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Fast Loading and Unloading Devices: Planning and Scheduling Requirements

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Abstract

This report has been compiled within the Platform project. The project itself aims at the enhancement of transhipment processes in an intermodal terminal. A crucial process within a terminal is loading and unloading of Intermodal Transport Units from trucks onto trains and vice-versa. Traditional terminal technology, such a gantry cranes, reach stackers, straddle carriers or mobile cranes are usually applied without precomputed schedules. Whereas one of the goals of the project is to show possible enhancements through scheduling and planning the use of these devices, this report describes and compares new terminal equipment. The new equipment allows for parallel or quasi parallel access to the ITUs on trains and thus provides fast transhipment processes. The comparison in the report focuses on the planning and scheduling requirements of these new fast handling devices.

1 Introduction

This report compares four different fast handling devices which can be applied to enhance transhipment in intermodal terminals. It has been collected during the preparation of the first deliverable in the PLATFORM project. The project aims at the enhancement of the management of transport and transhipment processes of an intermodal terminal. Within the project, a simulation environment for these processes will be developed. Since the devices available for terminal operations provide the key to faster transhipment processes, the comparison of several systems as it is reported here, may serve as basis to select appropriate simulation devices or technology.
The PLATFORM project is founded by the European Commission, PL 97-2170, further information is available at http://www.idsia.ch/platform/.

2 Requirements

For the simulation in PLATFORM we will have to realise two different scenarios. These are described in Annex 4 of the project description.
The first scenario will deal with *short trains* which enter the Intermodal Terminal at *high frequency*. The Intermodal Terminal itself therefore has to be equipped with a fast loading/unloading device which possibly allows for parallel loading and unloading of ITUs. Depending on this loading/unloading device, the terminal may be used as swapping area between trucks and trains. The planning and scheduling requirements for the arrival of trucks which are imposed by the loading/unloading system, will influence the negotiations between the dispatch departments of the forwarders and the commercial/planning departments of terminals. Usually this negotiation on the arrival of trucks for pick up or delivery of ITUs involves that trucks drive to their designated pick up/delivery section in the terminal according to a precomputed schedule.
The second scenario involves *long trains* at *lower frequency*. Therefore more traditional loading/unloading technology can and will be simulated.. Scheduling requirements are also important for the simulation of these more traditional terminals, but we will not consider them here.
Since some of the descriptions of fast loading systems are directly taken from original sources, the style and language of this document may not always be uniform and elegant. Due to time constraints, there are unfortunately no pictures to illustrate the different technologies; they will be supplied later.
All of these systems do not require any marshalling operations on the yard, this is one reason for the loading/unloading speed of ITUs.

3 Loading and Unloading Systems

The PLATFORM simulation requires a fast loading/unloading device. Therefore we will focus on 4 systems, which allow for parallel or quasi-parallel loading and unloading of ITUs. In the following we give a short description of each of these systems and compare the scheduling/planning activities involved with them. The ITUs, we are dealing with are containers and semi trailers, even though some of these loading/unloading devices were built for other ITUs. Still all of these systems are applicable for handling either containers, semi trailers or both.

3.1 The Daimler Benz Kombilifter

The *Daimler Benz Kombilifter* realises fast transhipment technology for swap bodies. It can also be applied for land containers equipped with supporting legs. The system does not take much space inside a terminal. For the management of a train containing 10 swap bodies a track with approximately 100 m length is sufficient. The tracks are embedded in the road surface, such that trucks can move over them, like tracks for tramways. Trucks deposit the normed swap bodies onto the marked positions on the tracks, leaving the swap body on its support legs. The train composed of Kombilifter carrying wagons rolls backwards underneath the swap bodies to a defined take-over position. Pneumatic lifts, integrated in the Kombilifter wagons, now lift the swap bodies independently from one another. Fine tuning of the swap body position on the wagon is done by an integrated centring device. The support legs are then folded back and the swap bodies sit on the commonly applied rail cones of the Kombilifter. Loading or unloading of 10 swap bodies takes 25 minutes with one workman. This time can be decreased by applying more personnel. Loading and unloading can be done in a quasi-parallel manner, requiring the sequential up-lining of the swap bodies, which are then simultaneously loaded.

Scheduling and Planning Requirements

The trucks must arrive at the terminal until a certain deadline to catch the outgoing train. Since the swap bodies are normed as well as the Kombilifter wagons, the order of arrival of ITUs for train composition is not very crucial, as long as the ITU arrives in time. Still, since access to the ITUs on a train is sequential, trucks should arrive in a scheduled order and deposit their ITU on a specially marked spot on the track. Places in KomibiLifter trains could be booked and reserved, like places in passenger trains. Thus Forwarders would be told to arrive with a very small time interval (2-5 minutes) at the tracks of the terminal, disposing their ITUs on a reserved spot. For unloading a train order is important, since the swap bodies are lined up along the track and can only be accessed at the front and the back of the former train. Using terminal terminology, this means, that *export ITUs need to arrive until a certain deadline* for train composition (e.g. 25 minutes before departure, if there is only one workman and 10 swap bodies are loaded). For the pick up of *import ITUs the trucks should be arriving on a pick up schedule* which is imposed by the import train structure and the time for pick up an ITU from the track.

3.2 The Krupp Fast Handling Device

The Krupp Fast Handling Device (in the following text abbreviated with FHD) spans one loading track, one empty track and one service position, e.g. for transhipment to a cross conveyor or skid/pallet system. It is equipped with a crane bridge moving along the loading track. The track of this crane bridge is elevated on one side in order to allow the cross conveyor operation.

The FHD allows the unloading and reloading of flat wagon while *passing through* the transhipment area. Announced loading units of common shape and sizes are checked with respect to identity and location in a so called *pre-zone* of the plant. The FHD automatically tranships the ITUs either directly to the roadside or to a Compact- or High Rack Store. Raileside handling operation and internal transport are carried out automatically, transhipment to trucks is operated manually in the last phase, thus avoiding overlapping of manually (truck driver) and automatically operated areas.

The FHD can be applied in three different configurations:

- ♦ The small size configuration consists of one FHD which directly transfers the loading units between train and truck.
- ♦ Different sizes are configured to allow daily throughputs between 300 and 1200 or 1600 ITUs, alternatively in Compact- or High Rack System application.
- ♦ One configuration with a number of FHDs and cross conveying equipment allows a fast Rail-Rail connection, which is required for hub stations.

Transhipment Area

The transhipment area of the FHD consists of a craneway, crane bridge, trolley and lifting gear with telescopic spreader and can move in the whole of the transhipment area. The spreader is adjustable to container lengths between 20’ and 49’, swap bodies between 7,15 m and 13,6 m and semi trailers. Due to the small cycles and the configuration of the device, handling of one transhipment is very fast.

The transhipment of ITUs is carried out automatically in order to reach a high performance of transhipment and to meet the requirements of a continuos and error free transhipment of ITUs.

The train is conveyed through the transhipment area by a radio controlled shunting engine or a special robot with high accuracy. Thus, all ITUs are passed through this area and can be handled selectively.

Conveying and Storage Technology

Terminals of medium and large sizes can use stacking and conveying technology, consisting of cross conveyors and Compact- or High Rack Storage systems. The cross conveying equipment is operated between rail- and roadside of the terminal and serves for internal transport, buffering and placing at disposal.

System Control

The overall system control is subdivided into two levels, processing data at different niveau. The central processing level is for administration of material and information flow of the whole terminal. The second level carries out the actuation and location control of subsystem like the FHD, High Rack Stores and cross conveying equipment.

Scheduling and Planning Requirements

The picture of the FHD is still very unclear to me, so it is very hard, to figure out the scheduling and planning requirements, since the report gives no clue, how a train is concretely managed.

3.3 The Automated Loading System[1]

The Automatic Loading System (ALS) of Kölker & Thiele, Wuppertal, Germany is a fully developed system which will enable intermodal transport units like semi-trailers to be loaded and unloaded within a maximum stopping period for a train of eight minutes. All that is required is an ordinary transfer terminal with no crane facilities but with approximately eight meter wide loading platforms to left and right of a rail track at the level of a low loader wagon's platform. Loading takes place below the overhead contact line. The system needs only one type of low loader wagon equipped with two laterally mobile crawler based carriages with a built-in lifting and lowering device. The semi-trailers require very little modifications for this loading process.

The system functions as follows:

The semi-trailer to be loaded on the wagon is driven to a pre-determined position about one meter from the edge of the platform and parallel to it. After decoupling the semi-trailer the truck tractor can leave the station. To provide ease of access for the road vehicles, loading takes place on alternate sides (cf. Figure 1). The method gives each semi-trailer an access space of about fifty meters, such that there is no need for time-consuming manoeuvring.

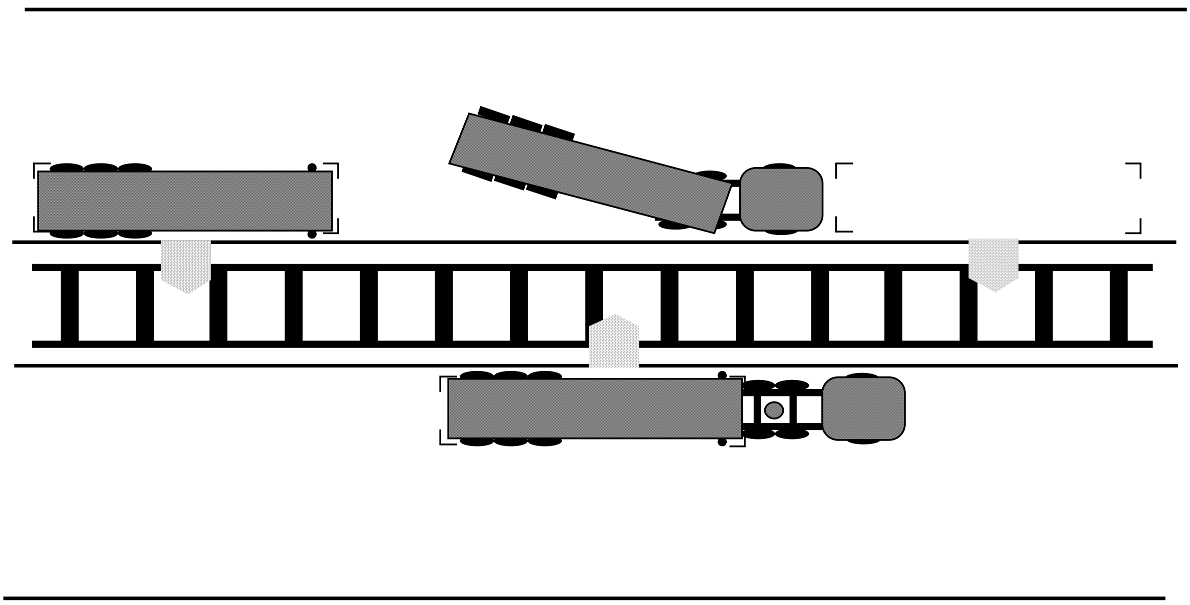


Figure 1: ALS freight platform

[1] Adapted from a Demo-Video of the Automatic Loading System, Kölker & Thiele, Wuppertal, Germany.

The stopping point for the train is determined specifically, so that the semi-trailer parked on the loading lane can be transported laterally onto the low loader section of the wagon – below the overhead contact wire – with total precision.

A central control signal from the locomotive starts the carriages on the wagons travelling simultaneously under the semi-trailers parked in the loading lane.[2] When the carriages have reached a pre-determined position, a limit switch stops them and automatically activates the lifting device. A sequence switch activates the return to the wagons together with the semi-trailer picked-up. The central pivot of the semi-trailer ensures exact mounting, when it is lowered onto the wagon's locking device. The carriages are automatically secured to prevent them shifting accidentally on the wagon (cf.Figure 2). Unloading takes place in the opposite order. The entire fully automatic loading process takes a maximum of three minutes – irrespective of whether one, several, or all semi-trailers are loaded or unloaded simultaneously (cf.Figure 3).

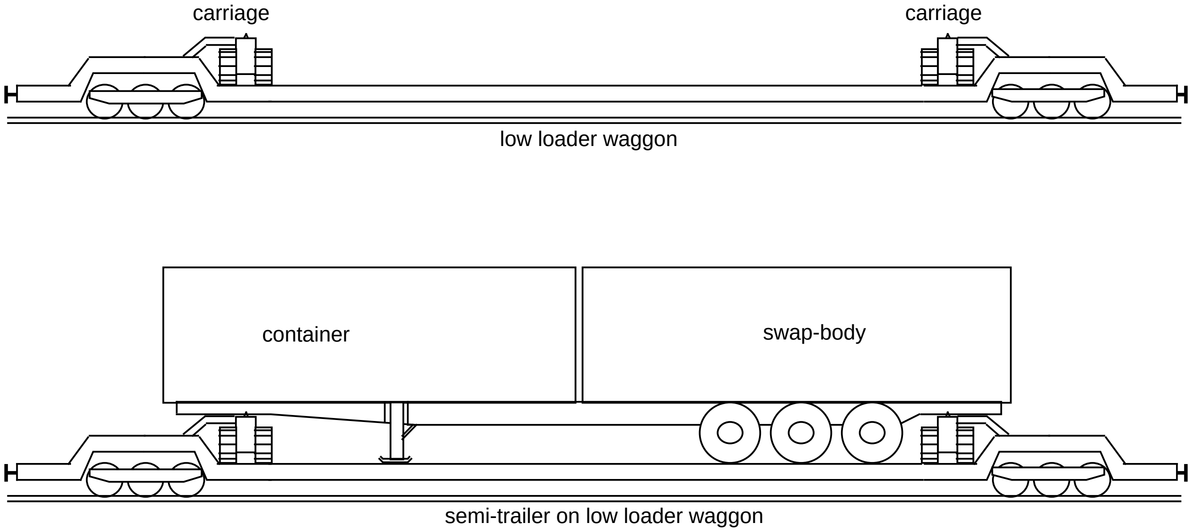


Figure 2: Low loader wagon with carriages and with semi-trailer

The Automatic Loading System can handle all conventional semi-trailers with a length of between 13.5 and 15 meters as well as carrier vehicles for 7.15 and 7.45 meter swap-bodies or for 20, 30, 35, 40, and 45-foot containers, which carry two of any of these loading units.

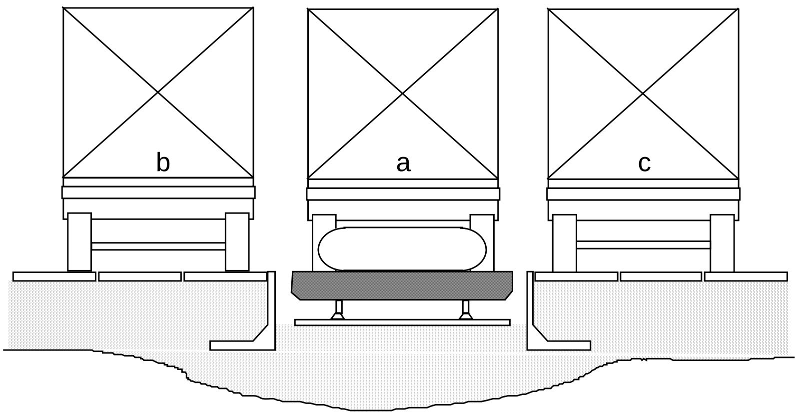


Figure 3: ALS unloading (a to b) or loading (c to a) takes three minutes.

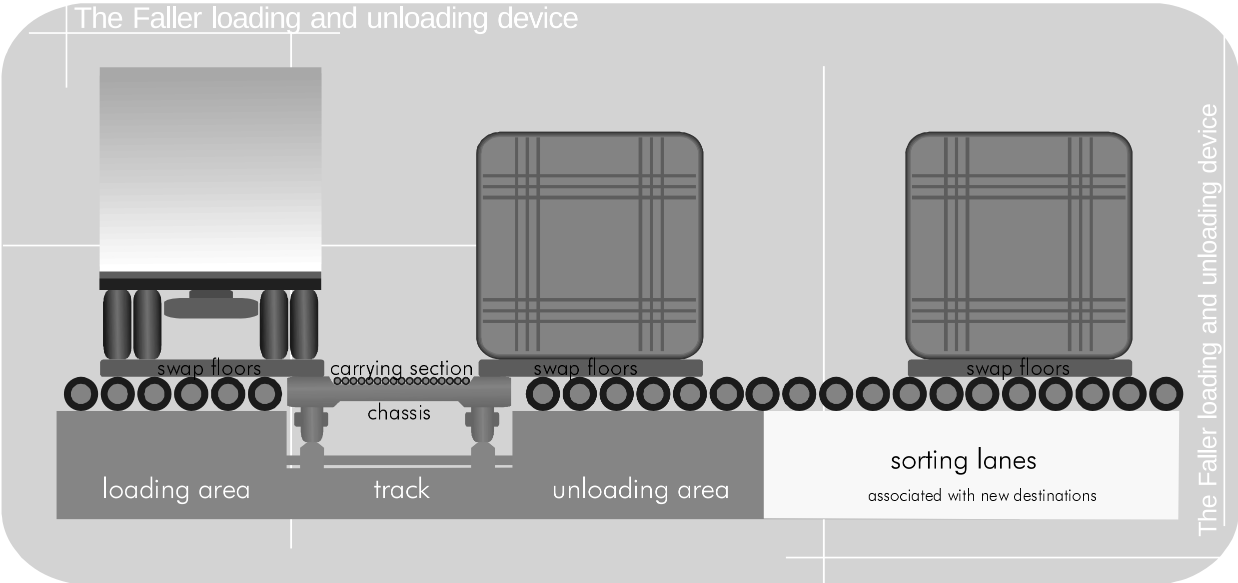
While mobile cranes for translateral loading require loading lanes with a base that can take axle weights of sixty tons and more, the loading platforms required by the ALS can be built with standard, two meter square,

[2] This has to be triggered by the platform management system, which determines the carriages traveling out for loading or unloading the semi-trailers in a full train.

prefabricated sdlabs made of reinforced concrete. Thus transfer stations can be built, extended, or if necessary reduced in size or even disassembled completely in a very short time. The slabs can all be reused again at another location.

3.4 The Faller System

The Faller system has been designed by Alexander Faller and is not yet operational in any terminal or demo site, unlike the other three systems introduced here. The system employs specially designed wagons, which are rolled and sorted within a terminal. The main focus of this device is the fast loading, sorting and reloading of ITUs. Trains entering the terminal carry ITUs with different destinations. Instead of shunting wagons to new trains, this system separates the ITU from the wagon.



Wagons

The wagons are composed of 3 components, which allow to separate the rolling part of a train from the freight carrying parts:

- The chassis with independent suspension of wheels
- The carrying sections or carrying floors[3]. These sections are equipped with motors to moves the ITUs from and onto the train.
- Swap floors, which carry the actual ITU. These swap floors are locked with the carrying floor during transit.

Terminal

The terminal consists of a track and several sections for loading and unloading, as well as sorting the ITUs. On the left-hand side of the track, the loading area carries the ITUs, waiting for their train. On the right-hand side of the track, the unloading area is directly connected to the sorting area. At the beginning and end of each sorting line links to swapping areas as well as the roadside are situated. Each of the sorting lane is associated with a destination, to which train run from this terminal.

Transhipment

In a terminal Z a train coming from A with ITUs destined to terminals B, C, D, etc. enters the track. It always stops at a fixed take-over position. Then the hydraulic buffers are released to allow exact positioning of the swap floors to the rolling devices.

[3] I did not yet find an appropriate English term for this.

The ITUs are moved to the unloading section and then passed into the sorting section, where they are sorted according to their destination.

The ITUs waiting for transhipment into the new direction A of the outgoing train are already placed at the loading section and can be shifted onto the train now.

4 Comparison Overview

In the following table, we give a short overview on all important characteristics of the 4 systems. Not all devices are able to handle any kind of transport bin, especially the ALS and the Daimler KombiLifter systems are limited in this way. The Faller system is designed for all types of ITUs, but it requires normed wagons for the trains. The Krupp Fast Handling Device appears to be the most universal system, in terms of ITUs to handle. Still, comparing the equipment and space requirements, the ALS and the Daimler KombiLifter system look much more favourable, since they require only a small space, and the new equipment to be installed in the terminal is available at low cost. One last important feature to note and compare is the access to the ITUs on a train. The ALS and the Faller devices offer access to all positions on a train simultaneously. The Daimler KombiLifter allows only access at the front and the back of the train, but this can be also called quasi parallel in the sense, that, once the ITUs are lined up, they are lifted simultaneously. Also, since the queuing up of the swap bodies can be done in a short amount of time and the shunting of the train wagons can be performed before loading the swap bodies onto the train, this provides for the quasi-parallel access. The Krupp Fast Handling device accesses one ITU on a train a time.

Since we only aim at comparing the features of the fast handling devices and thus provide a decision basis for the selection of the device to simulate in the faster scenario, we will not select a system within this report.

Device	*ITUs*	*Wagons*	*Access to ITUs on a train*	*Remarks*
Daimler Benz Kombilifter	Swap Bodies Land Containers	Normed wagons	Front and back of the train	• Easy to install, requires not much technical gear and space • Quasi-parallel loading of a train, once the ITUs have been lined up sequentially
Krupp Fast Handling Device	All	Commonly used wagon types	One position at a time on a moving train	• Modular design • Requires much new technology and space
ALS	Semi trailers	Normed wagons	All positions simultaneously	• Easy to install, normed building parts can be assembled within a few days • Requires not much technical gear and space
Faller	All ITUs	Normed wagons	All positions simultaneously	• Requires much new technology and space • Faller claims, the system can handle all kinds of ITUs, but leaves out the fact, that his wagons may not fit underneath the electric wires along the tracks

References

Most of the information used in this report has been taken from advertisment material of the manufacturers of the systems, therefore we can only provide a very small list of references.

- Alexander E. Faller. Statt vertikal verschieben: horizontal umschlagen. In Zukunftsaspekte des Aplentransits: Kombinierter Verkehr Deutschland – Schweiz/Österreich – Italien. H.-J. Zahorka and M. Raile (Eds.). Libertas – Sindelfingen, pp. 125–131, 1995.
- Information about the Daimler KombiLifter is available from the two licensed producers:
  LOHR Industrie
  F-67980 Hangenbieten
  Phone: INT-88-38 98 00
  Fax: INT-88-38 98 00

  Graaff GmbH
  Postfach 1145 and 1155
  D-31001 Elze
  Phone: (050 68) 18-0
  Fax: (050 68) 18-197
- Information about the Krupp Fast Handling Device is available from
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