

TOPCASED results and benefits

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Abstract: We will described in this paper the TOPCASED project progress and a synthesis of its results and already known benefits. The first part of the paper give an overview of the project history and its main event since 2005. Then we present the TOPCASED results in term of tools, usage, dissemination, partenarial point of view and national and international recognition. We also list all thesis subject developed during the project and some general papers.

Keywords: **Model Driven engineering, Tols, Framework, Eclipse**

1. History

Effective start: The project partners have started work on their own investment once the french Aerospace Valley cluster qualified it in July 2005. The outline of the project organization was established with a steering and a technical committee.

Official launch: Funding for the project was finalized by the french Department of Industry and the region in August 2006

First major release: In July 2007 Version 1.0 TOPCASED comes on the forge of the project. It contained:

- a first version of the framework based on version 3.3 of the Eclipse framework.
- SAM, UML, SysML, Ecore editors
- the generic tool change management GPM

This allowed to start the first experiments on simple cases to reach the level of TRL4 publishers

Second version: In July 2008 version 2.0 TOPCASED comes on the forge. It contained:

- developments of the framework based on version 3.4 (Ganymede) of the Eclipse framework,
- developments of the editors,

- a first version of the documentation generator,
- early versions of some verification tools such as checking engine of OCL and initialization of generic simulation engine.
- "Ski" Ecore editor in the Eclipse Foundation "Ecore Tools"

This version has run a more representative cases of industrial representative in order to achieve the level TRL5

Third Version: In July 2009 Version 3.0 TOPCASED comes on the forge of the project. It contained a full version of technology to support a process ModelBased including more advanced versions of the tools of Version 2.0 functionality requirements management in the models. It is based on version 3.5 (Galileo) of the Eclipse framework. This version has achieved a level of TRL6 publishers and transverse activities and especially the decision to use for the development of the A350 program.

Extension of the project it was decided by mutual agreement a one-year extension of the project to finish the thesis in progress.

Fourth version: In July 2010 version 4.0 TOPCASED comes on the forge of the project. This included an overhaul of the documentation generator and an extension / standardization of requirements management in the models. It is based on version 3.6 (Helios) of the Eclipse framework. This version has even more to continue to deploy the tools on real industrial projects and pilot projects more oriented research.

In July 2011 we delivered the **Fifth version** of TOPCASED on the forge of the project. It will contain, among other things an overhaul of the UML / SysML editors from work and convergence between TOPCASED and Papyrus project in the MDT-Papyrus project of the Eclipse Foundation. It will be based on version 3.7 (Indigo) Eclipse.

2. TOPCASED results

Since 6 years the project deliver several major version of tools, the last was the 5.0 in July 2011.

These versions are always eagerly awaited by the community as we can see a steady rate (for 2 years now) of 6000 downloads per month by industries and laboratories in the world (in various domain of application) and a significant increase of downloads when we made available to new versions. These developments, dissemination and relations with users are conducted through a collaborative infrastructure and a website: Forge TOPCASED located in the premises of the site including ENSEEIHT : <http://www.topcased.org>.

2.1. Tools components

TOPCASED versions include :

- different model editors developed using an optimised approach through the TOPCASED generative framework based on meta-models technologies : TOPCASED/SysML, TOPCASED/UML, TOPCASED/AADL, TOPCASED/SAM.
- different transformation languages and technologies (ATL, Acceleo, QVT ...) which are currently well-known by partners as well their usage domain. Several transformation tools was developed : Models to models, models to text (code, documentation, test)
- basic components in the chains of model checking: the language used FIACRE pivot between high-level languages (AADL, SAM, SysML / UML) and formal verification environments (TINA, CADP, SIGNAL, OBP ...), some translators to / from these languages, simulation models infrastructure, modeling rules engine (OCL Checker).
- Tool supporting transversal activities : version/configuration management, changes management, requirements management. These tools are based on respectively Subversion, a generic tool to manage modification processes (gPM) and a requirements traceability engine (Tramway)
- Coding environments enhance or totally developed in TOPCASED for C, Ada and VHDL.

2.2. Quantitative results

The first quantitative results are :

- 500 students trained as part of university education and engineering schools (master 1 and 2): INSA, ENSEEIHT, IUP UPS, Master Yaoundé, Ecole des Mines de Nantes, Polytech, IFSIC (Rennes) ENSIETA, University of Sigapour, Virginia tech, Beihang University Beijing, Université de Pau et des pays de l'Adour;
- Twenty industrial projects using the TOPCASED components;
- Thirty jobs created (CDD and CDI) related to the existence of the project results and their maintenance, and saved the equivalent of employment in developing skills on tools and technologies TOPCASED;
- 1 Million of source line (without comments) developed; and 1 Million of documentation line. Statistics of the projet could be found here : <http://www.ohloh.net/p/topcased/analyses/latest>;
- 50 developers on all TOPCASED components;
- 6 commits by day since 5 years;
- 4M€ of turnover (2008/2009) for the TOPCASED partners which developed services;
- 300K€ of recurring costs on licence fees.

2.3. Dissemination

Articles/Papers

TOPCASED was and will annually presented / represented in the national conferences such as ERTS2 or international Neptune, AFIS, INCOSE, Models, DASIA, Ada'Europe, Eclipse'Time, Eclipse'Summit, Eclipse'Con These presentations, the quality of representatives and the work led to recognition in this field of the "TOPCASED Guys."

Relationship with the Eclipse foundation

Three TOPCASED components are now integrated (or at a based of a components) in the Eclipse Foundation: Ecore Tools, EMF Search, MDT-Papyrus (UML modeler).. "

Industrials projects

The first deployments of TOPCASED on actual developments are underway:

- TOPCASED / SysML / UML:
 - Atos group,
 - CS Communication & Systems,
 - Rockwell Collins (Target A350)
 - Astrium (target satellites),
 - CNES
- TOPCASED / SAM GenDoc, OCL Checker (verification of modeling rules), EMF Search (search models), GPM (Change Management), code development environments (C, Java, Ada, VHDL) on legacy and A350 program, on different R&D projects at Airbus.

These usages are only the main ones in the perimeter of the Topcased Partners.

We can add several others usage at Alstom, Eurocopter, Rolls Royce Nuclear, Eurocontrol, Altran, Safran Engineering, Intecs.

Research projects

Several national research projects and/or Europeans use the project results TOPCASED: Spacify, ISTAR, DOMINO, MOPCOM-SOC, SPEED ...

Project results were incorporated into the ANR platform OpenEmbeDD and the ARTEMIS one CESAR.

Usage in Academics and school

Out of the scope of the consortium partnership we can say that TOPCASED is used in a lot of laboratories and school, We list here a short list of known users : NIST, Fraunhofer, Un Dresde, Brest, INSA-Lyon/Toulouse/Rouen, Georgia Institue, MIT, SEI, Univ Newcastle, Ecole Valaisienne, Mines Ales, Lycées Ac. Versailles, Univ. Strasbourg, carleton, Clemson ...

2.4. Partnership aspects

TOPCASED is a project where partners collaboration is essential to obtain strong results. Throughout the project, the steering committee wanted to expand this partnership to include new skills: more than 30 partners are working together

around a shared goal. This means that 11 organizations (academic and industrial SMEs) integrated the project during its developmen on their own specific investments.

The various key players in the project and their roles are:

- **embedded systems industrial** whose using their strong experiences in the development of critical systems provide needs, participate in technical decisions and developments, validate products: Airbus and Astrium from EADS, CNES, Continental, Thales Aerospace, Turbomeca, Rockwell & Collins.
- **Service companies** partners of these industrials both express their needs, participate in the validation of results but also bring their expertise in implementing tools: CS Communication & Systems, Sopra, Atos-Origin, Akka Silogic.
- **SMEs** that provide, through their high added value, expertise in key technology choices and implementation: Anyware Technologies, Micouin Consulting, Tectosages, OBEO, AdaCore, Geensys, Clearsy.
- **Research laboratories** which both conduct preliminary studies on the major choices using formal semantic foundation guarantees the opening of the workshop and also provide tools / techniques from previous work: INRIA (Units research of Rennes, Nantes and Rhône-Alpes), IRIT-CNRS, LAAS-CNRS, ONERA-DTIM, the CEA, the Lip6 and SEI (Software Engineering Institute).
- **Schools and universities** are participating in the effort to research and development, ensure the dissemination of knowledge related to the tools developed and the methods used, and finally host the project sustainable through their IT infrastructure: ENSIETA in Brest, ENSEEIHT, ESEO in Angers, INSA de Toulouse, University of Paul Sabatier in Toulouse, UFSC (University of Florianopolis) Brazil, Telecom Paris-Tech, University of Pau and the Adour countries, University of Toulouse Mirail.

Transfers occur between these different actors to facilitate the dissemination and tools sustainability, thesis (with or without CIFRE contract) elaborated, many work placement support some of achievements and student training.

2.5. National & International recognition

Beyond the original circle of partners (those funded under this contract) and the 'integrated' partners, thanks to the actions of dissemination and quality of these tools, TOPCASED is now recognized not only nationally but also worldily. An example of this recognition is the program TOPCASED Days, it is also possible to see the status of the download tools here: <http://admin.gforge.enseeiht.fr/cgi-bin/awstats.pl>.

This worldwide recognition was one of the project goal consistent with the mission of the Aerospace Valley cluster.

In the french area :

- as part of the fifth meeting of the observatory of the relationship between large companies and innovative SMEs, held Jan. 22, 2009 by the IE Club: Anyware Technologies and Airbus won the prize of the observatory in the "productivity" range for their collaboration in the Topcased project based on the open source platform Eclipse™
- in the "assises de l'embarqué", TOPCASED was nominated for awards in the 2009.
- The TOPCASED Project received the 2011 Aerospace Valley Trophy due to its significant obtained results and the already effective and expected fallout. TOPCASED will be put in the honour during the Bourget Air show at the Aerospace Valley pavillon.

2.6. Perspectives

Technically, there is still work to integrate verification models tool chain in the workshop and improve some components already deployed to gain in maturity (research is still ongoing on this subject).

These improvements will be made based on feedback from real projects, but also various experiments in progress.

Work is coming with the aim to integrate tools within TOPCASED : mecatronic modeling LME tools, Scilab/Xcos and SCADE Environment around the AgeSys project.

We also work in the frame of the OPEES project (ITEA) to ensure the sustainability of TOPCASED tools by the creation of a very long term support service and organisation. This organisation will be integrated in an Eclipse Industrial Working Group named Polarsys. See here for more details : : http://www.eclipse.org/org/press-release/20111102_polarsys.php and <http://wiki.eclipse.org/Polarsys/Proposal>.

The international industrial community now knows the TOPCASED project, in particular French, German and American industries. To ensure and establish a little more recognition we are in discussion with the U.S. aircraft industry (Boeing, Rockwell & Collins, ...).

in the economic area, jobs have already been created (see the quantitative data above) on the development and maintenance tools. Service companies, SMEs project partners are beginning to argue for significant turnovers proving a non-utopian business model in the medium and long term.

Based on the results of the downloads, the good international recognition today, we believe that the position of the project partners to come on the market offers excellent prospects both nationally and globally.

That is why the steering committee decided to organize an international conference to promote the exchange of users and provide better visibility into our work. The call for paper launched in September 2010 has received about 35 proposals from France, Italy, Germany, Brazil and the United States. We decided to accept all bids by organizing three days of presentation with parallel sessions, tutorials and round-table discussions.

This conference was held on 2, 3 and 4 February 2011 on the premises of ENSEEIHT : <http://www.topcased.org/index.php/content/view/53>.

For information and to demonstrate that the work "TOPCASED" have gone beyond the circle of the project funded, regional and France:

- 37 papers were presented :
 - 60% of the presentation was done by the original Topcased Partners
 - 19% was made by integrated partners
 - 30% was made by external organisations
 - 19% was made by non french organisations from Germany, Italie, Brazil.
- More than 130 participants
 - 80% were industrials and 20% from academics area
 - 90% were french
 - 61% from the original Topcased consortium
 - 39% from external organisation.

3. Thesis

Several thesis have been carried out under this project in relation to the various tasks :

- Benoît Combemale (IRIT-CNRS) de 09/2005 à 07/2008: "Approche de métamodélisation pour la simulation et la vérification de modèle". Prix Léopold Escande 2008 : http://ethesis.inp-toulouse.fr/view/prix/Prix_L=E9opold_Escande_2008.html Le thésard est à présent maître de conférences à l'Université de Rennes 1, intégré dans l'équipe de recherche Triskell, commune à l'UMR IRISA et au centre INRIA Renne#7
- Jean-François Rolland (IRIT-CNRS), ASTRIUM et CNES de 12/2006 à 12/2009 : "Développement et validation d'architectures dynamiques". Le thésard est maintenant embauché dans la société Atos Origin.
- Jan Stoecker (INRIA centre de Grenoble Rhône-Alpes / Laboratoire d'Informatique de Grenoble) de 09/2006 à 12/2009: "An Intermediate Model for the Verification of Asynchronous Real-Time Embedded Systems: Definition and Application of the ATLANTIF language". http://www.inrialpes.fr/vasy/Press/these_stoecker.html. Le thésard travaille actuellement dans une startup Allemande.
- Matthias Brun (ESEO, université de Nantes) de 10/2006 à 10/2010 : "Contribution à la considération explicite des plates-formes d'exécution logicielles lors d'un processus de déploiement d'applications dirigé par les modèles". <http://trame.eseo.fr/fr/menulequipe/matthias-brun>
- Florent Peres (LAAS-CNRS/Airbus) de 11/2006 à 01/2010 : "Réseaux de Petri temporels à inhibitions/permissions – application à la modélisation de systèmes de tâches temps réel".
- Lei Pi (IRIT-CNRS ONERA) de 09/2006 à 07/2010 : « Langages de description d'architecture sémantique et analyse comportementale ». Le thésard est actuellement embauché par la société AdaCore.
- Matthieu Giorgino (IRIT-CNRS) Thèse en cours depuis 09/2008 : « Méthodes génératives pour assurer la correction de structures de pointeurs ».
- Damien Thivolle (INRIA Centre de Recherche Grenoble Rhône-Alpes / Laboratoire d'Informatique de Grenoble / Université Polytechnique de Bucarest) de 10/2007 à

02/2011 : "Langages modernes pour la modélisation et la vérification des systèmes asynchrones"

- Yu Ma (IRISA/INRIA) de 09/2007 à 11/2010 : "Modular verification of globally asynchronous locally synchronous (GALS) architectures in an integrated modular avionics (IMA) design framework", thèse soutenue le 29 novembre 2010.
- Bastien Amar (IRIT) de 10/2007 à 6/2011 : "Traçabilité des artefacts de modélisation dans une démarche orientée modèles – application la co-évolution de modèles", thèse à soutenir en juin 2011.
- Hanh Nhi Tran (IRIT) de 02/2009 à 03/2011 : "Etude et mise en oeuvre d'un système de réécriture de graphes attribués", post-doctorante, enseignant-chercheur à compter du 1er avril 2011 à l'ENSIETA.

4. Papers

- [Neptune'2005] P. Farail : "TOPCASED : un environnement de développement open source pour les systèmes embarqués „
- [AFIS'2006] P. Farail : "The TOPCASED Project"
- [ERTS'2006] P. Farail : "the TOPCASED project: a Toolkit in Open source for Critical Aeronautic SystEms Design"
- [DASIA'2006] P. Farail : " The TOPCASED Project - A Toolkit in Open-source for Critical Applications and SystEm Development"
- [Eclipse Time'2006] P. Farail : "Airbus et Eclipse : le cas Topcased"
- [Eclipse Summit 2009] P. Gauffillet, S. Gabel : « harden your model with OCL ». Eclipse Summit 2009.
- [Eclipse Summit 2006] P. Gauffillet : « TOPCASED an eclipse based development environment for critical systems and software ». Eclipse'Summit 2006
- [Eclipse Con 2007] D. Sciamma, P. Gauffillet : «TOPCASED modeling tools». Eclipse'Con 2007

- [Eclipse Con 2007] D. Sciamma, P. Gaufillet : «TOPCASED». Eclipse'Con 2007
- [Eclipse Con 2010] R. Faudou, R. Schnekenburger« Papyrus advent for an open source IME at Eclipse »
- [Eclipse Con 2008] D. Sciamma : « Ecore Tools a complete modeling environment for Ecore».