Grant Agreement 224442

Advancing Traffic Efficiency and Safety through Software Technology phase 2 (ATESST2)

Report type Deliverable D6.2.1

Report name Evaluation of results

Dissemination level	**PU - Public**
Status	**Final**
Version number	**1.2**
Date of preparation	**2010-06-14**

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Revision chart and history log

Version	Date	Reason
1.2	2010-06-14	Final

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1 Background and context of the ATESST2 project

List of Beneficiaries

Beneficiary Number	Beneficiary name	Beneficiary short name	Country	Date enter project	Date exit project
1(coordinator)	Volvo Technology Corporation	VTEC	Sweden	Month 1	Month 24
2	Volkswagen/Carmeq Gmbh	CAR	Germany	Month 1	Month 24
3	Centro Ricerche Fiat S.C.p.A.	CRF	Italy	Month 1	Month 24
4	VDO Automotive AG	CONTI	Germany	Month 1	Month 24
5	Delphi/Mecel AB	MEC	Sweden	Month 1	Month 24
6	Mentor Graphics Hungary KFT	MGH	Hungary	Month 1	Month 24
7	Commissariat a l'Energie Atomique	CEA	France	Month 1	Month 24
8	Kungliga Tekniska Högskolan	KTH	Sweden	Month 1	Month 24
9	Technische Universitaet Berlin	TUB	Germany	Month 1	Month 24
10	University of Hull	UOH	UK	Month 1	Month 24

1.1 Challenges for the ATESST2 project

The main purposes of model-based development are to provide formal system descriptions that support communication among designers and stakeholders, system documentation and information management, systems analysis (verification, validation and certification), and synthesis (generating and reusing solutions). Model based development is an area where further research was needed to meet the challenges of cooperative active safety systems. The focus of ATESST2 was to adequately meet the engineer's needs regarding methodology and management of engineering information, and based on this to support systematic and cost-efficient development and V&V.

For the ATESST2 project the following challenges were identified [1]: a) managing the complexity of designs, for example handling failure scenarios and interacting behaviours, b) simplifying safety assessment and improving safety, and c) making successful tradeoffs between quality attributes, e.g. the high availability required, and associated costs, e.g. in terms of investment in infrastructure, replication of sensors etc.

1.2 Project objectives for the ATESST2 project

Based on the challenges above, the following concrete objectives for the ATESST2 project were derived [1]:

O1: Identify and compile stakeholders' needs on an *architecture description language* for development of *cooperative active safety systems*.

O2: Harmonize the structural descriptions of EAST-ADL with the latest evolutions of existing approaches, i.e. the AUTOSAR initiative, the OMG (UML2, UML profile for MARTE and SysML) and with the SAE AADL. This will be the back bone onto which further language constructs can be attached. ATESST2 results will be concretized in a new major release of the EAST-ADL.

O3: Develop requirements and V&V capabilities to deal with *cooperative active safety systems*. In particular, the V&V aspects of the interaction between the *embedded real-time system*, its environment and the application will be further investigated. Safety related requirements for such systems will be addressed and a way of supporting a *safety case* will be fully incorporated into the language.

O4: Develop adequate behavioural modelling for EAST-ADL. The purpose is to capture behaviour (including non-desired behaviours) and algorithms of the vehicle systems and its environment, forming the *cooperative active safety system*. This includes developing a native behavioural notation that allows simulation and verification within the defined system model, providing the ability to assess desired as well as emerging systems behaviours.

O5: Develop and adapt analysis techniques suitable for assessing safety, reliability, performance and cost, including their trade-offs for *cooperative active safety systems*.

O6: Improve the support for *field operational tests* by providing explicit descriptions of desired behaviours, test-cases and test results. This has the potential to enhance the planning, execution and evaluation of field-operational tests. Further, it would reduce the need for a large amount of testing that instead can be covered by model-based simulation and analysis.

O7: Investigate, develop, and validate language mappings to Mathworks' Simulink, Safety analysis and other relevant domain-specific modelling tools. This will enable realization of interfaces between external tools and an EAST-ADL tool environment, which in turn will enable V&V of EAST-ADL models using those tools.

O8: Develop support for reuse and variability management, especially user support for single product configuration with regard to safety aspects together with the possibility to describe configurations of *cooperative active safety systems*. Identified language constructs will be added to EAST-ADL.

O9: Develop methodology and guidelines supporting end user application of the ATESST2 concepts. This is necessary to ensure that end users apply the concepts according to the same principles.

O10: Define a language implementation in the form of a UML2 profile and promote it as a standard. The ATESST2 project aims at making the UML profile for EAST-ADL a standard appendix of the incoming new standard for RT/E called the UML profile for MARTE.

O11: Develop tools realizations, including an experimental tool, based on the Eclipse framework, as well as the investigation of the support possible through standard UML tools by use of the UML2 profile implementation. Interfaces to external domain tools will be developed for the experimental tool.

O12: Develop automotive system application examples for *cooperative active safety systems* that can be used to validate and demonstrate the *architecture description language*, tool and methodology developed in the ATESST2 project.

2 ATESST2 results framework and external factors likely to affect success

To meet the ATESST2 objectives, modelling techniques have been developed to facilitate an improved design process for cooperative active safety systems. These modelling techniques were concretized in terms of a modelling language, tools, and methodological support. The starting point in this development was EAST-ADL, an automotive architecture description language originally developed in the ITEA project EAST-EEA and EAST-ADL, an extended version of the language developed in the ATESST project.

ATESST2 extended EAST-ADL with new concepts for supporting modelling of cooperative active safety systems, in particular dealing with the challenges mentioned in chapter 1.1. An open source prototype tool Papyrus, developed in the ATESST project, continued to provide the support platform for EAST-ADL. The prototype tool is based on the open source Eclipse framework. Within this environment, specialized plug-ins were developed in the ATESST2 project implementing the extensions to the EAST-ADL profile and delivered new functionalities.

The ATESST2 project based its results on ATESST and EAST-ADL Therefore this chapter briefly describes this architecture description language and the ATESST2 approach:

The architecture description language EAST-ADL

To master complexity abstraction of the design is essential. An architecture description language can be used as a means to describe a complex design on different abstraction levels. The EAST-ADL is thus structured into several models representing the system on abstraction levels, each defining a type of architecture in its own right.

The most abstract models describe the electronic features of a vehicle and all resulting variants from a customer's point of view. These abstract models are then realized as abstract functional definitions of the electronic features. The functional definitions include interfaces and behaviour, redundancy and intended allocation. Hardware and middleware is described at a detail level sufficient to allow preliminary analysis of allocation decisions and understand the behaviour of the embedded system together with its environment. AUTOSAR concepts describe the more concrete hardware and software architectures. AUTOSAR is already the de-facto standard for automotive software, which means that the EAST-ADL relies on AUTOSAR for the representation of binaries, communication frames, SW configurations, etc.

EAST-ADL is described as a domain-specific meta model, the EAST-ADL specification. The EAST-ADL is implemented as a UML2 profile, where certain EAST-ADL constructs relies on UML2 and others are uniquely defined as stereotypes with properties.

The EAST-ADL concepts are defined with SysML and AADL concepts as a basis. Functions, ports and connectors as well as requirements and V&V concepts are well aligned with SysML and error modelling is well aligned to AADL. The alignment of the UML2 profile to MARTE is not completed, but both MARTE and EAST-ADL has been adjusted to prepare for this.

The ATESST2 approach

The ATESST project applied the concept of specification (meta model) and an implementation (UML2 Profile) to the EAST-ADL. In the ATESST2 project both the specification and the implementation of the EAST-ADL was further extended with new and noble concepts.

The prototype UML tool Papyrus was further refined in the ATESST2 project and plugins for EAST-ADL adapts it in several ways:

- A plugin for EAST-ADL feature modelling
- A palette allows basic EAST-ADL specific editing
- A view plugin allow tree browsing of EAST-ADL models
- A variability plugin makes it possible to define, view and resolve variability

- A plugin for basic export to a safety analysis tool
- A plugin for basic exchange of Simulink models

The ATESST2 project thus provided a language specification and implementation and an infrastructure for its definition and for application in user models.

In the ATESST2 project the EAST-ADL evolved to meet the ATESST2 objectives specified above, making EAST-ADL support an advanced design process for cooperative active safety systems. To achieve those objectives the project progressed through a series of logical development steps. The technical achievements in each of those steps were as follows:

a) The engineering needs were identified for stringent development, verification and validation of automotive cooperative active safety systems.

b) The EAST-ADL was refined to meet these engineering needs, refined modelling and analysis support in the areas of requirements, safety, environment models, behaviour, variability, and reuse.

c) The EAST-ADL was aligned to concepts defined in step b with concepts of other existing standard such as AADL, the UML profile MARTE and the emerging de-facto standard AUTOSAR.

d) The extended EAST-ADL was defined in a domain language meta-model.

e) The UML profile was refined for EAST-ADL to reflect the refinement of the EAST-ADL domain language meta-model.

f) The tool support for EAST-ADL in Papyrus was extended.

g) A methodology was defined for using EAST-ADL in cooperative active safety system design.

h) Case studies were performed to demonstrate and validate the approach.

Those development steps were carried through a program of work that consisted of seven work packages.

The development steps a through h, as described above, were handled by work packages in the following way: WP2 covered a, WP3 covered b, c and d, WP4 covered e and f, WP5 covered g and WP6 covered h. The steps a through h were iterated several times during the project, with the milestones marking a completed iteration. The steps reflected the dataflow rather than temporal order of the work packages, and the steps were partly performed as parallel activities.

The ATESST2 project consortium covered core competences required for the development of described model based development methodology and technology. The project recognized that multiple competences and stakeholders were related to advanced cooperative active safety systems. It was therefore essential to identify and involve related stakeholders and specialists in the course of the project, for example to discuss assess needs, and to share experiences and case studies with related projects. As an important project part, a multidisciplinary reference group were formed including experts on

- Integrated safety systems
- Hybrid control systems
- Stakeholders representing vehicle and component developers
- Stakeholders representing road infrastructure.

The appointed participants in the reference group, and their expertise were taken from within the existing partners organization's but also included some selected external stakeholders. The reference group reviewed central project intermediate deliverables, and meets two times during the project duration to discuss the project direction and provided feedback.

Workshops were also arranged as part of WP2, for eliciting needs, and as part of the standardization harmonization efforts, making the involved communities meet and agree on a roadmap and a process for integration. The reference group was invited to provide needs and requirements for the language for the initial phase of the project.

To evaluate the language constructs and prototype tools, the realistic case studies developed in the ATESST2 project were instrumental.

3 Purpose of the evaluation

This task – 6.2 – Evaluation - aims at providing an evaluation of the ATESST2 results – the main result being the refined EAST-ADL. This evaluation report is the key product of the evaluation process in the ATESST2 project. Its purpose is to provide a transparent basis for accountability for results. It can also be used for learning, for drawing lessons and for improvement

It should be clear that this task (6.2) is closely related to tasks in WP1. WP1 deals with management of the ATESST2 project.

Also, the work on the demonstrator and example systems have been very important to illustrate what can be achieved with the ATESST2 results.

Of course, evaluations activities have been continuously on going in the project and information in many deliverables describes evaluation of ATESST2 results and is therefore partly overlapping.

4 Key questions and scope for describing ATESST2 results associated to each objective

The following sub-bullets to each ATESST2 objective are key questions and scope for describing ATESST2 result found in chapter 6. Also, the sub-bullets serve as information on limitations and de-limitations.

O1. Identify and compile stakeholders' needs on an architecture description language for development of cooperative active safety systems.

- D2.1 Needs and requirements
- Requirements follow-up per WT and objective

O2. Harmonize the structural descriptions of EAST-ADL with the latest evolutions of existing approaches, i.e. the AUTOSAR initiative, the OMG (UML2, UML profile for MARTE and SysML) and with the SAE AADL. This will be the back bone onto which further language constructs can be attached. ATESST2 results will be concretized in a new major release of the EAST-ADL.

- AR M3 alignment
- AR M2 alignment
- Model based approach for DM, Documentation, Profile
- *MARTE*
- *AADL*
- *SysML*

O3. Develop requirements and V&V capabilities to deal with cooperative active safety systems. In particular, the V&V aspects of the interaction between the embedded real-time system, its environment and the application will be further investigated. Safety related requirements for such systems will be addressed and a way of supporting a safety case will be fully incorporated into the language.

- Requirements representation and tracing
- *V&V representation and tracing*
- ISO safety life-cycle support
- Error propagation
- ASIL allocation
- Cooperative active safety system

O4. Develop adequate behavioural modelling for EAST-ADL. The purpose is to capture behaviour (including non-desired behaviours) and algorithms of the vehicle systems and its environment, forming the cooperative active safety system. This includes developing a native behavioural notation that allows simulation and verification within the defined system model, providing the ability to assess desired as well as emerging systems behaviours.

- Error behaviour
- AUTOSAR behaviour?
- Execution behaviour and External behaviour composition
    - Execution semantics
    - Simulink exchange

O5. Develop and adapt analysis techniques suitable for assessing safety, reliability, performance and cost, including their trade-offs for cooperative active safety systems.

- HipHops
- *TIMMO/MAST/EDONA Timing*
- Optimization with timing look-up and customized approach to optimization variant definition
- *Optimization with regular variant configuration for optimization variants*

O6. Improve the support for field operational tests by providing explicit descriptions of desired behaviours, test-cases and test results. This has the potential to enhance the planning, execution and evaluation of field-operational tests. Further, it would reduce the need for a large amount of testing that instead can be covered by model-based simulation and analysis.

- RIF exchange
- Cooperative systems structuring

O7. Investigate, develop, and validate language mappings to Mathworks' Simulink, Safety analysis and other relevant domain-specific modelling tools. This will enable realization of interfaces between external tools and an EAST-ADL tool environment. which in turn will enable V&V of EAST-ADL models using those tools.

- Synchronous execution semantics
- EAST ADL->Simulink, Simulink->EAST ADL
- EAST ADL->HipHops

O8. Develop support for reuse and variability management, especially user support for single product configuration with regard to safety aspects together with the possibility to describe configurations of cooperative active safety systems. Identified language constructs will be added to EAST-ADL.

- Tool Support for Editing Variability Sepc & Configurations
- Tool Support for deriving resolved EAST-ADL models
- Transformation scheme for variable EAST-ADL models to HiP-HOPS
- *Configuration of safety aspects*
- *Cooperative systems*

O9. Develop methodology and guidelines supporting end user application of the ATESST2 concepts. This is necessary to ensure that end users apply the concepts according to the same principles.

- EPF model of methodology
- Document explaining the methodology

O10. Define a language implementation in the form of a UML2 profile and promote it as a standard. The ATESST2 project aims at making the UML profile for EAST-ADL a standard appendix of the incoming new standard for RT/E called the UML profile for MARTE.

- MARTE Annex
- UML Profile
- *COTS UML Profile*

O11. Develop tools realizations, including an experimental tool, based on the Eclipse framework, as well as the investigation of the support possible through standard UML tools by use of the UML2 profile implementation. Interfaces to external domain tools will be developed for the experimental tool.

- ATESST2 "Workbench" = Papyrus with profile and palette

- Exchange plugins for Simulink, HipHops, *RIF*, *CVM/EPM*
- Feature modelling, variability modelling, *variability resolution*
- Analysis plugins (MAST, HipHops,)

O12. Develop automotive system application examples for cooperative active safety systems that can be used to validate and demonstrate the architecture description language, tool and methodology developed in the ATESST2 project.

- parking brake
- steering column lock
- cruise control
- brake-by-wire
- power-assisted steering
- security system
- HAVE-IT

5 Approach and methodology

Evaluations have been on the agenda at every project and milestone meetings in the ATESST2 project. In between these meetings, evaluation of results has been an important activity in all work packages.

On the M5.5 meeting in Paris, results from the ATESST2 project were evaluated with each objective as a base. The key questions and scope, with information on limitations and de-limitat, are described in chapter 4 above. The findings per objective and ATESST2 requirements traced to each objective are described in the following chapter, i.e. chapter 6.

6 Results and traced requirements per ATESST2 objective

6.1 Objective 1

O1 Identify and compile stakeholders' needs on an architecture description language for development of cooperative active safety systems.

During the project the needs and requirements have been collected and the implementations of these have been traced. The traceability is shown with respect to: articles, deliverables and other output from the project.

Each work package has had the task to collect and trace its own needs and requirements and show how they are disseminated and reported. Each work task has also maintained a local task list with issues not connected to the overall ATESST2 needs and requirements.

A state-of-art report has been published, describing the research front edge of model based development methods and tools both in industry and academia.

Communication with an external user group have been made twice during the project and some feedback have been received, this feedback has been presented to the ATESST2 consortium

6.1.1 ATESST2 requirements traced to objective 1

Req id	Challenge id	Description
KTH-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Roadmaps and advice from the Artist community should be used as an input for the EAST-ADL refinement
WP2-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Elicitation of overall needs and requirements on the ADL
DoW-1	DOW-C#1-001, DOW-C#1-002	Requirements should be gathered on modeling technologies supporting communication and the communication technology enabling cooperative systems.
KTH-6	DOW-C#1-002	Needs from development of cooperative active safety systems shall be identified
DoW-6	DOW-C#1-002	The modeling needs for capturing product family and variability aspects shall be evaluated and refined to support cooperative systems.
DoW-5	DOW-C#1-001, DOW-C#2-001	The modeling needs for safety requirements and analysis shall be identified.

6.2 Objective 2

O2. Harmonize the structural descriptions of EAST-ADL with the latest evolutions of existing approaches, i.e. the AUTOSAR initiative, the OMG (UML2, UML profile for MARTE and SysML) and with the SAE AADL. This will be the back bone onto which further language constructs can be attached. ATESST2 results will be concretized in a new major release of the EAST-ADL.

The domain model description of the EAST-ADL language has been further formalized. The description is available as an OMG UML2 model, which is on the meta model level. This meta model conforms to OMG MOF supplemented by AUTOSAR M3 from version 3.1, this includes the use of the stereotype «isOfType», and an informal use of UML2 dependencies stereotyped by «instanceRef». Naming conventions have been established based on AUTOSAR. This allows for the EAST-ADL meta model to refer to concepts taken from the AUTOSAR meta model. The EAST-ADL meta model supplements AUTOSAR and has been controlled with regards to name-clashes and an XML Schema has been generated from the EAST-ADL meta model referring to concepts in the AUTOSAR meta model.

The formal meta model also serves as a model-based source for documentation of the language and a specification of the UML2 profile for EAST-ADL.

Alignment with MARTE was achieved by collaboration between the ATESST2 project and the ADAMS project, in which a table was produced that maps all applicable EAST-ADL meta model elements to the corresponding MARTE domain model element(s). This table is the basis for a later EAST-ADL profile implementation based on the MARTE profile. Furthermore, changes of MARTE domain model elements have been performed in order to achieve a conceptual alignment between EAST-ADL and MARTE.

Alignment with AADL was achieved based on the alignment work with MARTE as mentioned above. As the AADL standard was compared to MARTE, an overview of the EAST-ADL elements matching AADL elements is available.

Alignment with SysML was improved in the EAST-ADL meta model by naming the EAST-ADL meta model elements as the corresponding SysML element, and by referring to the SysML element in the documentation. EAST-ADL meta model elements that are directly inspired by SysML are, e.g., “Requirement”, “Satisfy” and “Refine”,

6.2.1 ATESST2 requirements traced to objective 2

Req id	Challenge id	Description
DoW-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A formalized meta-model of the architecture description language shall be developed. (including structural elements, behavioral description means, models of computations, and transformation rules to prototype tools and Simulink.)
CON-6	DOW-C#1-001	EAST-ADL should be established as a framework in which the AUTOSAR methodology can be embedded (Reason: AUTOSAR methodology does not cover the whole V-cycle – links to remaining development activities is needed).
CON-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	EAST-ADL should be established as a standard to structure and model automotive software intensive systems.
VTEC_HB-8	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001,	The Profile shall be documented in a report with selected diagrams, following the structure of the OMG specifications.

	DOW-C#2-002, DOW-C#3-001	
VTEC_HB-13	DOW-C#1-001	A strategy for AUTOSAR alignment shall be defined w.r.t. meta model and profile. For example, will an AUTOSAR profile be defined?
DoW-16	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	OMG standardization activities shall be influenced and monitored.
CEA-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Proposals shall be given to standardization bodies.
MGH-2	DOW-C#1-001	The EAST-ADL meta model (domain model) shall be compliant with the AUTOSAR meta-meta model (M3)

6.3 Objective 3

O3. Develop requirements and V&V capabilities to deal with cooperative active safety systems. In particular, the V&V aspects of the interaction between the embedded real-time system, its environment and the application will be further investigated. Safety related requirements for such systems will be addressed and a way of supporting a safety case will be fully incorporated into the language.

The ATESST2 project has been focusing on identifying and developing capabilities that effectively support requirements specification and management as well as specification and management of verification and validation artefacts within a model-based approach.

A conscious decision was made to not only consider test case specification in the V&V context but instead introduce a more general concept of V&V case, which may not only be a test case but any form of defined V&V activities such as reviews, model inspections, simulation runs etc.

The EAST-ADL language allows for explicitly modelling not only the embedded system itself, but also its environment and the interaction between the system and the environment. Therefore the EAST-ADL language provides a basis for a model-based approach towards V&V cases which fully respects the interaction between the embedded real-time system and its environment.

The EAST-ADL has explicit modelling means for dependability concepts such as hazardous events, ASIL levels and error models. Safety-related requirements are explicitly supported and can be fully connected with dependability models thus supporting modelling of a complete safety case within the language.

6.3.1 ATESST2 requirements traced to objective 3

Req id	Challenge id	Description
DoW-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002,	A formalized meta-model of the architecture description language shall be developed. (including structural elements, behavioural description means, models of computations, and transformation rules to prototype tools and Simulink.)

	DOW-C#3-001	
DoW-4	DOW-C#1-001, DOW-C#2-001	The modeling needs for capturing requirements and performing comprehensive analysis shall be identified.
WP3-3	DOW-C#1-001, DOW-C#1-002	Enhanced support for model-based requirements management shall be proposed
WP3-4	DOW-C#1-001, DOW-C#1-002	RIF interchange using an Eclipse plug-in to Papyrus shall be supported
CON-2	DOW-C#1-001, DOW-C#1-002	The ATESST2 workbench shall be extended with a plug-in supporting V&V
WP3	DOW-C#1-001, DOW-C#1-002	Language support for model-based requirements management shall be added
WP3-5	DOW-C#1-001, DOW-C#1-002	Language support for requirement views shall be added.
CRF-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Safety aspects of modeling shall be investigated and improved
MGH-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Safety aspects shall be integrated in EAST-ADL
WP3-9	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Modeling techniques shall be adapted to suite the ISO26262 standard.
KTH-1	DOW-C#1-001	EAST-ADL shall support safety aspects, error modeling, safety case, ISO26262
DoW-5	DOW-C#1-001, DOW-C#2-001	The modeling needs for safety requirements and analysis shall be identified.

6.4 Objective 4

O4. Develop adequate behavioural modelling for EAST-ADL. The purpose is to capture behaviour (including non-desired behaviours) and algorithms of the vehicle systems and its environment, forming the cooperative active safety system. This includes developing a native behavioural notation that allows simulation and verification within the defined system model, providing the ability to assess desired as well as emerging systems behaviours.

An update proposal for behaviour modelling support has been developed. The aim is to allow the language-level support for declaring behaviour attributes that are of interest for different purposes in system development in regards to modes, computations/algorithms, and execution dynamics. This includes the formalization of requirements, the specification of computation algorithms and execution dynamics of application programs, and the specification of related environmental conditions and behaviours. With the behaviour attributes declared in EAST-ADL, external

formalisms and tools (e.g., Simulink, UML, C code etc.) are still allowed to complement the behaviour definitions for analysis, function design, comprehension and communication due to technology or domain concerns. For example, varying modelling and analysis tools will be used by different automotive companies and suppliers, and in different development stages.

A study on transforming the proposed EAST-ADL behaviour model update into SPIN model for model-checking has also been performed. Similar conversion procedures can also be composed for other analysis tools, e.g., Matlab Stateflow and the real-time model checker UPPAAL.

Error modelling support has been updated with more fine-grained faults/failure semantics and enhanced alignments with dependability concepts in ISO26262 (e.g, ASIL constraint, hazard, safety requirements, etc.).

A mapping with AUTOSAR-behaviour has been developed, but not included as a part of the language, to avoid maintenance issues, and future inconsistencies with AUTOSAR.

Support for synchronous execution semantics is an on-going topic as the current language does not provide sufficient granularity for annotating (global) time and time operations.

6.4.1 ATESST2 requirements traced to objective 4

Req id	Challenge id	Description
DoW-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A formalized meta-model of the architecture description language shall be developed. (including structural elements, behavioural description means, models of computations, and transformation rules to prototype tools and Simulink.)
WP3-14	DOW-C#1-001, DOW-C#1-002	An approach for behavioral specifications suitable for the needs of cooperative active safety systems shall be defined.
WP3-2	DOW-C#1-001, DOW-C#1-002	Native behavioral modeling, transformations to commercial modeling, analysis and code-generating tools shall be supported.
WP3-15	DOW-C#1-001, DOW-C#1-002	An approach for defining desired behaviors shall be defined (for model based testing through simulation, as well as for real tests)
WP3-16	DOW-C#1-001, DOW-C#1-002	Support for simulation of cooperative systems shall be developed.
KTH-2	DOW-C#1-001, DOW-C#1-002	EAST-ADL shall support Behavior modeling
WP4-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructures-simulation monitoring capabilities to the Papyrus EAST-ADL modeling environment

6.5 Objective 5

O5. Develop and adapt analysis techniques suitable for assessing safety, reliability, performance and cost, including their trade-offs for cooperative active safety systems.

To meet the need for dependability analysis and to assess and evolve system designs with respect to safety, reliability, performance, and cost, we use the HiP-HOPS analysis tool. To support the new requirements of the ATESST2 project, the tool has been extended with a number

of new concepts, including the capability to model multiple perspectives (e.g. Hardware/Software/Middleware), new concepts to support the ISO 26262 safety workflow, particularly a novel algorithm for decomposing safety requirements in the form of ASILs, and also improved architectural optimisation capabilities. As a consequence, the internal HiP-HOPS meta model has been brought into closer alignment with the EAST-ADL meta model, thereby facilitating an interface between them by means of a newly developed model transformation plugin. The dependability analysis capabilities of the HiP-HOPS tool for use in analysing EAST-ADL models were successfully applied in a case study on an embedded software design for electric vehicles, performed in conjunction with the HAVE-it project.

Multi-perspective analysis advances the state of the art in model-based analysis by enabling an integrated dependability analysis of designs that are represented by more than one view or perspective. This is made possible by allowing fault propagation across perspectives by means of allocation relationships and using this information to construct fault trees and FMEAs that cover all perspectives in the model. To the best of our knowledge, other model-based dependability analysis techniques either use separate analyses for separate perspectives or have a single functional model that is effectively a joint representation of all perspectives, thus ignoring the separation of concerns that typically takes place in practical modelling.

To help support the new ISO 26262 automotive safety standard, the concept of hazards, safety requirements, and ASILs - automotive safety integrity levels - have been introduced to HiP-HOPS. The tool has been extended with a prototype implementation of a novel ASIL decomposition algorithm that can automatically assign ASILs to individual components, meeting the overall system safety requirements but without requiring every component in the system to meet that same requirement. We hope that this innovative approach will be able to steer interest in the ISO 26262 committee and influence the implementation of the new concepts in the standard.

To facilitate the interface between HiP-HOPS and EAST-ADL, a new plugin was created that makes use of model transformation technology. This is a more flexible approach that can be more readily adapted to changes in either meta model. In addition, HiP-HOPS was further extended to use a new XML-based input format, greatly enhancing the extensibility of the interface and allowing the use of widely available XML authoring and validation tools to ensure compatibility between the output generated by the plugin and the input file format used by HiP-HOPS.

Finally, HiP-HOPS also offers automatic design optimisation capabilities that have been greatly enhanced during ATESST2. The previous PESA-II algorithm was replaced by a newly developed variant of the NSGA-II algorithm, which is superior both in performance and in terms of results obtained. Together with the new analysis extensions described above, this introduces the capability to perform multi-objective architectural optimisation of EAST-ADL models with respect to safety, reliability, and cost. The design space to be explored can be defined by means of the variability constructs in EAST-ADL. Other optimisation objectives, e.g. timing, were also investigated.

Timing analysis is provided as a result from CEA LIST work in the EDONA project. It takes a MARTE-annotated model as input and interacts with the MAST schedulability analysis tool (from Univ. of Cantabria, Spain). An EAST-ADL model can be analyzed too, provided that additional information in the form of MARTE annotations (or stereotypes) is fed into the model. In principle this could be automated in future versions.

The timing analysis relies on two main descriptions, following MARTE approach: 1) the allocation of software functions to operating system (OS) scheduling resources (such as tasks) and allocation of these to the computing resources (such as ECUs and buses); 2) a set of end-to-end flows which describe the timing requirements (such as deadlines) on execution scenarios involving the software functions. These end-to-end flows are provided as a set of computing and communication steps which are allocated to tasks. Additional information such as speed factors, WCET or priorities complements the description. Given that, the MAST tool performs different kinds of timing analysis (depending on the chosen analysis techniques, e.g. RMA, offset-based

optimization) and results take typically the form of slacks and response time, overall and for each of the considered end-to-end flows.

6.5.1 ATESST2 requirements traced to objective 5

Req id	Challenge id	Description
DoW-4	DOW-C#1-001, DOW-C#2-001	The modeling needs for capturing requirements and performing comprehensive analysis shall be identified.
CRF-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Safety aspects of modeling shall be investigated and improved
MGH-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Safety aspects shall be integrated in EAST-ADL
WP3-9	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Modeling techniques shall be adapted to suite the ISO26262 standard.
WP5-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Model-based representation of safety-related information as required by ISO 26262, in particular safety cases.
KTH-1	DOW-C#1-001	EAST-ADL shall support safety aspects, error modeling, safety case, ISO26262
WP3-8	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Language support for error modeling compliant with HipHOPS shall be defined. HipHOPS shall be adapted to EAST-ADL basic modeling techniques.
DoW-5	DOW-C#1-001, DOW-C#2-001	The modeling needs for safety requirements and analysis shall be identified.
WP3-6	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Novel support for advanced model-based safety analysis and multI objective optimization shall be proposed
WP3-19	DOW-C#3-001	An automatic optimization algorithm will be developed assuming that such optimization is deemed to be feasible in the context of cooperative systems.
UoH-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001,	The ATESST2 workbench (Papyrus) shall be interfaced with the HiP-HOPS tool to provide safety, reliability, availability analysis and dependability versus cost optimization of EAST-ADL designs

	DOW-C#2-002, DOW-C#3-001	
UoH-4		EAST-ADL shall be extended with advanced capabilities for Safety Analysis and Optimization
DoW-12	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Methods for analysis-driven modeling and architecture evaluation in the context of EAST-ADL shall be developed.

6.6 Objective 6

O6. Improve the support for field operational tests by providing explicit descriptions of desired behaviours, test-cases and test results. This has the potential to enhance the planning, execution and evaluation of field-operational tests. Further, it would reduce the need for a large amount of testing that instead can be covered by model-based simulation and analysis.

The ATESST2 project has identified and developed several improvements for field operational testing. In the EAST-ADL language one can specify not only test cases but also desired behaviours and expected results. Since this is integrated in a fully model-based approach, it carries significant potential to enhance the planning, execution and evaluation of field-operational testing. Furthermore, the model-based approach allows for testing activities to take place much more early in the development lifecycle, i.e. when constructing the architectural and behavioural models. This helps to find errors more early resulting in significant cost benefits. Furthermore, it carries the potential to shift some of the (typically expensive) field-operational testing activities into (typically less expensive) simulation and analysis activities on EAST-ADL models.

6.6.1 ATESST2 requirements traced to objective 6

Req id	Challenge id	Description
DoW-2	DOW-C#1-001, DOW-C#1-002	Modelling constructs supporting test definition and test evaluation for field-operational test should be developed.

6.7 Objective 7

O7. Investigate, develop, and validate language mappings to Mathworks' Simulink, Safety analysis and other relevant domain-specific modelling tools. This will enable realization of interfaces between external tools and an EAST-ADL tool environment, which in turn will enable V&V of EAST-ADL models using those tools.

A plug-in for bidirectional exchange between EAST-ADL and Simulink has been developed. Compared with the plug-in developed in ATESST1, the plug-in now access Simulink models through the MATLAB API, instead of using mdl files. The contents is however stored in mdl files, which are used by the reference model mechanism in Simulink. This enables reuse of functions, so that a Function used in many FunctionPrototypes can have the same behaviour.

The HiP-HOPS exchange plug-in has been completely redesigned compared with the one developed in ATESST. The new plug-in is more modular, extensible, supports new versions of Hip-Hops and the EAST-ADL profile.

A reusable plug-in infrastructure for tool integration was developed. This was used for both the Simulink and the HiP-HOPS plug-ins. Both the plug-ins for HiP-HOPS and Simulink use the state-of-the-art model transformation language ATL (Atlas Transformation Language) to define the transformations. Using this language, the transformations are maintainable and reusable.

(See comment in O4 for synchronous execution semantics)

6.7.1 ATESST2 requirements traced to objective 7

Req id	Challenge id	Description
WP3-2	DOW-C#1-001, DOW-C#1-002	Native behavioral modeling, transformations to commercial modeling, analysis and code-generating tools shall be supported.
WP4-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructures-simulation monitoring capabilities to the Papyrus EAST-ADL modeling environment
WP4-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructure-analysis feedback in terms of architecture evaluation and design hints to the user based on the results from WP5

6.8 Objective 8

O8. Develop support for reuse and variability management, especially user support for single product configuration with regard to safety aspects together with the possibility to describe configurations of cooperative active safety systems. Identified language constructs will be added to EAST-ADL.

The EAST-ADL language has been extended significantly to provide comprehensive support for variability and reuse management. With respect to the extended objectives and intended application scenarios of ATESST2, some limitations and missing capabilities of the variability modelling concepts in the old version of EAST-ADL were identified at the beginning of the project. For example: skipping levels in the containment hierarchy of FunctionTypes and FunctionPrototypes when binding variability and propagation of values for parameterized features from higher abstraction and composition levels down to lower levels. Language constructs for solving these issues were devised and incorporated into the language.

Reuse of subsystems as well as composition of individual systems into larger aggregations of cooperative active safety systems is now specifically supported by the conception of "compositional variability". This means that a FunctionType can be provided with a variability-related interface (its public feature model) that defines the variability of this FunctionType but at the same time hides the details of how this variability is realized internally. Just as the ordinary interfaces in component-oriented engineering enable rigid reuse and composition of ordinary, invariant components, this variability-related interface now enables even variant-rich components, i.e. FunctionTypes, to be reused rigidly and composed into aggregations of cooperative systems.

Comprehensive prototypical tool support was developed to allow editing and configuring highly variable EAST-ADL models. In particular, single product configuration is supported by an algorithm that automatically generates a complete system configuration from any given

configuration of the top-level feature model on vehicle level (either the core technical feature model or a product feature model).

Modelling support for Cooperative system has been presented and necessary language changes have been suggested. Changes have been minimised and modelling principles will be presented on how modelling of system-of-systems should be performed when using EAST-ADL. The results will be presented in a Concept presentation for Cooperative systems that shows modelling principles and in the language definition where language changes are necessary.

6.8.1 ATESST2 requirements traced to objective 8

Req id	Challenge id	Description
DoW-6	DOW-C#1-002	The modeling needs for capturing product family and variability aspects shall be evaluated and refined to support cooperative systems.
WP3-11	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Enhanced model-based variability support covering cooperative systems shall be proposed
WP3-13	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A Variability support plug-in shall be developed
WP3-12	DOW-C#1-001, DOW-C#1-002	Language support for product line engineering, especially transfer of specifications, shall be added.
CON-8	DOW-C#1-001, DOW-C#1-002	EAST-ADL shall support rich reusability of models and architectures across business units.

6.9 Objective 9

O9. Develop methodology and guidelines supporting end user application of the ATESST2 concepts. This is necessary to ensure that end users apply the concepts according to the same principles.

Outcome: D5.1.1 Document and process model

The EAST-ADL is primarily an information model, but as such it is being developed with an implicit methodology in mind.

In ATESST2, the procedure to define a user model in EAST-ADL has been formalized using the Eclipse Process Framework. The result is a clickable process model that allows the user to explore tasks and work products in a proposed sequence. The model has a core flow explaining how to define a basic structural model in EAST-ADL and several extension flows explaining how requirements, dependability, variability, V&V, and behavioural modelling are applied.

The model thus defines a pattern for how to use the EAST-ADL. The tasks and work products that are the building blocks of the presented process may also be re-ordered and aligned with company-specific processes. Thus is in line with the intention from ATESST2 to make a modelling approach rather than a fixed process.

It turned out that it is difficult to capture all the parallel assessments and orthogonal concerns that are taken into account in a realistic development scenario. From this perspective, it must be recognized that the ATESST2 methodology model is not a complete recipe for automotive development. Rather, it explains what to capture with what meta model element in EAST-ADL, and a pattern for the sequencing of tasks.

From a detailed methodology documentation perspective, it turned out that the Eclipse Process Framework was difficult to apply in the context of collaboration between several partners, and that the framework itself was not ideally suited for managing several orthogonal modelling concerns.

6.9.1 ATESST2 requirements traced to objective 9

Req id	Challenge id	Description
DoW-11	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A design methodology and guidelines for system modeling shall be developed.
WP5-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Typical content of the EAST-ADL modeling layers
WP5-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Verification and Validation modeling in the context of field operational tests i.e. test planning, execution and follow-up.
WP5-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: How to define requirements, their refinement and allocation.
CON-6	DOW-C#1-001	EAST-ADL should be established as a framework in which the AUTOSAR methodology can be embedded (Reason: AUTOSAR methodology does not cover the whole V-cycle – links to remaining development activities is needed).
CAR-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Concept descriptions and examples usable for industrial dissemination shall be developed
WP5-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: The approach for modeling cooperative active safety systems, i.e. a dynamic set of vehicles interacting with each other and with the environment.
WP5-7	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001,	Guidelines shall be defined: Modeling behavior for environment characterization and system definition.

	DOW-C#2-002, DOW-C#3-001	
WP5-6	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Variant handling as a means to define dynamically changing environments.

6.10 Objective 10

O10. Define a language implementation in the form of a UML2 profile and promote it as a standard. The ATESST2 project aims at making the UML profile for EAST-ADL a standard appendix of the incoming new standard for RT/E called the UML profile for MARTE.

All along the ATESST2 project, the EAST-ADL UML2 profile has been released following the revision process of the language specification - 6 releases since the beginning of the project, from 1.9.6 to 1.10.0 as yet and a final release will follow the final revision process of the language.

The EAST-ADL language is now part of the official release of OMG profile for Modelling and Analysis of Real-Time and Embedded Systems (MARTE), since its vote and publication November 2nd 2009. An annex describes how an EAST-ADL model can be modelled via MARTE stereotypes, establishing mapping between the main concepts.

The challenges ahead are to follow this standardization path by 1) following the revision of MARTE so that updates concerning the EAST-ADL specific parts can be provided in sync with the OMG process; 2) putting it into practice by implementing the EAST-ADL UML2 profile as a sub-profile of MARTE. This latter point was at first envisioned as possible within the context of ATESST2, however owing to the extent of the changes that the language has been subjected to, the focus has been changed on providing the best possible standalone implementation of the language as a result of ATESST2, and postponing the re-engineering of the profile w.r.t. MARTE in a subsequent project.

Besides, there are ongoing discussions on how to provide a project-independent support for the EAST-ADL UML2 language implementation. This could take the form of a dedicated sub-project within the Eclipse consortium. Interest from parties inside and outside ATESST2 (for instance in external research projects which depend on the EAST-ADL language) have been shown.

A COTS UML profile version was not provided. The availability and open-source nature of the implementation support for the language (profile and palette in the Eclipse environment) enables interested tool vendors to provide their own specific implementation of the profile.

6.10.1 ATESST2 requirements traced to objective 10

Req id	Challenge id	Description
VTEC_HB-8	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The Profile shall be documented in a report with selected diagrams, following the structure of the OMG specifications.
VTEC_HB-9	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002,	Changes in the DomainModel shall be traced, to know what updates are required in the Profile. Trace needs include: new concepts, renamed concepts, updated documentation,...

	DOW-C#3-001	
VTEC_HB-10	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A release plan of the Profile shall be defined taking the dependencies between Profile, Plugins, and Papyrus into account.
VTEC_HB-11	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The rationale on UML2 metaclass selection shall be documented in the Profile definition.
VTEC_HB-12	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Differences between Profile and Domain Model shall be documented. E.g. when attributes/domain model classes have been omitted. Also the duplication of UML concepts shall be documented to facilitate tool support.
VTEC_HB-15	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Papyrus should show profile stereotype documentation (Comments) for the user.
VTEC_HB-16	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST Workbench (Papyrus) shall support showing related elements (UML and Profile related) in a UML model.
VTEC_HB-13	DOW-C#1-001	A strategy for AUTOSAR alignment shall be defined w.r.t. meta model and profile. For example, will an AUTOSAR profile be defined?
WP3-19	DOW-C#3-001	An automatic optimization algorithm will be developed assuming that such optimization is deemed to be feasible in the context of cooperative systems.
VTEC_HB-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The Domain Model shall be documented in a report with selected diagrams, following the structure of the OMG specifications.
VTEC_HB-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The Domain Model shall be synchronized and integrated with other projects, current list: EDONA, TIMMO, ADAMS...

6.11 Objective 11

O11. Develop tools realizations, including an experimental tool, based on the Eclipse framework, as well as the investigation of the support possible through standard UML tools by use of the

UML2 profile implementation. Interfaces to external domain tools will be developed for the experimental tool.

The ATESST2 workbench consists in a core support of the language, which is a dedicated version of the Papyrus UML modeller. This includes the profile implementation, a creation tool palette including support for derived properties and a creation wizard that helps user get an initial correct structure for their model. This workbench has followed the revision process of the language and has been the main modelling platform during the course of the project. It has also been evaluated and used in other external research projects – such as EDONA.

Several plugins have been developed which add functionality to this core platform. These have achieved different levels of maturity. So far, the workbench provides a support for feature and variability modelling, exchange with HipHOPS for safety analysis, exchange with Simulink to import/export structured models to/from Papyrus/Simulink, and a support for import and export to RIF (requirement interchange format) will be released by the end of the project. As part of a collaboration with external projects, support for the projection of functional design level to a preliminary Autosar architecture is available from the EDONA project (this relies on the Artop implementation for Autosar and as such is subjected to restricted access) and an export to the MAST schedulability analysis was developed and used in an experiment of multi-objective optimization. The plugin relies on the use of MARTE stereotypes to provide some of the timing information – full translation from an EAST-ADL model has not been done yet.

6.11.1 ATESST2 requirements traced to objective 11

Req id	Challenge id	Description
CAR-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Prototype-Tools (Editor, RIF and PL-Plugins) usable for initial industrial application shall be developed
CON-10	DOW-C#1-001	The ADL and tools shall support the possibility to hide certain information in a secure way.
WP3-4	DOW-C#1-001, DOW-C#1-002	RIF interchange using an Eclipse plug-in to Papyrus shall be supported
CON-2	DOW-C#1-001, DOW-C#1-002	The ATESST2 workbench shall be extended with a plug-in supporting V&V
MEC-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Experience should be gathered to identify how to model systems with graphical tools and extract information from the models.
VTEC-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A tool suite shall be defined for dissemination and concepts validation
VTEC_HB-10	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A release plan of the Profile shall be defined taking the dependencies between Profile, Plugins, and Papyrus into account.

WP4-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST2 workbench shall be augmented with EAST-ADL specific support.
WP4-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructures-simulation monitoring capabilities to the Papyrus EAST-ADL modeling environment
WP4-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructure-analysis feedback in terms of architecture evaluation and design hints to the user based on the results from WP5
VTEC_HB-15	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Papyrus should show profile stereotype documentation (Comments) for the user.
VTEC_HB-16	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST Workbench (Papyrus) shall support showing related elements (UML and Profile related) in a UML model.
VTEC_HB-17	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST Workbench (Papyrus) shall support identifying elements in the repository from elements in a diagram.
VTEC_HB-14	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The annotation way of using a Profile shall be compared with the instantiation way of working using a palette.
WP3-19	DOW-C#3-001	An automatic optimization algorithm will be developed assuming that such optimization is deemed to be feasible in the context of cooperative systems.
UoH-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST2 workbench (Papyrus) shall be interfaced with the HiP-HOPS tool to provide safety, reliability, availability analysis and dependability versus cost optimization of EAST-ADL designs
DoW-18	DOW-C#1-001	Current state-of-the-art within the modeling disciplines addressed in the project shall be identified.

6.12 Objective 12

O12. Develop automotive system application examples for cooperative active safety systems that can be used to validate and demonstrate the architecture description language, tool and methodology developed in the ATESST2 project.

Several example systems have been developed during the project. Applications include parking brake, steering column lock, cruise control, brake-by-wire, power-assisted steering and a security system. There was a close cooperation with the HAVEit project, which deals with highly automated driving technologies. The vehicle architecture defined by HAVEit has been modelled by means of the EAST-ADL, and the cruise control model has been designed according to this architecture.

The different case studies cover different aspects and different abstraction levels of the EAST-ADL, and serve as assessment and exemplary application of the project results. For example, functional safety aspects have been addressed by the cruise control case study. A complete hazard analysis and risk assessment has been performed for the cruise control system according to the ISO DIS 26262 standard. Furthermore, the cruise control was extended to a platooning scenario, where several vehicles communicate and interact, in order to jointly drive in a platoon. This example demonstrates how to model cooperative systems by means of the EAST-ADL.

The goal of modelling on implementation level in the security system was to align EAST-ADL with System and SW design, also including designs with the SAE-AADL standard.

All example systems have been modelled with the EAST-ADL, and by applying the methodology developed in WP5. That way, the case studies provided feedback regarding the applicability of the project results. Furthermore, in the cases studies the different tools developed in the project have been employed, in order to evaluate and assess them. Papyrus was used for modelling with the EAST-ADL, HipHops was used for the safety analysis mentioned above, and cvm was used for modelling variability.

6.12.1 ATESST2 requirements traced to objective 12

Req id	Challenge id	Description
DOW-13	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#3-001	Language concepts defined in the project shall be verified and validated.
DoW-14	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	An automotive system shall be modelled and analyzed
M1-WP3-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Aa common case study for a multi function system using common components shall be defined.
CON-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Pre-industrial experience of system modelling shall be demonstrated
CAR-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001,	Concept descriptions and examples usable for industrial dissemination shall be developed

	DOW-C#2-002, DOW-C#3-001	
WP2-1	?	A set of engineering scenarios shall be maintained during the project.
M1-WP3-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A common case study for a stand-alone safety critical system shall be defined.

6.13 The usage of EAST-ADL Profile in Commercial UML Tools

ATESST2 has developed dedicated support for EAST-ADL modelling in the Papyrus open source UML tool. Support includes a ”palette” which makes it possible to add UML elements complete with EAST-ADL profile stereotypes applied. The tool has also support for automatic setting of ”Derived” attributes, i.e. those that can be deduced from the underlying UML model.

To validate the use of the EAST-ADL profile in commercial tools, the EAST-ADL profile has been tested in MagicDraw and Enterprise Architect.

Enterprise architect is an excellent tool for UML modelling and has been extensively used for meta modelling in ATESST2. In fact, the EAST-ADL meta model is entirely defined in EnterpriseArchitect. However, the support for UML profiles is not sufficient to allow convenient modelling with the EAST-ADL profile.

MagicDraw has the capability to import the Eclipse UML file that represent the EAST-ADL profile. Below is an example model showing how a Functional Analysis Architecture looks with the EAST-ADL profile applied.

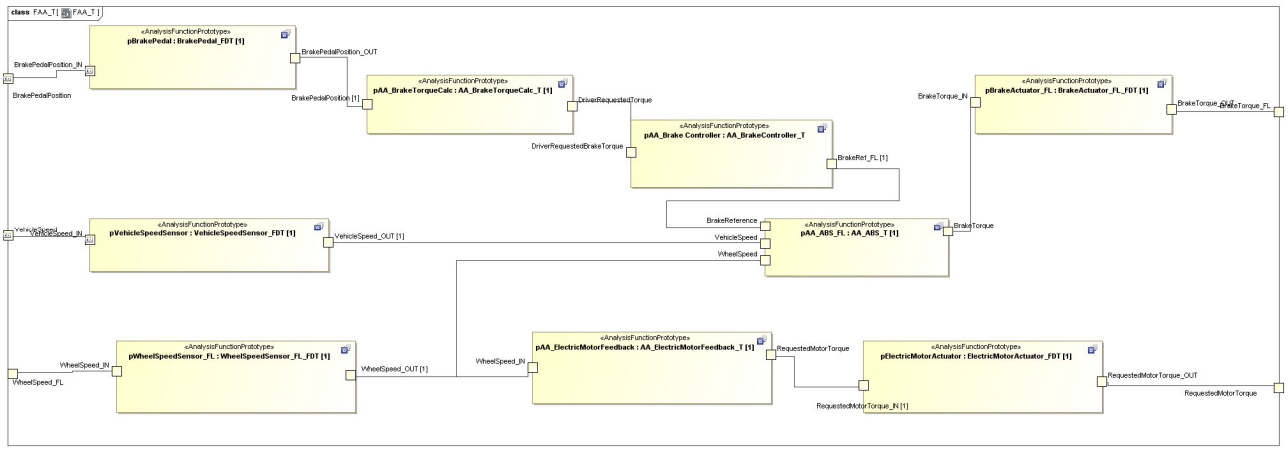

Figure 1. Functional Analysis Architecture in the MagicDraw UML tool

6.14 Evaluation of presentation material, brochure, concept presentations, and posters

Within the ATESST2 project, various presentation material have been developed including • Leaflet, posters and presentations • Publications from the project • Tutorials / examples.

In addition, project deliverables could partly be seen as part of the presentation material. All these categories are briefly assessed in the following.

• Leaflet, posters and presentations. Leaflets and posters have been updated during the project and made available on the project web. The concept presentations provide introductory descriptions of EAST-ADL concepts. They have also been provided on the web-site and have been used in disseminating EAST-ADL concepts to other projects. ATESST2 has received positive feedback for these presentations.

• Newsletters: During the final year of the project, the newsletters were restructured and developed to present EAST-ADL concepts. Their new formatting and focus have made them very useful for presenting the EAST-ADL, and since they are now also available on the web, they can easily be referred.

• Publications from the project. The ATESST2 project has yielded a large no. of publications.

Unfortunately information about the publications were not placed on the project web until April 2010 • Tutorials / examples and the demonstrator. Developing examples and tutorials that are readily accessible to various users has been a challenge due to the evolution of the EAST-ADL language itself, its concepts and the corresponding tools. A number of smaller examples have been developed internally in the project and used for project purposes, but these have not been made available openly. Some of these have been used on request in communication with external projects (for example a conceptual brake system with example models used for dissemination within the CESAR project). Currently, a brake by wire system example is being developed along with a tutorial that will be made available on the project web site. The demonstrator provides a comprehensive set of models that will be used during the final open workshop. It is currently not clear whether (parts of) the demonstrator will be made available on the project web page.

• Deliverables: Most deliverables are open and should be made available through the project web site. Unfortunately this was delayed until April 2010.

7 Evaluation considering stakeholders and issues

In the following, the evaluation considering the following stakeholders and issues are described:

- automotive industries (OEMs and subsystem suppliers)
- tool suppliers
- standardization efforts
- research and education efforts.

7.1 Evaluation with respect to adoption within automotive industries

The final evaluation elaborated the real exploitation, based on the achieved results i.e. elaborate a strategy on how to best exploit the produced results with respect to industrial practices. Many automotive companies are still mainly relying on word, excel and source code as their main means to handle complex software. Consequently, a guideline on how to introduce model based development in a step-wise manner were developed as part of work package 7. This guideline is connected to the examples and demonstrators being developed as part of Task 6.1.

The automotive partners part of the project represented OEMs (Fiat, VTEC, and VW) and subsystem suppliers (Conti, Delphi/Mecel). It should be noted that the OEMs in this case also to some extent had the role as consultants within their companies.

Specific efforts by the industrial partners are described in the following:

Carmeq/Volkswagen: As a subsidiary of Volkswagen, Carmeq is active in all areas of automotive software. Carmeq directly supports innovative development projects at Volkswagen. New methodology and results are therefore very quickly disseminated to the engineering departments and put into practice. Carmeq also provides support to automotive suppliers and in particular develops automotive production-quality software for automotive suppliers and actively participates in the AUTOSAR standardization initiative. In this context, the EAST-ADL is a strategic asset for dissemination of new methodologies and tool support.

Volvo: Volvo Technology has a strategic position in the Volvo group with a direct connection to all product companies. New methodology and results are therefore very quickly disseminated to the engineering departments and put into practice. The ongoing integration of the Volvo companies will make direct use of the engineering information support expected from ATESST2. The first step to exploitation is the internal dissemination as described in D7.1.1 Dissemination Plan

Continental: Software and function development methods will be improved by the results of the project where merging between ATESST results (EAST-ADL languages) will support the process around AUTOSAR standardization. These results will be exploited in the focus of process improvement to be considered for future family of engine management systems, chassis systems and other systems from other areas.

Fiat: Centro Ricerche Fiat S.C.p.A. (CRF) is a reference centre for the activities of innovation and research of Fiat Group, participated by the Group's Companies. CRF has a direct connection with the following Fiat Group's Companies: Fiat Group Automobiles, Iveco, Ferrari, Case New Holland, Magneti Marelli, Fiat Powertrain Technology. Starting from this strategic position in Fiat Group, CRF will exploit the ATESST2 results to the Fiat Group's Companies, focusing on the "functional safety approach". New methods and tools on the field of "safety requirements", "safety analysis", "functional safety", "suppliers relationship" are expected from the Fiat Group's Companies, the ATESST2 approach could be a useful opportunity. The first step of exploitation of the results will be an internal dissemination to promote, by means of internal workshop, the ATTEST2 results.

Delphi/Mecel: Mecel will mainly use the methodologies developed in the program and improve our own processes using these. We will also disseminate the project by internal presentations of the work and use it in educational projects.

7.2 Evaluation with respect to tool vendors

It was recognized that tool vendors were important if the EAST-ADL is to be exploited in the future. For this purpose, tool vendors were specifically targeted in the dissemination including also vendors not part of the project.

Specific efforts by the industrial partners are described in the following:

Mentor Graphics: Mentor Graphics, former VCT, has been committed to providing solutions for the automotive industry for decades and, as a result, co-operates with all major OEMs and suppliers. By means of this network, Mentor Graphics will promote the solutions provided within this project for future products. Mentor Graphics will also promote the results within in its own worldwide sales-organization.

7.3 Evaluation with respect to standardization bodies

The relation to various standardization activities was treated in Task 7.3 in the ATESST2 project. More in depth technical descriptions of related standardization approaches, as well as a description of similarities and differences of these approaches with respect to the EAST-ADL were described in the ATESST2 state of the art report

The standardization efforts that were most relevant in the respect that the ATESST2 project had the possibility to influence the forthcoming standard include

Autosar - is a partnership that involves all European automobile constructors with the objective to establish an open standard for automotive electronic and software architectures. It is expected to serve as a basic infrastructure for the management of functions within both future applications and standard software modules. The goals include modularity, scalability, transferability and re-usability considerations. Compared to ATESST2, Autosar is mainly focussed on the software architecture, software platforms, interfaces and lower level descriptions.

Activities inside the OMG real-time & embedded areas, especially with respect to the MARTE profile. UML1.x and UML2 are not directly useful for safety critical systems. The MARTE profile of the UML is addressing this and aims at defining paradigms for modelling of time-, scheduling-, and performance-related aspects of real-time systems, and also providing some support for Quality of Service and Fault Tolerance.

ISO-CD-26262 is an ISO standardization work looking at how functional safety for automotive systems should be accomplished. The International Standard is applicable to safety-related systems which include one or more E/E systems and which are installed in road vehicles and it addresses possible hazards caused by malfunctioning behaviour of E/E safety-related systems including interaction of these systems. The new ISO standard:

- provides an automotive safety lifecycle (management, development, production, operation, service, decommissioning) and supports tailoring the necessary activities during these lifecycle phases;
- provides an automotive specific risk-based approach for determining risk classes (Automotive Safety Integrity Levels, ASILs);

- uses ASILs for specifying the item's necessary safety requirements for achieving an acceptable residual risk;
- provides requirements for validation and confirmation measures to ensure a sufficient and acceptable level of safety being achieved.
- is the adaptation of IEC°61508 to comply with needs specific to the application sector of E/E systems within road vehicles.

Other related standards include the SysML, a visual modelling language for systems engineering applications, that is also planned to be a profile of the UML2 (developed in cooperation between OMG and INCOSE), and AADL. The AADL is a textual and graphical language supporting model-based engineering of embedded real-time systems. The AADL has been approved and published as SAE Standard AS-5506 by SAE in Nov 2004. From a systems modelling perspective, the AADL is more narrow in scope compared to the EAST-ADL, and for example does not contain functional and requirements descriptions. The ATESST2 project will consider the alignment of the EAST-ADL to these standards.

For Autosar and Marte, ATESST2 identified the relation between the standards and align EAST-ADL where appropriate. The effort will be disseminated to the respective community in order to provide information and influence ongoing standardization efforts.

The relation is complicated by the fact that these efforts are closed, but facilitated for ATESST2 since some of the partners are partners in these standardization efforts as follows:

Autosar: Volkswagen and Continental are core members, Volvo, FIAT and MGH are premium members, CEA is in the process of becoming members. Autosar deliverables are largely public, except for work in progress that is confidential until stable and ready for release according to an internal schedule.

CEA is a core member of the MARTE standardization work. The potential for attaching EAST-ADL to MARTE is being explored including investigation of technical issues, releases and overlap.

CRF, Volvo, and Mecel representing Delphi are members of the working group developing the ISO-26262 standard. Other partners, MGH are members of the national working groups that support the standardization process but does not attend the ISO meetings..

Thus with respect to exploitation, CEA promoted ATESST2 results at the OMG. Carmeq/Volkswagen, Conti, MGH, and VTEC, will, provided ATESST2 results are validated successfully, promote ATESST2 results within Autosar.

In addition MGH disseminated the knowledge gained from this project within other partnerships such as the LIN- and FlexRay consortia.

ATESST2 primarily acted to make the EAST-ADL de facto standard. This was because the formal standardization processes are to slow to be managed within the ATESST2 project, and because industrial acceptance can be achieved already based on the technical merits of the approach.

7.4 Evaluation with respect to exploitation with respect to research and education

The partners of ATESST2 were involved in several other research projects and likely to be involved in several more in the near future. Depending on the nature of these projects, the partners have the intention to promote the usage of the EAST-ADL in such projects.

VTEC, Carmeq/Volkswagen and Conti were involved in the ITEA project TIMMO. TIMMO developed timing modelling and analysis constructs for automotive embedded systems. AUTOSAR were used as a basis for the software architecture representation, while EAST-ADL was used to represent the higher abstraction levels. ATESST2 results were exploited by integrating the resulting EAST-ADL refinements in the TIMMO timing modelling approach.

VTEC, Conti (the French part) and CEA were involved in EDONA. EDONA seeked to develop seamless environment to supports development of automotive systems respecting AUTOSAR and ISO26262 standards. EAST-ADL was exploited by promoting it as a natural part of the EDONA solution: It supported an integrated modelling approach for engineering information from requirements to AUTOSAR models.

The University partners, KTH, TUB and UoH introduced ATESST results as appropriate within relevant courses. The precise timing of this introduction was dependent on the maturity of the results. However, results such as the state of the art survey was relevant to exploit in education at early stage. The further exploitation in education can take several forms including:

- use EAST-ADL as basis of diploma/M.Sc. theses

- use EAST-ADL as part of courses that involves ingredients on model-based development, including course on automotive software engineering and embedded control systems development.

In addition, TUB examined the potential of the EAST-ADL in other (non-automotive) domains, and if this was not feasible, investigated why this was the case. Both KTH and TUB expect that the work on developing the EAST-ADL may be the source for new research topics.

The UoH is currently commercializing HiP-HOPS, the automated safety analysis tool that is being harmonized and interfaced to EAST-ADL and Papyrus within ATESST-2 in collaboration with ITI GmBH, a German software house. New developments in HiP-HOPS, e.g. to support advanced forms of model-based safety analysis and architectural optimization were exploited via the commercial version of the tool. New developments in model-based design and safety analysis technology using EAST-ADL and HiP-HOPS were transferred to a number of active collaborations with companies in the European and global transport and space industries, which include Toyota, Denso, Ricardo, Jaguar, the European Space Agency and NASA.

8 Appendix A: Requirements and Evaluation

Req id	Challenge id	Description	Requirements Evaluation
DoW-2	DOW-C#1-001, DOW-C#1-002	Modeling constructs supporting test definition and test evaluation for field-operational test should be developed.	V&V concepts in language are described in D3.1 Appendix 3.1
CAR-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Prototype-Tools (Editor, RIF and PL-Plugins) usable for initial industrial application shall be developed	ATESST2 workbench released, see D4.3.1 for list of plugins
WP3-14	DOW-C#1-001, DOW-C#1-002	An approach for behavioral specifications suitable for the needs of cooperative active safety systems shall be defined.	The refined behavioral concepts for EAST-ADL apply to cooperative active safety systems.
WP3-2	DOW-C#1-001, DOW-C#1-002	Native behavioral modeling, transformations to commercial modeling, analysis and code-generating tools shall be supported.	Simulink plugin, see I3.4.3
WP3-15	DOW-C#1-001, DOW-C#1-002	An approach for defining desired behaviors shall be defined (for model based testing through simulation, as well as for real tests)	VVExpectedOutcome together with a behavioral definition linked via realize
WP3-16	DOW-C#1-001, DOW-C#1-002	Support for simulation of cooperative systems shall be developed.	The simulation approach for EAST-ADL relying on external tools applies to cooperative active safety systems.
KTH-2	DOW-C#1-001, DOW-C#1-002	EAST-ADL shall support Behavior modeling	An update proposal for behaviour modelling support has been developed.
KTH-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Roadmaps and advice from the Artist community should be used as an input for the EAST-ADL refinement	This input is not explicitly identified but taken into account through the partners' experience
DoW-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A formalized meta-model of the architecture description language shall be developed. (including structural elements, behavioural description means, models of computations, and transformation rules to prototype tools and Simulink.)	The variability-related parts of the domain model have been extensively reviewed and refined. D4.3.1 Simulink plugin, see I3.4.3
CEA-3	DOW-C#1-001	Results from related projects shall be integrated (EDONA, TIMMO,	First integration was our results from October

Req id	Challenge id	Description	Requirements Evaluation
		etc)	2008 with EDONA. TIMMO results integrated in October 2009.
CON-10	DOW-C#1-001	The ADL and tools shall support the possibility to hide certain information in a secure way.	Security aspects not done. Parts of a model can be exchanged.
DoW-4	DOW-C#1-001, DOW-C#2-001	The modeling needs for capturing requirements and performing comprehensive analysis shall be identified.	These needs are identified in D5.2.1
WP3-3	DOW-C#1-001, DOW-C#1-002	Enhanced support for model-based requirements management shall be proposed	D3.1 Appendix 3.1
WP3-4	DOW-C#1-001, DOW-C#1-002	RIF interchange using an Eclipse plug-in to Papyrus shall be supported	RIF Plug-in developed by CARMEQ. D4.3.1
CON-2	DOW-C#1-001, DOW-C#1-002	The ATESST2 workbench shall be extended with a plug-in supporting V&V	D4.3.1
WP3	DOW-C#1-001, DOW-C#1-002	Language support for model-based requirements management shall be added	D3.1 Appendix 3.1 and presentation/06_EAST-ADL_Requirements_and _VV.pdf
WP3-5	DOW-C#1-001, DOW-C#1-002	Language support for requirement views shall be added.	This requirement is not addressed explicitly but partly supported through the RequiremntContainer concept
DoW-11	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A design methodology and guidelines for system modeling shall be developed.	Methodology framework in EPF. D5.1.1
WP5-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Typical content of the EAST-ADL modeling layers	Concept presentations on www.atesst.org. D5.1.1
MEC-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Experience should be gathered to identify how to model systems with graphical tools and extract information from the models.	Experience is gathered through the case studies and examples
WP5-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Verification and Validation modeling in the context of field operational tests i.e. test planning,	This requirement is not addressed explicitly but D5.1.1 explains where V&V information comes

Req id	Challenge id	Description	Requirements Evaluation
		execution and follow-up.	in.
WP5-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: How to define requirements, their refinement and allocation.	D3.1 Appendix 3.1 & D5.1.1
CON-6	DOW-C#1-001	EAST-ADL should be established as a framework in which the AUTOSAR methodology can be embedded (Reason: AUTOSAR methodology does not cover the whole V-cycle – links to remaining development activities is needed).	D5.1.1
CON-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	EAST-ADL should be established as a a standard to structure and model automotive software intensive systems.	D7.3.1 Standardization plan and activities
VTEC-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A tool suite shall be defined for dissemination and concepts validation	ATESST2 workbench released; tutorial examples under-development for WP7
VTEC_HB-8	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The Profile shall be documented in a report with selected diagrams, following the structure of the OMG specifications.	D4.1.1 Profile Specification
VTEC_HB-9	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Changes in the DomainModel shall be traced, to know what updates are required in the Profile. Trace needs include: new concepts, renamed concepts, updated documentation,...	Domain model diffs were provided at each domain model integration
VTEC_HB-10	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A release plan of the Profile shall be defined taking the dependencies between Profile, Plugins, and Papyrus into account.	Release plan accessible from the Wiki
VTEC_HB-11	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The rationale on UML2 metaclass selection shall be documented in the Profile definition.	D4.1.1 Profile Specification
VTEC_HB-12	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Differences between Profile and Domain Model shall be documented. E.g. when attributes/domain model classes have been omitted. Also the duplication of UML concepts shall be documented to facilitate tool	D4.1.1 Profile Specification

Req id	Challenge id	Description	Requirements Evaluation
		support.	
WP4-3	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST2 workbench shall be augmented with EAST-ADL specific support.	D4.3.1 ATESST2 analysis workbench
WP4-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructures-simulation monitoring capabilities to the Papyrus EAST-ADL modeling environment	D4.3.1 ATESST Analysis workbench: see Simulink gateway
WP4-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Tool infrastructure-analysis feedback in terms of architecture evaluation and design hints to the user based on the results from WP5	D4.3.1 ATESST2 analysis workbench
VTEC_HB-15	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Papyrus should show profile sterotype documentation (Comments) for the user.	Will not be supported in the current 1.11.x Papyrus platform
VTEC_HB-16	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST Workbench (Papyrus) shall support showing related elements (UML and Profile related) in a UML model.	Will not be supported in the current 1.11.x Papyrus platform
VTEC_HB-17	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST Workbench (Papyrus) shall support identifying elements in the repository from elements in a diagram.	Will not be supported in the current 1.11.x Papyrus platform
VTEC_HB-14	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The annotation way of using a Profile shall be compared with the instantiation way of working using a palette.	Both ways are supported in the workbench. User feedback to be gathered from WP6 activities
VTEC_HB-13	DOW-C#1-001	A strategy for AUTOSAR alignment shall be defined w.r.t. meta model and profile. For example, will an AUTOSAR profile be defined?	D4.3.1 ATESST2 analysis workbench: see Autosar gateway; D3.1 for general alignment
DoW-16	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	OMG standardization activities shall be influenced and monitored.	D7.3.1 Standardization plan and activities
CEA-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Proposals shall be given to standardization bodies.	D7.3.1 Standardization plan and activities

Req id	Challenge id	Description	Requirements Evaluation
DOW-13	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#3-001	Language concepts defined in the project shall be verified and validated.	Several demonstrators developed with the EAST-ADL modeling technology; Deliverable I6.1.2, D6.1.1, D6.1.2, D6.2.1
DoW-14	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	An automotive system shall be modeled and analyzed	Demonstrators include parking brake, steering column lock, cruise control, brake-by-wire, power-assisted steering and a security system. Deliverable I6.1.2, D6.1.1, D6.1.2
M1-WP3-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Aa common case study for a multi function system using common components shall be defined.	Common architecture for all demonstrators according to HAVEit; Deliverable I6.1.2, D6.1.1, D6.1.2
CON-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Pre-industrial experience of system modeling shall be demonstrated	Demonstrators developed with the EAST-ADL modeling technology from the top level vehicle view to the detailed operational architecture
CAR-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Concept descriptions and examples usable for industrial dissemination shall be developed	o Demonstrators serve as example models o Concept presentations available on the website (WP7) o Modeling example available in svn\WP7\7.1\ModelingExamples
CRF-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Safety aspects of modeling shall be investigated and improved	I3.2.2 Language developments to support ISO26262 artifacts, safety case is in place.
MGH-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Safety aspects shall be integrated in EAST-ADL	D4.1.1
WP3-9	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Modeling techniques shall be adapted to suite the ISO26262 standard.	I3.2.2

Req id	Challenge id	Description	Requirements Evaluation
WP5-5	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Model-based representation of safety-related information as required by ISO 26262, in particular safety cases.	Dependability concept presentation
WP5-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: The approach for modeling cooperative active safety systems, i.e. a dynamic set of vehicles interacting with each other and with the environment.	Cooperative systems concept presentation
WP5-7	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Modeling behavior for environment characterization and system definition.	Guidelines for environment modeling are partly addressed in D3.1 Appendix 3.4
KTH-1	DOW-C#1-001	EAST-ADL shall support safety aspects, error modeling, safety case, ISO26262	I3.2.2 Dependability concept presentation
WP2-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Elicitation of overall needs and requirements on the ADL	I2_2_RequirementsDB
DoW-1	DOW-C#1-001, DOW-C#1-002	Requirements should be gathered on modeling technologies supporting communication and the communication technology enabling cooperative systems.	Partly addressed through cooperative systems model pattern
KTH-6	DOW-C#1-002	Needs from development of cooperative active safety systems shall be identified	Cooperative system concept presentation
WP2-1	?	A set of engineering scenarios shall be maintained during the project.	D6.1.2
DoW-6	DOW-C#1-002	The modeling needs for capturing product family and variability aspects shall be evaluated and rfined to support cooperative systems.	Cooperative system concept presentation
WP3-11	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Enhanced model-based variability support covering cooperative systems shall be proposed	Several enhancements of the variability mechanisms of EAST-ADL were introduced for this purpose, as will be detailed in deliverable I3.3.2
WP3-13	DOW-C#1-001, DOW-C#1-002,	A Variability support plug-in shall	The variability management framework

Req id	Challenge id	Description	Requirements Evaluation
	DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	be developed	CVM (formerly Io/VM) has been adapted and linked to EAST-ADL. See deliverable I3.3.3
WP3-12	DOW-C#1-001, DOW-C#1-002	Language support for product line engineering, especially transfer of specifications, shall be added.	The refined concepts of ProductFeature Tree and Technichal Feature Tree addresses this, D3.1 A3.3
CON-8	DOW-C#1-001, DOW-C#1-002	EAST-ADL shall support rich reusability of models and architectures across business units.	A refinement of the multi-level concepts was introduced for this, which is partly supported by the RIF plugin developed by CAR
WP5-6	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Guidelines shall be defined: Variant handling as a means to define dynamically changing environments.	In the end, the mode concept was chosen for this purpose
WP3-8	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Language support for error modelling compliant with HipHOPS shall be defined. HipHOPS shall be adapted to EAST-ADL basic modeling techniques.	Updated versions of HiP-HOPS available on SVN (I3.2.3)
DoW-5	DOW-C#1-001, DOW-C#2-001	The modelling needs for safety requirements and analysis shall be identified.	I2_2_RequirementsDB; also I3.2.2
WP3-6	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Novel support for advanced model-based safety analysis and multiobjective optimization shall be proposed	Future versions of HiP-HOPS and Papyrus plugin
WP3-19	DOW-C#3-001	An automatic optimization algorithm will be developed assuming that such optimization is deemed to be feasible in the context of cooperative systems.	Updated versions of HiP-HOPS and Papyrus plugin (I3.2.3)
UoH-2	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The ATESST2 workbench (Papyrus) shall be interfaced with the HiP-HOPS tool to provide safety, reliability, availability analysis and dependability versus cost optimisation of EAST-ADL designs	Papyrus/HiP-HOPS plugin available on SVN (I3.2.3)
UoH-4		EAST-ADL shall be extended with advanced capabilities for Safety Analysis and Optimization	New domain model releases and I3.2.2

Req id	Challenge id	Description	Requirements Evaluation
DoW-12	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	Methods for analysis-driven modeling and architecture evaluation in the context of EAST-ADL shall be developed.	EPF Methodology
WP5-8	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A handbook shall be defined to explain analysis-aided design decision making.	Handbook document
UoH-3	DOW-C#2-001, DOW-C#3-001	Analyses (Safety, reliability, availability analysis and dependability) and optimization (versus cost) of EAST-ADL designs shall support case study development	Support will be provided by new iterations of HiP-HOPS and associated Papyrus plugin
M1-WP3-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	A common case study for a stand-alone safety critical system shall be defined.	Safety case study would comprise EAST-ADL model and analysis results
VTEC_HB-1	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The Domain Model shall be documented in a report with selected diagrams, following the structure of the OMG specifications.	D4.1.1 EAST-ADL Specification. Eleven releases have been done during the project; the final delivery is in June 2010.
VTEC_HB-4	DOW-C#1-001, DOW-C#1-002, DOW-C#2-001, DOW-C#2-002, DOW-C#3-001	The Domain Model shall be synchronized and integrated with other projects, current list: EDONA, TIMMO, ADAMS...	First integration was our results from October 2008 with EDONA. TIMMO results integrated in October 2009.
DoW-18	DOW-C#1-001	Current state-of-the-art within the modeling disciplines addressed in the project shall be identified.	D2.1 StateOfTheArt
MGH-2	DOW-C#1-001	The EAST-ADL meta model (domain model) shall be compliant with the AUTOSAR meta-meta model (M3)	D4.1.1 Domain-Model Specification

9 References

[1] ATESST2: Description of Work