code matches the implementation model.</td>
<td>Back-to-back testing supports our MBAT workflow by allowing analysis &amp; testing to concentrate on the implementation model.</td>
<td>First draft written</td>
</tr>
<tr>
<td>Ricardo internal work instruction: B2B testing with BTC-EmbeddedTester</td>
<td>Quick start guidance on performing back-to-back testing.</td>
<td></td>
<td>First draft written</td>
</tr>
<tr>
<td>Ricardo internal guidance on testing of implementation with respect to requirements</td>
<td>Reference document for Ricardo engineers on the task of automatic testing of an implementation with respect to requirements, with test criteria and stimuli derived from formal requirements</td>
<td>Reference for a key-step in our MBAT workflow; link to MBAT method of “joint input constraints for analysis &amp; test”</td>
<td>First draft written</td>
</tr>
<tr>
<td>Ricardo internal work instruction: ModelAdvisor MBAT checks</td>
<td>Quick start guidance on using some basic analysis checks.</td>
<td>Describes simple static analysis checks to complement our MBAT approaches (e.g. to use analysis to find certain problems before testing); link to MBAT method “analysis first, then test”.</td>
<td>Currently being written</td>
</tr>
</tbody>
</table>
3.4.2 Siemens

Rainer Ersch from Siemens is very active in the OSLC community, which is the basis of the ARTEMIS IOS (Interoperability Specification). This is part of the training exercise addressed already in 3.1, MBAT RTP, and the material is public. It is clearly related to MBAT IOS as OSLC is a centerpiece of the IOS but not solely MBAT work, many groups and initiatives have contributed. He presented it at an internal ProSTEP iViP Workgroup Meeting November 2013 and at the IHK Conference about Lifecycle Management (http://www.continuouslifecycle.de/agenda.php). The presentation at the ARTEMIS Standardization Workgroup meeting in Vienna, Sept. 16, is described in the Dissemination Deliverable D_WP_0.3_4_2 and the MBAT Newsletter #4.

Title of the presentation:
Open Services for Lifecycle Collaboration / What if integration came standard?

By Rainer Ersch, Siemens AG

Contents of the presentation: (see Annex I)
Technical overview and History / Status / next Steps of OSLC
OSLC is a centerpiece of the MBAT IOS; promoting this standard at different events and with different organizations will help to foster the idea of an general recognized and relevant IOS.
3.4.3 BTC – ES

BTC has the following internal courses for engineers, influenced by MBAT work and for their tools used and integrated within MBAT:

"Training BTC EmbeddedSpecifier"
Dr. Udo Brockmeyer, BTC-ES

"Training BTC EmbeddedTester"
Dr. Udo Brockmeyer, BTC-ES

"Training BTC EmbeddedValidator"
Dr. Udo Brockmeyer, BTC-ES

"Training IBM Rational Rhapsody TestConductor"
Dr. Udo Brockmeyer, BTC-ES
## 4 Abbreviations and Definitions

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBAT</td>
<td>Combined Model-based Analysis and Testing of Embedded Systems</td>
</tr>
<tr>
<td>ARTEMIS</td>
<td>Advanced Research and Technology for Embedded Intelligence and Systems (European Technology Platform and JU (Joint Undertaking))</td>
</tr>
<tr>
<td>EPoSS</td>
<td>European Technology Platform for Smart Systems Integration</td>
</tr>
<tr>
<td>ETP</td>
<td>European Technology Platform</td>
</tr>
<tr>
<td>ECSEL</td>
<td>Electronic Components and Systems for European Leadership (new JTI starting 2014)</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IFIP</td>
<td>International Federation for Information Processing</td>
</tr>
<tr>
<td>IOS</td>
<td>Interoperability Specification (for ARTEMIS RTP)</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>JTI</td>
<td>Joint Technology Initiative</td>
</tr>
<tr>
<td>MOGENTES</td>
<td>Model-Based Generation of Efficient Tests for Critical Embedded Systems</td>
</tr>
<tr>
<td>OSLC</td>
<td>Open Services for Life Cycle Collaboration</td>
</tr>
<tr>
<td>ProSE</td>
<td>Promoting Standards for Embedded Systems</td>
</tr>
<tr>
<td>RTP</td>
<td>Reference Technology Platform</td>
</tr>
<tr>
<td>SRA</td>
<td>Strategic Research Agenda</td>
</tr>
</tbody>
</table>
5 References

[ARTEMIS, 2011, 2013] ARTEMIS Strategic Research Agenda; ARTEMIS publication December 2011, Update and Addendum 2013


6 Annex I: Siemens OSLC Presentation

Open Services for Lifecycle Collaboration

What if integration came standard?

Rainer Ersch
OSLC Steering Committee Member

Nov. 2013

Table of Content

- Motivation
- The Integration Problem
- OSLC Principles
- The History / Status / next Steps of OSLC
Motivation

- Today’s products are getting more and more complex
- Different engineering disciplines need to work together
- The different roles in the engineering process are using highly specialized tools
- New engineering methods and technologies have to be adopted
- Legacy engineering methods have to be kept and integrated
- The components for the engineering environments are provided by:
  - Different vendors
  - Open source projects
  - In-house development

The Integration Problem

- Point-to-point Integrations don’t scale
- Monocultures lock you in
- Maintenance, management, and change costs go up over time
- Ongoing and unexpected costs drain resources
- End-user productivity suffers
- Integrations consume more of the IT budget
- Integration failures are the top 2 causes of software project delays
- Even more: limited ability to respond to change
- Constrained by exhausted IT budget and lower productivity

*Commissioned study conducted by Forrester Consulting.
The Basics: What is OSLC?

Open Services for Lifecycle Collaboration (OSLC) ... 

... is an open community to define a set of specifications that enable the integration of lifecycle development products and services 

... is a Member Section of the open standardization organization OASIS (http://oasis-oslc.org) 

... is build on the W3C Resource Description Framework (RDF), Linked Data and REST, enabling integration at data level via links between related resources 

... specifies user interface techniques to enable preview, creation and selection of links 

... defines resources in terms of RDF properties 

... uses HTTP to perform resource operations.

The Basics: why should I care?

- create software using reusable and open assets that will interoperate with other tools both inside and outside your influence providing time and cost savings

- reduce the complexity and risk of increasingly complex software infrastructures, and improve the value of software across a broader set of internal and external stakeholders

- choose the best tools for your job and have them interact seamlessly to achieve traceability and visibility with the rest of your organization

- focus energy and resources on higher-value customizations, deliver more business value to your clients, and increase client satisfaction

OSLC is beneficial to many stakeholders

Contributing Organizations: http://oslc.co/organizations
OSLC’s Simple Solution
Users can work seamlessly across their tools

- Federated Systems
- Linked Data
- Architecture of the Web
- Linked Lifecycle Data (OSLC)
- Automation
- Monitoring
- Linked Management
- Quality Management

- Keep investment
  - Non-disruptive
- Integrate data instead of tools
- "Just Enough" integration
- Increased reuse
- Better visibility
- Increased traceability
- Decreased maintenance costs

*OSLC is an open and scalable approach to lifecycle integration. It simplifies key integration scenarios across heterogeneous tools.*

OSLC Working Groups

**Summary**
- Core WG defines technology base
- Working with W3C Linked Data Platform WG (Status: Last Call)
- Performance Monitoring & Reconciliation WGs: new in 2012
- 3rd and 2nd major revisions in progress
- Re-scoped SCM WG to more general Config Mgmt
- User groups: Mobility and Embedded Systems started

**Participation**
- CESAR & other EU research project decided to base their Interoperability Framework on OSLC
- Various tool provider have joined
- Leading industry companies support OSLC

**Growing Interests beyond ALM**
- Integration Systems/PLM
- Integration Service Management / Cloud
- DevOps (within Automation today)

---

Open-Services.net
Specification Technical Components

- **Create** a resource using HTTP POST and content being resource format of choice
  - URI for doing the POST is defined in the basic:ServiceProviders in the basic:creationFactory service
- **Read** a resource using HTTP GET and standard HTTP content negotiation
  - Client uses HTTP Accept request header to specify desired resource formats
    - Accept: application/json, application/xml
- **Update** a resource using HTTP GET to get resource properties to be updated and HTTP PUT to send updated resource
  - Clients must preserve unknown content
- **Link** a resource using properties where values are just URIs:
  - Turtle format for a bug resource (abbrev)
  
```html
<http://example.com/bugs/3333> a oio:cm.ChangeRequest;
```
Specification Technical Components

Querying for resources
- Query Capability has base URI
- Clients form query URI and HTTP GET the results
- OSLC services MAY support OSLC Query Syntax http://open-services.net/rdf/View/ Main/OSLCCore/SpecQuery

Query syntax examples:
- Find high severity bugs created after April fools day
- Find bugs related to test case 31459
  http://example.com/bugs?foo=bar&q=tc:31459
- Find all bugs created by John Smith
  http://example.com/bugs?foo=bar&q=creator:foo\&givenName=John\&familyName=Smith

Open-Services.net

Specification Technical Components

Resource representations
- OSLC services should handle any type of resource
  - Not just those defined by OSLC domain specs
- Resources defined by OSLC use a RDF data model
  - therefore are simply defined by their set of properties
- OSLC services MUST produce and consume RDF/XML representations
  - Clients and services MUST NOT assume any subset of RDF/XML
- Other representations are allowed such as:
  - XML: OSLC defined format that allows for consistent formats and is RDF/XML valid
  - JSON: Rules for representing namespaces and QName properties
  - Turtle: No constraints, use as-is
  - Atom Syndication Format: <atom:content> SHOULD be RDF/XML

Open-Services.net
Specification Technical Components

UI Preview & Delegation
- Rich hover:
  Scenario supported: hover over link to get in context preview of resource
- Resource Delegation:
  Simple resource format defined and retrieved using HTTP content negotiation

OSLC Sample Integration

© MBAT Consortium
Specification Technical Components

Tracked Resource Set protocol:
- Allows OSLC server to expose a set of resources
- Allows OSLC clients to discover a set of resources to track additions, removals, state changes
- Does not assume that clients will dereference the resources.
- Is suitable for dealing with large sets containing a large number of resources, as well as highly active resource sets that undergo continual change.
- Is HTTP-based and follows RESTful principles.

⇒ Almost real-time data collection into a data warehouse which enables additional analysis, reporting and structuring of the combined data
OSLC Organization

History

Status

Outlook

History of OSLC

- With development of the Jazz platform, acquisition of Telelogic and large partner integrated tools, IBM needed a integration technology for their wide range of tools
- Early ideas were presented in customer programs
- Open initiative started with IBM, customers, and other vendors in 2008
- First specification (released in 2009): Change Management V1.0
- Proof of concepts with IBM tools and home grown tools of customers

⇒ At the beginning:
  open community on the Web with no specific governance model
OSLC Community Stepping Up

OSLC at OASIS
- Internationally recognized independent SDO
- Formal support from 22 organizations (at launch)
- Participation governed by established OASIS model

Extend OSLC Eco System
- Partnering with other orgs

Steering committee
- Multi-organization steering committee established
- New governance model introduced

Community governance of OSLC

Early State:
- IBM de facto governance (with community support)

Community governance timeline:
- 2008
- June 2012
- May/June 2013

OASIS OSLC Founding Members

- accenture
- Bank of America
- Boeing
- EADS
- Eclipse
- Ericsson
- Fujitsu
- IBM
- JPMorgan Chase
- Kovair
- KTH
- Mentor
- National Instruments
- Persistent
- Red Hat
- Siemens
- Sodius
- Software AG
- Tasktop
- WSO2
- Koneksys

Open-Services.net
The OASIS OSLC Steering Committee 2013

Next Organizational Steps

- Technical Committees on OASIS
  - TCs are the future space for specification development
  - Supersede the Specification Workgroups on http://open-sevices.net
    http://open-sevices.net will remain the entry point for the community with blogs, user groups, basic information, etc.
  - With the release of OSLC Core Spec V3.0 (expected in Q1/14) by the OASIS-OSLC Core TC, OSLC becomes a real open standard

- Partnering with other organizations
  - OSLC4MDSE workgroup on OMG
  - Liaisons with INCOSE is in finalization
  - ProSTEP iViP (with CPO) is candidate
  - Others in preparation
OSLC Eco System

- Scenario-driven & Solution-oriented
- Leading choice for strategic integration technology
- Generally applicable specs available for many domains covering ALM, DevOps, ISM, and PLM

W3C WORLD WIDE WEB CONSORTIUM
Linked Data Platform Working Group

OASIS
OSLC Member Section

Eclipse Lyo
Enabling tool integration with OSLC

Reference Implementations, SDK, examples
Open and Independent Governance and Leadership

OSLC:
- Inspired by the web
- Proven
- Free to use and share
- Open
- Changing the industry
- Innovative

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Leverage the growing industry impact of OSLC

Open Services for Lifecycle Collaboration
Lifecycle integration inspired by the web

OSLC Steering Committee
Founding members: Accenture, Creative Intellect, EADS, Siemens, Tasktop, and IBM

- Integrate over 40 tools natively and through third-party adapters
- Foundation for major Interoperability projects
- Deepening and expanding scope
- Leading choice for Strategic Integration Technology

Eclipse Lyo
Enabling tool integration with OSLC

OSLC4U spec form for OSLC Core, CM, QM, & AU

Lyo makes OSLC integrations easier
- SDK, test suites, and reference implementations
- Java (OSLC4U) library; recent Perl contributions
- Pending community contributions for .NET

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Thank you for your attention