OETCS/WP3/Brussels/WS/Minutes

openETCS

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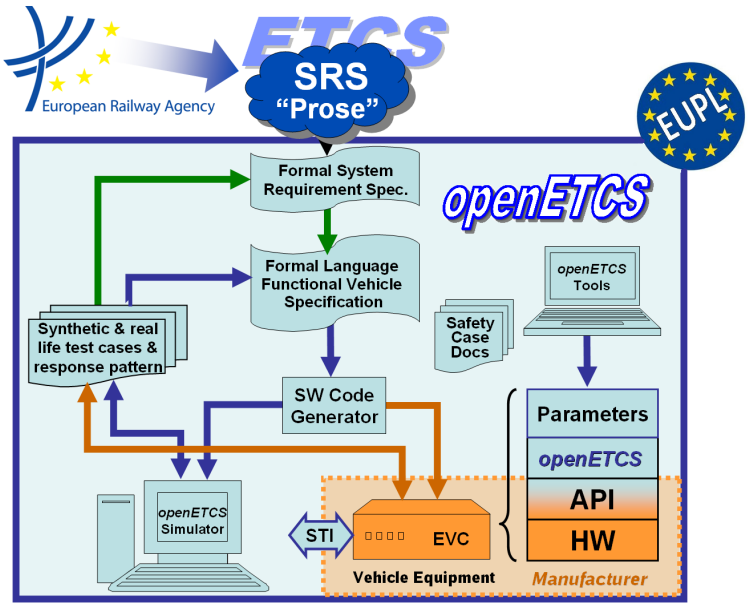
2012 – 2015

Work Package 3: “Modelling and Code generation”

openETCS Modelling Work Package

Workshop in Brussels

openETCS WP3 SRS task force and Fausto Cochetti 09 - 10 September 2014



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Work Package 3: "Modelling and Code generation" **OETCS/WP3/Brussels/WS/Minutes**
09 - 10 September 2014

openETCS Modelling Work Package

Workshop in Brussels

openETCS WP3 SRS task force
Fausto Cochetti
WP3

Minutes of meeting

Prepared for openETCS@ITEA2 Project

Abstract: This document resumes the items presented during the WP3 meeting in Brussels 09 to 10 September 2014. Venue: MAI Brussels, Rue Washington 40 - 1050 Brussels (IXELLES)

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Workshop **ITEA OPEN ETCS WP3** on 09 - 10 September in Brussels, called up by Alstom

Attendees:

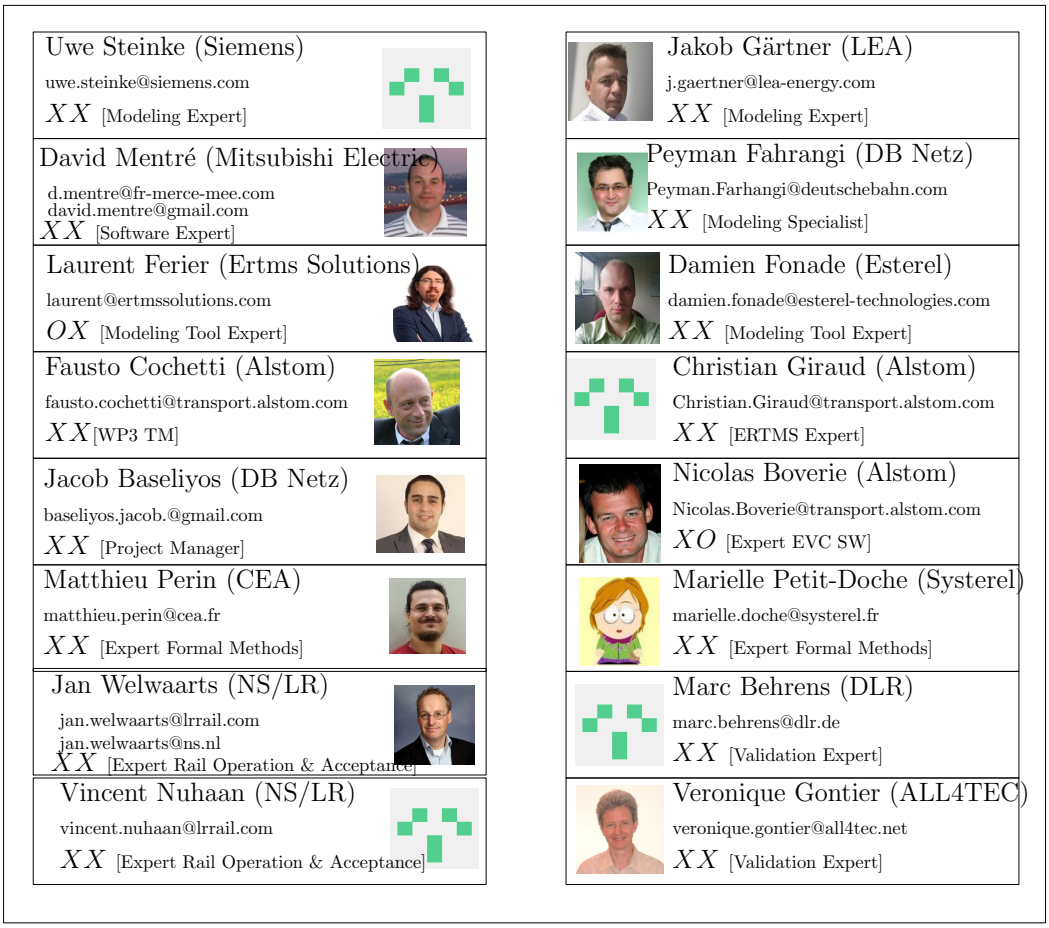

Figure 1. ***Participants around the table during the meeting***

Companies and institutes represented have been:

- ALL4TEC
- ALSTOM
- CEA
- DB
- Esterel (acting as technical support for Alstom)
- LEA (new entry : shall be subcontracted by DB)
- Mitsubishi Electric

- NS/Lyods
- SIEMENS
- SYSTEREL

0.1 Reminder from the agenda

0.1.1 first day

- Short presentation of each company/organization acting in WP3 and present at the workshop
- Presentation by Veronique Gontier (ALL4TEC) of Train Position Slides with a summary of rules and conventions applicable for establishing reference systems. The conclusions are in line with the assumptions and conventions adopted for the iteration 1 modeling.

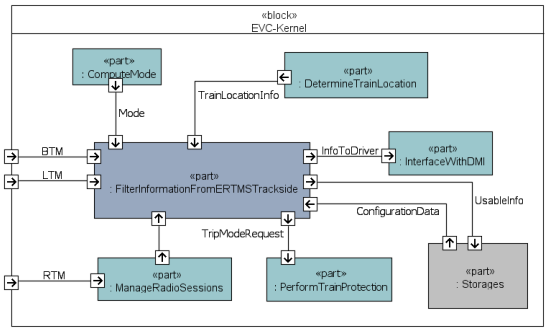

Figure 2. ***fragment from early architecture concept analysis***

- remarks and discussion on specific items e.g. implications of linking, references in SRS for balise data filtering (i.e. data discarding in specific situations). Discussion seems related to some early analysis of architecture concept (see figure 2) that was not included in the scope of iteration 1 (see figure A3) and is therefore still open and needs to be considered and covered during next iteration.
- presentation by Nicolas Boverie (Alstom) of BL3 API status and new features introduced. It was put in evidence that there will be no impact on train location and balise reading functionalities.
- presentation by Nicolas Boverie (Alstom) of "Basic Principles on Time, MMU and Balise interfaces" (illustrated only partially for time reason[1]). The full pdf presentation and a sample of MMU data (position counter and speed) with time stamp recorded from Alstom equipment are made available for evaluation.[2]

[1] presentation will be repeated during next technical meeting
[2] see excel file on same repository "samples_API_data_time_mmu_balise".

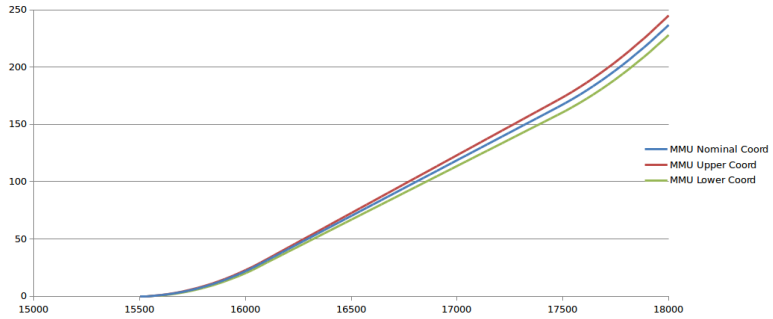

Figure 3. ***odometry plot from recorded sample***

0.1.2 second day

- presentation by Jacob Baseliyos (DB) of the general project aspects as seen from the WP1 perspective and proposal of DB to take over the lead in the task of defining a shared architecture design.

  According to this proposal the progress should be congruent with the delivery of a (one or more) release of code to WP5 to be integrated in the demonstrator software. At a given time a concept should be available to run for a "open proof validation" simulation with the demonstrator from Wp5 over the four track 30 km long Utrecht - Amsterdam line, which is equipped with a national ATP + level 2 ETCS track-side[3] equipment.[4] To be feasible this

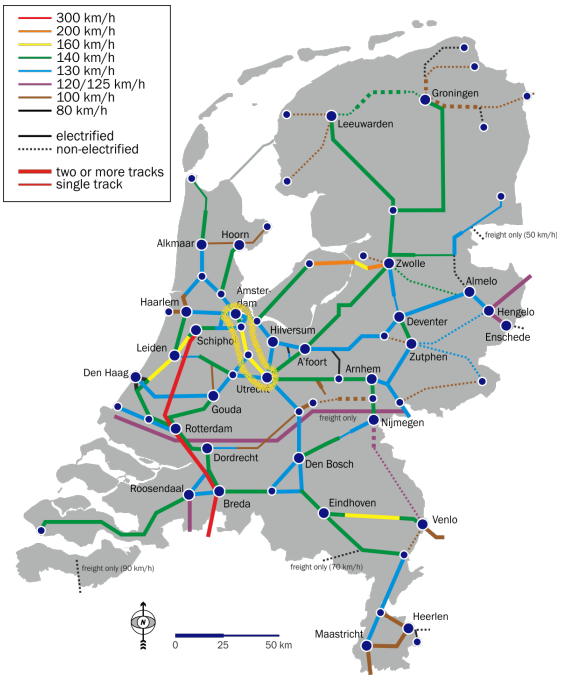

Figure 4. ***Map showing the Amsterdam Utrecht corridor***

  approach requires that the demonstrator is able from the beginning to manage all the peculiarities of the chosen track and trains and that the code generated by the Scade code generator can be easily integrated in the demonstrator replacing existing code fragments from the demonstrator itself. This can only be achieved if fragmentation is done on corresponding modules and interfaces between them is conserved. In other words the demonstrator code needs to be lined up with the WP3 model architecture.

- presentation by Uwe Steinke (Siemens) of the status of the ongoing SCADE model activity within the scope of iteration 1 and illustration of significant design details.

[3] Under the umbrella of the BB21 ("Beter Benutten" = "improve exploitation") Programme Dutch Railways are undertaking a number of projects to achieve better utilisation of the network. These include the Bev21 development program, a new ERTMS /ETCS safety system, a radio communication package, the 25Kv-50Hz electrification and time schedule management. The development of the Bev21 System is an important part of this programme. Bombardier Transportation has been awarded a contract to develop the Bev21 System and gain Dutch national safety acceptance of both wayside an on-board systems that support the ERTMS/ETCS standards at Levels 1, 2 and STM and dual signalling for both ERTMS equipped and conventionally equipped trains. ProRail is providing a dual signalling system on its busy Amsterdam Utrecht main line as part of a project to quadruple the route. Installation of ETCS Level 2 and conventional Automatic Train Protection in a complex three-phase changeover allows the line to be used by both Ertms-fitted and unfitted trains.

[4] fixed track data and train configuration data should be made available to Wp4 by NS, test scenarios with dynamic data as MA should be provided by WP4 and implemented in an appropriate test environment for simulating track behavior.

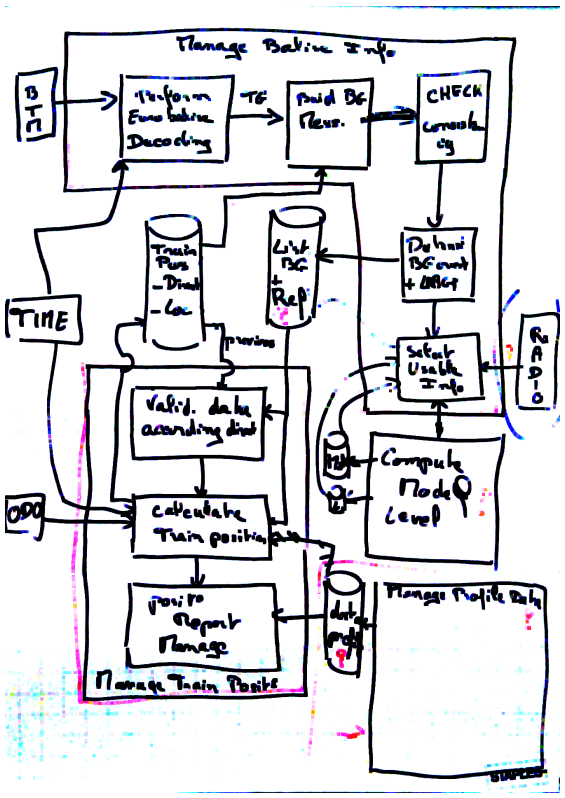

Figure 5. ***First sketch of draft architecture proposed during November 2013 Berlin Workshop***

This scope was defined during the Berlin workshop of November 2013, see picture shown in figure 5 and then verified and converted to a SysMl artefact in *model/sysml/WP3-Initial-Architecture/WP3-Initial-Architecture.uml* see figure A2 and A3 [5]

The Data Dictionary is composed by internal data deriving from designer needs and input / output data defined in subset 026, Sysml model "WP3-Initial-Architecture" in papyrus[6]

There are two different Data-dictionaries one is in Scade one is in Papyrus there is no automatic line up of the two data definition environments [7]

It should be stressed that the architecture fragment chosen for iteration 1 could not be exhaustively be verified to any consistent requirement set.

The completion of iteration 1 scope has still to be achieved, some of the modules as e.g. "LRBG orientation" or "select-usable Info" were assigned to people that are no more in the project or that never where able to work on it.

[5] It has to be remarked that all relevant information related to the model is available only within the tool-chain environment and is not documented in paper form. Even a more stringent constraint is given by the need of using Scade, which is not available as open source tool to consult the existing models. It should be implemented in the tool-chain a free-license version of Scade for consulting models in read-only even when non acting as direct modeling contributor. Even the out-prints from Scade are not human readable being made of hundreds of pages with code and split diagrams.

A more synthetic and a more readable form of design deliverables are needed at least for the shared architecture definition. It is suggested to go for SysML + explaining text paper like documents.

[6] In order to facilitate the documentation task it was requested to implement a print/plot function in the Tool-chain papyrus module as suggested by Matthieu Perin with an Eclipse plug-in (Marc Behrens raised the issue) *Image Export Plug In from uni-kassel An Eclipse plug in to to simplify the task of exporting images from GEF diagrams. Its goal is to allow exporting GEF diagrams to images in several formats in a generic and extensible way. It contributes two Diagram Image export wizards and allows for other plug ins to contribute diagrams to export (the figure providers) and image formats (the image exporters) to generate images. It is made that modular in order to be extensible. Uses existing libraries to generate certain formats (e.g. the Batik SVG Toolkit to produce SVG). This should allow to export the Papyrus generated SysML diagrams into relevant architecture documents.*

[7] Some workaround could maybe come from the EMF compare tool.

An important feature of Scade showed by Uwe was the management of arrays of records. This feature will be considered in order to implement a dynamic track map data structure. The array elements can be accessed by dedicated operators, and are reflected in the generated C code by standard record arrays. No benchmark of performance related to array operations was done yet.

Another important remark was related to the fact that only four of the formulas introduced in the document DetermineTrainLocationProcedures[8] were actually needed to implement the train position management.[9]

- presentation by Jan Welwaarts of the handling of a special situation of SIL 4 upper position constraint on the detection window and a possible reduction of confidence interval.

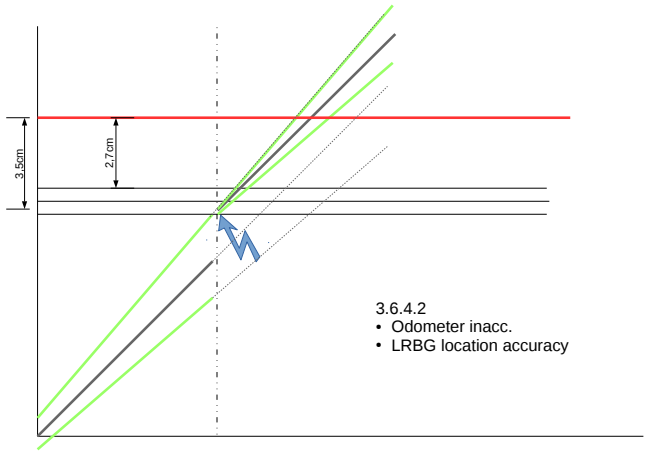

Figure 6. ***example of use of upper constraint to restrict the confidence interval on position***

- presentation by Vincent Nuhaan of situations of possible position error compensation. Vincent has shown the results of a of the software implementation (using Labview) of the ETCS part handling Train Positioning and the calculation of the distance (including tolerances) between the trains front end and any type of track side location (target, MA, change of slope, ..), given in reference to any BG in rear of the train (LRBG/in rear of the LRBG, linked/unlinked, linked) taking into account:
  * Tolerances (odometer, BG installation, detection inaccuracy)
  * Having BGs in advance of the LRBG
  * Receiving linking information for distances in rear of the on-board LRBG (in advance of the reference LRBG given by the RBC)
  * Detecting a BG at the edge of the expectation window without shortening the worst case distances (jumping towards the target)
  * Linking holes between two and linking holes between more than two BGs

  Some of this issues are not considered in the Subset 026, which is mainly driven by the track-side point of view, where all the data have fixed positions and are affected only by installation accuracy errors. The issues should be verified by Wp4 and monitored by Wp3 in order to be prepared to manage them if found to impact on the chosen architecture scope for next iteration.

[8] System Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.docx
[9] see A.1

0.2 action plan and next steps

+ Proceed with highest priority on the SCADE iteration 1 modeling according to scope defined in November 2013 Berlin Workshop avoiding any impact on existing work-plan from next iteration setup.

+ Analyze by Wp4 and by Wp5 the new architecture features introduced by the Alstom Document *OpenETCS_Database* compared to architecture outlined during prior Workshops and specially with the draft presented in the Berlin Workshop and iteration 1 SysML artefact.

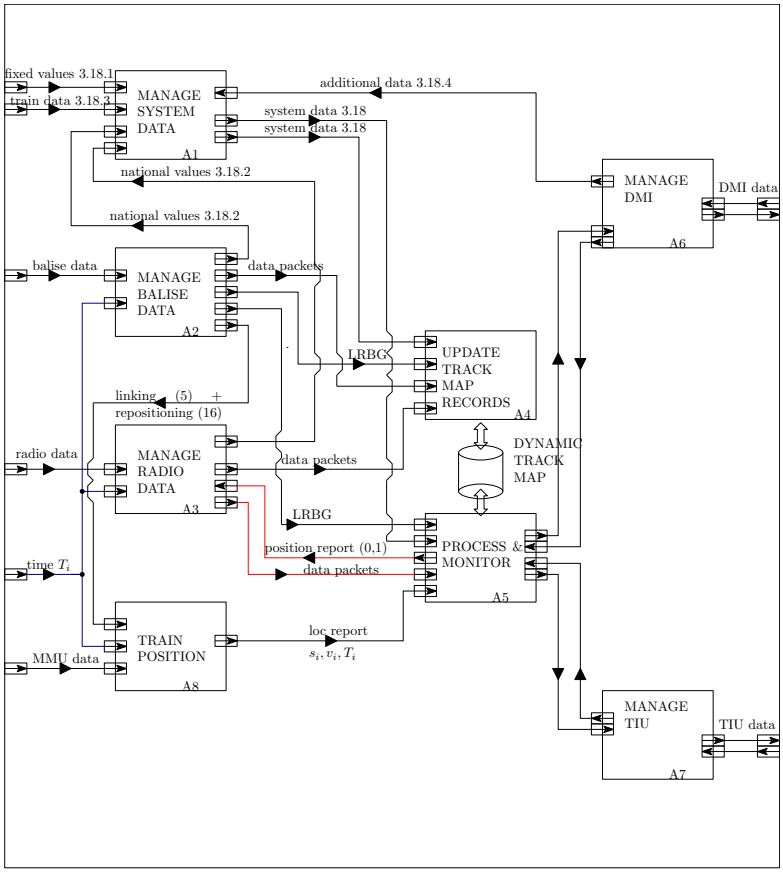

Figure 7. ***high level draft for the shared reference architecture taken from OE Database document***

+ set up a process aimed to refine the architecture and to converge towards the need of the chained processes in Wp4 and Wp5, by taking in account the results from first iteration.

  This setup should comply to rules of agile methods and involve people dedicated to the modeling design as well as people from validation team Wp4 and Wp5 able to give contributions related to validation setup (Wp4) and able to harmonize towards the integration rules for the confluence of madeling artefacts into the demonstrator software (Wp5).

  As stated e.g. in the Open ETCS Software Release and Deployment Plan *Unlike other development projects the modeling result (i.e., the content of the releases) is not directly feeding into a product. But, will have to support the internal stakeholders for the modeling results* [10] and in fact means that the processes are developed hand in hand with the progress of the achieved intermediate results.

  Nevertheless it should be hold in mind that the most valuable part of a complex design like the one considered here in this project consists in the analysis related to the identification of

[10] SoftwareReleaseAndDeploymentPlan/openETCS Software Release and Deployment Plan.tex

the best suited architecture and a correct partitioning on functional blocks. Such an analysis requires a full overview of the complete system, a specific experience on all the critical aspect that need to be taken in account and the knowledge on how to cover the requirements with simplest structure (data and function). It seems that exactly this is the part where Alstom can give the strongest contribution to Wp3 and to the Wps chained to Wp3.

It has to be planned to organize a sequence of technical Workshops for refining existing architecture drafts and converge towards a shared definition of the system architecture. The final result shall be a common reference for the stake holders in Wp3, Wp5 (fitting the demonstrator) and Wp4 (copying with the validation premises).

It was decided to supersede for the time being to compile an exhaustive requirement map and to concentrate to available architecture concepts.

In order to start this process an architecture from Alstom will be made available as part of new release of OpenETCS_Database document and a concept of validation will be needed from WP4[11] as well as a concept for integration of the model code in the demonstrator from Wp5. In parallel it will be necessary to produce an architecture document with SysMl

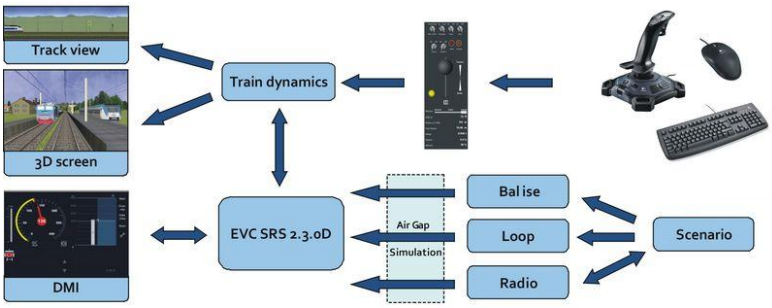

Figure 8. ***Demonstrator***

diagrams and explaining text reflecting the scope and the assumptions of the iteration 1 (Berlin Model). All this documents need to be available to the involved people and need to be analyzed before workshop.

Proposal for people to involve: Christian Giraud, Uwe Steinke (for support and document review, avoiding any major impact on iteration 1 process), Marielle Petit-Doche, Nicolas Boverie (document review), Jaime Paniagua, David Mentre, Jakob Gärtner, Baseliyos Jacob, Jan Welte, Veronique Gontier, Vincent Nuhaan ... (?) to be discussed.

Main plan is to have a first workshop of one week, where all documents and remarks raised are discussed and used to identify a path towards an optimized model scope copying with the needs of all involved stakeholders. Then to work on all the open points while preparing a second workshop, where a stable architecture document (with a tailored scope)[12] can be released and serve as reference for following modeling and validation process.

[11] Validation should be against the architecture design and a concept for the validation strategy, the applicable tools, test environment and possible test scenarios should be addressed

[12] Priority will be on functions related to train positioning and track reference frame update management

Accordingly the priorities seen are to preserve the existing work-plan for the ongoing modeling activities for the completing of the iteration 1 model. This will give at least useful feedback on the fit to purpose of the tools used.

The most relevant step, with highest priority will be to work for a reference architecture. An essential contribution from Alstom to reach this target will be the release of the WG2_OpenETCS _Database[13] document in order to evolve towards a shared reference architecture with the contribution from wp4 and wp5

+ set up a glossary of terms like "linked", "linking" etc in order to use same terminology in all contexts

0.3 Roadmap

A possible roadmap towards a stable architecture concept for end of November would imply the preparation af first extended[14] technical workshop where all the major open issues related to basic concepts in the iteration 1 architecture and that are needed in the extended scope to be defined with the support of Wp4 are discussed and brought to a defined level to be completed.

For this workshop some input documents need to be prepared : at least a clear architecture and design document illustrating the iteration 1 concept and an updated version of the OpenEtcs Database document from Alstom, where the specific issues related to architecture scope are covered. This documents should made available by mid of October so that the workshop can be organized end of October in week 44 starting Oct 27.

Then after this first workshop the parts chosen to be part of the scope should be completed to produce a draft for the iteration 2 architecture document in time for the second workshop that could be organized at end of November in week 48.

0.3.1 Role of Wp4

At the given moment having evaluated the level and limits of existing requirements the Wp3 teams can try to consolidate an architecture concept starting from a high level sketch and going in deep for the modules that have to be considered as relevant for the follow-up processes.

At the time being one of the crucial aspect to be taken in account is the definition of a feasible validation path, starting from the assumption that Wp3 will converge towards a shared reference architecture of scope to be refined. This means the validation should support the definitions of the architecture and should provide a possible validation concept against a system architecture definition.

0.3.2 Role of demonstrator of Wp5

At this stage it seems clear that a possible strategy of completion of the project would be to consider the exporting of the functionalities produced within Wp3 towards the demonstrator available in Wp5. However this approach has to consider the different requirements and therefore different architectures which are the input to the design of the two systems, e.g. it is not expected that the simulator has to manage all the combinations of operating situations needed on a real train and can in general operate on clean nominal situations. This would rise the question if it makes sense to upgrade the EVC component of the simulator to the functional level of

[13] present title refers to WG3 but should be changed because document is actually stored on repository of WG2

[14] 1 week seclusion of system architecture stakeholders

an operative train.[15] In this case it is quite probable that this will break the time frame of the current project.

0.3.3 Methods and Procedures proposal

The present repository structure in github reflects the varied evolution of the project spread over many classes and branches and contains a number of obsolete or even filled up with no contents repositories. For a better overview it is recommended to try to review al the relevant contents needed for the further progress and to unify this in a repository structure reflected by a documentation and a release plan. (is it in charge to Wp1 ?)

For each new document (probably no more than 6) to be emitted in the kernel design and validation process it should at least be indicated what is the content, who will be in charge for the completion and who for the review and what input have to be provided for this.

Presently the issue tracker is used for raising and closing project related issues, the number of void messages send by the tool make its use not always very efficient. It has to be found a way to regulate and to reduce the messages to the level of need and priority, privileging and stimulating so relevant feedback.

[15] even skipping for the time being all the questions related to achievement of an appropriate Sil level

Appendix A: Items of technical discussion

A.1 Formulas to manage calculation of position estimates

The estimation of the train position is currently based on the odometric measure of the distance traveled by the train made with an on board device and by the detection of reference balises installed on the track when the Balise antenna detects them.

The values of the odometric tracking device (wheel sensors + Doppler radar + accelerometer) are subjected to errors mainly due to the slip and slide effect on the wheels used to sense the movement, which arise when train is accelerating or decelerating. The estimation interval is required (see [1]) to be below 5% of the estimated (measured) value.

The accuracy of reference balise detection is affected by the antenna lobe aperture and the possible geometric misalignment of the magnetic axis af antenna and balise. It is required that the estimation interval for the balise center location is within ± 1m with a confidence of $1 - 10^{-9}$ for safety consideration. The size of confidence interval as multiple of standard deviations of a normal distribution can be found in tables of the error function. The relation between standard deviation and detection window size is given by technological and constructive parameters of the train board antenna and of the balise.[16]

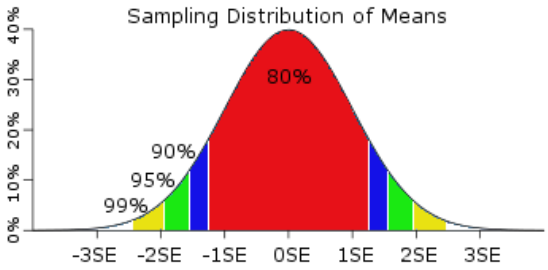

Figure A1. ***illustrating relation between confidence level and interval size***

It should be hold in mind that the behavior of the odometric measure will be biased by the cruise regime of the train, in other words traction will produce slide effect with consequent overestimation of the distance traveled while braking will generate underestimation. An this type of behavior can be partially compensated. Therefore the use of the error function to estimate the confidence level for the odometry is not applicable.[17] The stringent requirement that has to be observed by the odometric equipment and, which can be referred for further calculations is

[16]The accuracy of installation of the balises, that is to say the difference between the designed position on the track, which is reflected in the data preparation and the position of affective installation of the balise is confined by the upper limit given by the Q_LOCACC parameter and is not taken into account for now, in this context we are considering only the accuracy limits related to on-board devices. We should also stress here that the distance between train front end and balise antenna as well as the distance between front end and rear end are given and known constants and should not be considered as contributing to accuracy loss. The precision of the on-board time dispenser can always be chosen so that it is not relevant in calculations. Finally the effect of the time delay between effective detection of balise center and moment of performing calculation can be determined by the presence of a time stamp on the detected balise telegram and knowledge of the actual speed, which can be assumed as constant over the typical delay interval.

[17]Contribution from statistical uncorrelated intervals would give rise to quadratic composition $\sigma_T^2 \sim \sum \sigma_i^2$ differing substantially from formulas presented

that in all conditions it will maintain the accuracy within the given upper and lower limits which can drift apart by a maximum amount of 5% of the nominal value. Therefore it can be assumed that the odometry device produces a triple of values $s_i^{(-)}$, $s_i^{(o)}$, $s_i^{(+)}$ (see [2]) This is the context in which the formulas 1 and 2 cited by Uwe Steinke see ([3]) are to be understood:

$$\sum s_i^{(-)} \leq \sum s_i^{(o)} \leq \sum s_i^{(+)} \tag{A1}$$

means that the nominal value will be always confined within the prescribed 5% interval. [18] and similarly assuming $s_1^{(-)} \leq s_2^{(+)}$

$$s_2^{(-)} - s_1^{(+)} \leq s_2^{(o)} - s_1^{(o)} \leq s_2^{(+)} - s_1^{(-)} \tag{A2}$$

The difference value of two odometric samples is confined by the combined interval.

For what regards the third formula in chapter 2.3 and the fourth formula in chapter 5.2 of [3] the understanding seems not so straightforward and some clarification will be needed.

A.2 some diagrams from Papyrus related to architecture adopted in iteration1

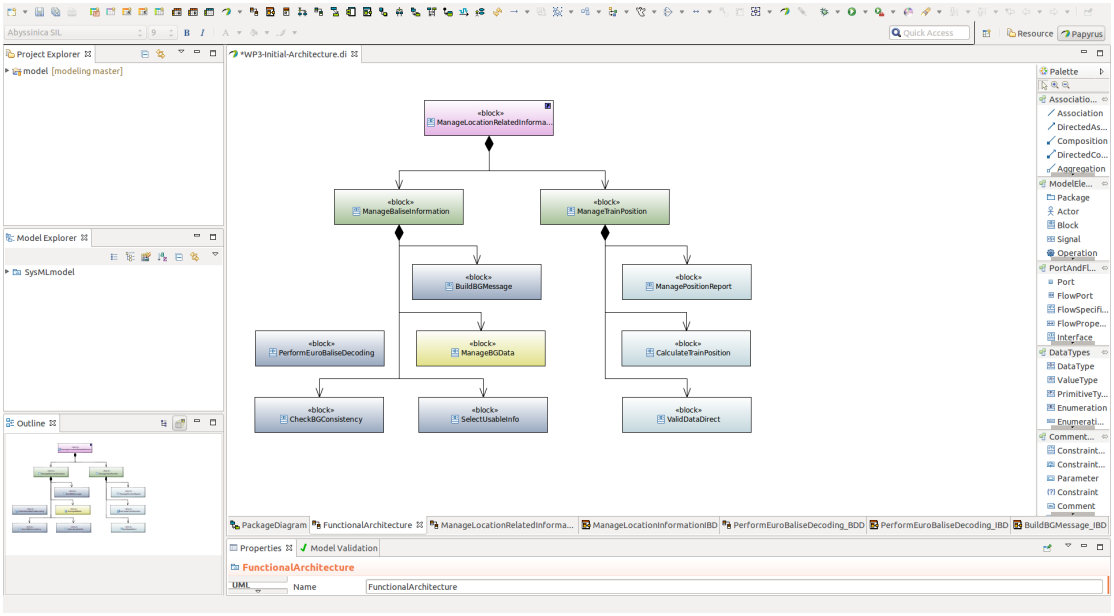

Figure A2. ***Sketch from Papyrus tool of iteration 1 architecture***

[18] it should also be noted that:

$$\frac{\sum s_i^{(+)} - \sum s_i^{(-)}}{\sum s_i^{(o)}} \leq \frac{5}{100}$$

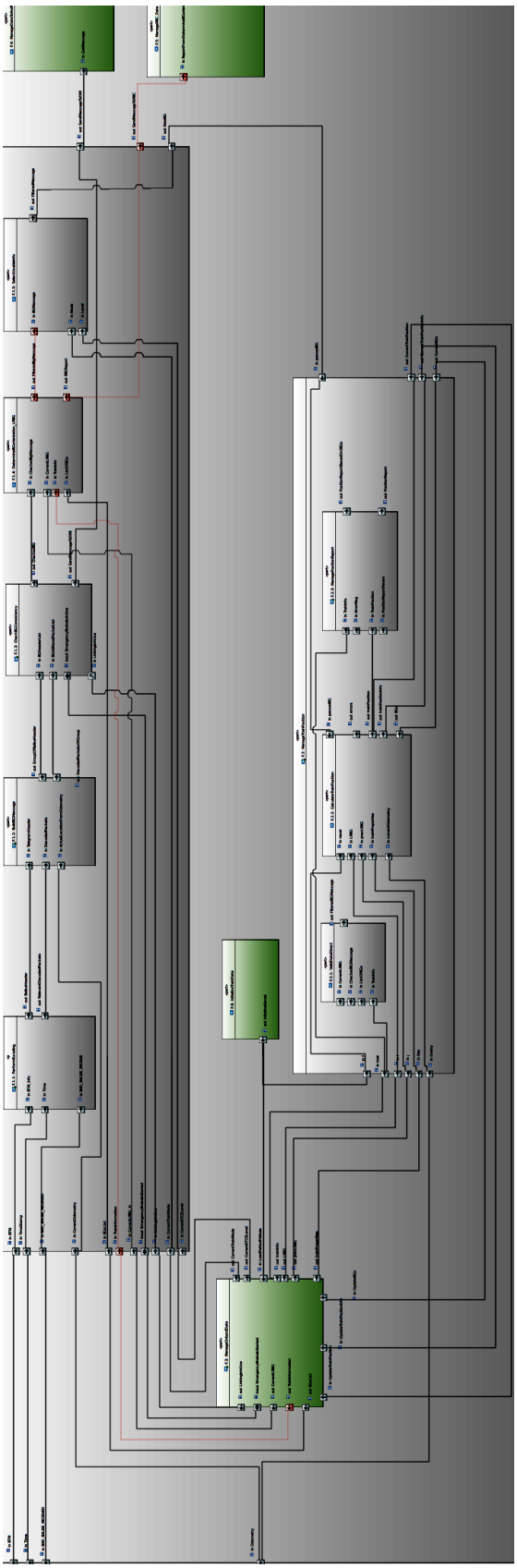

Figure A3. ***Sketch from Papyrus tool of iteration 1 architecture (IBD view)***

Appendix: References

[1] ERA. *Performance Requirements for Interoperability, SUBSET-041*, v3.1.0 edition, March 2012.

[2] Nicolas Boverie. *API Requirements for OpenETCS*. Alstom Transport, v1.4 edition, June 2014. https://github.com/openETCS/requirements/blob/master/D2.7-Technical_Appendix/OETCS_API%20Requirements_v1.4.pdf.

[3] Uwe Steinke. *Determine Train Location Procedure*. OPEN ETCS Wp3, provisional edition, January 2013. https://github.com/openETCS/Analysis/WorkingRepository/Group4/SUBSET_26_3-6/DetermineTrainLocationProcedures.docx.

[4] ERA. *Glossary of Terms and Abbreviations, SUBSET-023*, v3.0.0 edition, March 2012.

[5] ERA. *System Requirements Specification, SUBSET-026*, v3.3.0 edition, March 2012.

[6] openETCS. *openETCS SysML model*, 2014. https://github.com/openETCS/modeling/tree/SysML_modeling/model/sysml/WP3-Initial-Architecture.

[7] Uwe Steinke. *openETCS: WP3-Initial-Architecture*. OPEN ETCS Wp3, provisional edition, September 2014. https://github.com/openETCS/modeling/openETCSDesignDocuments/firstIteration/WP3_InitialArchitecture_DesignDescription.pdf.

[8] Uwe Steinke Peter Mahlmann Bernd Hekele Peyman Farhangi, Christian Stahl. *openETCS System Architecture and Design Specification*. OPEN ETCS Wp3, provisional edition, September 2014. https://github.com/openETCS/modeling/ArchitectureAndDesign/FirstIteration/openETCSArchitectureAndDesignSpecification.pdf.