Final report

Dryport RFID – Pilot phase

Europe an Community
European Regional
Development Fund

The Interreg IVB
North Sea Region
Programme

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Document history

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0.1	2011-11-28	Document created
0.2	2012-01-03	Sections added
0.3	2012-01-30	First official draft
0.4	2012-03-05	Revision after comments

Abbreviations & Definitions

Abbreviation	Description
RFID	Radio Frequency Identification.
STA	Trafikverket – Swedish Transport Administration.
STA ICT	Trafikverket ICT – Swedish Transport Administration ICT company.
PGRC	Port of Göteborg Rail Center.
OPERA	IT system owned by STA used to identify the wagon composition per train set.

1 Introduction

1.1 Project

This report summarizes the pilot phase of the project Dryport RFID. The phase marks the end (February 2012) of the entire Dryport RFID project, which has been ongoing in different forms and intensity since its initiation during the fall of 2008.

The project's outline is described in this initial chapter, providing an insight into the project's background as well as a brief summary of conclusive project observations.

1.2 Background

Dryport is a three-year public/private sector Interreg North Sea Region project with partners from the ports and logistics sector, from local authorities representing important logistics areas and from key universities. Working together through a programme of workshops, studies and site visits, the Dryport partners will examine the development, design and effective operation of dryports that are fully integrated with the freight handling systems of the seaport facilities they serve.

The project aim is to develop, design and set effective Hinterland intermodal freight transport nodes - Dryports that are fully integrated with the Gateway's freight handling systems, to adapt a public concept to a private sector model, to monitor CO2 effects and to integrate Dryports into the EU Motorways of the Sea concept.

In a fully developed Dryport concept the seaport controls operations, but the terminal itself must not serve only one port, as it can (should) be part of a larger network. Dryports are used more consciously than inland terminals in order to deal with increased (container) flows, with a focus on security and control through information and communication systems. The real difference is that the gates of the port are extended and that the forwarder sees the Dryport as an adequate interface towards port and shipping lines.

Visit www.dryport.org for more information about the project. The below organisations constitute the project's beneficiaries.

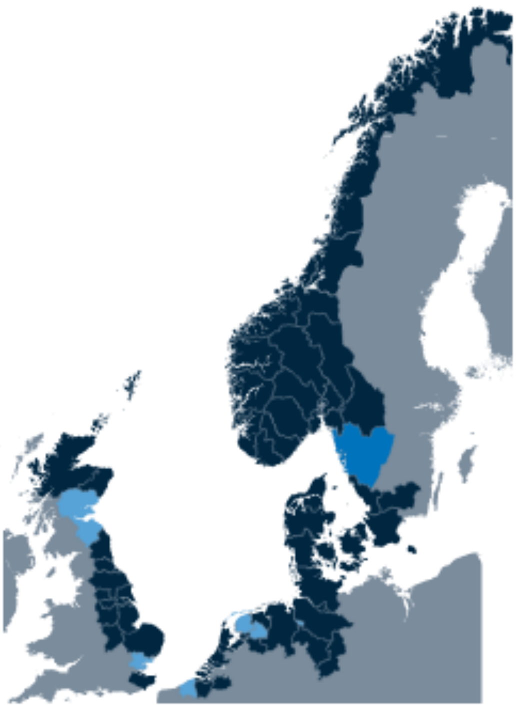
United Kingdom
Transport Research Institute
SEStran
Essex County Council for Haven Gateway
Babergh District Council

Sweden
Västra Götalandsregionen
Falköping Kommun
Port of Göteborg
Swedish Transport Administration

Belgium
Port of Zeebrugge
Kamer van Koophandel West Vlaanderen

The Netherlands
Gemeente Emmen
Provincie Friesland

Germany
Institut Arbeit und Wirtschaft, Universität Bremen



1.2.1 Dryport RFID

One highly crucial factor when creating efficient transport flows is the smart utilization of information technology. Dryport RFID has its basis in the potential of improving information sharing between intermodal supply chain actors as well as providing means to gain better control of rail transport movements between seaports and dryports.

Dryport RFID was initiated in the fall of 2008 with process mapping of the, at that time, existing supply chain activities involved when transporting an intermodal container between a seaport and a hinterland dryport. The outcome of the initial project phase shed light on the high degree of manual work involved in the supply chain administration. A potential for process improvement across the supply chain soon became evident.

The following project phase (2009) further identified and defined the supposed effects of an automated handling of the intermodal transport flows, such as production streamlining and deviation management. During the same time, the Swedish Transport Administration completed a pre-study covering which RFID[1] standard to use to identify rail wagons in the Swedish rail network. STA became project members and the decision was taken to plan for a demonstrator based on the RFID and information standard designated by STA on rail wagon level.

In 2010 the project focused on the planning of such a demonstrator in the transport relation between the Port of Göteborg and the dryports in Örebro and Eskilstuna operated by the rail operator Tågfrakt and terminal operator m4 respectively. The demonstrator was then performed during the fall/winter of 2011.

The demonstrator and the project as a whole show possibilities and explore gains in the transports between hinterland terminals and seaports through efficient information sharing in the intermodal supply chain by the application of RFID and standardized communication.

The remaining report focuses on the demonstrator phase and its results. The results from the previous work done in the project can be found in previous project reports, see section 11 for reference material.

1.3 Summary

1.3.1 Project scope

The demonstrator is based on the previous phases in the project; from the initial process mapping of intermodal rail transports to/from the Port of Göteborg, further on to the effect assessments of an RFID system and to the actual preparations of the demonstrator.

The demonstrator is a close co-operation between the port, the rail operator (in this case also one of the dryport operators) and the STA. The demonstrator aims at creating an infrastructure and information base by implementing a set of RFID readers along STA's railway tracks, RFID tagging of railway cars and the use of the traceability web application developed in the project. The ultimate aim is then to verify the theoretically mapped effects from a shared RFID system in railway transports.

1.3.2 Connections to other organizations and/or projects

STA, together with the standards organisation GS1, has a strong focus on creating a national and European RFID standard in the railway sector. STA has initiated and participated in a number of pilots and projects within the area during the last couple of years. Dryport RFID is an important project from STA's point of view since it provides the authority with valuable evaluation data regarding hardware as well as software and information transactions. Partly based on the experiences from the Dryport RFID demonstrator, STA will begin to implement its RFID infrastructure in Sweden during 2012.

[1] RFID (Radio Frequency Identification) is a technology to automatically identify objects or assets, e.g. within supply chain processes

1.3.3 Conclusive experiences

The project has implemented six RFID read points along the distance between Gothenburg and Örebro. During the demonstrator three read points have been utilized. The project has produced a web-based application “Dryport RFID web” which has been utilized during the demonstrator to visualize the RFID information from the RFID tagged rail wagons. RFID has only been applied on rail wagon level and not on container or other load unit levels.

The demonstrator indicates positive effects of using RFID technology in rail transports. It is evident that access to a shared data set between different parties involved in the rail transport and handling operations between a seaport and a dryport is of mutual interest. The choice of rail traffic in the demonstrator has involved limitations in terms of successfully evaluating the effects of the system. The designated rail operator is considered “best-in-class” in terms of administrative routines and operational handling, why effects identified earlier on in the project have been difficult, if at all possible, to identify.

The RFID technology in itself has proven to be relatively trustworthy, but cannot be considered 100% accurate based on the demonstrator findings. STA has carefully noted this information and will continue to work on solutions on how to eliminate deviations to occur in the future.

The project was terminated in February 2012. All involved project parties can see benefits of utilizing the technology in a wider scale, but no decisions have been taken on further steps.

For further details on goal fulfilment and project results, please see the following sections.

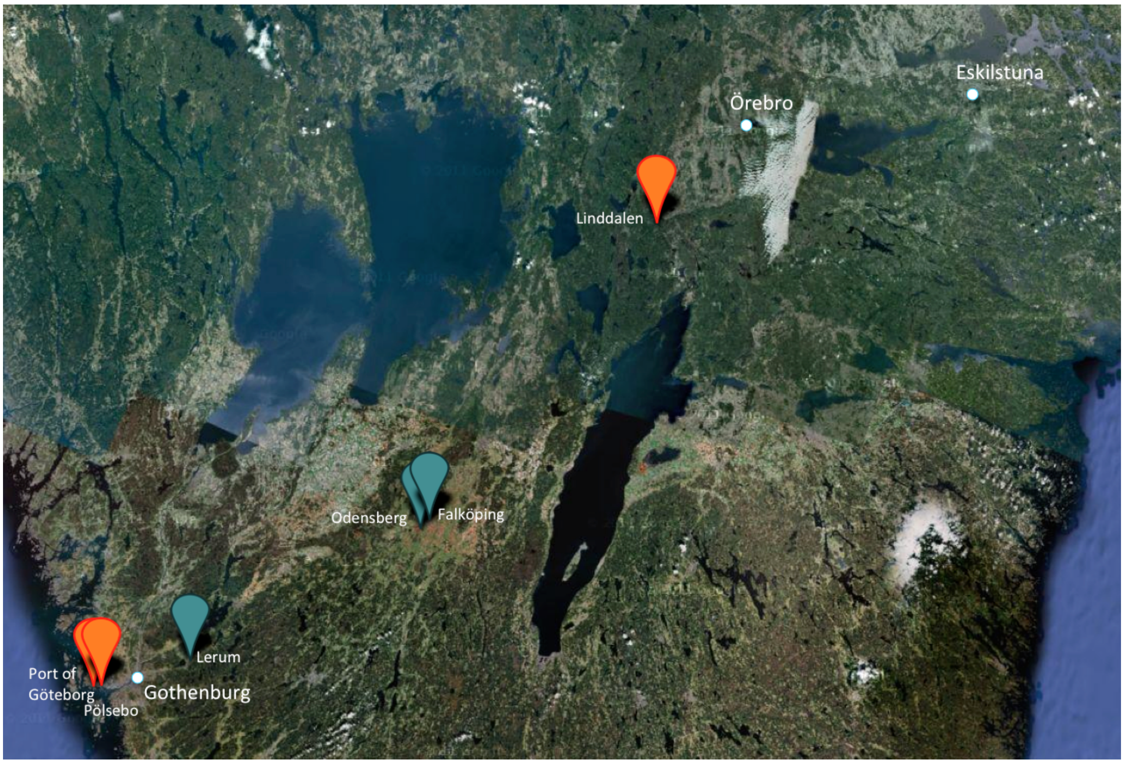
2 Goal fulfilment

2.1 Project goals

The project's two main stakeholders, the EU project and STA, have followed and contributed to the project from a shared onset, but with diverse underlying purposes. From an EU transport perspective the project should give insight into the possible logistics effects on sea and dryport terminal functions. The purpose of STA being part of the project was to collect data to evaluate the system from a technical perspective. The project has aimed at fulfilling the following main goals, to which comments on goal fulfilment are given:

- Implement an RFID system in the rail network to provide the seaport and dryport with wagon information
- Utilize collected RFID data in the rail network
- Evaluate the effects of RFID based identification for ports, terminals and rail operators

Establish an operational RFID infrastructure between Gothenburg, Örebro and Eskilstuna and tag train wagons
As noted in section 1.3.2 Dryport RFID has provided STA with an important evaluation platform for its coming initiatives within the RFID area in rail transports. STA is and has been involved in several other RFID projects over the last years in order to learn more about the technical implications and challenges with the technology. By being an active project member STA has fulfilled its internal objectives by closely evaluating the implemented technology. During the project course a total of six read points have been installed between the Port of Göteborg and Örebro/Eskilstuna. Out of the six read points only three have been utilized in the demonstrator phase (indicated with orange pins in the below image). The remaining three read points (indicated with green pins) were installed with early versions of RFID hardware and set-up, which turned out not to be satisfactory from a STA quality perspective. For this reason the read points were not used in the evaluation as this would not have generated valid data. STA will replace these read points in early 2012 with an updated hardware configuration.

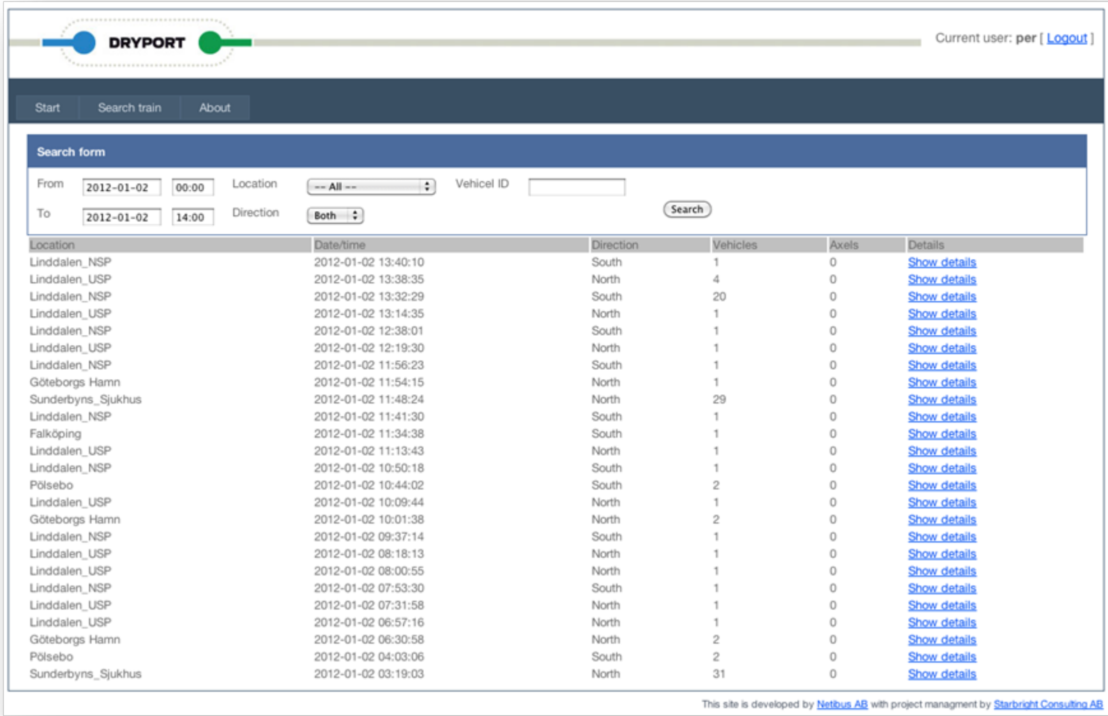


Each read point consists of an RFID reader & antenna together with axle detectors and data communication set-up by STA and STA ICT. This combination of equipment makes it possible to detect the direction of the train as well as number of vehicle axles (from which the total number of rail vehicles can be calculated) and RFID-tagged vehicles.

The rail operator Tågfrakt, based in Falköping, operates 23 wagons in the traffic set-up between the Port of Göteborg and Eskilstuna. These wagons have all been marked with two RFID tags according to STA guidelines.

Utilize collected RFID data in the rail network

During the project the RFID data has been made publicly available to the project group at the Internet address: http://188.121.65.148/Dryportweb/Default.aspx. The website foundation is based on STA's information standard and has been developed in the project with an integration to STA's RFID service. From the website it is possible to search and find information on all RFID-enabled rail movements in Sweden.



Location	Date/time	Direction	Vehicles	Axels	Details
Linddalen_NSP	2012-01-02 13:40:10	South	1	0	Show details
Linddalen_USP	2012-01-02 13:38:35	North	4	0	Show details
Linddalen_NSP	2012-01-02 13:32:29	South	20	0	Show details
Linddalen_USP	2012-01-02 13:14:35	North	1	0	Show details
Linddalen_NSP	2012-01-02 12:38:01	South	1	0	Show details
Linddalen_USP	2012-01-02 12:19:30	North	1	0	Show details
Linddalen_NSP	2012-01-02 11:56:23	South	1	0	Show details
Göteborgs Hamn	2012-01-02 11:54:15	North	1	0	Show details
Sunderbyns_Sjukhus	2012-01-02 11:48:24	North	29	0	Show details
Linddalen_NSP	2012-01-02 11:41:30	South	1	0	Show details
Falköping	2012-01-02 11:34:38	South	1	0	Show details
Linddalen_USP	2012-01-02 11:13:43	North	1	0	Show details
Linddalen_NSP	2012-01-02 10:50:18	South	1	0	Show details
Pölsebo	2012-01-02 10:44:02	South	2	0	Show details
Linddalen_USP	2012-01-02 10:09:44	North	1	0	Show details
Göteborgs Hamn	2012-01-02 10:01:38	North	2	0	Show details
Linddalen_NSP	2012-01-02 09:37:14	South	1	0	Show details
Linddalen_USP	2012-01-02 08:18:13	North	1	0	Show details
Linddalen_USP	2012-01-02 08:00:55	North	1	0	Show details
Linddalen_NSP	2012-01-02 07:53:30	South	1	0	Show details
Linddalen_USP	2012-01-02 07:31:58	North	1	0	Show details
Linddalen_USP	2012-01-02 06:57:16	North	1	0	Show details
Göteborgs Hamn	2012-01-02 06:30:58	North	2	0	Show details
Pölsebo	2012-01-02 04:03:06	South	2	0	Show details
Sunderbyns_Sjukhus	2012-01-02 03:19:03	North	31	0	Show details

This site is developed by Netibus AB with project managment by Starbright Consulting AB

Evaluating the effects of RFID based identification for ports, terminals and rail operators

From the demonstrator experiences it is clear that RFID can generate benefits for practically all involved parties in the rail traffic. The benefits manifest themselves in more efficient handling operations, both administrative and operational, especially at the seaport. However, the demonstrator has only included one rail traffic line with a limited number of wagons, why the seaport and the combined rail operator/dryport operator have had difficulties in assessing the full potential of such an RFID system. Contributing factors to this fact is that no integration has been made between the RFID system and the existing IT systems in the seaport (no system exist in the dryport) and that a "best-in-class" rail operator has been selected as demonstrator object.

Comment

The overall conclusion is that all project goals have been fulfilled with an unfortunate, but anticipated, limited effect evaluation according to the previous paragraph.

2.2 Delimitations

The project has not included:

- A full-scale RFID deployment
- Integration to any seaport or Dryport terminal systems
- Development of administrative processes between the actors

2.3 Cost accounting

Project costs have been distributed among the project financiers as listed in the table below. No project financier has exceeded the assigned budget.

Situation 2012-03-07				
No	**Financier**	**Budget 2011/2012**	**Invoiced per Mar 7 2012**	**Diff. Budget vs. Invoiced amount**
1	Göteborgs Hamn	74 631	74 631	0
2	Falköpings Kommun	82 320	57 320	25 000
3	Trafikverket	146 200	82 220	63 980
4	Västra Götalandsregionen	395 400	378 007	17 393
Total		**698 551**	**592 178**	**106 373**

3 Project course

The project has followed a structured process with decision points at defined intervals to ensure the project pace and quality. Yet, a main factor causing a delay in the project time plan was that the intended rail traffic to be covered in the demonstrator between the dryport in Falköping and the Port of Göteborg came to an end in the summer of 2010. As a result, discussions and inquiries on alternative traffic set-ups were initiated during the fall of 2010 instead of initiating the demonstrator at the time. This led to that the demonstrator was prepared during the spring/summer of 2011 and finally performed during November/December 2011 with the alternate set-up between the Port of Göteborg and Örebro/Eskilstuna.

4 Demonstrator set-up and feedback

4.1 Hardware – Tags, readers and axle detectors

Three RFID read points have been used in the demonstrator, one in the vicinity of the Port of Göteborg (location Pölsebo, in the left picture), one at the Port of Göteborg (in the right picture) and one south of the dryports in Örebro and Eskilstuna (location Linddalen, consisting of two RFID readers covering both north- and southbound traffic).

Three more read points (locations Odensberg, Falköping and Hunstugan/Lerum) have been installed on the stretch between Port of Göteborg and Eskilstuna, but these are of early hardware configurations and have not been used in the demonstrator as these readers are known not to generate correct and valid data.

Each read point consists of an RFID reader, an RFID reader antenna, a GPRS modem and two axle readers installed in the track. The read point in the Port of Göteborg also includes a PC as indicated in the picture above.

The used readers have been fully operational and functional during the evaluation period. There have been issues with the axle readers that are used to determine the trains' directionality, causing a situation where it has not been possible to detect the wagons' directionality. STA is currently working on the procurement of a hardware constellation that will be used in the full scale RFID implementation throughout locations in Sweden. This set-up will reduce the number of components required per read point and will facilitate a more easily maintenance solution.

A reflection that has been made by STA is that future read point installations should be denser in areas of more traffic. This would decrease the risks of totally missing read events if one read point for some reason is offline at the time of a train passage. More read points at critical passages would then likely increase the total system's uptime.

Form factor
104mm x 33mm x 8.4mm

Memory capacity
512 bit

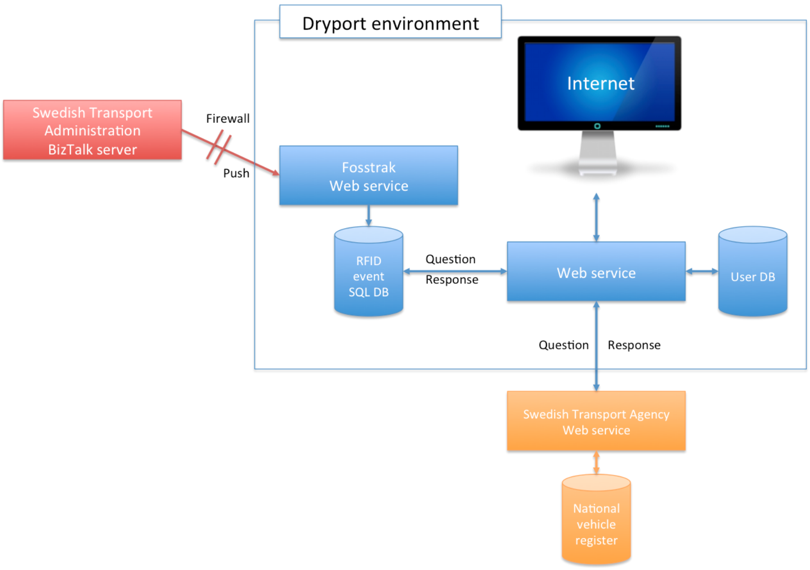
Silicon
240 bit EPC Global Class 1 Gen 2

Quantity used in the project
46 pcs (2 per wagon)

The RFID tags used in the project are of Omni-ID fabricate with a measured read range of approximately 8m in STA test environments. More information: http://www.omni-id.com/products/RFID_tags-max-abs.php The price per tag is roughly 35 SEK.

4.2 Software – Server and client application

The software architecture that STA has provided for the project is a prototype solution that has been developed since 2006. Each RFID read point is connected to a central database over either GSM/GPRS or LAN, which records and stores all read events in EPCIS format. The read events are made available to external partners through an early version of a web application developed during 2010.
For this project a specific web application was developed by the project, called Dryport RFID Web. The application was installed according to the below set-up overview with connections both to the STA's RFID environment as well as the Transport Agency's web server giving access to the national rail vehicle register. This architecture made it possible to convey further information to the end-user about the rail vehicle's characteristics.



An open source RFID service platform, Fosstrak (http://www.fosstrak.org/), internally used by STA was implemented to handle the connectivity between the STA BizTalk server and the internal Dryport RFID event database. Fosstrak is entirely based on EPCIS standards (http://www.gs1.org/gsmp/kc/epcglobal/epcis) developed by EPC Global.

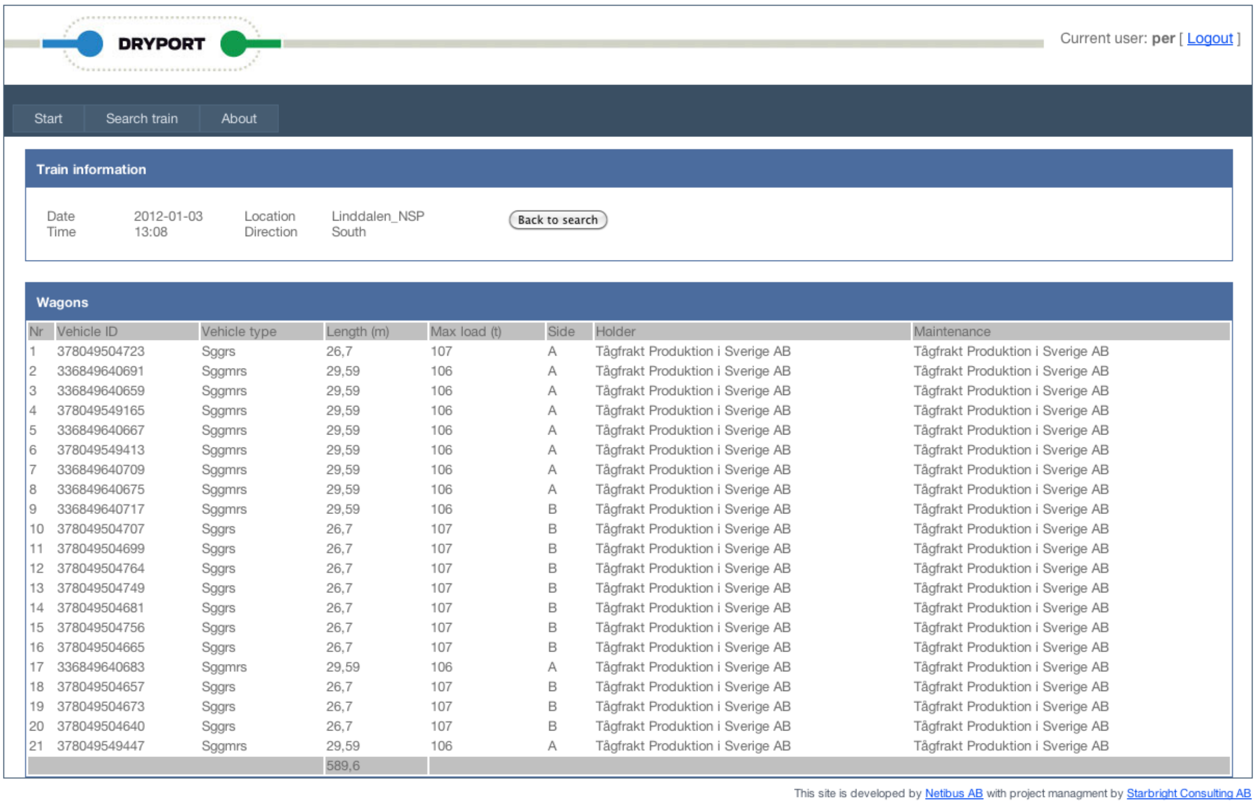
The Dryport RFID Web application was made available through http://188.121.65.148/Dryportweb/Default.aspx
The application made it possible to search for train movements according to the following search criteria:

- Date & Time
- Read location
- Direction
- Vehicle ID

The search result provided information about:

- Location
- Date & Time
- Direction
- Number of vehicles
- Number of axles

Each registered train movement contained more details as the below picture shows.



Nr	Vehicle ID	Vehicle type	Length (m)	Max load (t)	Side	Holder	Maintenance
1	378049504723	Sggrs	26,7	107	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
2	336849640691	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
3	336849640659	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
4	378049549165	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
5	336849640667	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
6	378049549413	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
7	336849640709	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
8	336849640675	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
9	336849640717	Sggmrs	29,59	106	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
10	378049504707	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
11	378049504699	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
12	378049504764	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
13	378049504749	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
14	378049504681	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
15	378049504756	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
16	378049504665	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
17	336849640683	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
18	378049504657	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
19	378049504673	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
20	378049504640	Sggrs	26,7	107	B	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
21	378049549447	Sggmrs	29,59	106	A	Tågfrakt Produktion i Sverige AB	Tågfrakt Produktion i Sverige AB
			589,6				

The Dryport RFID Web application was set-up by STA ICT in a pilot server environment that was not under official surveillance. For this reason the server went offline on a number of occasions just prior the evaluation period, but was fully operational during the evaluation and its condition was checked on a daily basis.

Conclusion

As a consequence of the pilot version of the web application, its layout and functionality needs a revision in order to fully provide the user with a powerful and user-friendly tool to track and trace rail movements. The overall most important feedback that goes back to STA is to provide the identity of the trains that pass the RFID readers. In its current version it is only possible to produce the information that a train has passed with the ID of its wagons, but it is not possible to know exact which train it was. This has been discussed on a number of occasions in the project, but there is not a clear solution to the issue at present. However, this is information that would generate the possibility to integrate STA RFID information directly to port and dryport systems in the future. Prior the availability of this information, this will not be possible, limiting the RFID system potential significantly.

The application lacks a fully supported user management, which would be a natural development step, giving the possibility to differentiate system functionality depending on user roles. Another desired function is to be able to define user-based search criteria so that these criteria must not be entered each time a user searches for trains/vehicles.

However, the most important factor of the RFID system is that STA will maintain the highest data quality, so that it can be fully relied on by for supply chain operations and so that the data can be further processed and compiled by different actors to new sets of information. If (or more likely when) more organizations and end-users are relying on RFID data from the system, the data soon becomes critical, where single (one or a few vehicles) or complete (an entire train) missed RFID reads will be fatal generating negative consequences.

In parallel with the focus on procurement and purchasing the correct RFID hardware for the 2012 deployment, STA has been revising the entire system's architecture internally during 2011 with the goal of a new solution operational by early 2012.

5 Results

The demonstrator was evaluated on December 13th 2011 via phone conference with all project members present (see paragraph 11 for contact details). The evaluation focused on the agreed timeframe of November 15th to December 6th and was made against the criteria listed under this section.

5.1 Verification of operational effects

The demonstrator constitutes the final step of the Dryport RFID project with the ultimate goal of verifying the effects from the potential improvement areas identified earlier in the project (2009). Giving the Port of Göteborg and the rail/terminal operator Tågfrakt access to the Dryport RFID web application, including all information generated during the demonstrator timeframe, the verification process has been performed.

The two main improvement areas, production streamlining and deviation management are discussed in this section. No distinction has been made between the port and the rail/terminal operator.

5.1.1 Production streamlining

Assumption
Improving the advance information basis including which wagon identities that arrive to the sea port/inland terminal would facilitate a load planning process that could be performed long before the train actually arrives.

Estimated effects
- 60 minutes time saving per full train in the seaport, given a fully systematic planning
- 20-30% increased crane capacity (equivalent to 6-10 containers more per hour)
- Reduced number of straddle carrier movements (no estimation given)

Outcome
Both the seaport and the rail/terminal operator have verified positive effects of having an improved information basis prior the train arrival that is based on the reality instead of the ”intended reality” which is often the case in these kind of rail setups. However both parties state that it is impossible to verify the estimated effects based on the current pilot set-up. The main reason is that the train of focus in the demonstrator is regarded as “best in class”, which implies that few or no deviations between the pre-notified information and the actual train set-up occur.

According to the Port of Göteborg, the 60-minute time saving could still be valid for more complex train setups such as operated by Green Cargo and ICS.

Another effect is that the manual registration of wagon ID’s performed today can be eliminated at the dispatch process. This has not been fully tested and verified in the demonstrator. No system integration has been possible to accomplish towards the seaport IT system (CATOS), due to both a short project timeframe, but also priorities at the seaport in order to get the new system in full operation. System integration would naturally have been ideal since the RFID information could then have been automatically processed for load planning purposes.

A required prerequisite to accomplish system integration is to include a train identifier in the data set from the STA system. Without the possibility to easily and systematically identify which train an RFID data set belongs to integration is not seen to be feasible. The issue has been lifted at a number of meetings, but there is no clear solution to it since a train can be identified by different numbers on its journey between e.g. an inland terminal and a seaport. The question is thus how to connect the RFID data to a specific train ID and then which train ID to use. STA is informed and aware of the issue, but no solutions have been developed during the project. For a full-scale implementation this is a requirement that somehow needs to be fulfilled.

Note
Efforts were made during the project to include Green Cargo and the inland terminal in Hallsberg in the demonstrator in order to present a significantly more complex train setup. Both parties were positive to be part of the project, but it was not practically feasible since Green Cargo do not allocate certain wagons for certain traffic flows, which would imply that some 800 wagons would have to be tagged with RFID tags; a situation that could not be handled within the project timeframe and budget. The situation and risk in difficulties to verify the effects have been presented to the steering committee at several occasions, but it has been decided to go with the more controlled setup.

5.1.2 Deviation management

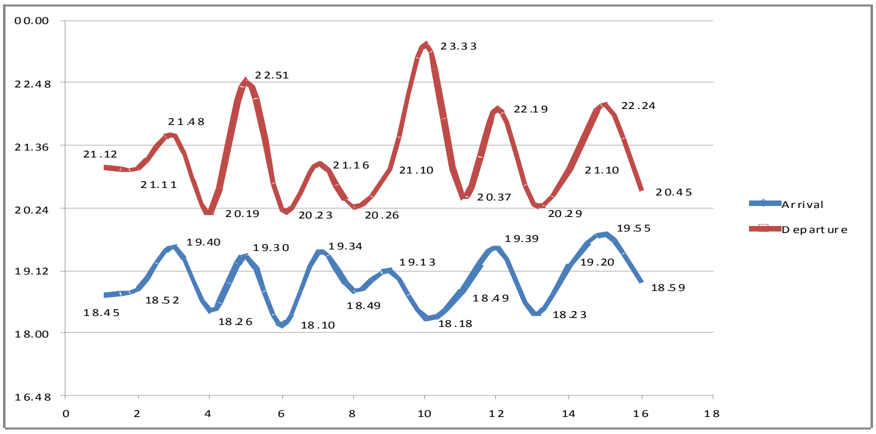
Assumptions
As noted in this project's 2nd phase final report it is, if possible, even harder to estimate effects connected to deviation management, partly dependant on that the consequences of the deviations can be multiple and partly because the number of deviations that can be remedied with the help of RFID data are limited.

The two deviations that were identified as possible to limit with the technology are:
- Train delays
- Wagon deviations

Outcome
The below diagram illustrates the arrival and departure times at the Port of Göteborg for the specific train in the demonstrator setup. E.g. on day 1 of the demonstrator the train arrived at the port at 18:45 and departed at 21:12 giving an offloading/loading time of 2 hours and 27 minutes. The assigned slot time in the port is between 19:30 and 22:30, which implies that the train was delayed at arrival on 4 occasions and at departure on 2 occasions.

The delays at arrival can be considered minor and has not affected the operations in such a way that the prepared containers have been taken aside to make place for an incoming train. The two delays at departure (ca. 20 and 60 minutes) can also be considered minor in this context and the lost time at the seaport has been possible to catch up on the way to the inland terminal. Since no major delays occurred during the demonstrator it has not been possible to verify the identified effects. Nevertheless, the information would still be valuable if available in the event of a major delay.

The second deviation seen to be limited by RFID is the deviation that occurs when the number of wagons do not match the load order, which leads to a situation when containers are prepared to be loaded but there are not enough wagons to load the containers on. By having complete and real-time information about the actual wagons on the way to the seaport/terminal, any deviations can be adjusted during the trains' journey instead of discovering the deviation at arrival. No such deviations have been identified during the demonstrator period, why these effects have not been possible to verify either.



Note
Today, all trains arriving to the seaport/inland terminal can be identified in STA's IT-system Opera by a train ID with status regarding how the train relates to the given timetable for that specific train. In other words it is possible to identify deviations through the Opera system, but only on a high-level for the entire train set and not broken down on wagon ID. A delay or deviation might be caused by that a wagon, due to damage, has been forced out of production. If only looking at the Opera information, the delay can be identified. However it is not given that the information that the train will arrive with one wagon and container less than planned is communicated to the receiving party. This might be very valuable information since it affects both the incoming operations and the end-customer expecting the container, but also the succeeding loading operation at the port/inland terminal which will have to deal with one fewer wagon in the train set. It would naturally be more productive to have all this information concentrated to one system, be it Opera or the seaport/inland terminal IT systems.

By recording all train movements in/out of the seaport it soon becomes possible to draw patterns on how the rail infrastructure is utilized over time. If implemented in full scale this information could be used to identify possible areas/periods of improvement. Only from looking at the specific train in the demonstrator, it is quickly noted that there is a certain time surplus in the schedule; the assigned slot-time is 4 hours, but the average measured slot-time is barely 2,5 hours. Naturally a certain time margin is required, but with better information/system support it might be possible to limit current margins to operate more trains during given time period.

To fully understand RFID's impact on the seaport/inland terminal operations it would be of high interest to test and evaluate these aspects with train setups of higher complexity.

5.2 Additional effects

Apart from operational and deviation management effects additional results from an RFID implementation have been brought up in the project.

5.2.1 A broader perspective

Intermodal transports, although environmentally attractive and sustainable, are often associated with cumbersome handling that drives cost, thereby making the transport alternative less appealing to transport buyers. By providing means of making the seaport and dryport terminal interfaces as seamless as possible and giving the customers and other supply chain actors access to transport information, the transport alternative may become more competitive. An effective dryport with a streamlined connectivity to a seaport will naturally be of more interest to a transport buyer than an equivalent dryport, but with less effective operations and seaport interfaces. RFID could be a future factor that gives the dryport a competitive edge in the sense that information and the smart use of it will be a prerequisite to run even more effective terminal functions.

5.2.2 Safety – Dangerous goods

The rail operator performs an operational inspection of the wagons every week to ensure the wagon positions in the train. It is extremely important to know exactly where each wagon is located within the train if/when an incident with dangerous goods occur. The rail operator is responsible of registering this information in Opera (STA's IT system), but RFID information would constantly produce this information at every read point (instead of once every week at best) leading up to increased security on rail transports. In the event of an incident the concerned authorities could instantly be notified at which wagon/s in the rail set that carries dangerous goods giving prerequisites for improved rescue operations.

5.2.3 Improved data quality in STA systems

STA sees great possibilities in the automation of wagon information and train composition into the authority's IT systems. Instead of relying on manual processes performed at different terminals and marshalling yards throughout Sweden this information is sent in real-time to the concerned systems. Although the data fed into the IT systems is said to be correct it is known for a fact that this is far from always the case, according to STA.

5.3 Data analysis and quality

The below table illustrates the statistics of train passes and readability per read point both in terms of missed wagons (column 5) and how they were distributed over number of reads (column 6).

NSP = rail direction south
USP = rail direction north

Read point	# Train passes	# Registered wagons	# Missed wagons	Read % (wagons)	Reads with deviations	Read % (reads)
GÖTEBORG NSP	16	359	7	98,09%	4	75%
GÖTEBORG USP	16	366	0	100,00%	0	100%
PÖLSEBO NSP	16	366	0	100,00%	0	100%
PÖLSEBO USP	16	366	0	100,00%	0	100%
LINDALEN NSP	15	334	9	97,38%	6	60%
LINDALEN USP	15	339	2	99,41%	1	93%
TOTAL	94	2 130	18	99,16%	11	88%

From the table it can be concluded that the readability exceeds 99%, but for reasons that have not been totally clarified, some 18 wagons spread over 11 read events have not been registered. It should be noted that 10 of the 18 wagons that were missed occurred on the last day of evaluation (December 6th). As can be seen in the table the missed tag reads occurred at three of the read points (Göteborg NSP, Lindalen NSP and Lindalen USP). The project has tried to investigate the reasons behind the deviations, but it has not been possible to establish a pattern behind the missed reads, which should be seen as a major weakness from a quality perspective.

Discussed (but not verified) reasons as to why the tags have not been registered are e.g. weather conditions (rain/fog), train speed and RFID reader configuration (separate factors or in combination), but the reasons remain unclear since the deviations have not been consistent. Different tags have been missed, i.e. it has not been the same tag that has been missed over and over again. A possible reason could have been the tag placement on the rail wagons, but if so it should have generated more missed tag reads during the period.

Note
The deviations should be of highest concern to STA since future actors reliant on the information will be highly affected by an inconsequential system. The reality is that 100% system reliability is required when more supply chain actors will integrate the information to their IT-environments and rely on the availability and validity of information to perform their business operations.

The deviations noted in the project have however not affected STA's efforts to implement a national rail vehicle identification system based on RFID, but have instead spurred STA to establish a stable and reliable system. During the beginning of 2012 the authority continues to perform acceptance tests of RFID readers from the three designated suppliers. Following the tests will be a period of exchange of existing test readers installed at various locations in southern Sweden, after which some 24 more readers will be installed with focus on the areas of western and southern Sweden. In parallel with the focus on hardware, STA also develops the software and system architecture to handle the generated RFID information.

From an information quality perspective it can of course be questioned if RFID in fact is the technology to use in this type of application. In a similar evaluation project with STA, the Volvo Group (Volvo Logistics) and Green Cargo 100% readability was in fact achieved. The project was performed in a similar supply chain set-up in wintertime with harsh and cold conditions, but nevertheless no problems were registered with missed rail wagons. The deviations in that project referred to pure administrational errors.

Despite these project experiences, the final conclusion from this project is that until STA has exchanged the initial versions of RFID equipment with thoroughly tested components and developed the system architecture, the current version of the RFID system/implementation cannot be recommended to supply chain actors due to the lack of 100% readability.

5.4 National implications

Dryport is a multifaceted project with several sub-projects, but they all share the ultimate goal of developing, designing and establishing effective hinterland intermodal freight transport nodes. Dryport RFID has focused on the information streaming in intermodal rail freight and the operational efficiency improvements that could be achieved by introducing new identification and traceability data to the intermodal actors.

RFID as a technology and this specific project does not provide an ultimate answer to the establishment of effective transport nodes, but forms one important step in the development towards smarter and more sustainable intermodal transports between seaports and dryports. By learning more about the current processes, visualizing improvement areas in the set-up and by providing evaluation data from a live environment, subsequent projects may learn from the project findings and pick up where this project ended.

The likely future trend is that more and more goods services will be transferred from seaports to Dryports, such as customs processes and load unit and goods storage. This geographical movement is expected to demand further control and insight into the transports between the terminal areas in order to provide effective operations in the respective nodes. In this project only rail wagon identification has been investigated, but the future may hold automatic identification at lower levels such as container/trailer and load units within the transport units.

5.5 General project reflections

5.5.1 Collaboration

It is evident that all project members have found the collaborative forms in the project very positive. Although the project group constellation has changed quite significantly over time, everyone has strived together towards the shared goals set up during the project start. Still, a majority of RFID-related projects are closed and do not look in a broader perspective including other organisations and commonly shared information. In this aspect Dryport RFID has made a difference.

5.5.2 Project process and time plan

As noted previously under section 4, the demonstrator was delayed due to factors the project had no possibilities to influence. Despite this the project has been carried out according to the overall plan and finally got the demonstrator up and running. Not too surprisingly the rail traffic set-ups have changed since the project initiated in the fall of 2008, but it was not anticipated to have such a delaying effect on the project. The delay has not caused any budget deviations or other divergences other than that if the project group had been consistent over the three years during which the project was ongoing, it is possible that the RFID set-up could have been implemented with deeper integration to existing IT systems.

5.5.3 Summary

The project has been highly educative and informative, shedding light on processes and their quality that previously only have been relatively grasped by the administrative personnel, but not clearly documented and analysed from a higher and shared supply chain perspective.

6 Conclusion

Dryport RFID has been an ongoing project through the last good three years with shifting project members and rail traffic set-ups as a result. The project has shed light on manual processes and cumbersome information handling causing unnecessary deviations and hurdles on the path to a more seamless intermodal transport system. The increase in containerized rail freight in combination with infrastructure capacity challenges call for smarter ways for terminals at sea ports and hinterland dryports to interact. RFID is one identification technology that already at wagon level identification is seen to bring positive effects to the transport system as a whole, although hard to concretize in hard facts as illustrated in this project.

Whether we will see RFID as a technology to be used for improved information exchange in intermodal transports in the coming years depends on a set of success factors that e.g. include the continued centralized drive from national authorities involved in the development and implementation plans. RFID projects in general are closed projects that do not have to take external input into consideration. Dryport RFID is on the other end of the openness scale where exactly information openness between supply chain actors is a prerequisite for the system to work and prosper. For open systems to work common understanding and conventions covering standard issues are required.

Establishing a common RFID standard (ISO 18000-6C) on a European level will be required since some 60% of the rail wagons operating on Swedish rail infrastructure come from another European country. The standard issue does not only cover which RFID tags and readers to use, but perhaps even more importantly the standards for information exchange (EPCIS) between supply chain actors and authorities on a national, but also cross-national level.

Apart from standards, high information quality and smooth integration interfaces to/from STA systems will also be fundamental prerequisites for the system to organically grow and consolidate itself as a self-evident system to use for rail/goods traceability and terminal operations. Actors may soon become reliant on the information generated by the system and if the information loses in quality, the system can fast become questioned.

As discussed in the report the lack of both verified benefits and tag read reliability (99,16% achieved), it can be questioned if RFID is the right technology to use in this kind of supply chain application. Until STA has proved the system stable, terminal operators and other supply chain actors cannot be recommended to invest in such a system. When stability has been proved, Dryport RFID project members (and members from the mentioned Volvo project) see a great value in the technology and in a situation where STA will implement a fixed national infrastructure that can be utilized for internal or co-operative purposes; the incentives to use RFID as a basic vehicle identifier are great. On this basic vehicle information level, further information can be added according to a nested visibility set-up, where load units and ultimately goods could be tracked and traced.

RFID has still to prove itself as THE technology to provide a fundamental information base to build on in intermodal transports. It will be of high interest to follow STAs further implementation steps in the area.

7 Termination

The project Dryport RFID was terminated in March 2012. This final report is the main project deliverable.

8 Next steps

The project has evaluated a system that is in its initial state and further analysis is required in order to fully understand RFID’s potential in the investigated supply chain context.

The performed project ended in a technical evaluation more than in a business value and supply chain effect evaluation, why a natural next step (after a stable STA implementation can be guaranteed) would be to define a project with the goal to fully investigate the economic and supply chain benefits that can be generated by the system. This requires a very close involvement of the project members on an operational level, why both well-represented project and reference groups are required in such a project.

By integrating RFID data to actual IT systems in use at seaport terminals and dryports, the data can be used for operational and tactical decisions during a project period, which could streamline the operations and from which effects could be measured.

9 Project communication

During the project's course, the project has been presented at a number of occasions as follows. Responsible speaker within brackets:

- GS1 Norway, Oslo, 2009 (Hans Börjesson)
- ITS World Congress, Stockholm, September 2009 (Hans Börjesson)
- Dryport conference, Emmen (NL), Nov 2009 (Mats Åkerfeldt, former STA)
- Transport & Logistik Fair, Gothenburg, May 2010 (Per Sjöholm & Arvid Guthed)
- GS1 RFID in Rail, Stockholm, February 2011 (Per Sjöholm)
- Green Corridor Demo Day, Gothenburg, September 2011 (Per Sjöholm & Lennart Andersson)
- Nordic Rail Fair, Jönköping, October 2011 (Per Sjöholm)
- VTI Transportforum, Linköping, January 2012 (Lennart Andersson)

10 Contacts and reference material

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Project reference material:

Name	Version	Date
Final report Phase 1	1	2008-10-28
Final report Phase 1.5	1	2009-03-27
Final report Phase 2	2	2009-06-08