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EUDD*plus*: European Driver's Desk Advanced Concept Implementation – Contribution to Foster Interoperability

SIXTH FRAMEWORK PROGRAMME

SUSTDEV-2005-3.3.1.3.2

Publishable Final Activity Report 2006 - 2010

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Publishable Executive Summary

The project EUDD*plus* aims at the development, in-field testing and validation of the interoperable, harmonised and modularised train driver's desk. It represents the logical and necessary link between the successful FP 5 project European Driver's Desk (EUDD) and the large-scale exploitation of that driver's desk concept´, advanced in ergonomics, safety and life cycle costs (LCC). Simultaneously, the EUDD*plus* shall use the findings of the FP 6 Integrated Project MODTRAIN, in which the EUCAB working area elaborates the harmonised driver's cab system requirements specs (SyRS) of the future.

More specific, EUDD*plus* project aims at the reduction of the Life Cycle Costs of the system driver's desk of about 15 % compared to today's reference cases. Moreover, the project aims to justify the ergonomic advantages of the new desk configuration by scientific analysis and to prove the technical and operational feasibility of the desk layout and therefore the practical implementation of the ORS (Operational Requirements Specification) 612 resulting from the MODTRAIN project.

A modern multi system locomotive has been the platform for EUDD*plus* implementation. Constraints given by the vehicle are to be respected, opportunities for efficient future drivers desk upgrading will be considered as far as requirements have been identified and specified in detail.

At an early stage of the project the precision and the specification of the desk concept were performed according to the available drafts of the ORS 612 from the MODTRAIN project. The detailed analysis of the constraints given by the existing vehicle platform resulted into the basic specifications for the desk hardware and the mechanical integration into the locomotive. In order to compensate the delays of the ORS 612, the EUDD*plus* consortium established direct support for the ORS further development, in particular with regard to the display software specs. In parallel, the preparations to achieve the in-field test certification in Austria and neighbour countries took place through in-depth dialogues with responsible persons from the authorities. The results of these discussions were directly fed into the desk concept and integration concept.

The further work plan consisted of the following major steps:

- Specification compliant to ORS/FRS/SyRS/FIS, development and vehicle integration of the new desk including software development.
- In-field tests on the Wildenrath railway test ring by re-enacting cross-border operation involving drivers from several European operators to test the advantages of the driver's desk (usability testing).
- Draft of recommendations for future broad scale exploitation and future certification.

After decision for integration of the EUDD*plus* driver's desk concept into an Alstom PRIMA II prototype to be tested at the Test and Validation Center Wegberg-Wildenrath, the technical work has been continued concerning concept precision and specification, system engineering and construction and desk integration.

Furthermore an EUDD*plus* us test simulator with the same functionalities than on the locomotive integrated desk has been established. It was used for test preparation of the drivers as well as for demonstration activities during a Public Demonstration Day in Wildenrath and the EUDD*plus* Final Conference. Further dissemination events using this test simulator to demonstrate the EUDD*plus* driver's desk concept are to be expected.

The main effort of the work contained in preparation of the in-field tests which took place with 17 drivers from Austria, Belgium, Czech Republic, France, Germany, Hungary, Italy, the Netherlands, Slovenia and Switzerland at the Test and Validation Center Wegberg-Wildenrath from 9 November to 4 December 2009. Important information for in-field tests preparation had been generated from the two days reference tests which took place at the Výzkumný Ústav Železniční zkušební centrum (VUZ Test Centre Velim) end of August 2009.

After the in-field tests took place the test results gathered by questionnaires, by an eye tracking system and by operational data recorded has been scientifically evaluated by the ergonomics' point of view. Furthermore the test results gave input for evaluation if the EUDD*plus* specifications are in conformity with the TSI and for LCC considerations.

Furthermore the fulfilment of EUDD*plus* specifications according to the essential requirements given by the Conventional Rail Technical Specification of Interoperability for Locomotives and Passenger Rolling Stock has been proved and a general concept for authorisation of innovative railway technologies such as EUDD*plus* has been elaborated. Beside several technical meetings, some main events took place: the EUDD*plus* Intermediate Seminar in Brussels on 30 September 2009, a Public Demonstration Day in Wildenrath on 8 December 2009 and the EUDD*plus* Final Conference at the UIC Headquarters in Paris on 27 January 2010.

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1 Section 1 - Project Execution

1.1 Project objectives

The objective of the project EUDD*plus* was to enhance a Europe wide standardisation and harmonisation of a locomotive driver's desk functional arrangement and layout, including the testing and verification of the ergonomic advantages, sub system performance and the potential economic benefits (LCC). A UIC 612 conform European driver's desk has been implemented and tested (usability testing) into a multi-system locomotive platform.

More specifically, the general objectives of the project EUDD*plus* were the following:

- To achieve a reduction of the Life Cycle Costs (LCC) of the system driver's desk of at least 15 % compared to the reference case (given by the test locomotive with conventional desk). The LCC calculations shall consider all elements of the product's lifetime, which are
  - Engineering costs including software development and programming
  - Manufacturing costs
  - Costs for operation including maintenance and repair as well as staff operating costs
  - Costs for staff training and education
  - Costs for technical (hardware and software) upgrades
  - Cost impacts due to supplier competition enabled by component standardisation including interfaces
  - Disposal costs
- To justify the ergonomic advantages of the EUDD desk layout during in-field tests
- To prove the technical and operational feasibility of the EUDD concept and MODTRAIN ORS (Operational requirements specification) 612 implementation
  - The shift of functions from hardware to software with enhanced flexibility, improved ergonomics and reduced costs
  - The new arrangement of traction/braking operation
  - The modularisation of remaining hardware controls according to functional and logical groupings
  - The standardisation of component interfaces facilitating future interchangeability
  - The application of drive-by-wire control concept
- To facilitate the future series homologation procedure of the EUDD*plus* desk layout for all European networks by involving the ERA (European Rail Agency) and the national authorities for the entire project duration via a user platform.

The international state-of-the-art with regard to the man-machine-interface (MMI) to control trains is still characterised by a lot of different national and operator-specific solutions impeding the interoperability of the rail system in Europe. This situation hinders seamless rail traffic across Europe and thus reduces the efficiency of international rail operation. The great variety of train driver's desk layouts does not only concern the Train Operating Companies (TOCs) but also the suppliers who had to develop dedicated driver's desk solutions for each of their customers and are therefore not able to profit from "economies of scale". The lack of harmonisation in train driver's workplaces finally impacts the competitiveness of the rail system towards other modes of transport.

Besides the missing interoperability, the layout of state-of-the-art driver's desk often provides poor ergonomic conditions – even if the driver's workplace determines safety relevant man-machine interactions. This particularly concerns the driver's cab of multi system rolling stock where the desk is frequently overloaded with several national equipments.

By using and implementing promising results from former EUDD and MODTRAIN projects, EUDD*plus* shall pave the way for an important improvement of the state-of-the-art. In particular this concerns improvements

- in rail system interoperability in Europe
- in ergonomics and safety
- in cost reductions (LCC)

1.2 Contractors involved

Contractor's Number *	Contractor's name	Contractor's short name	Country
1 (coordinator)	TSB Innovationsagentur GmbH / Forschungs- und Anwendungsverbund Verkehrssystemtechnik Berlin	FAV	Germany
2	Siemens Aktiengesellschaft	SIE	Germany
3	Bombardier Transportation GmbH	BT	Germany
4	ÖBB Traktion GmbH	OEBB	Austria
5	MAV-GÈPÉSZET Zrt	MAV	Hungary
6	Ceske drahy a.s.	CD	Czech Republic
7	AustriaTech – Gesellschaft des Bundes für technologiepolitische Maßnahmen GmbH	ATE	Austria
8	IAS Institut für Arbeits- und Sozialhygiene Stiftung	IAS	Germany
9	Technische Universität Wien / Vienna University of Technology	VUT	Austria
10	Fundació Politècnica de Catalunya - Universitat Politècnica de Catalunya	FPC-UPC	Spain
11	Union Internationale des Chemins de fer	UIC	France
12	Union of European Railway Industries	UNIFE	Belgium
13	Deuta Werke GmbH	DEUTA	Germany
14	SKODA TRANSPORTATION s.r.o.	ST	Czech Republic
15	ALSTOM Transport S.A.	ALS	France
16	EAO Lumitas GmbH	EAO	Germany
17	W. Gessmann GmbH	GES	Germany

1.3 Work performed and main achievements

With the project's **Kick-off Meeting** on 09 August 2006 in Munich, Siemens premises, the work programme of the various WP's had been discussed and further stated more precisely. A corresponding **Action Plan** for the coming months had been established.

Basically, the project follows the chain of technical processes from concept precision to exploitation, supported by horizontal activities, such as user involvement, certification preparation and project management.

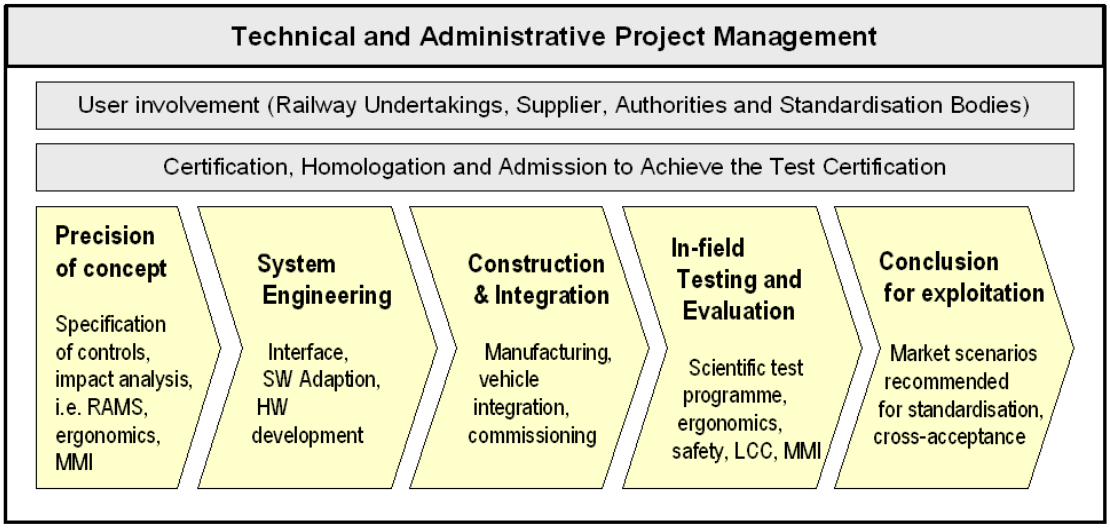

Fig. 1: Arrangement of vertical and horizontal activities in the EUDD*plus* project

WP 1 Project Management

The WP 1 was dedicated to perform the project management tasks. It comprised the technical as well as the administrative coordination. The following list should provide an overview about the main project management activities/achievements:

- Preparation, organisation, accomplishment and post-processing of major project events, e.g. the EUDD*plus* Kick-off-meeting (09 August 2006), the Steering Board Meeting (03 September 2008), the Technical Management Team Meeting (15 January 2009), the EUDD*plus* Intermediate Seminar (30 September 2009), the EUDD*plus* Public Demonstration Day (08 December 2009), and the EUDD*plus* Final Conference (27 January 2010).
- Preparation, organisation, accomplishment and post-processing of WP kick-off and technical meetings.
- Numerous discussions by email, phone, conference calls and meetings in order to discuss the project's progress continuously including discussions about contractual, organisational, technical und operational issues.
- Support of the WP's 2, 3, 4, 5, and 7 e.g. by
  - Presentation of the EUDD*plus* approach, objectives, work plan, current project status towards UIC SG 4 (July 2006), and UIC SG 15 (September 2008, July 2009); afterwards help to establish the list of interested members of the user platform (operators and suppliers)
  - close interaction with WP leaders in terms of action list follow-up and technical progress (e.g. for desk configuration precision)

  - Support for the preparation of certification, e.g. for dialogue with the responsible persons from the Austrian authorities; support for a new approach of WP 3 concerning the project's progress and significant progress in Cross Acceptance and authorisation issues outside the project.
  - Support for preparing, accomplishing and evaluation of both the reference tests at the Výzkumný Ústav Železniční zkušební centrum (VUZ Test Centre Velim) on 29 and 30 August 2009 and the in-field tests at the Test and Validation Center Wegberg-Wildenrath from 9 November 2009 to 4 December 2009.
- Preparation and submission of the Cost Statements to the European Commission, including the Periodic Management and Activity Reports and corresponding annexes.
- Ongoing information of the project partners and the EC project officer on the status of EUDD*plus*.
- Preparation and conclusion of the EUDD*plus* Contract Amendments due to adjustments of the Description of Work, the reallocation of tasks and budgets of partners, the justification of subcontracts, and further contractual issues.
- Supporting and fostering the inclusion of project partner Deuta into the UNIFE Topical Group Cab.
- Preparation of payments to the partners.
- Preparation and submission of deliverables and the Final Report to the EC, including the corresponding annexes.

The close and vital interaction between EUDD*plus* project and the IP MODTRAIN (sub project MODLINK) had been established right from the beginning via FAV that is EUDD*plus* coordinator and MODLINK SP leader at the same time. This synchronisation between the both projects was critical due to the delay of the Operational Requirements Specification (ORS) 612 in MODTRAIN. The ORS 612 – drafted by the MODTRAIN operator group with the help of the supply industry and researchers – had been identified as the major input for the EUDD*plus* concept precision. Consequently, the delayed ORS 612 seriously affected the EUDD*plus* progress. Besides the issue of ORS 612 delay, the collaboration with MODTRAIN works well – last but not least due to the fact that some organisations/persons are partner in both projects.

In the in-field test phase the coordination activities focused on fostering and guiding of the process of in-field test preparation and performing, e.g. booking of test infrastructure, freight wagons, signalling equipment and additional services, gathering of test drivers and clarification of liability situation, responsibility for technical and operational safety during the in-field tests.

WP 2 EUDD*plus* User Platform

The involvement of the users started with a presentation of the project by the coordinator towards UIC SG 4 in July 2006. In the following months UIC and UNIFE identified the interested operators and suppliers that should compose the core of the EUDD*plus* user platform.

Train Operating Companies (TOCs) outside the project consortium (namely SBB, SNCF) were involved in the final discussions about the EUDD*plus* concept precision and specifications as well as during the preparation of the in-field tests. Furthermore TOCs outside the project consortium have been contacted for possible test participation at an early stage of in-field test preparation. Additionally the members of the UIC SET 15 have been continuously informed about the current project status.

UNIFE involved the System, Subsystem and Component Suppliers via different UNIFE groups: the Technical Plenary and the Topical Group CAB. Several presentations were given to inform the

members of these groups with the current status of the project. As several project partners are members of CEN WG 37, this group was also informed continuously about the project's progress.

The EUDD*plus* Intermediate Seminar organised by partner UNIFE and coordinator FAV was held in Brussels on 30 September 2009. An EUDD*plus* Public Demonstration Day organised by coordinator FAV was held in Wegberg-Wildenrath on 8 December 2009. The EUDD*plus* Final Conference organised by partner UIC and coordinator FAV was held in Paris on 27 January 2010.

WP 3 Homologation Support

In WP 3 the preparatory work for the in-field test certification started right after the kick-off. Constructive dialogues with the responsible authorities and persons in Austria resulted into the preferable scope and extent of certification to ensure as much as possible day-to-day field operation. In addition a basic roadmap for the certification procedure had been drafted. Discussions with working inspector helped to identify the constraints to be considered for the new desk concept and experienced independent assessors were identified to accompany the certification process in Austria.

As been decided to integrate the EUDD*plus* desk into an Alstom PRIMA II locomotive prototype and to accomplish the in-field tests on the test tracks of the Test and Validation Center Wegberg-Wildenrath, so that a full authorisation procedure was not necessary anymore. Taking into account the changing of the location for the in-field tests from regular tracks of OEBB network to the Test and Validation Center Wegberg-Wildenrath and the significant progress in cross acceptance and authorisation issues, a new approach for dealing with authorisation issues in WP 3 has been developed together with experts from the European Railway Agency (ERA).

Correspondingly the following tasks had been fulfilled within WP 3:

- Proof that the EUDD*plus* specifications meet the essential requirements defined in the Interoperability Directive 2008/57/EC and specified in the Conventional Rail Technical Specification for Interoperability Locomotive and Passenger Rolling Stock (CR TSI Loc&Pas RST)
- Integration of the EUDD*plus* specifications in a spreadsheet which contains a detailed list of parameters and their link to the requirements of certification authorities and network operators of several European countries.

WP 4 EUDD*plus* Concept Precision and Specification

First result of the work within WP 4 was an analysis of critical aspects for final concept decision mid of November 2006. The document provided evaluations and recommendations with regard to the critical technical aspects such as desk position, driving/braking arrangement and displays/software. It considered the constraints given be the existing vehicle platform and the current certification conditions. Based on these recommendations fundamental decisions about the desk concept to be implemented had been taken in December 2006.

The precision and specification of the desk concept for implementation constituted the main technical task in the first six months of the project. With reference to the MODTRAIN specification process the draft ORS[1] 612 was used as most recent EUDD-related specification for the definition of the desk concept. Since the ORS 612 process was delayed in MODTRAIN, incremental interaction of the projects MODTRAIN (EUCAB)-EUDD*plus* had been introduced via UIC and ÖBB with the support of other operators. In addition, some ORS drafting related tasks had directly been supported by EUDD*plus* experts (e.g. with regard to software specification).

[1] Operational Requirements Specification

The work within WP 4 had been continued with the following tasks: elaboration of the EUDD*plus* desk configuration according to EUCAB and former EUDD results, comparison of the Alstom PRIMA II desk design with the UIC 612, adaption of the design for the tests, elaboration of different drawings of the desk and specification of the 4 display screens (TRD, ETD, CCD, TDD[2]), specification of hardware and software for set point values of speed, dynamic braking and automatic braking and for the travel direction selector. For this purpose several meetings and a TMT meeting took place.

WP 5 System Engineering

Within WP 5 the specification of mechanical, electrical, pneumatic and TCMS interfaces according to the concept requirements, the development and adaption of hardware desk components including the electrical traction brake controller, the automatic brake, the automatic speed control and the auxiliary desk, and the development and testing of software for the 4 displays/terminals have been done.

WP 6 Construction and Desk Integration

First functional tests on PRIMA II locomotive has been done in April 2009. Furthermore the work within WP 6 included the implementation and evaluation of the EUDD*plus* demonstrator desk according to the specifications given by WP 4 and WP 5 into the PRIMA II locomotive test platform, the construction of the desk including the cabling, the mounting of equipment, the testing before vehicle integrating into the locomotive and the vehicle integration of the prototype desk according to the specification.

After presenting of the locomotive and the driver's cabin equipped with the EUDD*plus* desk to the project consortium on 3 September 2009, extensive functional static and dynamic testing of the PRIMA II locomotive on Wildenrath test ring took place in September/October 2009.

In parallel the EUDD*plus* desk for the training simulator was developed and produced. It was delivered for preparation of the test drivers to Wildenrath by 4 November 2009. It also had been used for the EUDD*plus* Public Demonstration Day, the EUDD*plus* Final Conference and will be used for further dissemination activities.

WP 7 In-field Test Programme and Evaluation

From the technical and ergonomic point of view, the EUDD*plus* in-field tests at the Test and Validation Center Wegberg-Wildenrath will be more realistic concerning the interactions with driver's desk and cab**.** The equipment of Wildenrath test centre and the planned scenarios will enable to reproduce representative driving situations in a better way than on in-service tracks. It is the still missing link between simulator tests and service operation.

Based on the decision to perform the in-field tests at Wildenrath test centre the test programme has been specified according to the needs of the project (scientific evaluation from the ergonomics' point of view and input for authorisation activities) on the one hand and the technical, operational and organisational constraints on the other hand. The test scenarios had been designed in a way that made the drivers able to use all the driving equipment at least one time, including different operational modes (normal operation, degraded modes, shunting). The scenarios had been scheduled to enable the nearly same test conditions for every test driver.

[2] TRD – Train Radio Display, ETD – Electronic Timetable Display, CCD – Command and Control Display, TTD – Technical and Diagnosis Display

The given test requirements lead to a further specification of all hard- and software criteria to be tested, e.g. display of the electronic timetable on ETD, vehicle integration of an ERTMS[3] simulation for driving with different ETCS[4] levels. Therefore the planned test scenarios have been continuously reviewed and improved.

Furthermore the usefulness of an additional method of data collection during the tests – the measurement of the driver's eye movements with the help of an eye tracking system – has been discussed. Finally it has been decided to use such an eye tracking system for certain test scenarios. A milestone of in-field test preparation were the reference tests held at the Výzkumný Ústav Železniční zkušební centrum (VUZ Test Centre Velim) end of August 2009. 4 drivers from 3 countries (Czech Republic, Germany, and Hungary) performed these reference tests.

Fig. 2: Škoda 109E locomotive prototype used for the EUDD*plus* reference tests

[3] ERTMS – European Rail Traffic Management System

[4] ETCS – European Train Control System

Fig. 3: Design of the driver's desk of the Škoda 109E locomotive prototype based on EUDD principles

From 9 November to 4 December 2009 the in-field tests took place at the Test and Validation Center Wegberg-Wildenrath with 17 drivers from 10 countries (Austria, Belgium, Czech Republic, France, Germany, Hungary, Italy, Netherlands, Slovenia, and Switzerland).

Scientific analysis and evaluation of the human factors during the in-field tests (questionnaires, comments and monitoring of the drivers during the tests, eye movements recordings, and luminance measurements) had been done. LCC advantages of the EUDD*plus* concept with regard to the results of the in-field tests and the former projects EUDD and MODTRAIN/MODLINK/EUCAB had been verified and further refined.

WP 8 Conclusions for Broad Scale Exploitation

WP 8 activities have to be seen with a strong relation to WP 2, WP 3 and WP 7. On the basis of user platforms important input to WP 8 came from the TOCs, the System, Subsystem and Component Suppliers, and from Authorities, Notified Bodies and Standardisation Bodies. The contact to the ERA gave the essential input for the new approach of WP 3 that was again one of the inputs of WP 8.

A realistic scenario about the exploitation and market penetration of the EUDD/EUCAB layout based on the in-field testing results as well as on the updated LCC considerations, taking into account international cross-acceptance and standardisation has been prepared. As a precondition therefore necessary test items for authorisation and LCC consideration to be verified during the in-field tests had to be defined.

Within WP 3 had been proved whether the EUDD*plus* specifications meet the essential requirements defined in the Interoperability Directive 2008/57/EC and specified CR TSI Loc&Pas RST. The EUDD*plus* specifications had been integrated in a spreadsheet which contains a detailed list of parameters and their link to the requirements of certification authorities and network operators of several European countries.

1.4 End results over the full duration

WP 4	**EUDD*plus* Concept Precision and Specification**
WP 5	**System Engineering**
WP 6	**Construction and Desk Integration**

Controls

The following table and figures show the hardware driver's desk elements foreseen with UIC 612 including their recommended position in comparison to the EUDD*plus* desk concept integrated into the PRIMA II locomotive prototype.

Recommended Position in UIC 612	**The same position on PRIMA II?**
Mandatory elements with fixed location	
001 Train radio display (TRD)	yes
002 Technical & diagnostic display (TDD)	yes
004 Control command display (CCD)	yes
012 Train radio emergency call	yes
013 ETCS : override (EOA)	yes
014 ETCS : release intervention	yes
015 ETCS : acknowledge	yes
016 Pantograph / Diesel engine	Yes
017 Main Circuit Breaker / Power transmission	Yes
019 Automatic Speed Control (ASC)	Yes
025 Sanding	Yes
027 External front light	Yes
029 Task (on desk) & driver's cab lighting	Yes
033 Travel Direction "Forwards"	Yes
034 No Travel Direction: "Neutral"	Yes
035 Travel Direction "Backwards"	Yes
038 External warning horn	yes (but more on the right side of the desk)
041 Document holders	Not implemented
101 Train radio-handset	Yes
Mandatory elements with optional location (may alternatively be located on the vertical surfaces to the right and left of the driver kneehole niche)	
036 Driver's Identity card reader	Not implemented
104 Lighting strength of the instrument lighting	Alternative location: Left panel below the desk
105 Floor & knee space (knee hole) heating	Not implemented
106 Cab air blower rotational speed	Alternative location: Right panel below the desk
107 Driver's cab temperature	Alternative location: Left panel below the desk
108 Air-conditioning/ventilation	Alternative location: Left panel below the desk
109 Pressure protection driver's cab	

Recommended Position in UIC 612	**The same position on PRIMA II?**
114 Windscreen wiper & windscreen washer	Alternative location: Right panel below the desk
115 Windscreen heating	Alternative location: Right panel below the desk
036 Driver's Identity card reader	Not implemented
104 Lighting strength of the instrument lighting	Alternative location: Left panel below the desk
Mandatory elements with optional location according to the location of the desk in the cab (left or right side)	
010 Emergency stop valve with "Emergency stop" function	Only on the right side of the desk
Mandatory elements with fixed location only for locomotives and driving coaches	
009 Brake pipe pressure adjuster (overcharge)	Yes
020 Combined traction/dynamic brake controller with integrated driver activity control push button	Yes
026 Release brake	Yes
032a Driver's automatic brake controller (automatic brake)	Yes
Mandatory elements with fixed location only for locomotives	
037 Direct brake	Yes
Optional elements with fixed location:	
003 Only for STM "LZB"	Not implemented
005 Emergency signals (warning lights, may no longer be requested in a new TSI OPE)	Not implemented
006 Electronic timetable display (ETD)	Yes
007 BP (brake pipe) & MP (main air reservoir pipe) pressure gauge (option: to be integrated in the TDD)	Yes
008 Brake-cylinder pressure gauges (option: to be integrated in the TDD)	Yes
015 ETCS: acknowledge (option to have a redundant device at the right side)	Yes
018 Train Power Supply	Yes
024 Train lighting (may be replaced in the target system due to TCMS providing the trigger information – see section 5)	Yes
028 Instrument lighting (may be replaced in the target system due to TCMS providing the trigger information – see section 5)	Left panel below the desk
030 Gooseneck microphone	Not implemented
031 Driver activity control button	Not implemented
040 Key board	Not implemented

Recommended Position in UIC 612	The same position on PRIMA II?
Optional elements with fixed location only for locomotives	
021 Door control: left doors-release & cancel release	No
022 Door control: Forced closing	No
023 Door control: right doors-release & cancel release	No

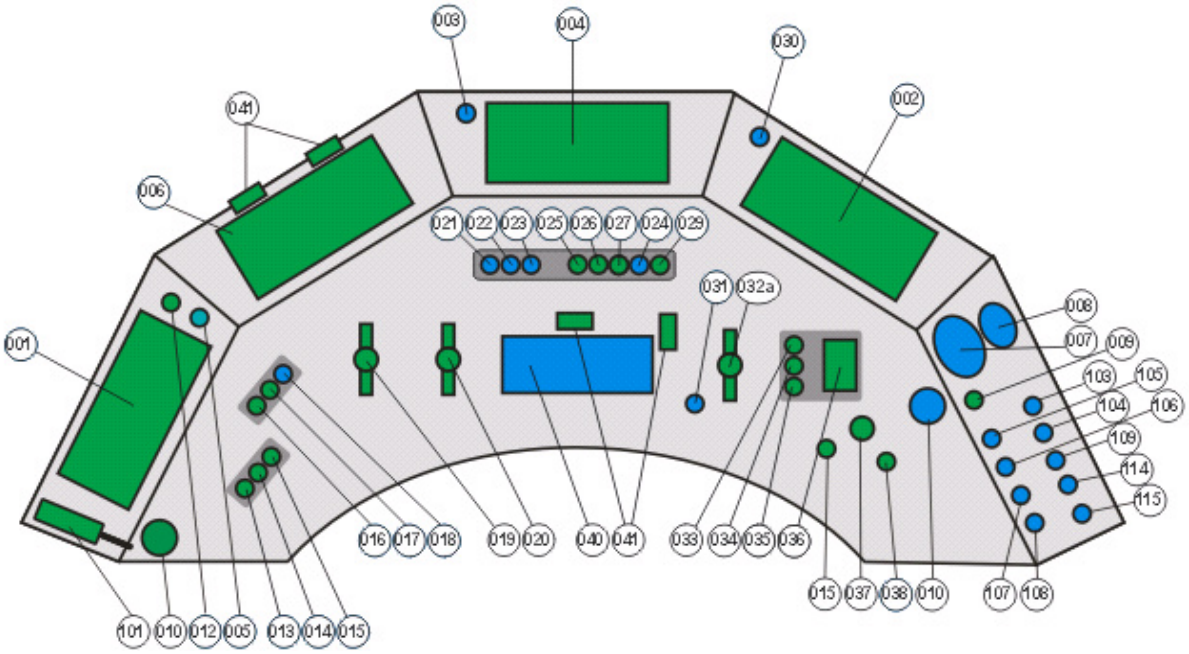

Fig. 4: Driver's desk according UIC 612

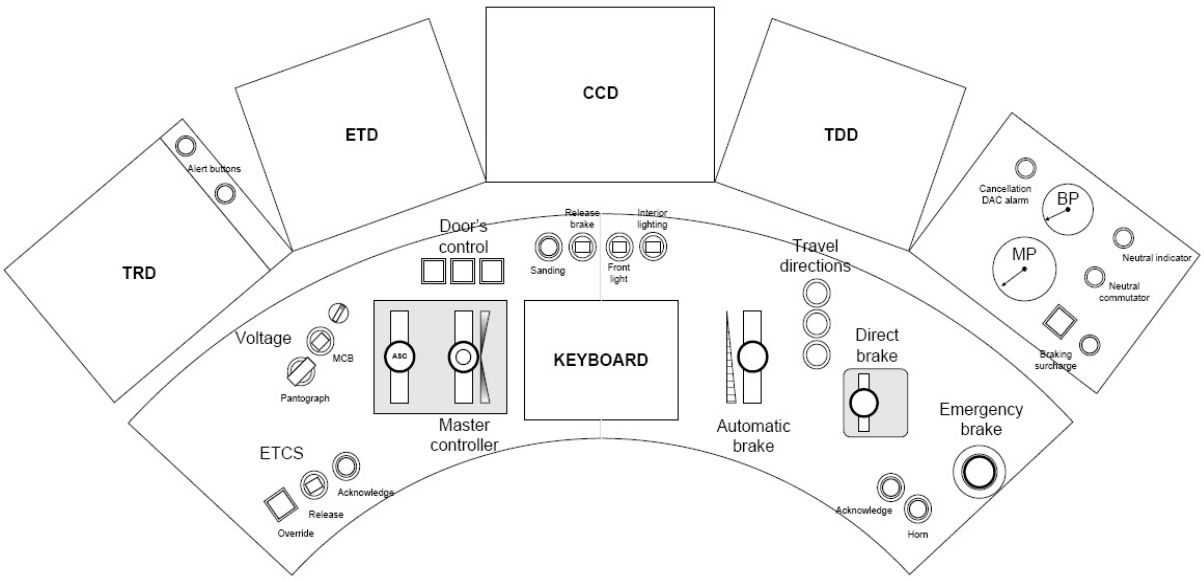

Fig. 5: EUDD*plus* desk concept integrated into PRIMA II locomotive prototype

Displays

Fig. 6: EUDD*plus* desk - Displays

The EUDD*plus* driver's desk is equipped with four displays which are giving all needed information to the driver (from left to right: TRD, ETD, CCD, TDD[5]).

Requirements and recommendations have been defined regarding the design, the hardware components and the visibility and legibility of the displays.

Desk integration

Fig. 7: PRIMA II locomotive prototype used for the in-field tests at Wildenrath test centre

[5] TRD – Train Radio Display, ETD – Electronic Timetable Display, CCD – Command and Control Display, TDD - Technical and Diagnosis Display

The EUDD*plus* desk concept has been integrated left side oriented into the PRIMA II locomotive prototype. The first presentation to the EUDD*plus* consortium took place at the Wildenrath test centre on 03 September 2009. The EUDD*plus* desk concept is based on the ORS given by UIC 612 and takes into account the improvements of the MODTRAIN/MODLINK/EUCAB project.

Fig. 8: Left side oriented EUDD*plus* desk integrated into the PRIMA II locomotive prototype

The EUDD*plus* desk concept and the auxiliary desks are 80 % compliant to UIC 612.

The main discrepancies compared to UIC 612 resulted to the following comments:

- Installing a badge reader on the desk is a concern due to place limitation.
- The redundancy mode of displays had not been realised in conformity to UIC 612.
- Using a lever for ASC[6] with a fixed angle +/- 55 can limit the precision of speed for HST[7] and VHST[8] configuration.
- The number of colours used in TDD in some screens is too high.
- It is difficult to integrate national safety equipment on a side oriented desk comparing to a larger desk.

[6] ASC – Automatic Speed Control

[7] HST – High Speed Train

[8] VHST – Very High Speed Train

Training simulator

Fig. 9: EUDD*plus* training simulator

Fig. 10: Instructions given to the test-drivers at the EUDD*plus* training simulator

The EUDD*plus* desk for the training simulator was delivered to Wildenrath test centre by 04 November 2009. During the in-field tests the EUDD*plus* training simulator was used for preparation of the test drivers and for the accomplishment of the final debriefing after the test runs.

The EUDD*plus* training simulator is suitable for the dissemination of the project's results: Within the duration of the project it has been presented during the EUDD*plus* Public Demonstration Day and the EUDD*plus* Final Conference. A presentation of the EUDD*plus* training simulator during the 2010 Innotrans is planned.

WP 7 In-field Test Programme and Evaluation

Test programme

The test scenarios had been designed in a way that made the drivers able to use all the driving equipment at least one time, including different operational modes (normal operation, degraded modes, shunting).

Fig. 11: Test locomotive PRIMA II with the MODLINK/EUCAB and the EUDD*plus* project logos

Fig. 12: Train set used for the in-field tests on the large Wildenrath test ring T1

The characteristics of the test scenarios are described below:

scenario 0	• driving with a train set (locomotive with nine container-carrying wagons, train length: 192 m, train weight: 263 t, braking percentage: 103 %) on the large Wildenrath test ring T1 • 50 minutes long • maximum speed 120 km/h • driving with ETCS and fixed signals • normal operation with pre-departure tests, train data entry, accelerating, decelerating, power supply transition, ETCS level transition, stop at a red signal • familiarisation with the driver's desk
scenario 1	• driving with a train set (locomotive with nine container-carrying wagons) on the large Wildenrath test ring T1 • 50 minutes long • maximum speed 120 km/h • driving with ETCS and fixed signals • driving under daylight conditions • normal operation with pre-departure tests, train data entry, accelerating, decelerating, power supply transition, ETCS level transition, stop at a red signal • measurement of the driver's eye movements
scenario 2	• driving with a train set (locomotive with nine container-carrying wagons) on the large Wildenrath test ring T1 • 50 minutes long • maximum speed 120 km/h • driving with ETCS and fixed signals • driving under nightlight conditions • normal operation with pre-departure tests, train data entry, accelerating, decelerating, power supply transition, ETCS level transition, stop at a red signal
scenario 3	• driving on the small Wildenrath test ring T2 without wagons • 40 minutes long • maximum speed 85 km/h • driving without ETCS and fixed signals • failures and incidents to be solved: failure of the compressor, failure of the display • measurement of the driver's eye movements
scenario 4	• driving on the small Wildenrath test ring T2 without wagons • 40 minutes long • maximum speed 85 km/h • driving without ETCS and fixed signals • failures and incidents to be solved: emergency brake, driving in standing position
scenario 5	• shunting on Wildenrath test track T5 without wagons • 20 minutes long • driving in slope (maximum 40 ‰) • use of the auxiliary desks, sanding

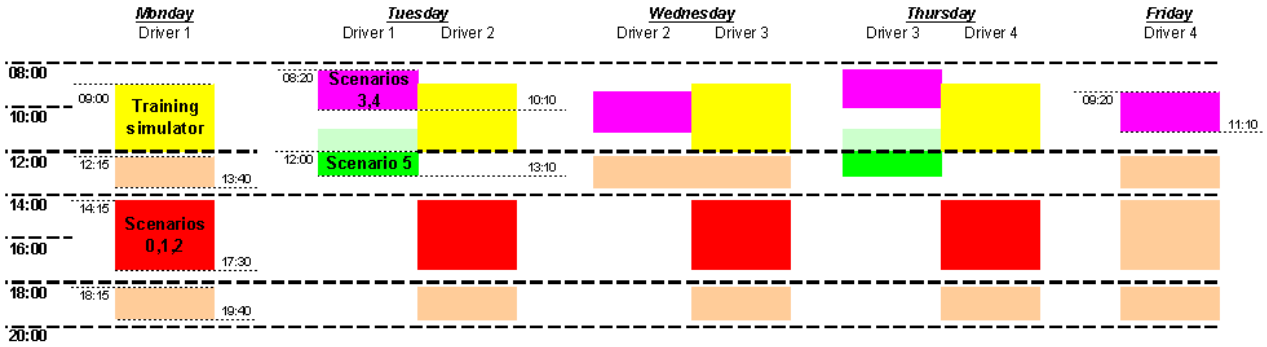

Fig. 13: Distribution of the scenarios in a typical test week

From the ergonomics' point of view it was essential to analyse the usability (perceptability, operability, reachability, and understanding) of the hardware (mainly controls) and software components (displays) of the desk to the drivers.

Fig. 14: Scenario 5 - Shunting movements for which the auxiliary desk was used

To ensure transitions between ETCS levels while driving, there have been foreseen six additional trackside signals beside the large 6 km long Wildenrath test ring T1. To give the drivers the impression of a 60 km long trip the signals should be to show different signalling aspects for every round. These signals based on LED technology could be activated by rail contacts and GSM-R.

Doing so it was possible to announce and indicate speed restrictions, standing positions, neutral zones, begin and end of cab signalling.

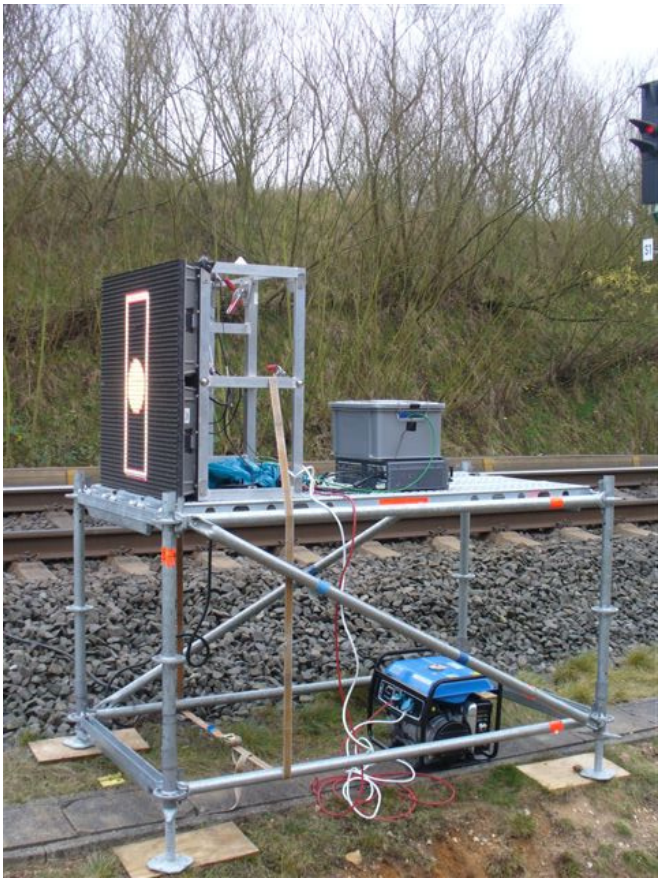

Fig. 15: Additional Trackside signal beside the large Wildenrath test ring T1

Fig. 16: Activating principle of the additional trackside signals

Methods of data collection

Certain methods for collection of objective and subjective data have been applied during and immediately after the test runs:

- Measurement of the luminance in the cab
- Recording of the driver's eye movements
- Recording of driving data
- Observation of the actions of the driver
- Questionnaires for assessment of the desk ergonomics, the display units, the interaction of the software and hardware
- Stress and strain assessments
- Comments of the driver while driving on the locomotive or on the simulator

An eye tracking system was used to register the eye movements of the test drivers during the driving, which allows the extraction of the following information:

- Number of visits on an area of interest[9] (e.g. How often the display TDD was looked at?)
- Number of fixations in an area of interest (e.g. How intensive the TDD has been regarded during the whole registration time?)
- Duration of attention (e.g. the analysis of the relative time the test drivers look at the control elements or displays in comparison to the relative time they look at the track)
- Transitions between areas of interest (e.g. How many percent of test drivers look immediately up at the track after having looked at the TDD?)
- Reception sequence between areas of interest (e.g.: Which way goes the eye flow from a starting point like e.g. the TDD over two or more areas of interest?)

Eye movement registration data of all test drivers were cumulated to

- show how much attention test drivers need for control devices and display information during the operating of the scenarios
- help to determine the reasons for the possible reports of high mental effort
- help to analyse if the appearance of a special symbol on a display can be perceived by test drivers

[9] Area of interest is a defined area of the environment, where a test person can look at. There is no differentiation of the regarded points within one area of interest. For the purpose of the EUDD*plus* project an area of interest can be e.g. any control device on the driver's desk.

Fig. 17: Measuring of the driver's eye movements

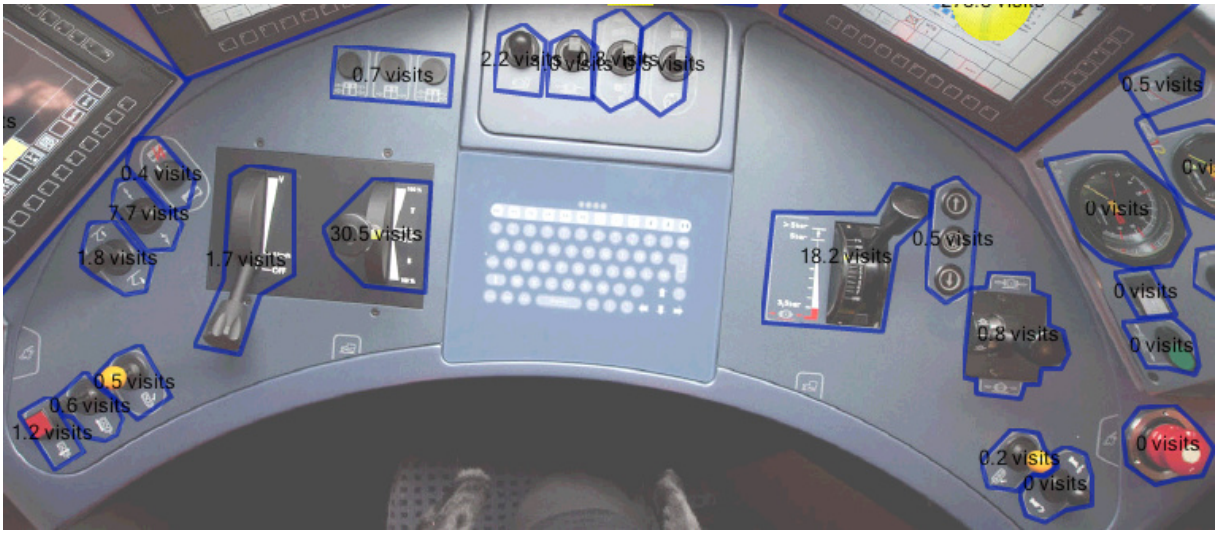

Fig. 18: Number of visits of the eye on the desk while driving with ETCS

Fig. 19: Density Distribution during the drive with ETCS

Fig. 20: Gaze transitions during a power supply transition while driving with ETCS

General assessment

Based on the feedback from the subjects included within the in-field tests it can be stated that the EUDD*plus* driver's desk is an ergonomically well designed easy and intuitive operable workplace for the engine drivers. By means of modular structured controls on the operating level and four displays on the monitoring level the engine drivers are able to drive the train easily and safely. In general the EUDD*plus* driver's desk was assessed as very good.

Fig. 21: Debriefing after each scenario - fill-in of questionnaires

Arrangement of the controls and their position

The modular structured controls and their arrangement on the desk helped the test drivers to become familiar with the new desk and to find the most of the controls very quickly. Based on the comments little changes of the position of the controls were proposed.

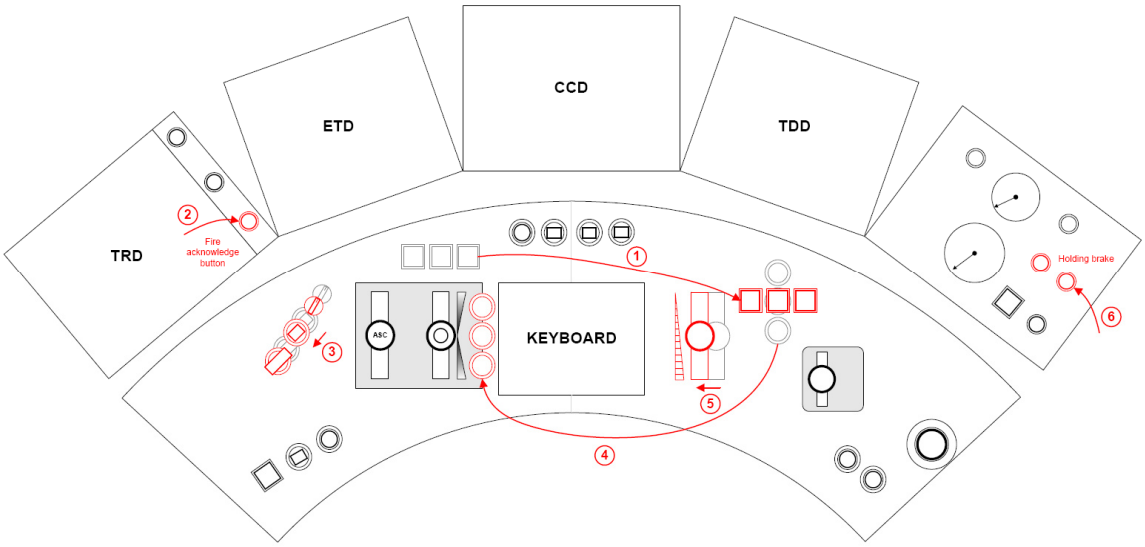

Fig. 22: Proposal for reallocations of controls

Usability of elements on the desk

Also the usability of the most elements was assessed well in general. There were found some problems with the operation of few elements, especially regarding the operation of the Automatic Speed Controller, the Traction/Brake Controller, the pantograph and DAC[10].

Regarding the Automatic Speed Controller the time delay between the movement of the lever and the displacement of the corresponding indicator at the speedometer should be reduced. It has been proposed that a definition and a limit value of this delay should be stated more precisely in future amendments of the UIC 612. The input of the target speed on the TDD was not a practical solution for the test drivers and should be improved, especially for high speed operational cases.

Regarding the Traction/Brake Controller there was a problem of skipping the zero position which must be solved, because it would affect the comfort and on a long term the machine. The similar problem occurs regarding the control for the pantograph: The end position “Pantograph emergency” is too easy to reach and can be activated by accident. The possibility to make the barriers between each position harder should be analysed.

The assessments of the three DAC controls (a sensitive button integrated in the Traction/Brake Controller, sensitive buttons on the desk and the foot switch) proved that a control for the DAC should be located on the master controller. Nevertheless, the location which is presently described in the UIC 612 (on the top) is not acceptable. Actually the drivers did not use this sensitive button during the tests. They preferred the foot switch.

Visibility and perceptibility

Some perceptibility problems occurred regarding the task and driver’s cab lighting control. It has the same shape as the two elements for the release brake and the external front light in the centre module located next to each other. It is proposed to change the shape of two of these three switches, making it easier to differentiate them from each other.

Due to the amount of the different positions for the front light switch, it is difficult to recognise the actual selected position. Thus, a pictogram should be added on the TDD to give feedback about the actual position of this switch.

In order to improve the visibility of the elements in the dark the pictograms of the controls should be elevated. Due to the fact that not all drivers missed this function it should be possible to switch the lighting off.

General preferences

General preference of pressure information is divided: Nearly half of the drivers’ preferred traditional mechanical gauges and a half the digital solution like provided on the TDD. From the human factors point of view, the digital solution bears no problems concerning the readability and understandability of the pressure information. But taking in consideration the results of the in-field test it is proposed that the pressure gauges should stay optional in the UIC 612.

The objective is to use the new digital design on driver’s desks in the future. In general, elevated push buttons were preferred by the drivers. It is recommended that it should be taken into consideration for future amendments of the UIC 612, maybe as a recommendation.

The elevation of a push button seems to make it easier for the driver to activate it without watching it. The possibility to elevate also the ETCS override should be considered, given its off-centred position on the left side of the desk to avoid the activation by accident.

[10] DAC – Driver’s Activity Control

Software

The special focus of analysis was the software. The CCD basic image in general is assessed very positively. The implementation of the planning area led to a discussion about its necessity. The information for driving under ETCS is very good implemented. The only negative remarks were given about the braking curve which occurs without any announcement. The value of the braking distance is also too small and should decrease with a progressive speed. Some pictograms are not clear, e.g. the abbreviation CTP.

The new designed ETD should be improved. Some elements on the ETD should be suppressed and others reorganised. The shape of the speed profile on the left side should stay like during the tests. It was a very good reference and gave security to the drivers. But the text size is too small and the display contains too much information. The marking should show the current position and not the next position like implemented on PRIMA II.

In contrary the TDD contains only the necessary information on the screen. Some improvements can be done regarding the pictograms and the pressure information graphics. An indication for the main pipe pressure should be added. Additionally, the status of the train power supply and a consumption indicator can be added on the right side of the screen.

LCC considerations

One major target of the project was to achieve a reduction of the Life Cycle Costs (LCC) of the system driver's desk of at least 15 % compared to the reference case (given by the test locomotive with conventional desk).

The important effort made in the engineering phase of EUDD*plus* - a multisystem driver's desk specifically designed for universal locomotives - will pave the way for this desk to reach larger markets, this is it will be able to satisfy different clients and cover different areas without important changes of its design and manufacture processes. In so doing, EUDD*plus* will have better life cycle costs than regular desks because enabling better economies of scale; The averaged overall LCC savings have been estimated for 12 % in respect to regular desks. These savings respond principally to reductions in engineering costs and better experience curves on manufacturing processes. However, for all this to happen, EUDD*plus* shall achieve production series of at least 70 - 90 units without important modifications of the engineering activities and manufacture processes.

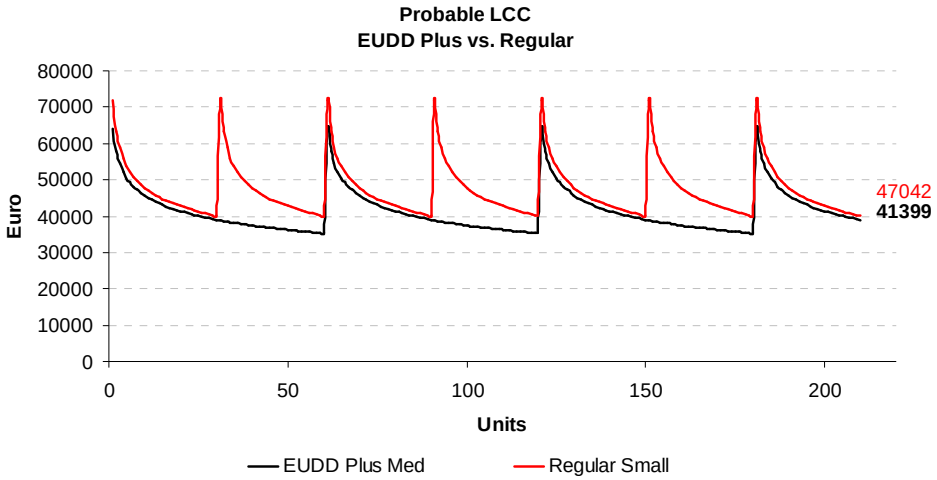

Fig. 23: Probable LCC scenario with EUDD*plus* performance in a medium range 60 – 90

EUDD*plus* should as well recover the investments done in previous projects, this is, EUDD, MODTRAN and EUDD*plus*, which will happen when sufficient EUDD*plus* desks are produced, TUB has estimated that a breakeven should be reached by the 2000th produced unit. This breakeven may be smaller if larger series of desks are produced, being possible to breakeven from the 700th produced unit onwards.

The market for locomotive multisystem desks, and therefore for EUDD*plus* desks, has been estimated in having a 10 % annual growing pace for the next decade, which leads to a necessity of about 3000 desks until 2021. This is result of the imminent obsolescence of 1970's and 1980's locomotives as well as because of an increase of the cross-border freight traffic.

EUDD*plus* desk could even achieve larger production series (> 100 units) leading to a maximal potential of 30 % savings in LCC in respect to regular desks.

WP 3 Homologation Support
WP 8 Conclusions for Broad Scale Exploitation
WP 2 EUDD*plus* User Platform

Methodology of conformity check

As a basis the items of the CR TSI Loc&Pas RST as a part of the EUDD*plus* relevant categories listed below have been identified and put into a spreadsheet.

4.4	Brake command
4.4.1	Emergency braking command
4.4.2	Service braking command
4.4.3	Direct braking command
4.4.4	Dynamic braking command
4.4.5	Parking braking command

7.2	Visual and audible vehicle identification and warning functions
7.2.2	External lights
7.2.2.4	Lamp controls
7.2.3.2	Warning horn sound pressure levels
7.2.3.4	Warning horns, control

9.1	Driver's cab design
9.1.1	Cab design
9.1.1.1	Interior layout
9.1.1.2	Desk ergonomics
9.1.1.3	Driver's seat
9.2	Working conditions
9.2.1	Environmental conditions
9.2.1.3	Lighting in driver cabs
9.3	Driver/machine interface
9.3.1	Driver/machine interface
9.3.1.2	driver display unit and screens
9.3.1.3	controls and indicators
9.3.2	Driver supervision
9.3.3	rear and side view
9.4	Marking and labelling in Driver cabs
9.5	Equipment and other facilities onboard for staff
9.5.3	On-board tools and portable equipment

Fig. 24: List of EUDD*plus* relevant categories

The relevant sections of the requirements of the CR TSI Loc&Pas RST have been split up into items that have been compared to the specifications for the EUDD*plus* driver's desk given by UIC 612 (and related UIC 640 and 651). 86 % of these items are in conformity with the requirements of the TSI. 2 % did not meet the requirements and 6 % of the items could not be assessed exactly. The missing 6 % are declared as open so far.

By reason that the tested EUDD*plus* desk concept meets the EUDD*plus* specifications given by UIC 612 with conformity of 80 %, all items have been classified into four categories to be assessed in terms of conformity with CR TSI Loc&Pas RST:

a) conformity has been assessed in the framework of the in-field tests (e.g. “the interior layout shall allow both seated and standing driving positions”)

b) conformity has been assessed by visual inspection (e.g. one the emergency devices shall be a red punch button)

c) information on conformity has been obtained by interview with Alstom experts (e.g. “only one service braking command shall be active in a train”)

d) conformity could not be assessed in the framework of this project (e.g. optical or mechanical characteristics of the windscreens)

Based on these categories the assessment has been carried out, by appropriate consideration within the in-field test evaluation, visual and manual inspection, and interviews with Alstom experts. The assessment results are shown in the following spreadsheet:

ANNEX 7 / *TSI TEXT*	**Control mechanism**	**Criteria and threshold values for control**	**Result**
BRAKING COMMAND [4.4]			
Emergency braking command [4.4.1]			
At least two independent emergency brake command devices shall be available,… [4.2.4.4.1]	Visual inspection	At least two independent emergency brake command devices identified	Passed
…allowing the activation of the emergency brake by a simple and single action from the driver in his normal driving position, using one hand. [4.2.4.4.1]	In-field tests questionnaire	The Question “Was it possible to activate the emergency brake by a simple and single action from the sitting driving position, using one hand?” was answered with yes by all drivers.	Passed
One of these devices shall be a red punch button (mushroom push button). [4.2.4.4.1]	Visual inspection	One red punch button identified	Passed
The emergency brake position of these two devices when activated shall be self locking by a mechanical device; [4.2.4.4.1]	Manual inspection	Position of the device stays unchanged – movement to original position is only possible by application of mechanical force	Passed
Unlocking this position shall be possible only by an intentional action. [4.2.4.4.1]	Manual inspection	The red punch buttons have to be pulled up again and the mechanical effort is significantly higher for moving the automatic brake controller from the emergency brake position than for moving from another position	Passed
The activation of the emergency brake shall also be possible by the Control-Command and signalling on-board system, as defined in the CR CCS TSI. [4.2.4.4.1]	Prototype expert evaluation	Confirmed by Alstom experts	Passed

ANNEX 7 / *TSI TEXT*	Control mechanism	Criteria and threshold values for control	Result
Service braking command [4.4.2]			
The service brake function shall allow the driver to adjust (by application or release) the brake force between a minimum and a maximum value in a range of at least 7 steps (including brake release and maximum brake force), in order to control the speed of train. [4.2.4.4.2]	Manual inspection	Moving the lever of the automatic brake controller in the possible positions and distinguish at least 7 steps	Passed
Only one service braking command shall be active in a train [4.2.4.4.2]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
To meet this requirement, it shall be possible to isolate the service braking function of the other service braking command(s) of the unit(s) part of a train formation, as defined for fixed and predefined formations. [4.2.4.4.2]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
When the speed of the train is higher than 15 km/h, the service brake activation shall lead automatically to the cut-off of all tractive effort; [4.2.4.4.2]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
This cut-off shall not be reset until the traction command is cancelled by the driver. [4.2.4.4.2]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
Direct braking command [4.4.3]			
Locomotives (units designed to haul freight wagons or passenger carriages) assessed for general operation shall be fitted with a direct brake system. [4.2.4.4.3]	Inspected in operation	Minimum of 3 experts have independently confirmed the functionality while driving at the test track	Passed
The direct brake system shall allow the application of a brake force on the concerned unit(s) only, with other unit(s) of the train remaining unbraked. [4.2.4.4.3]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
Dynamic braking command [4.4.4]			
It shall be possible on electric units for the driver to prevent the use of regenerative braking so that there is no return of energy to the overhead contact line when driving on a line which does not allow that (see CR ENE TSI clause 4.2.7). [4.2.4.4.4]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
it is permitted to use a dynamic brake independently from other brake systems, or together with other brake systems (blending). [4.2.4.4.4]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
Parking braking command [4.4.5]			
The parking braking command shall lead to the application of a defined brake force for an unlimited period of time, during which a lack of any energy on board may occur. [4.2.4.4.5]	Prototype expert evaluation	Confirmed by Alstom experts	Passed

ANNEX 7 / *TSI TEXT*	Control mechanism	Criteria and threshold values for control	Result
It shall be possible to release the parking brake at standstill in any situation, including for rescue purposes. [4.2.4.4.5]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
VISUAL AND AUDIBLE VEHICLE IDENTIFICATION AND WARNING FUNCTIONS [7.2]			
External lights [7.2.2]			
Lamp controls [7.2.2.4]			
It shall be possible for the driver to control the head, marker and tail lamps of the unit from the normal driving position; this control may use independent command or combination of commands. note: it is not required to control the lights in a particular combination to display an emergency warning signal in case of emergency situation. [4.2.7.1.4]	Visual inspection In-field tests questionnaire	Activating and deactivating the lamp controls in normal driving position overall response to question about reachability was assessed as very good by the drivers	Passed
Horn control [7.2.3.4]			
It shall be possible for the driver to sound the audible warning device from all driving positions specified in clause 4.2.9 of this TSI. [4.2.7.2.4]	In-field tests questionnaire	Reachability of the warning horn device on the driver's desk was assessed very positive by the drivers	Passed
DRIVER'S CAB DESIGN [9.1]			
The driver's cabs shall be designed to permit operation by a single driver. [4.2.9.1.1]	Inspected in operation	Minimum of 3 experts have independently confirmed the functionality while driving at the test track	Passed
Cab design [9.1.1]			
Interior layout [9.1.1.1]			
The interior layout of the cab shall take into account the anthropometric measurements of the driver as set out in the Annex E. [4.2.9.1.4]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
Freedom of movement of personnel in the cab interior shall not be inhibited by obstructions. [4.2.9.1.4]	Visual inspection	No obstructions for free movement in the cab identified	Passed
The cab floor corresponding to the working area of the driver (access to the cab excluded) shall be without any step. [4.2.9.1.4]	Visual inspection	No step identified on the cab floor	Passed
The interior layout shall allow both seated and standing driving positions on locomotives and driving coaches intended to be used in a train formation with a locomotive. [4.2.9.1.4]	Inspected in operation	Minimum of 3 experts have independently confirmed the functionality while driving at the test track	Passed
The cab shall be equipped with at least one driver's seat (see clause 4.2.9.1.5) and additionally with a forward facing seat not considered as a driving position for possible accompanying crew. [4.2.9.1.4]	Visual inspection	One driver's seat indentified	Passed

ANNEX 7 / *TSI TEXT*	Control mechanism	Criteria and threshold values for control	Result
Driver's desk ergonomics [9.1.1.2]			
The driver's desk and its operating equipment and controls shall be arranged to enable, in the most commonly used driving position, the driver to keep a normal posture, without hampering his freedom of movement, taking into account the anthropometric measurements of the driver as set out in the Annex E. [4.2.9.1.6]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
To allow the display on the driver's desk surface of paper documents required during driving, a reading zone of minimum size 30 cm width per 21 cm high shall be available in front of the driver's seat. [4.2.9.1.6]	Visual inspection	Measurement of the reading zone	Passed
Operating and control elements shall be clearly marked, so that they are identifiable by the driver. [4.2.9.1.6]	Visual inspection	Checked, if all control devices are clearly marked	Passed
If the traction and/or braking effort is set-up by a lever (combined one or separated ones), the "tractive effort" shall increase by pushing the lever forwards, and the "braking effort" shall increase by drawing the lever towards the driver. [4.2.9.1.6]	Inspected in operation	Required mode of operation of these controls verified	Passed
If there is a notch for emergency braking, it shall be clearly distinguished from those of the other positions of the lever. [4.2.9.1.6]	Visual inspection	Position and effort to move the automatic brake controller to/from the emergency brake position is clearly distinguishable	Passed
Drivers seat [9.1.1.3]			
The driver's seat shall be designed in such a way that it allows him to undertake all normal driving functions in a seated position, taking into account the anthropometric measurements of the driver as set out in the Annex E. [4.2.9.1.5]	In-field tests questionnaire	18 % of the drivers answered the question "does the seat allow to undertake all the driving functions in a seated position" negative	Not accepted
It shall allow for correct posture of the driver from the physiological point of view. [4.2.9.1.5]	Physiological assessment	Not applicable – has not been carried out in framework of EUDD*plus*	Open
It shall be possible for the driver to adjust the seat position in order to meet the reference position of eyes for external visibility, as defined in clause 4.2.9.1.3.1. [4.2.9.1.5]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
The seat shall not constitute an obstacle for the driver to escape in case of emergency. [4.2.9.1.5]	In-field tests questionnaire	Drivers have been asked if the seat hindered them from leaving the cab quickly after executing an emergency braking – more than 50 % stated no	Not accepted
Ergonomics and health aspects shall be considered in the design of the seat, its mounting and its use by the driver. [4.2.9.1.5]	Not applicable	Not applicable – has not been carried out in framework of EUDD*plus*	Open

ANNEX 7 / *TSI TEXT*	Control mechanism	Criteria and threshold values for control	Result
The mounting of the driver's seat in locomotives and driving coaches intended to be used in a train formation with a locomotive shall allow adjustment to get the necessary free space needed for the standing driving position. [4.2.9.1.5]	In-field tests questionnaire	Drivers have been asked if there is enough space for standing driving positon – 50 % of the drivers stated no	Not accepted
Windscreen in driver's cabs [9.1.3]			
Equipment [9.1.3.3]			
The windscreen shall be equipped with de-icing, de-misting and external cleaning means, under control of the driver. [4.2.9.2.3]	Inspected in operation	Availability of these functionalities has been checked	Passed
WORKING CONDITIONS [9.2]			
Environmental conditions [9.2.1]			
Lighting in drivers Cabs [9.2.1.3]			
Cab general lighting shall be provided on driver's command in all normal operational modes of the rolling stock (included "switched off"). [4.2.9.1.8]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
If provided, lighting of instruments shall be independent of the general lighting and shall be adjustable. [4.2.9.1.8]	Manual inspection	Mode of operation of this control was tried out	Passed
In order to prevent any dangerous confusion with outside operational signalling, no green lights or green illumination are permitted in a driver's cab, except for existing class B cab signalling systems (as defined in the CR CCS TSI). [4.2.9.1.8]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
DRIVER MACHINE INTERFACE [9.3]			
Driver machine interface [9.3.1]			
Driver display unit and screens [9.3.1.2]			
For functions in the scope of this TSI, the information or commands to be used by the driver to control and command the train, and given by means of display units or screens, shall be designed to allow proper use and reaction from the driver. [4.2.9.3.3]	In-field tests	Term proper is a too general formulation – to make this formulation more concrete subitems are proposed in Deliverable D3.2	Open
Controls and indicators [9.3.1.3]			
All indicator lights shall be designed so that they can be read correctly under natural or artificial lighting conditions, including incidental lighting. [4.2.9.3.4]	In-field tests questionnaire	Not tested explicitly in EUDD*plus*	Open
Possible reflections of illuminated indicators and buttons in the windows of the driver's cab shall not interfere with the line of sight of the driver in his normal working position. [4.2.9.3.4]	Prototype expert evaluation	Confirmed by Alstom experts	Passed

ANNEX 7 / *TSI TEXT*	Control mechanism	Criteria and threshold values for control	Result
In order to prevent any dangerous confusion with outside operational signalling, no green lights or green illumination are permitted in a driver's cab, except for existing class B cab signalling system (according CR CCS TSI). [4.2.9.3.4]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
Audible information generated by on-board equipment inside the cab for the driver shall not be lower than 6 dB(A) above the median received noise level in the cab, measured as defined in the Noise TSI. [4.2.9.3.4]	Measurements during operation	Not tested in EUDD*plus*	Open
Drivers supervision [9.3.2]			
DRIVER´S ACTIVITY CONTROL FUNCTION – Any lack of driver's activity when the train is in driving configuration (cab activated) and is moving (criterion for movement detection is at a low speed threshold) shall be detected within 60 seconds and shall lead, in the absence of driver reaction, to a full service brake or an emergency brake application on the train. [4.2.9.3.1]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
In case of application of a full service brake, its effective application shall be automatically controlled and in case of non application, it shall be followed by an emergency brake. [4.2.9.3.1]	Prototype expert evaluation	Confirmed by Alstom experts	Passed
Rear and side view [9.3.3]			
The cab shall be designed to allow the driver to have a rear view of each side of the train at stand still, while at the same time still being able to operate the emergency brake. [4.2.9.1.3.2]	Visual and manual inspection	Moving into a position that allows rear view and operate the emergency brake	Passed
The above requirement is permitted to be met by one of the following means: opening side windows or panel at each side of the cab, exterior mirrors, camera system. [4.2.9.1.3.2]	Visual and manual inspection	Putting the head through the aperture of the window and operate the emergency brake	Passed
In case of opening side windows or panel, the opening shall be sufficiently large for the driver to put his head through the aperture. [4.2.9.1.3.2]	Visual inspection	Check, if there is sufficiently space to put a head through the aperture	Passed
MARKING AND LABELLING IN DRIVER CABS [9.4]			
The following information shall be indicated in the driving cabs: Max. speed (Vmax), Identification number of rolling stock (traction vehicle number), Location of portable equipment (e.g. self-rescue device, signals), Emergency exit [4.2.9.3.5]	Visual inspection	Check, if the mentioned indications are available	Not accepted
Harmonised pictograms shall be used to mark controls and indicators in the cab [4.2.9.3.5]	Visual inspection	Compare the pictograms used against the pictograms proposed in UIC leaflet 612	Passed

ANNEX 7 / *TSI TEXT*	Control mechanism	Criteria and threshold values for control	Result
EQUIPMENT FACILITY AND OTHER ONBOARD STAFF [9.5]			
Onboard tools and portable equipment [9.5.3]			
A space shall be available in or near the driver's cab to store the following equipment, in case they are needed by the driver in emergency situation: hand-lamp with red and white light short circuiting equipment for track-circuits; scotches, if the parking performance is not sufficient depending on track gradient; a fire extinguisher in accordance with HS RST TSI 2008 clause 4.2.7.2.3.2; on manned traction units of freight trains: a respirator, as specified in the SRT TSI. [4.2.9.4]	Visual inspection	Check, if sufficient space is available	Passed

Generally, the analysis has shown that the tested EUDD*plus* driver's desk is in conformity to a huge part of the CR TSI Loc&Pas RST. It has been demonstrated that the EUDD*plus* driver's desk and thus, major parts of the UIC 612 are in conformity to this TSI (all the items of the EUDD*plus* driver's desk that have been assessed against the CR TSI Loc&Pas RST are in conformity to UIC 612). It has been shown that UIC 612 is – at least for all the parts realised and tested in EUDD*plus* – a sound basis to ensure that the essential requirements are met by a driver's desk and therefore appropriate to enhance interoperability.

The relevant sections of the requirements of the CR TSI Loc&Pas RST have been split up into 53 items that have been compared to the tested EUDD*plus* driver's desk. 79 % of these items have met the requirements of the TSI. 8 % did not meet the requirements and 13 % of the items could not be assessed exactly.

The main conclusions for further development of Cross Acceptance and more efficient authorisation procedures are:

- Consistent denotation in different documents to enhance transparency and common understanding would be very helpful. E.g.: The dynamic braking command equates to the combined traction/dynamic brake controller defined within UIC 612. Both documents use different terms.
- Tasks not mentioned within UIC 612 derived from UIC 651 and 640 should be integrated. E.g.: Most of the pictograms are defined within UIC 612 but some are only mentioned in UIC 640 like emergency brake (640 Appendix F 1), emergency windscreen wiper control (640 Appendix F 4), Two tone horn (640 Appendix F 22) and Engine compartment lighting (640 Appendix K 1).
- More concrete formulation within both documents (TSI and UIC 612) would simplify the definition for adequate measuring methodologies. Regarding TSI the description of displays is not as precise as it should be to propose/define standardised assessment procedures. This could take the form of a code of practice or manual.
- The emphasis to classify proper use and reaction is not clear according to this phrase.
- It would be helpful to adapt UIC 612 contents to TSI contents. According to the conformity check in the scope of this project deviations regarding emergency brake were discovered.

- To unlock the ASC controller you have to turn the handle counterclockwise as required by UIC 612. Some drivers and technicians remarked that unlocking this device would not be easy. Alstom made an additional test with an ASC controller which has to be unlocked by turning the handle clockwise and it turned out that unlocking was significantly easier. Therefore it is proposed for UIC 612 to consider also the location of the controller: If the controller is located on the right side of the driver's desk the direction of the rotation should be counterclockwise, in case the controller is located on the left side the direction of the rotation should be clockwise.
- Based on current EU policy (Interoperability Directive) the approach to check if EUDD*plus* specifications are in conformity with the essential requirements, which are mandatory, turned out successful.
- European Cross Acceptance activities have been supported by complementing the ERA spreadsheet with EUDD*plus* specifications (i.e.: UIC 612).
- As an essential result, it turned out that it is very helpful, if specifications are checked against the Technical Specifications of Interoperability to which compliance is mandatory. Particularly if the specification establishes a basis for systems, as UIC 612, the benefits of a conformity assessment will increase accordingly. Such an assessment of conformity with the respective TSI is therefore recommended also for specifications of other railway subsystems. For the assessment the procedure elaborated within EUDD*plus* can be easily applied to other rail subsystems.

The EUDD*plus* results will actively be used in the following standardisation activities on European level:

- Technical Recommendation (TecRec) of the driver-machine-interface as an agreed paper between UIC and UNIFE, based on the UIC 612, EUCAB and EUDD*plus* results, which contributes to the CEN WG37 activities and to the implementation of the EUDD*plus* desk prototype.
- prEN CAB with a part based on the results of the EUDD*plus* project in close interaction with CEN TC256.

2 Section 2 – Dissemination and use

Annex: Plan for using and disseminating the knowledge

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
	Press release (press/radio/TV)	***General public***			
December 2009	Press Release Public Day of the project EUDD*plus*	European Railway Sector	EU		UIC, UNIFE, FAV
	Media briefing	***Higher education***			
December 2009	Integrated EUDDplus desk concept integrated in Alstom PRIMA II locomotive prototype and in-field testing Alstom Press Conference in Wildenrath	Scientific Press	EU	unlimited	ALS, FAV
January 2010	Project development and in-field testing of EUDD*plus*	Scientific Press	EU	journalists' requests	FAV
	Conferences				
September 2008	Presentation on UIC, SET 15 (Cab and operations including TCMS) meeting	User platform members (i.e. operators and suppliers)	EU	15	UIC, FAV
June 2009	Presentation on UIC, SET 15 (Cab and operations including TCMS) meeting	User platform members (i.e. operators and suppliers)	EU	15	UIC, ALS, VUT, FAV

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
September 2009	EUDD*plus* Intermediate Seminar	European railway sector	EU	40	FAV and all
December 2009	EUDD*plus* Public Demonstration Day in Wilden-rath	European railway sector	EU	40	FAV and all
January 2010	EUDD*plus* Final conference – results and way ahead	European railway sector	EU	50	FAV and all
May 2010	Euro Zel 2010: M. Barta, X. Zubillaga, S. Köszegi, M. Rentzsch, Ch. Karsten: Human Factors Evaluation of a Standardised Drivers Desk Under Real Life Con-ditions	European railway sector	EU	ca. 200	IAS, VUT
May 2011	9th World Congress on Railway Research WCRR 2011, Lille Usability Testing of the future standardised Euro-pean Driver's Desk under "Real World" conditions planned	International railway sec-tor	International	ca. 750	ALS, IAS, VUT
	Project web-site				
	www.euddplus.eu	Public and restricted to project team area	World wide	unlimited	FAV
	Flyer/broschures				
September 2010	Newsletter (InnoTrans 2010) Publication on test results	International Transport experts	International	1500	FAV

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
	Direct e-mailing				
Autumn 2008	e-News with information on developments in transport sector => dedicated issue on EUDDplus	Regional and national stakeholders in transport	Germany	300	FAV
January 2009	UNIFE Executive Communication Briefing	Industry, SME, users	International	130	UNIFE
May 2009	UNIFE Executive Communication Briefing	Industry, SME, users	International	130	UNIFE
Summer 2009	e-News with information on developments in transport sector => dedicated issue on EUDDplus	Stakeholders and re-searchers in rail transport	International	100 experts	FAV
September 2009	Projekt EUDDplus – Referenztests in Tschechien erfolgreich absolviert www.**fav**.de/News/2009/News_**FAV**_Netzwerk_17_2009.pdf	Regional and national stakeholders in transport	Germany	300	FAV
December 2009	e-News with information on developments in transport sector => dedicated issue on EUDDplus	Regional and national stakeholders in transport	Germany	300	FAV

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
February 2010	EUDD*plus* Final Conference (27 January) Continuation of the standardisation work once the EUDD*plus* project has come to an end http://www.uic.org/com/english/uic-e-news/en-preparation/170/	European Railway Sector	EU	Download	UIC
	Film/video				
June 2010	EUDD*plus* Project Documentation: Video on in-field testing in Wildenrath	European Railway sector and interested public	EU	3.000 in conferences, seminars and website download	ALS, IAS, VUT, FAV
	Exhibition	***Industry (sector x)***			
September 2010	Innotrans 2010 Presentation of the EUDD*plus* training simulator and of the EUDD*plus* project documentation planned	International Railway Sector	International	unlimited	all
	Publications				
2007	Ch. Spanner, T. Meißner (2007): Maßnahmen für den interoperablen Schienenfahrzeugeinsatz - European Driver's Desk. In: e&i elektrotechnik und informationstechnik, a31-a34, Heft 4, Springer, Wien.	Science and Users	German language	6000 prints	FAV, ATE

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
2007	T. Meißner (2007): EUDD*plus* - European Driver's Desk Advanced Concept Implementation - Contribution to Foster Interoperability. In: Sustainable Surface Transport Research Technological Development and Integration. Projects Synopses 2000-2006, p. 330-332, European Commission 2007.	Stakeholders	International	Download	FAV
September 2009	Nachlese: Projekt EUDD*plus* – Referenztests in Tschechien erfolgreich absolviert http://www.tsb-berlin.de/de/tsb-gruppe/service/news/artikel/d/2010/02/16/a/nachlese-projekt-euddplus-referenztests-in-tschechien-erfolgreich-absolviert/	Regional and national stakeholders in transport	Germany	Download	FAV
December 2009	Future standard driver's desk: EUDDplus tests in Wildenrath (Siemens test center) http://www.uic.org/com/english/uic-e-news/163/article/future-standard-driver-s-desk	European Railway Sector	EU	Download	UIC
December 2009	EUDD+ Public Day http://www.unife.org/news_detail.asp?n=EUDD+-Public-Day&nid=2934	European Railway Sector	EU	Download	UNIFE

Planned/ actual Dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
February 2010	Nachlese: EUDDplus – Abschlusskonferenz bei der UIC in Paris http://www.tsb-berlin.de/de/tsb-grup-pe/service/news/artikel/d/2010/02/16/a/nachlese-euddplus-abschlusskonferenz-bei-der-uic-in-paris/	Regional and national stakeholders in transport	Germany	Download	FAV
March 2010	Driver Desks Crossing Europe with EUDD*plus* EURAILmag n°21	Science and Users	English language	5000 prints	ALS, FAV
September 2010	EUDD*plus* – Ein einheitliches europäisches Lokführerstandskonzept auf dem Weg zur Realisierung Publication planned for ETR Eisenbahntechnische Rundschau	Science and Users	German language	5000 prints	FAV, ALS, IAS, VUT
Autumn 2010	Usability Testing of the future standardised European Driver's Desk under "Real World" conditions Publications planned for IRJ International Railway Journal and European Railway Review	Science and Users	English language	5000 prints	IAS, VUT
2010	Prima II On Test In Germany Railvolution n°6/09	Science and Users	English language	5000 prints	FAV
	Posters				
September 2010	EUDD*plus* Poster Presentation at Innotrans 2010 planned	International railway sector	English language	unlimited	FAV