Intelligent Transport System for Innovative Intermodal Freight Transport

Project final publishable summary report

1. Executive Summary

The TelliSys “Intelligent Transport System for Innovative Intermodal Freight Transport” project was launched to develop an intermodal transport system to optimize the performance of intermodal logistic chains and contribute to a more efficient European transport. Intermodal transport is deemed the best way to deal with the increasing transport demand in the European Union without having to accept the negative ecological impact of the currently dominating road transport. Within the interdisciplinary European consortium a complete transport system, consisting of a family of intermodal loading units (“MegaSwapBoxes” or MSBs), a super low deck truck including new low dimension tyres and a suitable trailer chassis have been developed.

In order to develop a competitive transport solution, the loading units are volume optimized to compete with the transport volume of leading road transport solutions. This led to an internal height of up to 2.97 m while keeping the system at a total height of 4 m to comply with European regulations. Additionally, the members of the product family are designed to match the differentiated requirements of specific market segments. This includes characteristics like openable side walls to enable side loading, a liftable roof to simplify loading processes and varied stackability. The loading units are carried by a new super low deck truck and trailer chassis with a fifth wheel height of only 850 mm. This height is 60 mm lower than currently available low deck trucks and was achieved by completely redesigning the truck and the development of special low dimension tyres. The consortium produced prototypes which were presented to the public as a proof of concept in 2015. The prototypes were tested in multiple test runs through Europe and fulfil every necessary requirement.

During the three-year duration, the TelliSys consortium has closely worked together to present the most suitable solution for the very challenging task: from the market and lead user analysis, to the definition, design and construction of each component. The intermodal concept has been tested and evaluated showing financial advantages - with cost savings of up to 15 % - over other current transport systems and a 25 % reduction of Global Warming Potential, reducing significantly the environmental impact.

TelliSys generated a market-oriented intermodal technology concept that opens new opportunities for intermodal transport in Europe and abroad which meets the EU's demand for more energy-efficient, low-emission transport solutions. Transport solutions like TelliSys are required to cover the increasing transport demand in the future and to reduce the load on the limited capacity roads which will improve the situation for every European citizen.

2. Summary description of project context and objectives

The project "Intelligent Transport System for Innovative Intermodal Freight Transport" – TelliSys aims to optimize the performance of intermodal logistic chains. To contribute to more efficient transport, the interdisciplinary TelliSys consortium (cf. Figure 1) develops an innovative intermodal transport system, consisting of a family of volume optimized MegaSwapBoxes, a suitable trailer chassis, a super low-deck truck and purpose-built tyres. The project was launched in December 2012 under the 7th Framework Programme (FP7) of the European Commission for a duration of 3 years.

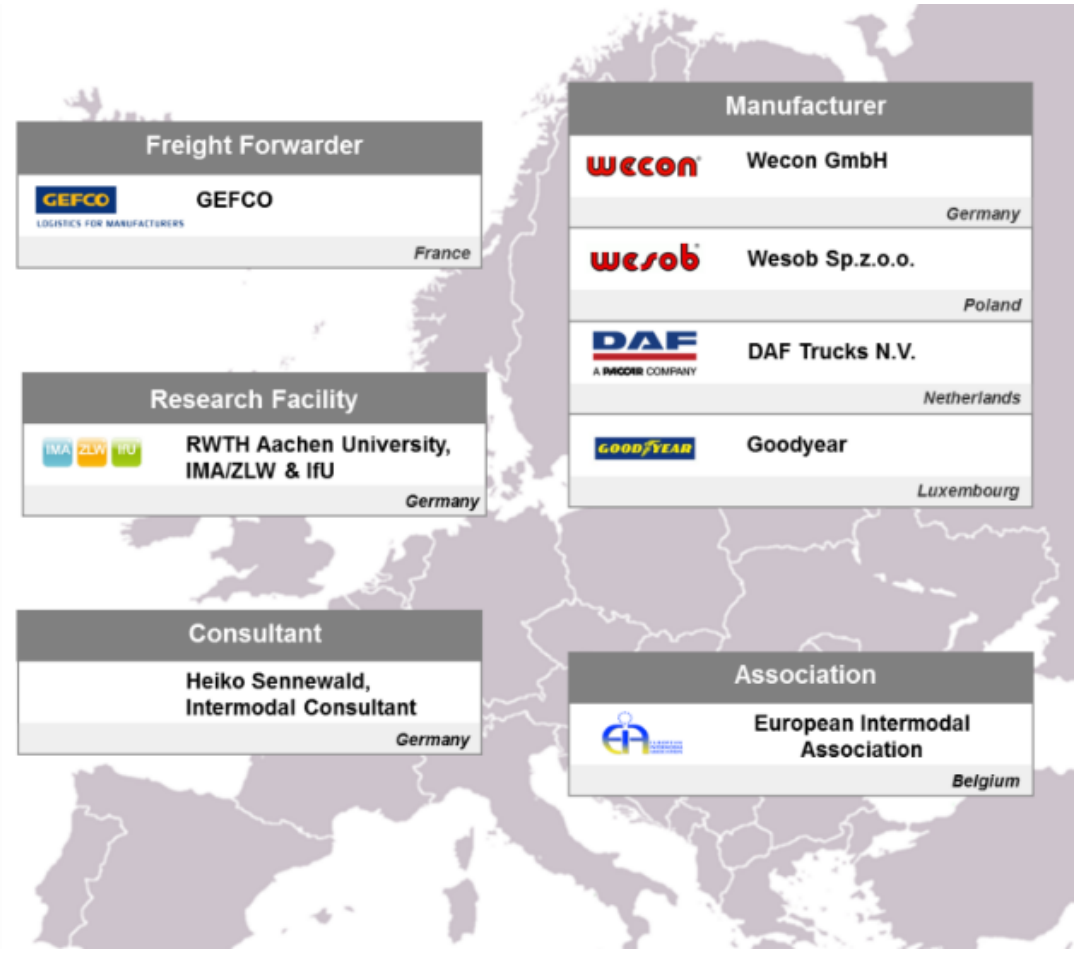

Figure 1: TelliSys consortium

The increasing transport demand – prerequisite for economic growth – is still challenging the European transport system. Even though the transport demand depends on the more and more volatile economic performance of the member states, it can be assumed that there will be a continuous increase of transported tonne-kilometres in the coming years. To be able to handle the increasing transport demand without having to suffer from heavy ecological repercussions, the multimodal logistic chains have to be optimized. A sustainable transport system in the European Union can only be established with the help of the unused potential of the intermodal transport.

In order to tackle the outlined challenges, the European Commission published the white paper – Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system - in 2011. This white paper provides a comprehensive strategy for a competitive transport system that fosters mobility. At the same time, the white paper describes a vision to drastically reduce carbon emissions in transport (aim is 60 % reduction of the 1990 levels by 2050). To meet this goal, appropriate infrastructure and transport equipment is necessary.

Furthermore, the transport sector faces several challenges in terms of safety, traffic congestion, loading processes and interoperability of available modes of transport. One crucial objective is to optimize the performance of multimodal logistic chains, e.g. by making greater use of more energy-efficient modes. Thus, the intermodal freight transport becomes more relevant over the next years. The design of future intermodal loading units will be affected by this in terms of interfaces to different carriers (e.g. road trailer or railway waggons) of the different transport modes. These requirements have to be respected in future concepts for loading units.

In the current European freight transport many different loading units – developed for specific purposes and markets – are being used. The trend for enhancing loading units goes towards maximisation of the cargo volume and the facilitation of loading transhipment processes. Current common loading units are shown in Figure 2. Some of them can be used in intermodal transports, while others are applicable in just a single transport mode. Containers can be used in intermodal transports, but are outperformed by the road solution Megatrailer in terms of loading volume. The intermodal transport is in dire need of a competitive solution.

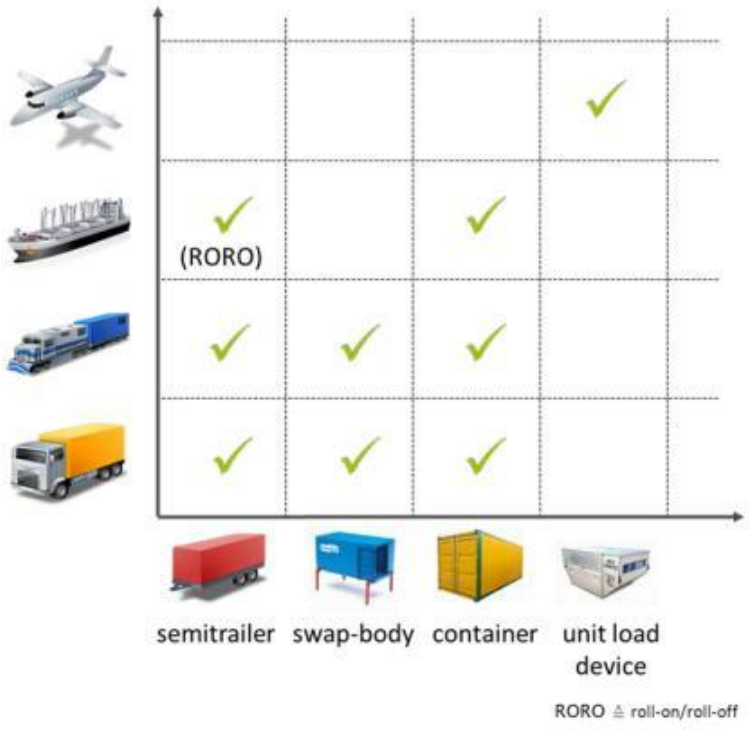

Figure 2: Intermodal loading units (source ACEA 2011)

A new loading system has to outperform the currently used units to have an enduring impact on the transport sector. It has to compete with the ISO containers, regarding the widespread application options, and with the Megatrailer in terms of raw loading volume. Therefore, the TelliSys consortium conducted – with the help of a multidisciplinary advisory board – an extensive analysis of the current market situation and future market needs. The technological progress in the transportation field and the evolving markets had to be taken into consideration in order to develop a solution that combines the different existing solutions for loading units, trailers and low deck trucks. Only if done right, the developed solution can have an impact on the European transport market. This defines the 2 main objectives of the project:

- Development of a complete volume optimized intermodal combination satisfying current market demands, including a family of new intermodal loading units developed to address various use cases.

- Enhance the performance of intermodal logistic chains and contribute to a more efficient transport by easing the transition between different transport modes.

TelliSys builds on the results of the preceding project TelliBox, "Intelligent MegaSwapBoxes for advanced Intermodal Transport", which developed the first iteration of a MegaSwapBox, an intermodal loading unit that combines the benefits of containers with the benefits of swap bodies, incorporating the market's diverse requirements for intermodal loading units into one single concept. Despite the success of the TelliBox project regarding market and customer interest, the evaluation showed flaws that hindered its commercial success. To solve these issues the TelliSys consortium identified that a single loading unit cannot address all requirements of every market segment and decided to develop a family of MegaSwapBoxes. The members of the product family can address the requirements of specific market segments. The new super low-deck truck unit and the purpose-built tyres enable the optimization of the cargo volume by allowing up to 2.97 m inside height while keeping the system below the 4 m maximum height on the road.

Based on the identified use cases, TelliSys delivers three innovative solutions for intermodal transport to improve the current state of the art:

- An intermodal transport system for the European market consisting of a tractor unit, a trailer chassis and a side-loadable intermodal MegaSwapBox suited for road-, rail- and short sea transport.

- An intermodal transportation system developed specially for the automotive industry that provides 2970 mm inside height for 3 layers of metre-trays.

- An intermodal transportation system for the intercontinental transport that uses a single 40 ft. or 45 ft. MegaSwapBox end-to-end offering maximum transport volume.

The design of the MegaSwapBoxes and the truck including tyres posed different challenges that the project solved successfully. For the MegaSwapBox the main issue was to optimize the internal volume while keeping the outside dimensions within legal regulations of European road and rail transport and in accordance to common standards and norms. New solutions for a thin but stiff

bottom frame, an openable water, dust and theft proof side wall, and a hinged roof had to be developed. For the super low deck truck a series of innovations had to be designed in order to reach an as low as possible fifth wheel height. These have to ensure driving safety and be part of an optimized component layout to match the stringent space constraints. The manoeuvrability and applicability of the truck cannot be decreased below the standards of low deck trucks.

TelliSys offers a loading unit for potential customers that specifically fits their needs without unnecessary features that drive up the system complexity and costs. This single intermodal loading unit concept lets the customer retain full choice of mode of transport. Its standard handling options ease the transhipment between modes of transport. It can be easily integrated in current existing supply chains and is flexible to possible changes in the future. The TelliSys concept will enable the implementation of new logistic concepts like horizontal and vertical cooperation of logistics service providers.

3. Description of the main S&T results/foregrounds

Project methodology

The working schedule of the TelliSys project begins with the definition of a solution space (cf. Figure 3). An extended market analysis is conducted and lead user requirements are gathered. In a second step, the characteristics of the modular MegaSwapBox, the trailer chassis and the super low deck truck are specified. After the production of the prototypes and the corresponding test runs, an optimization loop is integrated to allow a continuous improvement process. The project TelliSys ends with a proof of concept in the form of prototypes that can be used to highlight the potential of intermodal transports.

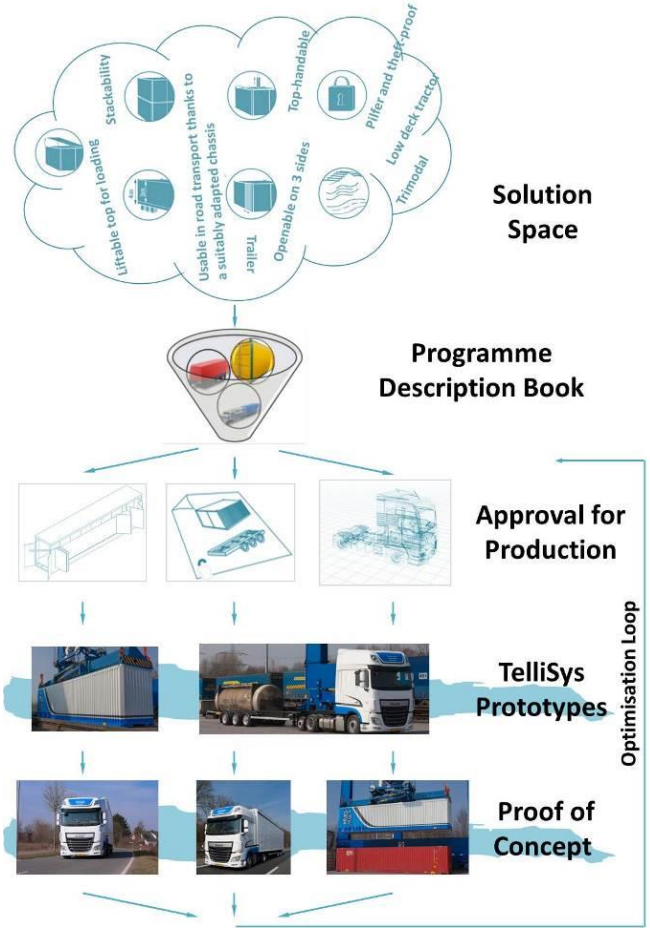

Figure 3: Project approach

3.1. Market Analysis

The goal of the analysis was to define the vision for the project and set the foundations for the development of a product suiting the market requirements as best as possible. The programme vision contains the framework of the project based on the lead user requirements and the market analysis. It shows the need for an innovative intermodal transport system and presents the characteristics of the TelliSys components. In total, the consortium carried out 21 lead user interviews.

The as-is analysis confirmed the demand for a new adaptable and efficient intermodal transport system, that allows a more efficient management of logistic chains. The examination of the results of the lead user interviews provided a list of general and more specific requirements for future transport systems.

Intermodal transport is not only subjected to road, rail and water legislation but also to special intermodal legislation in the countries where the transport takes place. As one result of the as-is and market analysis, an overview of the legislative framework for intermodal transportation in Europe can be found within the project public deliverables.

The market analysis provides an overview of the current market situation for intermodal transport in Europe. While the use of 45 ft. units in the western European market is growing, they rarely get used in the eastern European market which is dominated by 80 ft. waggons and the corresponding 40 ft. units. Another significant result is that many customers prefer loading and unloading from the side and back, which makes standard containers unappealing. For the intermodal transport, craneable Megatrailers with an internal height of 3 m are the equipment of choice for many forwarders. The benefit of this internal height, which enables the transport of 3 layers of so called metre trays, outweighs disadvantages like the need for special railway waggons and clunky handling processes. One of the biggest disadvantages of almost all currently used intermodal loading units is that they either have a too low internal height (e.g. HC containers have an internal height of approx. 2.70 m) or are above the maximum height of 4 m when transported on road.

The most commonly named requirements for the MegaSwapBox (MSB), the truck and the trailer chassis from the lead users interviews are (cf. Figure 4):

- **Size:** 45 ft. loading units are interesting for road transport and the European market, while 40 ft. loading units have big advantages regarding the standardization of vessels and wagons and are the standard loading unit in the eastern European market. The new legislation in Europe on masses and dimensions gives 45 ft. container more possibilities on road transport. 24 tonnes of payload are a must have.

- **Height:** the optimal internal height ranges between 2.95 m and 2.98 m. A total 4.00 m vehicle height must be respected for road use. The box height must be limited to 3.20 m for railway application (3.20 m ≙ C 75 UIC codification).

- **Handling:** the new loading unit needs standard handling devices (at least corner castings and grappler pockets).

- **Weight:** importance of a minimum payload of 24 t.
- **Stackability:** at least stackability of 3 (2+1) loaded units for trimodal transport. This feature has a big impact on the construction and weight of the box.
- **Loading:** openable long sides can improve the efficiency of loading processes and may grant access to new markets. The new loading unit should ideally have the possibility to be loaded from the back and at least one side. It must be possible to load from the side over the full length of the container.
- Main interesting **IT requirements:** tracking and tracing, security and temperature control.

The researches during the analysis phase lead to development of following TelliSys components:

- A **Family** of modular 40 ft. and 45 ft. **MegaSwapBoxes** for different use cases:
  - Intercontinental MSB for overseas and long distance transport, like the transportation from Europe to Russia and China.
  - Continental MSB designed for safe transport along central Europe on road, rail and short sea transport.
- A **Super Low-Deck truck** specially designed for the intermodal traffic with a total weight of 44 t and the ability to transport TelliSys and standard chassis. The truck need to have an extreme low fifth wheel height to allow maximum internal height for the transportation of maximum cargo volume load units while keeping the total system height under the 4 m limitation.
- A **Trailer Chassis** developed for intermodal transport and the ability to transport the TelliSys MSB and standard ISO containers.

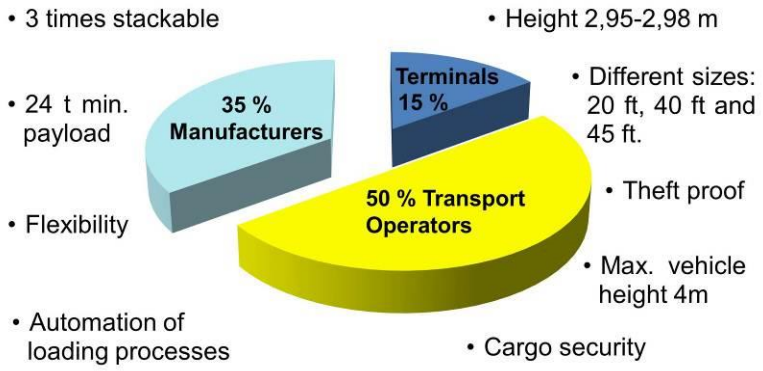

Figure 4: Lead user requirements

3.2. Concept design

The concepts and final designs result from the technical implementation of the requirements outlined during the analysis. The solution space containing different designs for all TelliSys components was defined for the MSB family, truck and chassis.

MSB

Nine different conceptual designs for the MSB (Intercontinental and Continental) were developed. Some of them varied in the design of the bottom frame, the internal height and possible expansions. Based on the defined requirements three solutions were taken into consideration for further evaluation: The continental MSB, the Automotive MSB and the Intercontinental MSB (cf. Table 1).

Table 1: TelliSys MSB family

Characteristics	Continental MSB		Intercontinental MSB
	Stackable MSB	Automotive Box	
Size	40 ft / 45 ft	45 ft	40 ft / 45 ft
Height (internal)	2940 mm	2970 mm	2970 mm
Width (internal)	Euro-pallet	Euro-pallet	Euro-pallet
Long sides	One open	Two open	Closed
Pay load	Min. 24t	Min. 24t	Min. 24t
Roof	Hinged	Hinged	Hinged
Handling	Corner castings	Corner castings Grappler pockets	Corner castings Grappler pockets
Stackability	2 times (1+1)	Not stackable	3 times (2+1)

The MegaSwapBox designs fix known disadvantages of 45 ft containers or swap bodies like reduced inside measurements, improper outside height and difficult handling. The solutions are incorporated into three main designs, from which two of them were also produced as prototypes: Automotive MSB and Continental MSB.

Both versions differ in their layout and working principle: The Continental MSB (cf. Figure 5) has one openable sidewall in addition to the standard rear portal. Handling processes can be performed via the corner castings, which are installed on the 45 ft position. It is equipped with a semi insulated liftable roof. The water tightness of the liftable roof is guaranteed by a two way sealing system. A rubber sealing and drainage system guarantee high level water tightness. For the openable long side a special sliding tarp system was developed, which enables quick opening and closing by sliding and simultaneously folding the tarpaulin. The sliding system also increases the side wall stiffness which is necessary to gain container approval.

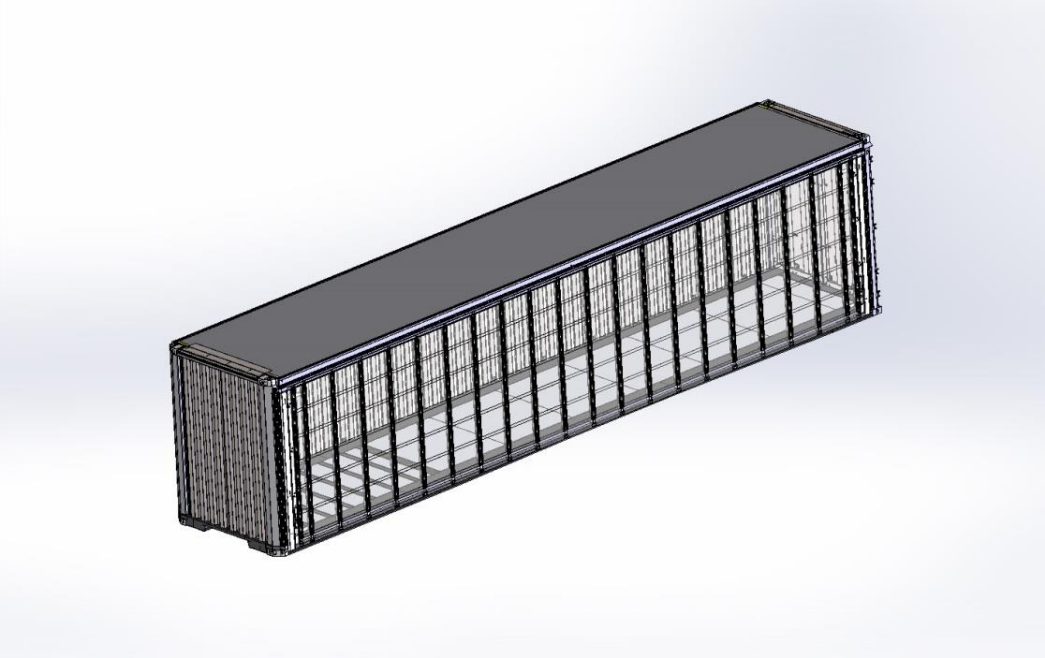

Figure 5: TelliSys Continental MSB 45 ft design

As a result of the development process two patents could be filed. One was filed for the advanced sliding tarpaulin system, which maintains usability in situations where standard tarp solutions would be blocked by the transported goods. The second patent was filed for a solution that prevents the water sealant from clamping between the tarpaulin parts.

The Automotive MSB (cf. Figure 6) has been designed to match the specific requirements of the automotive industry as best as possible. It is equipped with two openable long- and one openable rear side. The roof can be slid and lifted to enable optimal loading from 4 sides. Inside dimensions match automotive loading equipment: 2970 mm internal height for 3 layers of iron-barred boxes and 34 euro pallet slots. The automotive version is not stackable and is handled via grappler pockets.

The Automotive MSBs internal height of 2970 mm in combination with a fifth wheel height of 850 mm enable new transport applications. Solutions for reducing the tare weight of the box frame will help to extend the advantages in combined traffic. A slidable and stiff tarp system developed for liftable roofs is a milestone in this loading unit design. Besides such a system helps saving handling time during opening/closing of the loading space, and its stability increases transport safety.

The TelliSys family includes also an Intercontinental MSB version, e.g. for coastal vessel transport between Spain and Great Britain. For all developed designs variations in length types e.g. 40 ft / 30 ft based on the main design are quickly realizable. Besides customisations like a grappler pocket for vertical handling in the continental design or standard tarpaulin to achieve lower weight are also possible.

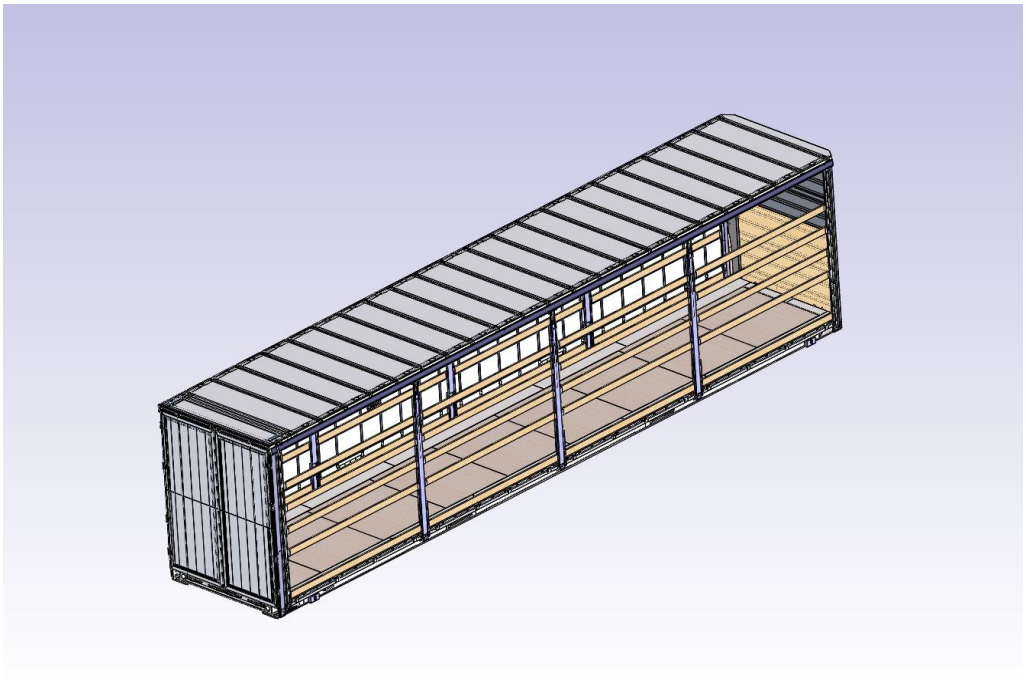

Figure 6: Automotive MSB design

Super low-deck truck

The final design is a 6x2 tractor that fulfils the Euro 6 standard (cf. Table 2). In order to achieve an as low as possible fifth wheel height: A three axle truck with an extremely low fifth wheel height of 850 mm has been developed, the next level of low-deck truck. This fifth wheel height led to challenges in the design phase which resulted in a complex chassis- and suspension design. The required GCW (gross combination weight) of 44 t for intermodal transport in Europe combined led to the concept of a three axle 6x2 truck (cf. Figure 7).

Table 2: TelliSys Super Low-Deck truck

Characteristics	Super Low-Deck truck
Type	FTr 6x2, EURO 6
Front Axle	8.0 T
Rear Axle	11.5 T
Tag Axle	4.0 T
GCW	44 T
Fifth wheel height	850 mm
Vehicle weight	Target 8000kg

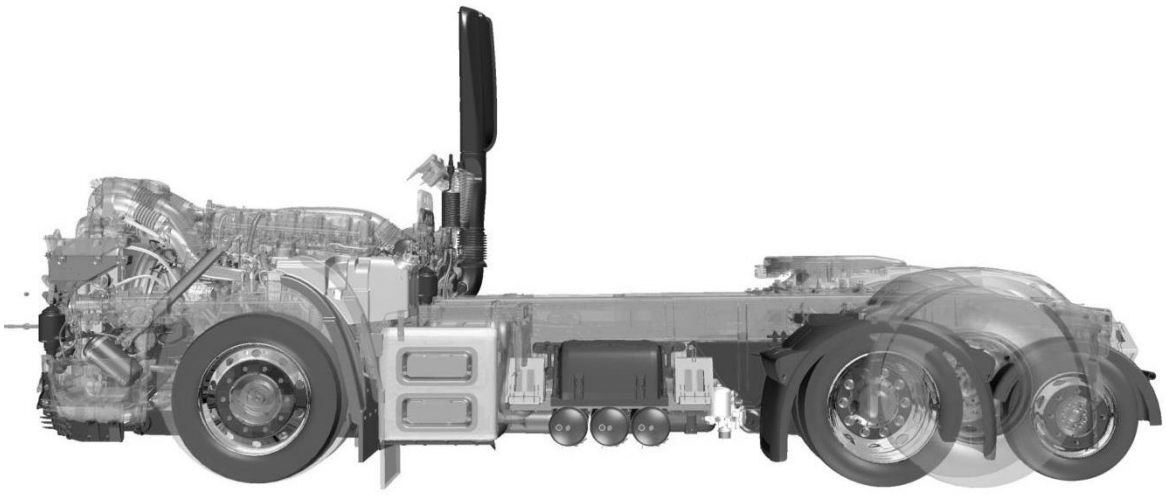

Figure 7: Height Comparison: Standard DAF truck vs Super Low-Deck truck

The vehicle is equipped with 22.5 inch steered and driven axles, and fitted with a 17.5 inch tag axle. The reason for the relatively small tag axle lies in the placement of the drive axle directly underneath the fifth wheel. Because of the fact that three axles are required and combined with a GCW of 44.0 t, 20.0 to 23.0 t axle load should be covered by the truck (depending on the trailer), creating an extremely short wheelbase and placing a relatively light (4.0 t) tag axle. Another important reason for choosing a 22.5 inch drive axle, which sets a low fuel economy figure, is the 25 % traction rule required within the European Law. Stated is that 25 % of the total GCW should be carried out by the driven axle, which means 11 t axle load have to be on the driven axle.

In order to be able to achieve a fifth wheel height of 850 mm, the chassis frame design had to change drastically. Placing the fifth wheel (with a construction height of 140 mm in total) at the right position and height was the major challenge, because not only the ground clearance Sign Off Standards had to be respected, but also the packaging of the chassis frame itself, driven- and tag axle, and suspension with sufficient travel. All had to be designed and fitted in this small area.

Tyres

Special tyres with a small diameter have been developed for the drive and steer axles to allow a super low deck tractor. The following requirements have been analysed and observed for the definition of the dimension of the tyres:

- Reduced tyre dimensions compared to standard truck tyres to meet TelliSys super low deck truck requirements in terms of “tyre space box".
- ETRTO (European Tyre and Rim Technical Organisation) standards for determining the maximum load and inflation to be stamped on the tyres as well as the maximum and minimum tyre dimensions.

The main challenges and activities during the tyre development have been to study and optimise the carcass design according to Goodyear standards to pass all performance requirements, to analyse and

optimise the strain energy density in the rubber and in different tyre areas, as well as to study and optimise the temperature distribution and the way to dissipate more heat in the diverse areas of the tyre.

Trailer chassis

The chassis was conceived as light as possible with a Tara weight to be less than four tons, a coupling height of 850 mm with a gooseneck tunnel and to be compatible with standard ISO containers. A total of three different concepts for the chassis were discussed and evaluated.

The TelliSys trailer chassis (cf. Figure 8) is designed to carry up to 36 t of payload while having a tare weight of less than 3,900 kg. The chassis design with screwable axle bearings is a pioneer for drawbar chassis designs for the manufacturer. The design allows for more flexibility by using one chassis design for several axle and tyre configurations.

The main goal keeping the tare limit can be achieved without any loss of solidness. Possible customer requirements like spare tyres or a toolbox can be realised by screwing the carrier behind the air vessels. The room before the first axle can also be used for customisations.

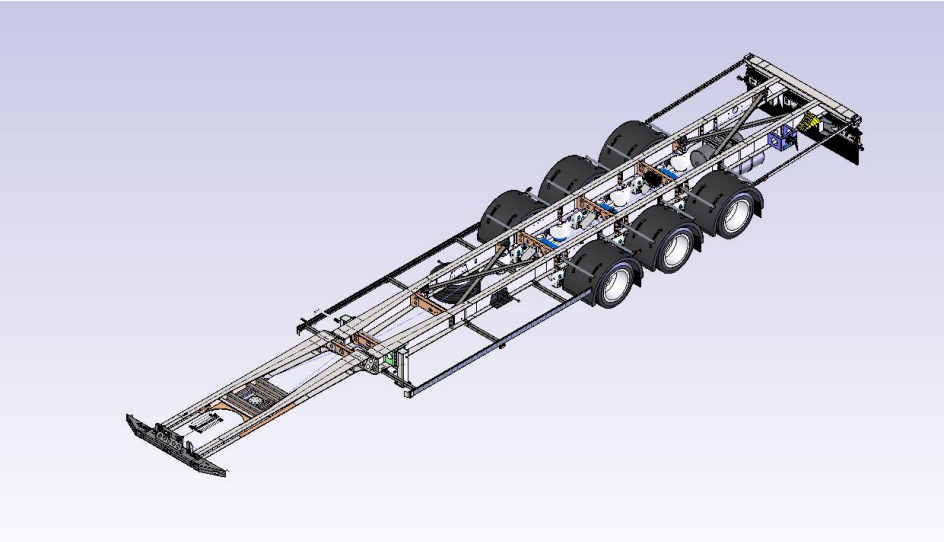

Figure 8: TelliSys trailer chassis design

3.3. Evaluation and decision of concepts

Profitability analysis

The Value oriented cost-effectiveness estimation, also called NOWS method (cf. Figure 9), is a participation-oriented, entrepreneurial cybernetic approach for the evaluation of costs and benefits of an investment. The method enables a decision maker on investment opportunities to combine the classical analysis of an investment in monetary terms with relevant non-monetary variables or the so-called soft factors in the profitability analysis. The intersection point of the cost and benefit curve provides a profitability indicator comparing different scenarios with each other. This approach needs to be considered in comparison to the classical economic efficiency approaches: these conventional approaches limit themselves basically to the quantifiable objectives in terms of monetary data, e.g. costs and revenues (so called "harder" factors). In contrast, the NOWS approach considers non-monetary objectives such as time, quality, flexibility, employee perspectives or organizational environment (so called "softer" factors) to be evaluated in terms of money.

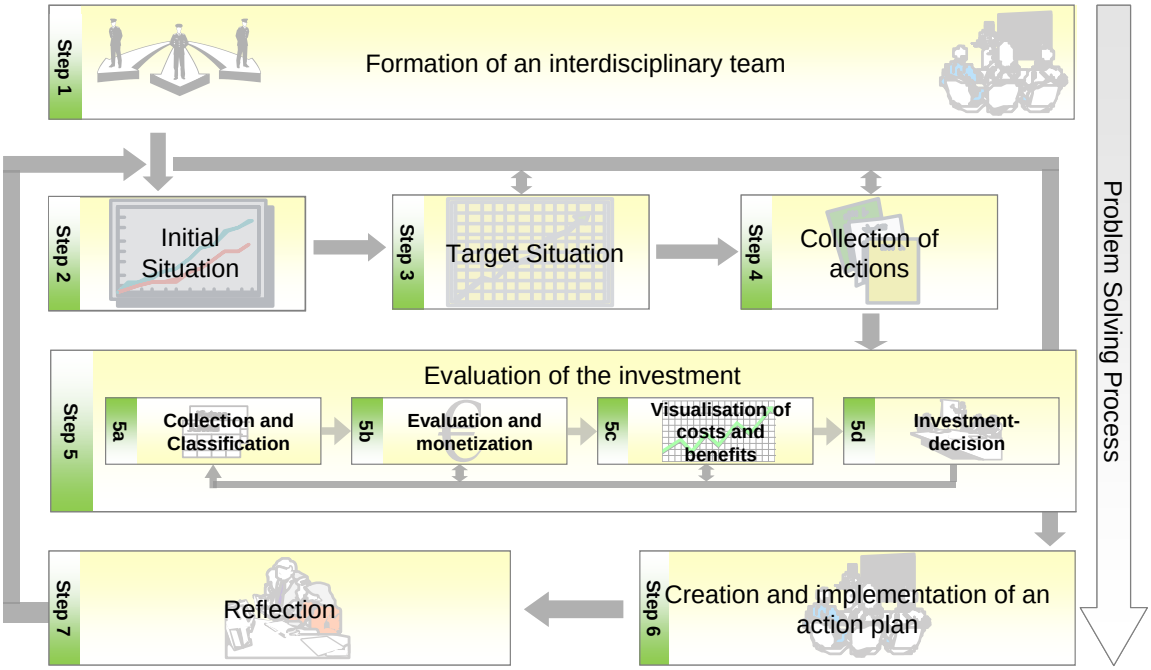

Figure 9: Value oriented cost-effectiveness estimation (NOWS)

The calculations are based on a realistic scenario – data from real transports of a transport operator for the automotive industry were calculated. The routes were designed for the specific transport systems: one route over roads for the Megatrailer system, and an optimized intermodal route for TelliSys.

The profitability calculation shows that by using TelliSys the customer can save up to 15% in comparison to the Megatrailer system (cf. Figure 10).

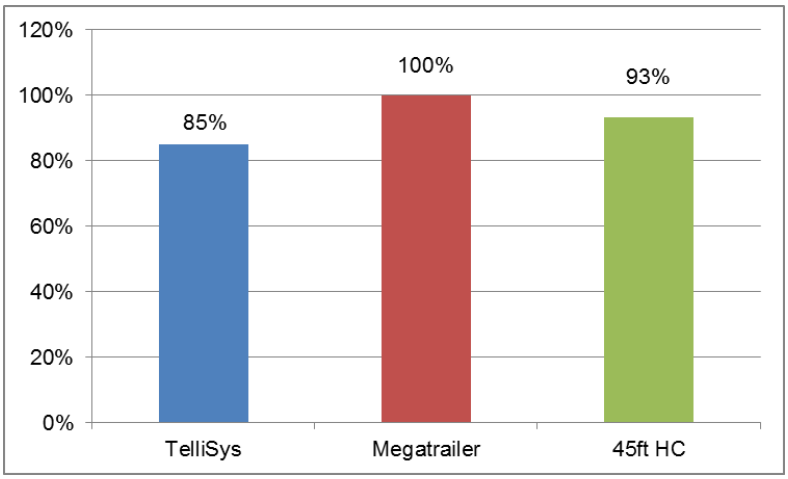

Figure 10: Comparison of the costs of the different systems

Environmental impact analysis

In order to evaluate the environmental burdens of the TelliSys transport system, data from a cross European route has been gathered to perform a Life Cycle Assessment (LCA). The LCA is a standardised scientific method to evaluate the environmental impact during the whole lifecycle of products, processes and materials in a systematic and objective form. This approach is commonly used to compare competing technologies regarding their respective environmental burdens.

As pointed out earlier, TelliSys was developed to increase the environmental efficiency of transport in the European transport sector while being able to compete with leading transport systems. In the LCA, TelliSys was compared with the Megatrailer and the 45 ft HC ISO container system. The focus of the environmental impact assessment was the operation phase of the product lifecycle.

From an environmental point of view, the results show that TelliSys performs significantly better than the Megatrailer system in five impact categories: Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP), Depletion of Abiotic Resource (DAR) and Ozone Depletion Potential (ODP). In the prominent impact category GWP the TelliSys result is about 24 % lower than the result of the Megatrailer system and slightly (1%) lower than the result of the 45ft HC container system (cf. Figure 11).

In the categories land use, marine aquatic ecotoxicity potential and photochemical oxidation, the results of TelliSys are higher than the ones of the Megatrailer system, which is related to the specific environmental impacts of train transport versus road transport (infrastructure, equipment etc.).

This indicates that using TelliSys technology and the intermodal route, a total of 16.8 kg CO_2 – Eq. per m^3 transported cargo can be saved. Taking into account the total amount of cargo transported (36 loads per day) during the considered period (five years) a total of 67,292,505 kg CO_2 – Eq. can be saved. The results indicate that by using TelliSys technology and utilizing train transport in this case, the distance travelled by road can be reduced by up to 81.2 %.

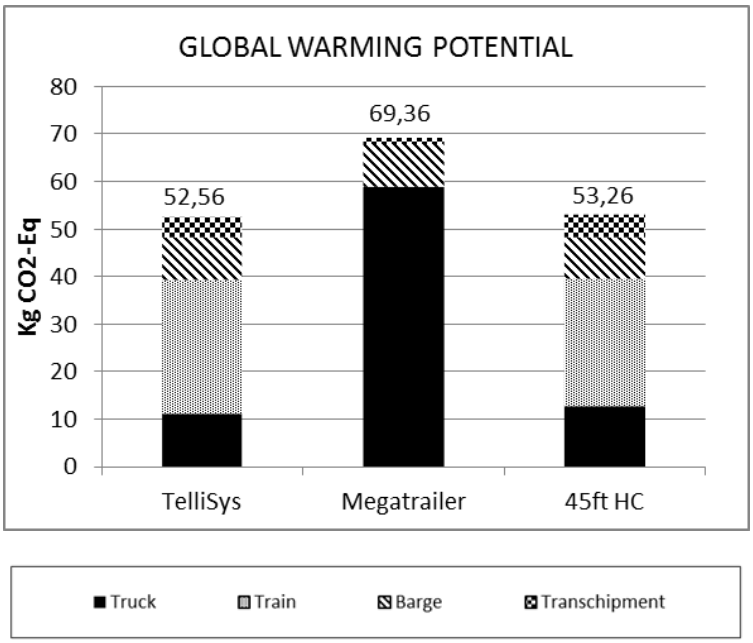

Figure 11: Global-warming potential and Land Use of TelliSys, Megatrailer and 45 ft HC container transport systems with consideration of conventional energy supply (functional unit of 1 m3 of cargo).

3.4. Construction of prototypes

The final decision was to build a prototype tailored to the European market, taking into consideration the lead users' desired features. Moreover, the selected solution is the technically most challenging one. The TelliSys MSB prototype (cf. Figure 12) is a 45 ft version with an internal height of 2940 mm and a minimum payload of 24 t. The new loading unit has one openable long side, corner castings and is stackable two times. The Super Low-Deck (cf. Figure 14) truck is a newly developed 6x2 super low-deck truck with a fifth wheel height of 850 mm, and complies with the Euro 6 regulation. A chassis (cf. Figure 16) for 45 ft loading units with a coupling height of 850 mm is designed to keep the total vehicle height at 4 m.

Additionally, a second variant of the loading unit family was produced as a prototype, the Automotive Box (cf. Figure 13). This prototype is a 45 ft. loading unit with an internal height of 2970 mm which enables the transport of a third layer of so called metre trays. The Automotive Box has two openable long sides and is designed for the combined transport on rail and road. It is fully compatible with the other components of the TelliSys transport system.

Continental MSB:

Figure 12: Continental MSB prototype

Automotive MSB:

Figure 13: Automotive MSB prototype

Super Low-Deck truck:

Figure 14: Super Low-Deck truck prototype

Tyres:

Figure 15: Tyres for super low-deck truck prototype

Trailer:

Figure 16: Trailer chassis prototype

3.5. Testing of prototypes

Before the extensive field test for the whole combination started, internal tests of all components were held separately. The field tests were performed on an intermodal test route under realistic freight transport conditions and various test cases to detect possible weaknesses (cf. Figure 17). After the evaluation of the test runs and the recommendations for the improvement of the prototypes, the optimisation process began. The optimisation ended with the last part of the demonstration phase, the final event, with a presentation of the prototypes to the interested public.

First test run

After passing final internal tests of all single TelliSys components, the first test run started in March 2015. Before the presentation of the project at the "transport logistic 2015" fair in Munich, key trade fair for the logistics and supply chain sector, the TelliSys combination operated between Germany and Italy (cf. Figure 18).

Figure 17: Shots from the test runs

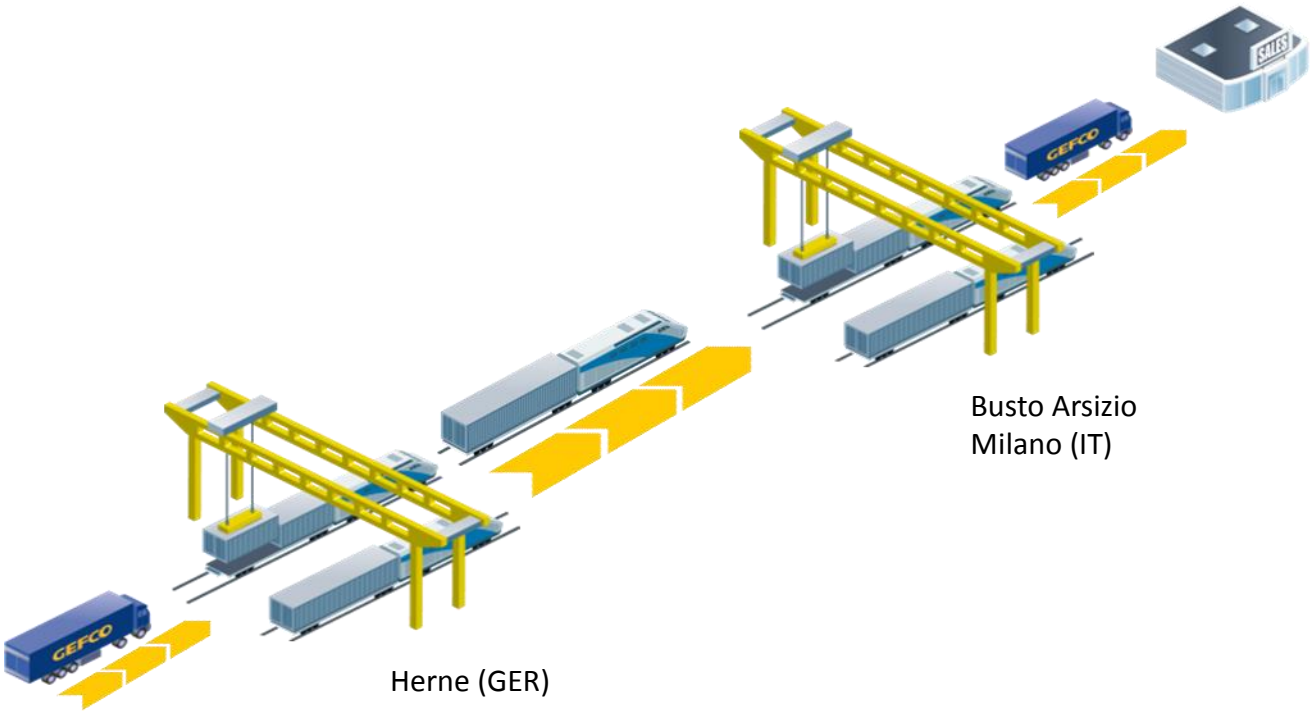

Figure 18: First TelliSys test run

During the test run road and rail movement including all operational aspects of said modes of transport have been tested:

- Pre - & post – carriage by road
- Terminal handling
- Stackability
- Rail transport
- MSB waterproofness
- Loading - & unloading processes

The TelliSys combination completed the first test run without major problems and all prototypes arrived at destination in pristine condition. The performance of the combination matched the expectations. A crucial conclusion is the limited supply of terminals capable of handling the MSB due to its characteristics (corner castings for top craning only on the 45 ft. position). As a consequence, not all railway connections for combined transport in Europe are usable for TelliSys. Further analysis of terminals across Europe will help to evaluate the possibilities of further handling tests. Besides, the specifications of the MSB will be evaluated in order to improve handling operations, e.g. adding grappler pockets.

Second test run

After the optimizations to the issues identified during the first test run were included, a second test run started in July 2015. This time the TelliSys combination was planned to be operated on the line between Germany, France and the Netherlands by combining road and barge movement, including all operational aspects belonging to this mode of transport.

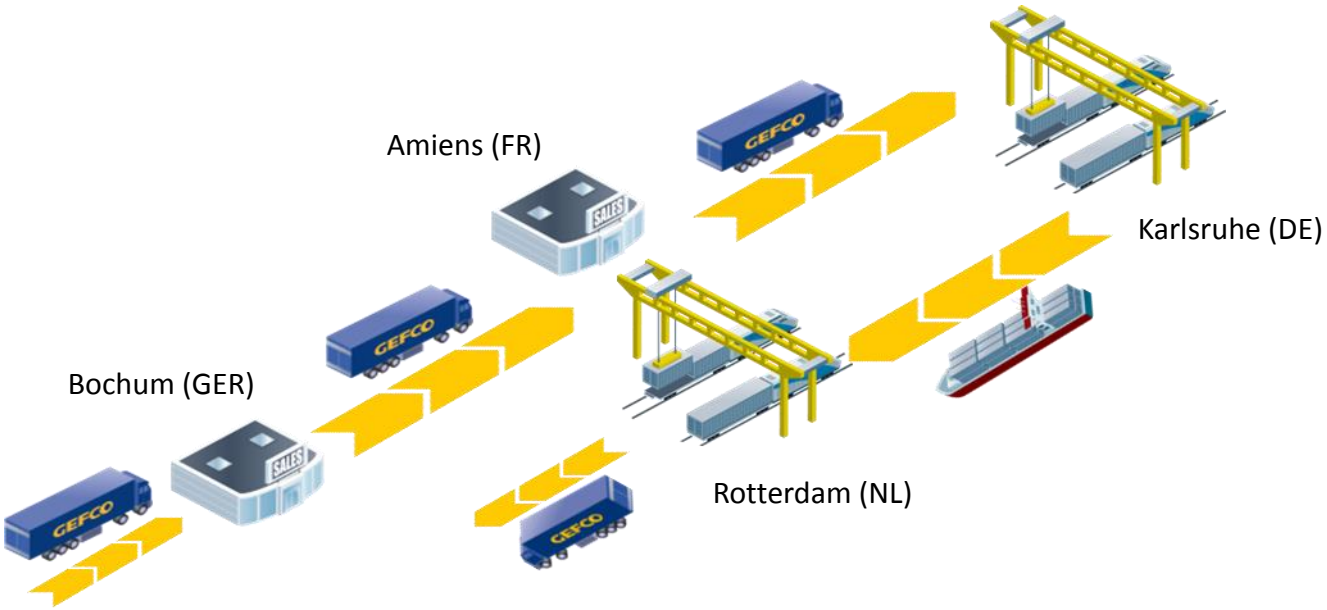

Figure 19: Second TelliSys test run

The TelliSys combination worked well and met the expectations without facing any issues during the road transport. Similar to the first test, the technical layout of terminals along the chain of combined transport became a bottleneck for the TelliSys combination. This emphasizes the need for infrastructural development on a broad European level, e.g. improvement of the availability of cranes able to handle containers from the 45 ft corner castings, in order to push combined transport to a higher competitive level. A study on the use and sale of new equipment having the ability to crane 45 ft container from the 45 ft position has pointed out that currently approximately 10 % of European terminals (out of 100 enquired terminals) have the required equipment on hand.

The barge transport, which is a stress test for the stackability of the box, was part of the initial plan for the second test run. Standard containers can be stacked at least 5 times which is the requirement to be fully suited for barge transport. The containers get moved around during the transport and can result in the container being positioned in the bottom layer with 4 containers on top of it. Therefore, terminal and barge operators can refuse to transport the Continental MSB due to loss of flexibility and impossibility to crane the MSB at certain terminals. This happened during the second test run. While craning the continental MSB was not an issue, the barge operator refused to take it on board because not all terminals on the route have the required equipment.

Further field tests

Parallel to the first and second test run of the continental MSB prototype, further field test were handled with the automotive box. After the public presentation in a press event in Ascheberg by WECON on 26th of March, this new loading unit was available for use by any company interested. A loading test was performed during May 2015 together with our Advisory Board partner showing 10 % more cargo volume over currently used mega-swap-bodies. The Continental Automotive MSB has been thoroughly tested for more than two months in round trips on the route between Italy and Turkey.

Performance of MSB

During the first test run the required handling procedures for road and rail transport were proven to be no issue. The craning, which was tested at a terminal, from the trailer chassis onto a train or onto other containers worked smoothly as expected. However the design decision to only include corner castings on the 45 ft position might be an issue which requires a solution in the future: the amount of terminals which are able to crane containers from the 45 ft position is very limited. These issues can be prevented by the introduction of a 40 ft version of the Continental MSB as the 40 ft corner castings are the standard.

The second produced prototype, the Continental Automotive MSB, garnered a lot of interest from potential customers during the participation at the "transport logistic 2015" fair in Munich, even though the prototype was not presented in Munich. As a result the idea of bringing the automotive version directly to the customers was born. A series of showcase events were held during May 2015 after the fair (cf. Figure 20). During these showcase events the automotive MSB was thoroughly tested and found to be an interesting transport alternative to the currently used Megatrailer or similar swap bodies having less internal height. Furthermore, the loading unit performed very well during the round trips on the route between Italy and Turkey. During these two months the MSB showed excellent performance and no issues have been observed.

Figure 20: Automotive Showcase Events

Performance of Super Low-Deck truck

The specifically for TelliSys developed super low-deck truck and trailer with a coupling height of only 850 mm performed very well during the test runs. The truck and the trailer have been developed specifically for the intermodal transport by DAF Trucks N.V. and the German company WECON GmbH, respectively.

During all performed tests more than 11,000 km were driven and the performance was always as expected. Even challenging terrain in terms of height differences were mastered by the truck and

trailer. The natural problem of low deck trucks is the ground clearance but it proved to always be sufficient. Super low-deck trucks require special tyres to be able to achieve an 850 mm coupling height while having a gross vehicle weight of 44 t. For the project special new low profile tyres for the steered and driven axles, which are characterized by a very low height with high load capacities, were developed. These new tyres were performing very well during the test runs.

Overall results

The TelliSys combination performed very well regarding the aspects: road transport, clearance between vehicle components, clearance between vehicle and ground, flexibility during loading and unloading processes, and maximized transport volume. The handling operations of the Automotive MSB did not encounter any problems during combined transport, making use of the grappler pockets to handle the loading unit. The internal height of 2970 mm is the key feature for the success of the loading unit.

For the Continental MSB, the handling of the loading unit proved to be an issue as it is limited to those terminals with the necessary equipment to crane a loading unit from the 45 ft corner castings position. Therefore, during the test runs, it had to be ensured that the selected route (including terminals) matched the handling requirements. A further examination from project partner GEFCO revealed the severity of the handling difficulties since just one from each five terminals asked had the required equipment. For this reason, the specifications of the Continental MSB had to be reviewed and adapted to the current terminals situation. In order to solve this problem, the company WECON has developed the 40 ft Continental MSB for current European routes where terminals are not able to crane from the 45 ft position, and for the eastern European market, where the availability of 90 ft wagons is extremely limited.

The engineering solutions developed during the project will find their way into future generations of DAF, WECON, WESOB and Goodyear products.

4. The potential impact and the main dissemination activities and exploitation of results

4.1. Potential impact

The freight transport activity in Europe will keep on rising in the coming 35 years – with an increase of around 25 % until 2030 and 40 % until 2050. The goal of shifting 30 % of road freight over 300 km to other transport modes until 2030, and more than 50 % by 2050, described in the current White Paper "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system" requires innovative intermodal solutions like TelliSys. The TEN-T corridors (cf. Figure 21) planned to be completed in 2030 and promote rail freight transport. The corridors will increase the possible height of transported containers so that the TelliSys MSB can be transported on regular wagons. The project showed that further infrastructural development is required, foremost in the development of existing train terminals throughout Europe. Without change in the modal split, the increasing transport demand cannot be covered.

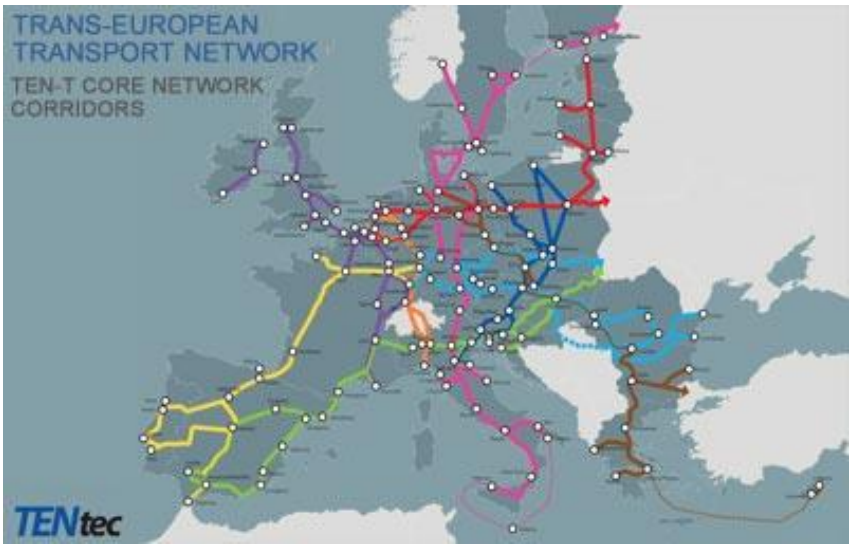

Figure 21: TEN-T corridors (source European Commission)

TelliSys aims to offer a more environmentally-friendly volume optimized, secure and safe transport system for the European transport sector. Solutions that improve multimodal logistic chains are required to combat the dominating road transport solutions. The potential shift from road to combined road-rail transport in Germany has been estimated to be about 8 % in 2014, which is not enough to reach the goals of the European Union. Innovative transport systems like TelliSys can help to increase this number and change the modal split in favour of rail transport. The rail transport is a solution to the increasing transport demand while not cutting back on the goals of the European Union to drastically reduce the GHG emissions.

The TelliSys system opens new intermodal market possibilities being the first loading unit able to transport efficiently up to 100 m^3 by road, rail and water. Thus the system is very competitive compared with the favourite road solution: the Megatrailer. Due to its total internal height of up to

2.97 m and the flexibility of it loading process, costumers transporting their goods by road with a Megatrailer may change easily to intermodal transport using the TelliSys system without changing their standardized production processes and transporting the same cargo amount. Besides, this flexibility stimulates horizontal and vertical cooperation between costumers and hauliers and easier the founding of cargo in return trips, while reducing the number of empty trips.

Furthermore, the environmental performance of TelliSys is outstanding. Tests indicated that the transport system can save at least 10 % fuel on long haul routes compared to current long haul systems and a Life Cycle Assessment shows an increase of the environmental efficiency by up to 25 % compared to current road transport technologies. Besides, the road safety will increase due to the reduction in traffic intensity related accidents. The quality of life of commuters and truck drivers will be enhanced when the roads are less frequented and the road trips are shorter.

Figure 22: The TelliSys transport system

The developed components (cf. Figure 22) of the TelliSys combination have acquired all necessary certificates to be able to be sold in the European Market. This means that the results of the project can be used to promote intermodal transport directly. This was already done by the consortium which allowed logistics companies to use parts of the combination in their own tests. Although the varying complexity of the TelliSys combination components requires different market launch strategies as the time to start series production varies for the components, customers can improve their freight transport even with a single solution without having the whole concept yet.

TelliSys generates a market-oriented intermodal technology concept that opens new opportunities for intermodal transport in Europe and abroad. The Continental MegaSwapBox addresses the European market by maximizing transport volume per unit on the road while complying with the European legislation. The intercontinental MegaSwapBox is a strong intermodal loading unit designed for

oversea transport, offering a bigger transported volume compared to an ISO-Container but with higher flexibility.

To ensure a successful exploitation and market interest, all TelliSys components have been designed taking into account four main characteristics: price, maintenance, handling, and compatibility with existing equipment. Due to the modular design, changes in the components to accommodate specific user requirements can be easily applied. Thereby, the final inner height, materials used for the side wall, loading capabilities, or adjustments in the handling components can be customized for a specific cargo or transport scenario.

Figure 23: The Continental Automotive MSB

The Continental Automotive MSB, for example, (cf. Figure 23) has been designed to address the highly specific needs of the automotive industry. This part of the market has developed special loading boxes with different heights, which cannot always be efficiently transported with currently used loading units. TelliSys` height and flexibility during the loading and unloading processes represent a major advantage for the industry. This new height enables the stacking of three standard pallet-boxes, instead of two, thus the costumer can transport up to 33 % more cargo. At the same time the TelliSys MegaSwapBox offers approx. 15 % more cargo volume over a 45 ft high cube container.

The main goals of the project have been reached and will lead to sustained market success:

- Development of a family of new intermodal loading units addressing different use cases.
- Development of a completely volume optimized intermodal combination.
- TelliSys offers more environmental friendly and cost efficient ways of transport.
- The new intermodal transport system can open new market possibilities for the intermodal transport.

4.2. Dissemination and exploitation

The TelliSys consortium disseminated all publishable results to the interested public in line with the project agenda. They provided a direct flow of information to potential customers through different media – like presentations, exhibitions, papers, and the project website.

Scientific exploitation

Over the course of the project, the scientists of the RWTH Aachen participated in a number of scientific conferences around the world and published a total of four papers: the ITS World Congress 2013 in Tokyo, the Transport Research Arena 2014 in Paris, the 13th International Heavy Vehicle Transport Technology Symposium (HVTT13) in Argentina and the Global Cleaner Production & Sustainable Consumption Conference in Barcelona have been attended. The conferences were used to present the results of the ongoing project and to keep in touch with the scientific community. The conferences helped to ensure that the project was on the right track and was not going to be outshined by other technologies or transport solutions.

Among others, two important theses were generated during the project time. The thesis "Life Cycle Assessment of an innovative intermodal transport system – Compared with existing transport systems during their operation phase" dealt with the environmental impact of the TelliSys concept compared to Megatrailer and High Cube Container. The master thesis "Development of a cost calculation model suited for intermodal transport and application on the TelliSys transport system" aimed to create a lightweight tool to calculate the costs of the three transport modes road, rail and inland waterway for any route in Europe. The thesis focusses on the container transport (40' PW /45' PW / 45' TelliSys MSB) and enables the comparison of the 3 containers.

Selection of published articles, press releases and press conferences:

- GEFCO Magazine – (2013)
- Angedacht Magazine IMA-ZLW-IfU – (2013 and 2015)
- EIA Newsletter – 1/2013
- DAF press release – (18.03.2015)
- WECON press conference – (26.03.2015)
- Trans Aktuell – 09/2015 (24.04.2015)
- GEFCO press release – (12.05.2015)
- DVZ Magazine – (13.05.2015)
- NFM Magazine – 05/2015 (13.05.2015)
- LT-Manager – 05/15 (20.08.2015)
- Trucker Magazine – 06/2015 (05.07.2015)
- GEFCO Kompakt – 08/2015 (07.2015)
- Verkehrsrundschau – 17/2015 (24.04.2015)
- Business-on – (26.11.2015)
- Ruhr Nachrichten – (26.11.2015)

Conferences and exhibitions:

- April 2013 Presentation at EIA general assembly, Brussels (EIA)
- June 2013 Transport logistic trade fair, Munich (Presentation) (all partners)
- September 2013 Intermodal China, Shanghai (EIA)
- October 2013 Presentation to UNECE (EIA)
- October 2013 ITS World Congress, Tokyo (Paper) (RWTH)
- April 2014 Transport Research Arena 2014, Paris (Paper) (RWTH)
- May 2014 ITF, Leipzig (EIA)
- September 2014 IAA Nutzfahrzeuge, Hannover trade fair (WECON)
- October 2014 The Aachen Colloquium Automobile and Engine Technology (DAF)
- October 2014 HVTT13 International heavy vehicle transport technology symposium, Argentina (RWTH)
- June 2014 Truck und Bus – VDI, Eindhoven (DAF)
- May 2015 Transport logistic trade fair, Munich (all partners)
- June 2015 13. International Conference Commercial Vehicles 2015, Eindhoven, Netherlands. VDI Automotive and Traffic Systems Technology (DAF)
- October 2015 Final Event (all partners)
- November 2015 Global Cleaner Production & Sustainable Consumption Conference, Barcelona (RWTH)
- November 2015 Innovation Award Münsterland 2015 (WECON, HSE and RWTH)

The final presentation of the projects outcomes was divided into two parts – the presentation at the transport logistic 2015 fair in Munich and the final event at the DAF test track in Eindhoven. The TelliSys project was nominated for the "Innovationspreis Münsterland 2015" in the category "collaboration between industry and science".

Transport logistic 2015 fair

- The biyearly fair, transport logistic, took place from May 5th to May 8th, 2015 in Munich (cf. Figure 24). The fair was visited by over 55,000 visitors from all around the globe and is known as the most important fair in the fields of logistics and supply chain management.

- At the fair the concepts of the Super Low-Deck truck, the trailer chassis and the Continental MSB were presented to a wide interested public by the whole consortium.

- An official presentation was held on May 6th which was attended by many potential buyers to inform them about the project and present them the prototypes.

- A highly positive resonance showed the market significance of the TelliSys Intermodal Technology Concept.

Figure 24: Transport logistic 2015 fair

Final event

- The final event took place on October 23rd 2015 at the DAF Trucks N.V. test track in Eindhoven (cf. Figures 25 & 26).
- Over 29 Stakeholders were present at the final event, including the whole TelliSys consortium and two EU Project Officers.
- The final event included a presentation of the TelliSys results and a personal test ride with the TelliSys concept.

Figure 25: Final Event – Consortium

Figure 26: Final Event – Prototypes

Innovationspreis Münsterland 2015 – Category "Cooperation between industry and science"

- The award is meant for developments and future-oriented ideas in the German region Münsterland.
- The Project TelliSys represented by the company of the mentioned region WECON won in the category "collaboration between private sector and science".
- The prize money was donated for lessons of the German language for local refugees.

Figure 27: Innovationspreis Münsterland 2015

5. Project Public website and contact details

Website: www.TelliSys.eu

Project coordinator:

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TelliSys consortium:

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- WECON GmbH, Germany
- WESOB Sp. z.o.o., Poland
- DAF Trucks N.V., Netherlands
- Goodyear, Luxembourg
- Heiko Sennewald Unternehmensberatung, Germany
- GEFCO Deutschland GmbH, Germany