PubTrans4All

Public Transportation - Accessibility for All

Deliverable 4.2

Vehicle-Based BAS Preliminary Design Recommendations

Grant agreement no.: 233701
Project acronym: PubTrans4all
Project title: Public Transportation – Accessibility for All
Filename: PT4A_D.4.2_Vehicle-Based_BAS_Preliminary_Design_Rec._20101231_v01
Title of the Deliverable: D 4.2 – Vehicle-Based BAS Preliminary Design Recommendations
Report Version: 0.1
Dissemination Level:

PU	Public	X
PP	Restricted to other programme participants (incl. the Commission Services)	
RE	Restricted to a group specified by the consortium (incl. Commission Services)	
CO	Confidential, only for members of the consortium (incl. Commission Services)	

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Work package contributing to the Deliverable: WP 4.3
Delivery Date: 2010/12/31
Due Date: 2010/12/31

Disclaimer

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 233701.

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Version	Date	Authors	Description	Date of Approval
0.1	2010/12/31	D. Behnken	New document	

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1. Executive Summary & Introduction

Task 4.2 consists of developing the preliminary design for the prototype of the vehicle-based boarding assistance system. The task started in study month 10, directly following the second consortium meeting and ended one month after the third consortium meeting in month 16 where the decision for the preliminary design of the new boarding assistance systems (BAS) was made.

Task 4.2 is based on the results of task 4.1 “Vehicle Based BAS Conceptual Design Recommendations” where several design concepts for a new BAS are illustrated as well as the recommendations that are made in Deliverable 3.1 “Recommendations for Improving Boarding Assistance Systems”. The different design concepts have been reviewed and discussed during the second consortium meeting with the result that three concepts (ramp, elevator lift, convertible step lift) should be verified by the Prototype Development Group (PDG) more in detail.

The first meeting of the Prototype Development Group was used to compare and evaluate first results of the technical feasibility of the three different variants. In addition the University of Belgrade presented the technical conditions and constraints of common UIC coaches and modern coaches. After a long discussion within the PDG the decision was made to take the ramp and the convertible step lift concepts no longer into consideration. Instead of those the very innovative concept of an elevator lift should be investigated more in detail. The first ideas and proposed concept of an elevator lift comprised many very complex and apparent insolvable requirements that the PDG decided to search for additional concepts until the following PDG meeting.

The detailed technical analysis of MBB Palfinger and the University of Belgrade which were presented to the PDG during the second meeting of the PDG showed that all first three variants (ramp, elevator lift, convertible step lift) are not applicable in classical UIC-wagons as well as modern high speed trains. Therefore new design recommendations were derived from the results of the evaluation of existing BAS (Deliverable 2.2), the results of the students contest held by the TU Vienna and internal developments of MBB Palfinger. All participants concluded that until the next meeting of the PDG for three new concepts (sloping mast lift, hinge lift, moveable twin pillar linear lift) feasibility test in a UIC coach should be done by MBB Palfinger. Furthermore the decision was made to concentrate on a solution for UIC coaches (see Deliverable 3.1, paragraph 3.1.1) and therefore to adapt the design recommendations regarding platform width, capacity and other parameters.

During the third PDG meeting in Vienna additional design constraints and recommendations in UIC coaches were presented to the PDG. Especially the required space to install a BAS within the vehicle was investigated in detail ending with the result that only two small areas inside the coach could be used to install and store a BAS (see picture 11). Based on the recommended area the feasibility tests of implementing the three new concepts (sloping mast lift, hinge lift, moveable twin pillar linear lift) in a standard UIC coach showed that also these concepts are not applicable on UIC or high speed trains. Due to the recommended space for a BAS it was decided to check the option of the installation of a swivel lift with a possible swivel radius of 180° and 270° at the same time. Although there were some technical constraints that had to be considered in detail the PDG decided to present the swivel lift concept to the consortium for decision.

The results of all feasibility studies for all concepts were presented to the consortium during the third consortium meeting in Belgrade. The swivel lift as the only reasonable BAS solution which is also useable for UIC-wagons and selected by the PDG members was presented to the consortium for evaluation and voting. After a long discussion and review of all required technical details as well as the results of the feasibility studies the attending members of the „PubTrans4All“ project voted unanimously for the 180/270° swivel lift solution as the best promising design concept for a prototype of a boarding assistance system for a UIC-wagon.

This deliverable refers the conceptual design concepts that have been considered by the PDG. It includes a short description of the feasibility test results as well as a short summary of the most important topics. Many requirements, recommendations and constraints are described in the very comprehensive Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” so that this document often is used for reference purposes.

2. Methodological approach

The results of the preliminary design recommendations for a vehicle based BAS evolved from:

- Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems”
- Deliverable 2.1: “Boarding Assistance System Evaluation Criteria Report”
- Deliverable 4.1 “Vehicle Based BAS Conceptual Design Recommendations”
- Technical experience of the engineering departments of MBB / Ratcliff Palfinger
- Technical experience of the faculties of TU Vienna and University of Belgrade
- Technical experience of the engineering departments of SIEMENS/ BOMBARDIER
- Market experience of MBB Palfinger and Ratcliff Palfinger
- Results of the several brainstorming and discussions with all PDG members
- Detailed feasibility studies of the several systems

3. General

3.1. Purpose & Scope

This document shows the results of the preliminary design process and serves as a technical basis for the development of the new vehicle-based boarding access system (BAS).

After approval by the project group the document together with the further deliverables of WP 2 and WP3 will help to prepare the specification of the new innovative vehicle-based prototype of a boarding assistance system.

3.2. Positioning of the BAS

To increase the willingness of people with reduced mobility to use public transport it is very important to have a safe and durable solution to board and alight the railway vehicles currently in use. This includes the assurance that it should be possible to have a system available at every station at all times and at the right place (one vehicle adapted for wheelchair user in the train) which cannot be assured by using platform based boarding assistance systems like the lift shown in picture 1.

Picture 1: Platform based lift (Guldmann LP 12)

Due to various environmental influences this can only be assured by using a vehicle based boarding assistance system. One reason could be the possible change of the time table or station. Another reason for a vehicle based BAS is the increasing international traffic where the different platform dimensions in different countries must be considered.

Furthermore it should also be possible to exit the train in case of emergency quickly and safely either along the track or at the station (Del. 2.1, para. 5.2.7). Particularly in the Scandinavian and Eastern European countries it is also recommended to have a vehicle based BAS due to the harsh local weather conditions (snow, ice) which could inhibit the use of a platform based solution (Del. 2.1, para. 5.2.6).

For additional explanations please have a look at the very comprehensive Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” paragraph 2.1.1 “2.1.1 Vehicle based versus platform based solutions – an overview” as well as the following paragraphs.

3.3. Type of Railway Vehicles

For low floor vehicles and many regional trains the usage of electrical/ manual ramps and fixed or moveable gap bridging devices is an appropriate solution for people with reduced mobility to board or alight. Therefore the PDG decided that the preliminary design recommendations for the new BAS will be mainly based on the requirements of standard UIC-wagons because they offer the most difficult situation → "Worst Case". Furthermore it is really important to find a solution for this kind of wagons because the regulations regarding accessibility must be fulfilled by all new East European members of the EU.

Picture 2: UIC wagon with small doors of 800mm

The requirements in modern high speed trains will also considered for the development of the new BAS although they are often similar to the older UIC coaches (see also 4.7).

Picture 3: High speed train ICE with doors of 900mm

3.4. Abbreviations

BAS	Boarding Assistance System
BDZ	Bulgarian Railways
BS	British Standard
CAD	Computer Aided Design
CDR	Conceptual Design Review
CM	Corrective Maintenance
DA	Design Approval
DF	Design Freeze
DIN	German Institute for Norms
DR	Design Review
EMC	Electromagnetic Compatibility
EN	European Norms
FAI	First Article Inspection
FMEA	Failure Modes and Effect Analysis
FTA	Fault Tree Analysis
HST	High Speed Trains
IDR	Initial Design Review
IRIS	International Railway Industry Standard
LCC	Life Cycle Cost
MTBF	Mean operation Time Between Failures
NFF	Norme Francaise
PDG	Product Development Group
PM	Preventive Maintenance
PRM	People with reduced mobility
RAMS	Reliability, Availability, Maintainability, Safety
TSI	Technical Specification for Interoperability
UIC	International Union of Railways
UNI	Italian Norms
VDE	Verband der Elektrotechnik, Elektronik, Informationstechnik e.V.

Table 1: List of Abbreviations

4. Results of the preliminary design process

In the following paragraphs of this report the results of the preliminary design process for a vehicle based boarding assistance systems that are based on

- Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems”
- Deliverable 2.1: “Boarding Assistance System Evaluation Criteria Report”
- Deliverable 4.1 “Vehicle Based BAS Conceptual Design Recommendations”
- Results of several meetings and discussions of the PDG members
- Technical experience of the engineering departments of MBB / Ratcliff Palfinger
- Technical experience of the faculties of TU Vienna and University of Belgrade
- Technical experience of the engineering departments of SIEMENS/ BOMBARDIER
- Market experience of MBB Palfinger and Ratcliff Palfinger
- Detailed feasibility studies of the several systems done by MBB Palfinger

will be described. The report includes a short description of the chosen conceptual designs and includes also a description of the feasibility test results as well as a summary of the most important topics. The advantages and disadvantages of each system have already been covered in deliverable 4.1 and therefore will not be described in detail again. The results presented in this report have also been presented to the members of the PubTrans4All PDG during the three PDG meetings from month 10-16 and to the whole PubTrans4all consortium group at the third consortium meeting in Belgrade.

The discussed concepts are listed in order as they have been proposed in the PDG meetings.

4.1. Parallel Ramp

The first conceptual design proposal chosen by the consortium for a more detailed feasibility study is based on a ramp concept which had been proposed by students within the PubTrans4All student competition.

The advantages and disadvantages of such a system are described in deliverable 4.1. paragraph 4.8.

Picture 4: Ramp solution (Student competition TU Vienna)

The technical analysis during the first meetings of the PDG provided the result that a ramp solution is not applicable for a height difference of more than 400mm which is the case for classical UIC-coaches and all other high floor trains. Therefore the parallel ramp was erased from the list of possible design concepts for the new BAS.

<u>Summary:</u>

The main reasons for excluding the ramp solution for the new BAS design are:

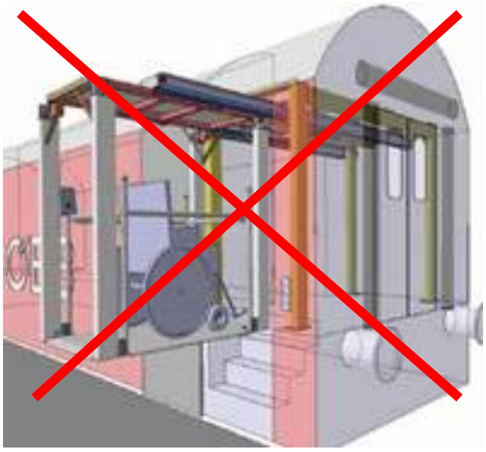
- **Ramp length:** In accordance to the TSI-PRM the slope of a ramp should not exceed the maximum of 10,2 degrees (18 %). Therefore a ramp for a train with a floor height of app. 1250mm would require a length of more than 7m.
- **Handling:** A ramp with a length of more than 7m will be very complex to handle and to operate.
- **Weight:** Additionally such a ramp would be very heavy in weight which makes manual or powered operation nearly impossible.
- **Capacity:** As the ramp in the case of operation should be used by all passengers or PRM it is possible that approx. up to 10 persons could stand on the platform at the same time which potentially could cause a capacity problem for the system (> 1t). To allow a usage as described the design of the ramp must be very solid and therefore will be very heavy.

For additional explanations please have a look at Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” paragraph 2.2.2.3 “Height difference for ramp applications” as well as the following paragraphs.

4.2. Elevator lift

The second conceptual design proposal chosen by the consortium for a more detailed feasibility study is based on the innovative idea from a student of the TU Vienna. The idea was evolved during the first student competition in 2006. Such a BAS has not been manufactured or integrated in a railway vehicle yet.

The system and the advantages as well as the disadvantages of an elevator lift are described in Deliverable 4.1. paragraph 4.3.



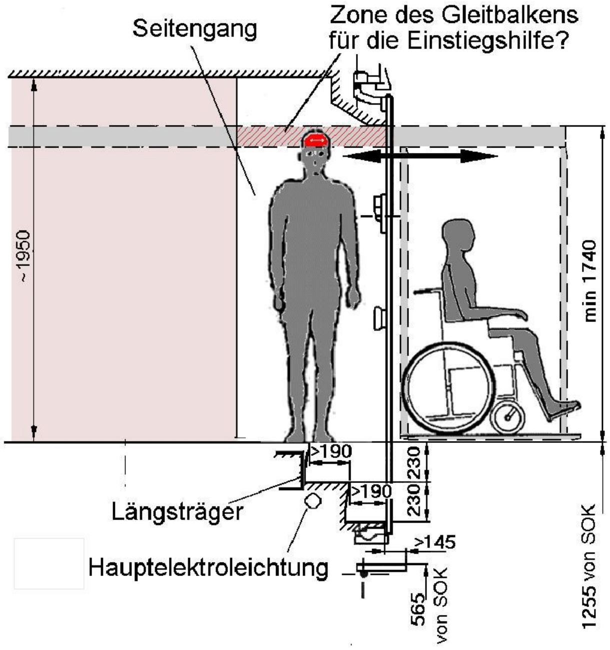
Picture 5: Elevator lift (student competition TU Vienna)

The technical analysis during the first meetings of the PDG provided the result that an elevator lift solution is not applicable for the very narrow doors (width and height) which are used in classical UIC-coaches and all other high floor trains (see also picture 3). Therefore the elevator lift was erased from the list of possible design concepts for the new BAS.

Summary:

The main reasons for excluding the elevator lift solution for the new BAS design are:

- **Head clearance in use:** Due to the linear movement and the height of the doors the height in the elevator cabin will be less then 1600mm (see also picture 3) so that it only can be used by wheelchair users or maybe sitting persons.
- **Head clearance not in use:** Due to the linear movement and the height of the doors the system will constrain the interior design and the gangway of the wagon (see also picture 3).
- **Door width constraints:** The installation of an elevator lift will cause a considerable reduction of the usable door width so that the passenger flow will be disturbed and current standards (TSI) could not be fulfilled.
- **Stowing position:** There is no possible space to stow the elevator lift in the entrance area or underneath the roof of classical UIC-coaches and all other high floor trains. The floor and the roof area are usually used and needed by other technical installations.



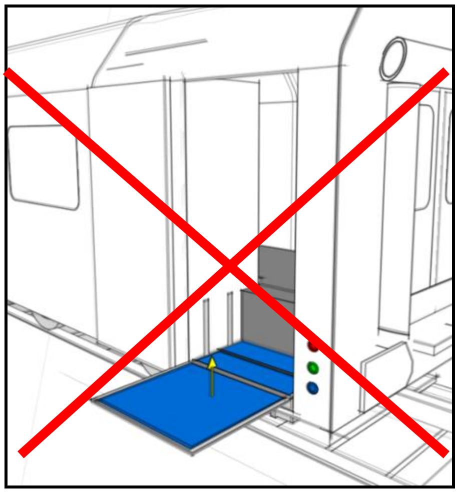
Picture 6: Profile Elevator lift (in UIC coach)

For additional explanations please have a look at Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” paragraph 3.1.8 “Door height for standing passenger” as well as the following paragraphs.

4.3. Step lift

The third conceptual design proposal chosen by the consortium for a more detailed feasibility study is based on a step lift solution which was presented in the student competition of the TU Vienna. Step lifts are used in buildings but some are also used in special vehicles like library buses.

The system and the advantages as well as the disadvantages of a step lift are described in Deliverable 4.1. paragraph 4.7.



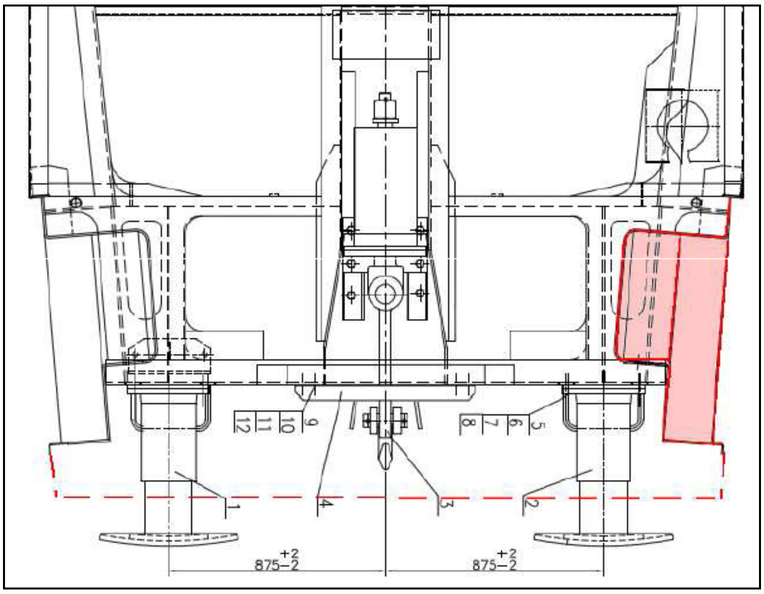
Picture 7: Step lift (student competition TU Vienna)

The technical analysis during the first meeting of the PDG came to the conclusion that a step lift solution is not applicable for classical UIC-coaches and all other high floor trains due to the missing installation space under the steps in the entrance area of these trains (see also picture 4 and 5). Therefore the step lift was erased from the list of possible design concepts for the new BAS.

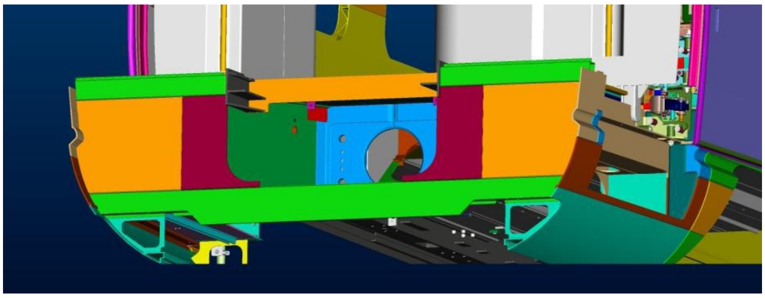
Summary:

The main reasons for excluding the step lift solution for the new BAS design are:

- **Installation space:** The installation of step lifts is only possible by using the room in the lower part of the entrance area. Usually this space is blocked by several other systems like the buffers, door guiding or electrical wiring (UIC coaches) or folding steps and coupling systems (HST).
- **Statics:** The installation of step lifts is only possible by cutting a hole in the car body under frame structure. This is usually impossible due to the high longitudinal tension force. Additionally a cut-out would weaken the strength of the car body structure which makes the installation of these lifts impossible in commuter or high speed trains.
- **Pressure tightness:** Additionally high efforts need to be spent for fulfilling the air pressure tightness requirements especially for HST.



Picture 8: Steel frame of the end of a standard UIC coach



Picture 9: Structure of the end of a modern HST coach

For additional explanations please have a look at Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” paragraph 3.1 as well as the following paragraphs.

4.4. Sloping mast lift

The first additional conceptual design proposal (of three new) chosen by the PDG for a more detailed feasibility study is based on a prototype sloping mast lift solution which was developed for the first generation of the German high speed train ICE.

A most convincing point in favour of this system variant is its simple, linear motion sequence as well as its single-piece platform. This way additional movements (e.g. folding out several platform components) could be avoided, reducing the sources of mal-function or failure when operated. Furthermore most of the movements of this lift have already been automated. Lifting and lowering is generated by an electrical spindle drive which is positioned bevelled. Lifting and lowering of the platform is also achieved by the electrical spindle drive. The lift is already equipped with sensitive edges and a light barrier to secure the automated movements.

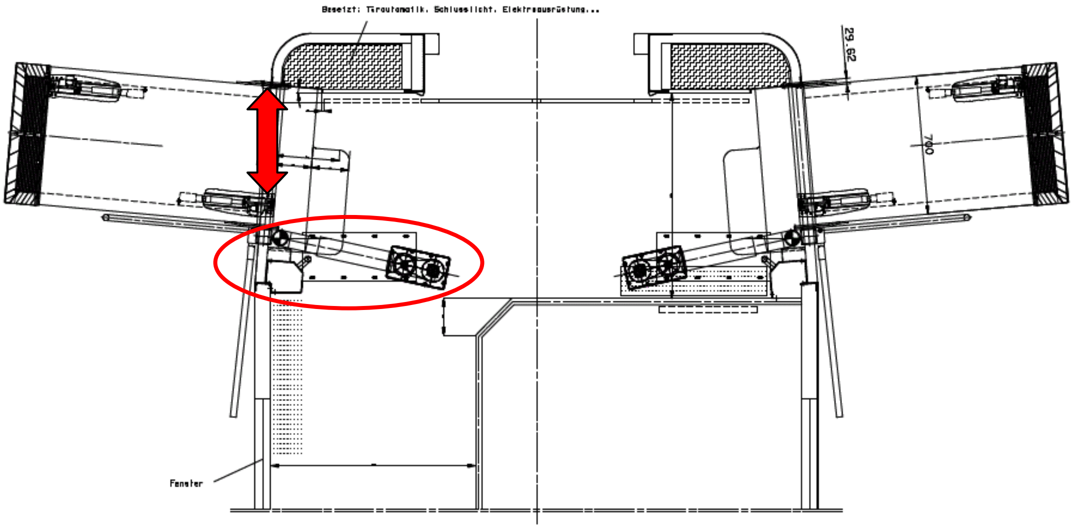
Picture 10: Sloping mast lift (MBB prototype for ICE1)

The outcome of technical analysis after the second meeting of the PDG provided the result that a sloping mast lift solution is not applicable for classical UIC-coaches and all other high floor trains due to the missing installation space in the entrance area of these trains (see also picture 8 and 9). Therefore the sloping mast lift was erased from the list of possible design concepts for the new BAS.

Summary:

The main reasons for excluding the sloping mast lift solution for the new BAS design are:

- **Door width constraints:** The installation of a sloping mast lift will cause a significant reduction of the usable door width so that the passenger flow will be disturbed and current standards (TSI) could not be fulfilled.
- **Stowing position:** There is no possible space to stow the lift in the entrance area of classical UIC-coaches and all other high floor trains (see also picture 8 and 9). The floor and the roof area are usually used for other types of required installations.



Picture 11: Sloping mast lift integrated in a UIC coach

Picture 12: Similar structure in current high speed trains

For additional explanations please have a look at Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” paragraph 3.1.1 as well as the following paragraphs.

4.5. Hinge lift

The second additional conceptual design proposal (of three new) chosen by the PDG for a more detailed feasibility study is based on a hinge lift solution which was presented in the student competition of the TU Vienna.

The design of this hinge lift appears very innovative. Lifting and lowering are achieved by two powered hinges. Lifting and lowering of the platform could be generated by an electrical spindle drive. The lift has a single-piece platform so that additional movements (e.g. folding out several platform components) are unnecessary. Additionally a seat for PRM is integrated. The lift could be equipped with sensitive edges and light barriers to secure the automated movements.

Picture 13: Hinge lift (student competition TU Vienna)

The technical analysis after the second meeting of the PDG has shown that a hinge lift solution is not applicable for classical UIC-coaches and all other high floor trains due to the missing installation space in the entrance area of these trains (see also picture 8 and 9). Therefore the hinge lift was erased from the list of possible design concepts for the new BAS.

<u>Summary:</u>

The main reasons for excluding the hinge lift solution for the new BAS design are:

- **Door width constraints:** The installation of a lift will cause a considerable reduction of the door width so that the passenger flow will be disturbed and current standards (TSI) could not be fulfilled.
- **Stowing position:** There is no possible space to stow the lift in the entrance area of classical UIC-coaches and all other high floor trains. The floor and the roof area are usually used for other equipments.

For additional explanations please have a look at Deliverable 3.1: “Recommendations for Improving Boarding Assistance Systems” paragraph 3.1.1 as well as the following paragraphs.

4.6. Moveable twin pillar linear lift

The third additional conceptual design proposal (of three new) chosen by the PDG for a more detailed feasibility study is based on a moveable twin pillar linear lift solution which is already installed in a commuter train in Switzerland.

All movements of this lift have already been automated. Lifting and lowering is generated by hydraulic cylinders. The lift has a single-piece platform so that additional movements (e.g. folding out several platform components) are unnecessary. Additionally a handrail is provided. The lift could be equipped with sensitive edges and light barriers to secure the automated movements. The lift is stowed alongside the door and will be moved to the door opening for usage.

Picture 14: Moveable twin pillar linear lift (in SBB train)

The technical analysis after the second meeting of the PDG came to the conclusion that a moveable twin pillar linear lift solution is not applicable for classical UIC-coaches and all other high floor trains due to the missing installation space in the entrance area of these trains. Therefore the moveable twin pillar linear lift was erased from the list of possible design concepts for the new BAS.

<u>Summary:</u>

The main reasons for excluding the sloping mast lift solution for the new BAS design are:

- **Door width constraints:** The installation of a twin-pillar lift will cause a considerable reduction of the door width so that the passenger flow will be disturbed and current standards (TSI) could not be fulfilled.
- **Stowing position:** There is no possible space to stow the lift in the entrance area of classical UIC-coaches and all other high floor trains. The floor and the roof area are usually used for other types of installations.

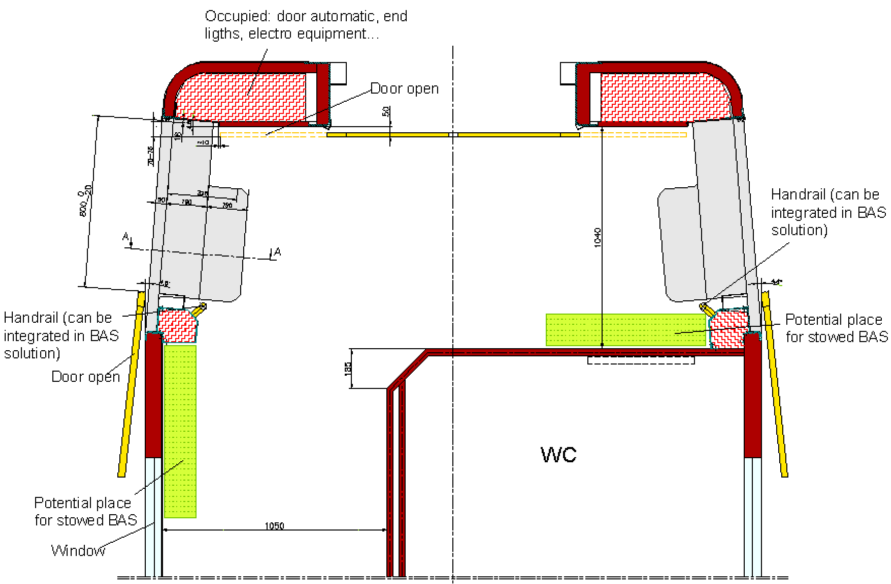
For additional explanations please have a look at the very comprehensive Deliverable 3.1: "Recommendations for Improving Boarding Assistance Systems" paragraph 3.1.1 as well as the following paragraphs.

4.7. Swivel lift

The last conceptual design proposal is based on the well known swivel lifts which are widely acknowledged in the railway market. They are mainly fitted to trains but some technical variants are fitted to vans or minibuses also. This concept was chosen by the consortium members at the third consortium meeting in Belgrade for the new BAS which shall be installed in a standard UIC coach.

Picture 15: Swivel lift in ÖBB Railjet train

The results of the University of Belgrade did illustrate that the layout of older UIC coaches and modern high speed trains that are designed for wheelchair users and other PRMs is nearly identical. Both of them have small doors with a width of 800 to 900mm. Due to statically reasons the doors are positioned at the end of the coaches. Because of the folding or sliding steps as well as other constraints there is no space under the doors for the installation of a BAS. Additionally the space at the coach end is occupied by mechanisms of the fire safety doors or other electrical components. Typical for these coaches is also that the passageway is at one side outside the longitudinal centre line of the vehicle (see also picture 8 and 9) because of the toilet and cabins adapted for people with handicaps and persons with reduced mobility. Finally there are usually only two potential positions left which could be used for stowing the BAS. They are highlighted (green) in picture 16.

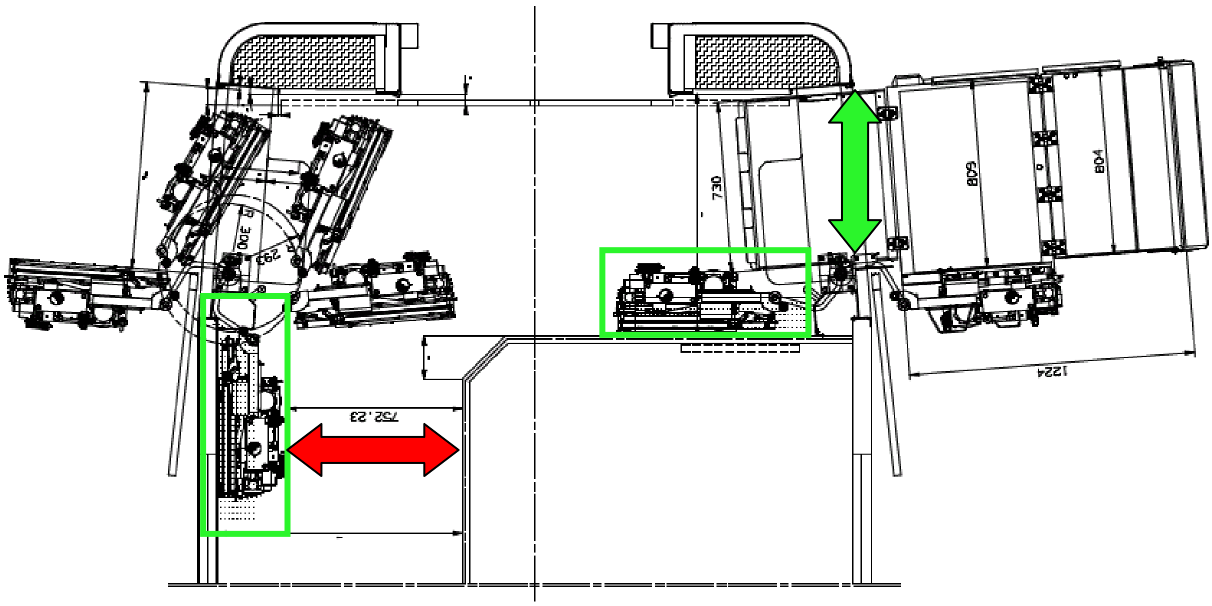


Picture 16: Entrance area of a standard UIC coach for disabled persons

The lifts usually consist of a solid steel frame with a swivel arm and a vertical lifting column. The upstroke is generated by a hydraulic cylinder or an electrical spindle drive. The divided platform is attached to the frame and usually manually operated. The lifts are operated and supervised by a trained operator. The turning radius is adaptable to the individual requirements (180°/270°) of the vehicle. Furthermore it is possible to board and alight the lift platform from the side which is helpful on very width limited platforms. Swivel lifts can be used in very narrow doors due to the very slim bracket which minimizes the door width only marginal.

Advantages:

- **Passage width:** The installation of swivel lifts will usually not cause a reduction of the clear passage width (TSI requirement) so if the system is not used the passenger flow will not be influenced.
- **Lifting height:** Swivel lifts allow lifting heights of more than 1400mm which will enable evacuation if the train is not situated in station (lifting from vehicle floor to rail track level).
- **No extra door:** The lifts can be installed in nearly all standard doors avoiding the need for an extra door for PRMs and thus saves additional costs.
- **Retrofitting:** The installation of swivel lifts in older or used vehicles is possible but may require adjustments that result in one-off-costs.
- **Design:** Due to the installation in the entrance area of the train the design of the cover in stored position could be adapted according to the special design requirements of the vehicle manufacturer and/or operator.



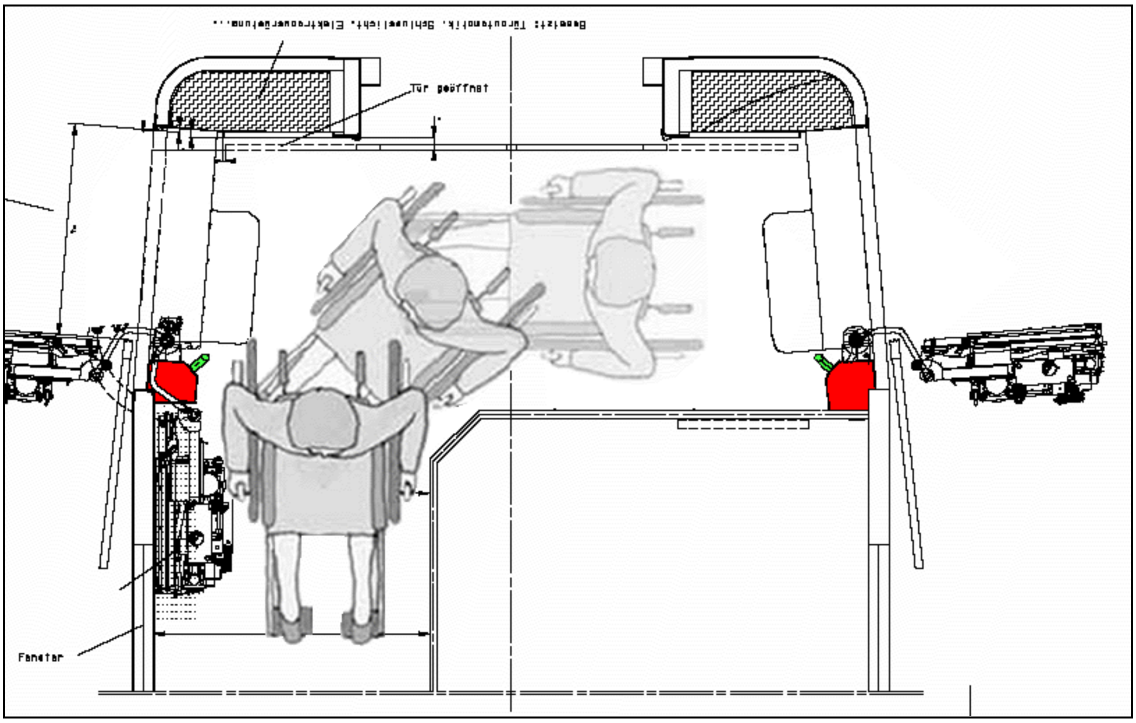
Picture 17: Entrance area of a standard UIC coach for disabled

Disadvantages:

- **Interface:** The interface of swivel lifts is sometimes not very simple. They are connected to the floor or the car body frame which occasionally causes some changes in the designs of the vehicles and/or the products of the BAS manufacturers.
- **Automation:** Some swivel lifts are automated to a high degree already but for the operation by the PRM him/herself many expensive safety devices are required. Currently the supervision/ operation by a conductor or driver is mandatory (TSI PRM).

Although the decisions for the swivel lift design had been made by the consortium there are still many complex technical difficulties that need to be solved.

- **Optimisation of the dimensions** (height, depth, width; see picture 18
- **Optimisation of the weight**
- **Positioning of the platform** (parallel to the train)
- **Usability for all PRM** (see 5.1; seat)
- **Automation** (using the lift with less manual operation)
- **Avoiding interference with the door mechanism** (see picture 18)



Picture 18: Entrance area of a standard UIC coach for disabled

5. Additional Design Requirements

Developing or manufacturing products for the railway industry is usually very difficult due to high technical requirements and standards that must be reflected and fulfilled. Therefore these technical requirements will be considered for the development of the new innovative boarding assistance system (BAS). See also Deliverable 2.1 paragraph 6.1 and 8.1.10.

Furthermore please refer to the results of the very comprehensive Deliverable 3.1: "Recommendations for Improving Boarding Assistance Systems" will be considered for the preparation of the technical specification of the new BAS.

5.1. Target group (Users)

As mentioned in Deliverable 2.1: "Boarding Assistance System Evaluation Criteria Report" in paragraph 4.1.1 the most challenging group of persons with reduced mobility for boarding and alighting railway vehicles is the group of wheelchair users. For 80% of them it is not possible to enter a railway vehicle without the support of technical solutions like ramps or lifts.

Wheelchair users will not be the only target group for the new BAS because many other people with mobility impairments would need assistance during boarding and alighting. They also will benefit from a new BAS system so that the requirements which are mentioned in Deliverable 2.1, paragraph 4.4.9 must be considered.

As the requirements for wheelchair users regarding the clear height are usually less than for other PRMs like older people or people with baggage it is very important to consider the required maximum possible clear headroom of the entrance doors (Del. 2.1, para. 6.2, Del. 3.1 para. 3.1.8).

5.2. Mechanical Interface (Entrance)

A very important topic regarding the development of conceptual design recommendations is the mechanical interface between the new boarding assistance system (BAS) and the body shell of the railway vehicle. For all current BAS solutions the integration and adaptation to the special requirements is very difficult and usually results in high one-off (engineering) and recurring (integration) costs.

The main reason for the high costs is that the entrance areas of all trains have differing widths, heights or shapes depending on the vehicle type making it very difficult to find a universal solution to suit all vehicles.

Therefore a key target for the future should be the definition of standard interfaces for entrance areas or BAS which can only be resolved by the UIC or one of the other major railway organisations.

In addition to the mentioned topics regarding the installation of the new BAS it is furthermore very important to respect during the development of the new BAS the turning radius of 1500mm for small manual wheelchairs and of 1800mm for bigger electrical wheelchairs. Consequently it is also very important to consider the whole entrance area for the PRM including the way to the designated parking space within the vehicle for the wheelchair user (Del. 2.1, para. 5.4.4).

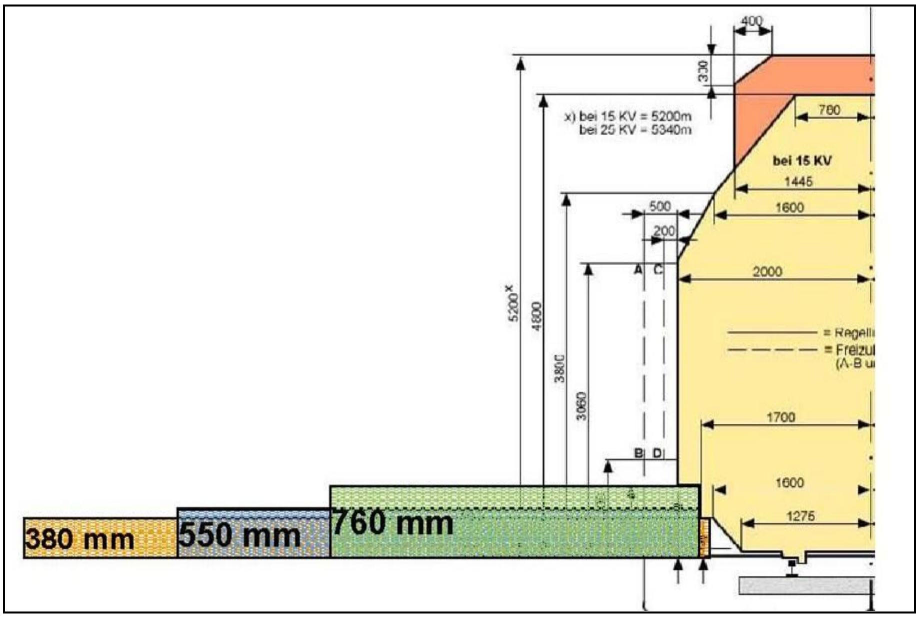
5.3. Electrical Interface (Power supply)

One other point to address for the development of a new boarding assistance system is the different voltages that are used in the European countries. They differ between 24V used in German commuter trains, 36V which are used in Switzerland and 110V which are mainly used in high speed trains. Some power packs therefore must be especially developed which is often very expensive. The new BAS therefore must be adaptable to the different electrical systems.

5.4. Environmental Interface (Platforms and stations)

Platforms and stations in Europe are very different regarding the height and width. Current standards heights are 550mm and 760mm with tolerances of -35 mm/ + 0 mm. But many stations are not renovated yet especially in Eastern Europe. Therefore it is possible that at some stations no platform or only very low platforms of 250mm / 380mm are available. In some regions it is furthermore possible that some stations have a height up to 1000mm. See also Deliverable 2.1. paragraph 5.4.5.

For the design of the new BAS it is also important to consider the possible lateral gradients on the station platforms as well as the lateral gradients of the trains due to the track super elevation if the station is in a curve (see also Deliverable 3.1, paragraph 2.2.2.2 “Maximum horizontal gap between platform and vehicle”.



Picture 19: Standard platform heights in Europe

5.5. Norms & Standards

For the development of a new BAS the following Norms & Standards should at least be considered. It is very important that the mentioned norms should only be a guideline. They shall not be the reason for eliminating one of the innovative ideas. See also Deliverable 2.1 paragraph 6.1.7 and 7.1. - 7.3.

TSI PRM	Accessibility for People with Reduced Mobility
DIN 32983	Lifts installed on vehicles for wheelchair users and for people restricted in their mobility - Additional safety requirements and testing
DIN EN 1756	Tail lifts - Platform lifts for mounting on wheeled vehicles - Safety requirements - Part 2: Tail lifts for passengers
EN 12183	Manual wheelchairs - Requirements and test methods
EN 12184	Electrically powered wheelchairs, scooters and their chargers - Requirements and test methods
ISO 7193	Wheelchairs - Maximum overall dimensions
UIC 565-3	Indications for the layout of coaches suitable for conveying disabled passengers in their wheelchairs
EN 14752	Railway applications – Bodyside entrance systems
UIC 560	Doors, entrance platforms, windows, steps, handles and handrails of coaches and luggage vans
TS 45545-2	Fire protection on railway vehicles
EN 50125-1	“Railway applications - Environmental conditions for equipment
EBO	Eisenbahn- Bau- und Betriebsordnung

Table 2: Norms & Standards

5.6. Operating conditions

The below listed parameters are an example for the general requirements of a BAS. They can differ between every vehicle and shall only show that a BAS will be used for a long time for many hours a day.

Parameter	Value (example)
➢ Lifetime:	> 30 years
➢ Vehicle operating time per day	> 18 hours
➢ Max. operating altitude	up to 1400 m SL (Class A1 EN 50125-1)
➢ Maximum Velocity	up to 360 km/h
➢ Encountering trains (free field)	up to 360 km/h
➢ Encountering trains (tunnel)	up to 360 km/h

5.7. Operating time

In accordance with the criteria that have been raised by the TU Vienna during the interviews it is very important for the operators that the BAS can be used with little or no assistance. Moreover the operation should not exceed the normal time the train is stopped in the station, which is usually less than 2 minutes.

Picture 20: Platform based lift with staff

The research of the TU Vienna has shown that the above mentioned requirements can currently only be achieved by vehicle based systems (Del. 2.1, para. 5.3.1; 5.4.1; 5.4.3) due to the fact that it will not be possible in the nearest future to have staff in all the stations for the usage of semi-automatic platform based solutions. Without staff the operation time will approximately double the normal stopping time because the system then must be operated by train staff. An automatic platform based system is not a solution either because it is not possible to stop the train always in the right position where the entrance door for PRMs is located.

5.8. Environmental conditions

The European Standard EN 50125-1 “Railway applications - Environmental conditions for equipment - Equipment on board rolling stock” should be taken as reference for conception of the BAS which includes the following topics:

Parameter	Value (example)
➢ Air temperature:	-25°C to + 45°C
➢ Atmospheric humidity:	up to 100%
➢ Solar radiation:	e.g. 6 hours/day
➢ Wind speed:	e.g. 35m/s
➢ Average rainfall:	e.g. 6mm/min
➢ Others climatic conditions	Snow, salt sprinkle, condensing

5.9. Weight & Energy Efficiency

The energy consumption of the system must be efficient and optimized (Del. 2.1, para. 5.3.2) which is including a light weight construction (< 150kg) to minimize the axle load of the railway vehicles.

5.10. Frequency of Operations

Usually all current boarding assistance systems are only used at the special request of wheelchair users except for electrical gap fillers. If the new BAS is to be used at every stop by all passengers or all types of PRMs and not only on request, will this increase the operating cycles by a factor of > 50.

Therefore the design of the system has to be also very durable to operate at every stop with no technical or safety problems.

5.11. Lift platform

The platform shall be equipped with barriers to prevent any of the wheels of the wheelchair from rolling off during its operation. A movable barrier (roll-stop) or inherent design feature shall prevent a wheelchair from rolling off the lift platform until the system is in its fully raised or lowered position.

Each side of the system platform which extends beyond the vehicle in its raised position shall have a barrier a minimum 50mm high. Such barriers shall not interfere with manoeuvring into or out of the aisle.

The roll-stop (outer barrier) shall be sufficient when raised or closed, or a supplementary system shall be provided, to prevent a power wheelchair from riding over or damaging it. The system shall permit both inboard and outboard facing of the wheelchair.

The system shall ensure the possibility to host a wheelchair compliant to PRM TSI and UIC 565-3 and possibly a sitting person (platform width 750mm, platform length 1200mm). The loading capacity shall be 350kg. Higher requirements for electric wheelchair users regarding space and weight should be taken into consideration (Del. 2.1, para. 5.4.4).

A secure stowage system shall be provided to ensure that the stowed system does not harm any passenger whilst travelling.

5.12. Emergency Operation

The system shall incorporate an emergency method to allow the deploying, lowering to ground level and raising and stowing the system in case of failure or absence of power supply.

In this case the maximum time for a complete lowering and lifting cycle shall be less than 5 minutes. The maximum force required to the operator to complete the full cycle shall be less than 100N.

5.13. Commands and Function

Commands and functions of the BAS system will be integrated in the door system. The system shall ensure that the vehicle cannot be moved when the doors are not closed and locked or the system is not fully stowed. The system shall also not start to move until the relevant release signal from the door system is submitted.

5.14. Safety & Fire Safety

The system must be safe in every lift cycle phase. Safety analyses shall be based on the European Norms EN50126-1, EN50126-2, EN50126-3, EN50128, and EN50129. Additionally the requirements and recommendations mentioned in Deliverable 2.1, paragraph 4.5.4 must be considered.

According to this approach, all the hazardous scenarios involving people on the train, people getting on or off the train, people on the platform or near the line, people performing maintenance activities on the train, shall all be analysed.

At present there is no common European standard defined for fire safety in trains. Therefore all the norms listed below should be considered in the development of the new BAS.

- TSI HS RST
- CEN/TS 45545
- DIN 5510
- NF F 16-101 /-102 /-103
- UNI CEI 11170-1 /-2 /-3
- RENFE DT-PCI / 5A
- UIC 564-2

5.15. Reliability & LCC

The system must be reliable in every life cycle phase. Reliability and Maintainability are very important for the new BAS. A high performance from the RAMS will help to reduce the total life cycle costs of the system (Del. 2.1, para. 5.3.6; 8.1.4).

Low LCC will help to install the system in more and more trains because financing railway projects is getting increasingly difficult (Del. 2.1, para. 6.1.1).

6. Conclusion

This deliverable contains the results of the preliminary design process for a new boarding assistance system that should be used by nearly all people with reduced mobility. As shown all concepts presented in the beginning of the project were not applicable due to various reasons so that the only current solution for the BAS is based on the well-known swivel lift concept that has already been installed in railway vehicles. One of the main innovations of the new BAS prototype is the ability to retrofit based on the optimisation (see 4.7) of the dimensions and the weight of the whole system and to automate the operation of the system where it is reasonable.

Furthermore all main requirements that are standard in the railway industry have been briefly explained (see 5.1 ff) to keep them in mind during the specification and development of the new boarding assistance system. They will be supplemented by the topics that derived from the deliverables 3.1 and 2.1.

In the next phase of the project the PDG will start with the specification of the BAS following intensive feasibility tests with BDZ to verify the mechanical and electrical interfaces of the lift. In month 28 (January 2012) MBB Palfinger will deliver the prototype to Bombardier Hennigsdorf where it will be installed in a mock-up or an UIC coach. The prototype after evaluation will be presented at the Innotrans 2012 and other exhibitions.

7. List of Pictures/ Tables