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CHINOS

CONTAINER HANDLING IN INTERMODAL NODES – OPTIMAL AND SECURE!

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List of Contractors:

No	Acronym	Name	Country
1	ISL	Institute of Shipping Economics and Logistics	Germany
2	NTB	North Sea Terminal Bremerhaven GmbH & Co.	Germany
3	GAC	GAC Shipping SA	Greece
4	ThPA	Thessaloniki Port Authority SA	Greece
5	TRICON	Tricon Consulting GmbH & Co. KG	Austria
6	dbh	dbh Logistics IT AG	Germany
7	TEAM	Team Lines Deutschland GmbH & Co. KG	Germany
8	EUR	Eurogate Technical Services GmbH	Germany
9	POLZUG	Polzug Intermodal GmbH	Germany
10	i2dm	i2dm Consulting and Development GmbH	Germany
11	T-SYS	T-Systems Enterprise Services GmbH	Germany
12	CCG	Cargo Center Graz Betriebsgesellschaft mbh & Co. KG	Austria
13	NTUA	National Technical University of Athens	Greece

For additional information on the CHINOS project, please take a look at the project's website: http://www.chinos-rfid.eu/ or contact the project's coordinator:

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CONTAINER HANDLING IN INTERMODAL NODES – OPTIMAL AND SECURE!

CHINOS is the acronym for the project "Container Handling in Intermodal Nodes – Optimal and Secure!", supported by the European Commission under the Sustainable Development, Global Change and Ecosystems thematic area, Sustainable Surface Transport Programme of the 6th Framework Programme. The support is given under the vehicle of STREP, Contract No. TST5-CT-2006-031418.

Project Objectives

The CHINOS system is required to provide more reliable data on the state of containers from logistical and security point of view. Presently, shipped goods can only be tracked at a few specific points in their logistics journey, usually at the shipping and receiving ports and at customs points and some trailer parks. But a common occurrence is that a container is found to have been tampered with during its journey, and the full or partial shipment has either gone missing or been damaged. But it is usually extremely difficult to determine at what point during the journey the damage or theft has occurred, and therefore blame or responsibility cannot be apportioned.

There are a few systems on the market that address some of these concerns, but they range from basic mechanical solutions to more sophisticated electronic devices and are virtually without exception proprietary systems that are incompatible with each other and do not comply with the proposed Global Standards for container identification.

Some standards do already exist, but they do not encompass the latest technologies available on the market nor do they comprehend all three aspects of container status management, namely:

- identification
- seal condition and
- damage documentation.

The CHINOS system aims to address these issues by encompassing all three ‘container status monitoring’ parameters into one single system as well as ensuring that the overall system is compatible with the upcoming container traceability standard proposals. The system is also fully electronic which allows for remote identification and monitoring. The data can also be stored and retrieved, either in real time or as historical data for analysis and statistical evaluation purposes.

The system consists of an electronic RFID transponder (also referred to as a Tag) attached to the container, able to provide positive unambiguous identification of a container. An electronic seal (e-seal) uses the current mechanically robust door seal mechanisms but adds the electronic RFID technology to enable seal identification and additional tamperproof electronic security to the device.

The damage documentation system (DDS), finally, ensures that a container cannot be illegally penetrated in order to access the goods without authorisation. It also serves the purpose of being able to detect accidental handling damage to the container which may have a detrimental effect on the goods inside the container. This offers the possibility of determining the origin and location of any damage and being able to help in apportioning responsibility for it.

The typical logistics journey of a container is complex, often starting its journey by road or rail before being transferred at a port or container terminal to a ship whereby it may be transported to another continent. And on arrival, the container will most likely follow a similar road or rail journey in reverse before reaching its final destination. The duration of each sector of the journey is variable. The identification stations therefore need to be flexible enough to encompass the need to monitor a container whilst moving by road or rail as well as the need to be able to individually access the information by hand in a port or trailer park, using mobile hand terminals.

The data about the identity, seal condition and physical condition of the container then needs to be communicated to a central database able to be accessed in real time by its authorised users.

A significant challenge of this project is ensuring that the data from several inherently incompatible systems is translated cohesively into a single system architecture compatible with the existing complex systems such as the port operating system.

Project Execution

CHINOS supports operators to exploit the upcoming challenges in the best possible way by employing innovative IT technology solutions. Processes can be optimised and accelerated tremendously by using automatic identification and condition checks with contact free reading possibilities (container RFID tags, electronic seals, optical checks) without requiring human intervention.

The first three Work Packages, WP1 - Detailed Requirement Analysis, WP2 - Available Technologies and Capabilities, and·WP3 - System Specification, have been completed in the first period of the project. The focus in the second period is laid on WP4 - Development and Test (Lab Phase) and WP5 – Installation and Test (On-site Phase).

·WP4 - Development and Test Lab Phase has started in Month 11 and contains the development and testing of the components and their integration that will then be transferred from the laboratory environment into the real-life test sites in WP5, which started in Month 17.

Work Package 4 concerns the laboratory testing of the individual elements of the system and the integration – under laboratory conditions – of the total system prior to implementing the live tests in a real operating environment.

The general purpose is to be able to identify the container and its current state and verify that it is in the same physical condition as when it started its journey.

The system consists of four main elements:

- Automatic Container Identification Unit (ACIU) consisting of Container Identification System (CIS) and electronic seal system (e-seal)
- Damage Documentation System (DDS)
- Chain Event Manager (CEM)
- Communication Controller (CC)

These systems all feed into a database system able to be accessed by authorised users to be able to determine the status of their cargo.

The container identification system is necessary to uniquely identify a container wherever it is in its supply chain or logistics trajectory. But in order to determine whether the container is in its original sealed state or whether it may have been tampered with during its journey, the E-seal system is able to determine that the container has not been opened to access its cargo.

The possibility of the transported goods potentially being damaged could also come from deliberate or accidental damage to the container itself. So the damage documentation system provides visual evidence that the container is substantially in the same condition throughout its journey as when it was loaded and sealed at the point of delivery.

The inputs from these three systems are consolidated into a common database via a communication controller and a chain event manager so that the data can be made available to authorised users in real time, anywhere in the container's supply chain.

Work Package 5 and the resulting deliverable describes the procedure to install the CHINOS components under real life conditions, plus the results from the tests at three operating sites, at Bremerhaven, Pruszkow and Thessaloniki, under normal operating conditions at the quayside, on rail wagons and on trucks.

The validation (according to the criteria determined in WP1) took place in WP6 where the validation scenarios have been viewed in real operation and measurements have been done. This phase was also ideal for dissemination actions. The first part of WP6 defined the validation scenarios in the test sites and therefore provides input for the tests to be performed in WP4 and WP5.

The performance of the validations includes the proof of the technical operation and recording the experiences as well as the values for the quantitative validation criteria in a structured way. Comparisons between operation before installation and operation after installation have been made.

The parameter values and experiences from the validation phase have been validated for each of the test series so that a final validation have been made if the expectations from the users have been met. Cost/benefit analyses have been performed for those cases where data is available so that a basis for exploitation is laid.

Dissemination (WP7) is a work package being employed during the whole lifetime of the project. In the range of activities the Mirror Groups have been of vital importance in order to get critical feedback on the CHINOS approach and development. In all reporting periods newsletters have been developed, the website has been continuously updated and an animation film has been produced. Furthermore, CHINOS was presented at several conferences, workshops and forums.

WP8 – Exploitation investigated how to exploit the CHINOS results in the best possible way i.e. to bring the components and the integration knowledge to the market. It provided the commercial promotion of the CHINOS concept aiming to its sustainable and autonomous future commercial development.

For each of the available CHINOS components as well as for the total concept marketing criteria and exploitation plans have been created. The continuing existence of positive and realistic perspectives for the exploitation of the results and the commercial promotion of the CHINOS concept together with the continuing commitment of the partners to the objectives of the project are substantial. Already in the first period, Deliverable 8.1 – Market assessment report and Deliverable 8.2 – Draft Exploitation Plan have been finalised. During this period, the Final Exploitation Plan has been developed.

In WP9 - Quality Assurance QA procedures for reports and technical components have been established, as well as QA measures for reporting, for software components and interfaces, for technical components as well as for validation scenarios. These procedures ensured that standards and procedures will be correctly applied and that each stage of the project is completed to high standards. The last Deliverable 9.3 – Quality assurance experience report has been finalised.

In the first period of the project the scene has been set by identifying processes, internal and external requirements, problems, challenges, validation criteria as well as existing technological solutions. The CHINOS-relevant existing business processes, IT systems, bottlenecks and possibilities of improvements have been described. Moreover, similarities and differences between the users were identified. The above are performed for the users sites which are: NTB, Polzug, CCG, and ThPA. Generally, the focus is the loading/unloading of containers, the truck gate procedures as well as the intermodal rail operations. Finally, the generic validation criteria are outlined, which, in essence, regard the reduction of time and/or cost. In WP 3 the results from the first phase have been transferred into logical and technical concepts being business processes, integration of the new technologies, technological components to be used etc.

During the initial phase of the project, the business processes of the terminals at Bremerhaven (Germany), Graz (Austria), Thessaloniki (Greece), and Warsaw (Poland) were analysed. Furthermore, the CHINOS system consisting of automatic container identification unit using RFID, damage documentation system using high-resolution cameras, chain event manager using a supply chain event management approach, and communication controller integrating the different components was specified and developed. Laboratory tests proved the functionality and interoperability of these subsystems. Afterwards the complete system was installed at different terminals in Bremerhaven, Thessaloniki, and Warsaw and validated under real-life conditions. Validation was performed in different scenarios including quayside, truck gate and rail operations. The functionality of the damage documentation system was validated as well. The successful tests produced valuable results, which were analysed in the last stage of the project.

First findings show that the Chinos system is able to satisfactorily identify and track the containers throughout their transport chain, either at the quayside or transported by rail or truck. At the same time the container seal status can be determined to assure that a seal has not been tampered with and the Damage Documentation system is able to record the physical condition of the container to check for accidental or malicious damage.

The system is able to be accessed remotely by internet and the Chain Event Manager is able to successfully identify and alert operators in case of discrepancies between scheduled and actual events.

In the last phase of the project, validation tests have been prepared and performed at various test sites throughout Europe. At the North Sea Terminal Bremerhaven (NTB), Germany, validation tests were performed at the quayside, the rail gate, and the truck gate. Stationary and mobile RFID readers and cameras for damage documentation were used. At the port of Thessaloniki, Greece, tests were performed at the quayside and the truck gate using the mobile equipment. At the Polzug rail terminal at Pruszkow, Poland, stationary and mobile equipment was used to perform tests at the rail gate and the truck gate. All validation tests showed that the application of RFID technology and damage documentation can be seamlessly included in the terminals' business processes and will significantly optimise the logistics processes in the terminals. In addition, the container security level will be enhanced by using electronic seals.

Subsequent to the validation tests, a detailed study was performed analysing the benefits which emerge using the new technologies. In addition, a movie was produced showing the validation tests and describing the background of the project which is used for dissemination purposes.

Scientific Achievements and Results

CHINOS aims at the optimisation of logistics procedures and the increase of security in container transport by applying a set of technical components such as

- RFIDs as container tags and electronic seals for automatic identification of container and seal and automatic check of the seal condition
- a system for documenting damages when taking over a container into the own responsibility
- a component for improved monitoring of the container chain by applying the Supply Chain Event Management (SCEM) approach
- a basis for communication of these data including the link to legacy systems of the partners along the chain.

These components have been validated in different geographical locations across Europe: in a large sea port in the North Sea (Bremerhaven), a medium-sized port in the Mediterranean (Thessaloniki), as well as rail terminals/freight villages in Poland (Pruszków) and Austria (Graz).

The test results clearly show that the components are applicable and beneficial for optimising container chains especially in the transfer nodes. However, it was also noted that the shipping industry is still reluctant in equipping their freight containers with RFID tags and electronic seals on a voluntary basis. Reasons are for example the imbalance of costs and benefits or still missing standards to secure investments (since container shipping is a global business requiring global solutions).

Overall Technical Conclusions

Results from the three tests in Real-life terminal operating conditions confirmed that the CHINOS system is able to satisfactorily identify and track the containers throughout their transport chain, either at the quayside or transported by rail or truck. At the same time the container seal status can be determined to assure that a seal has not been tampered with and the Damage Documentation system is able to record the physical condition of the container to check for accidental or malicious damage.

There were, however, some aspects of the system that did not work as well as intended, but the reasons for these shortcomings were identified and it is expected that the solutions can easily be incorporated if a fully operational system (as opposed to this prototype system) is developed.

Firstly, the interfacing between all the elements of the system, from the Automatic Container Identification Unit (ACIU) to the Damage Documentations system, the Communications Controller and the Chain Event Manager, as well as the web access to the system proved to work satisfactorily. At times there were issues with the internet connections but these were due to local problems trying to connect through company networks on a one-off basis rather than through an external ISP.

Handheld reading of containers ID tags and seals, plus the handheld Damage Documentation worked extremely well. Since the handheld information was sent with the same time stamp there was good correlation between IDs, Seals and pictures. One minor issue was with the handheld unit was that when reading the container IDs it had to be held at a slight angle to get the best read range. This was only due to the use of a proprietary reader housing and antenna that dictated the need to fit it in a non-preferred orientation. Automatic scanning of containers at truck gates with a stationary reader was also very satisfactory. Because trucks have to stop at a gate, the stationary reader is able to identify tags and seals and take damage documentation pictures and correlate them all. And as mentioned above, handheld reading was also successful.

The rail fixed reader station was the one that gave less than fully satisfactory results. In general nearly all container tags and e-seals were read, but on each test there were a small percentage missed. The reason for this is not fully understood but is thought to be due to software or triggering issues which can be overcome. The main problem was the lack of correlation between container tags and e-seals. This problem is fully understood but could unfortunately not be resolved without a redesign of the Savi operating system that we had no access to. It is something, however, that can easily be resolved if a fully operational system were to be developed.

One other e-seal correlation problem noticed was due to the long read range of the active e-seals. This caused some problems during testing because quantities of unused tags were often located within the operating range of the reader and were read in addition to the correct container seal. In a production situation this could be overcome by reducing the power (and hence the read range) of the e-seals so that they might be read at up to 10 metres instead of the present 100 metres.

Cost-Benefit Analysis

The goal of the Cost-Benefit Analysis is to evaluate the trade-offs between benefit aspects and cost components of the validation scenarios. This task can be beneficial from a terminal's point-of-view, only if the relative monetary outcome proved to be positive. Furthermore, the cost-benefit approach is considered to be the most secure analytical tool, in order to ensure and justify the proposed actions. Cost-efficiency is to be seen as a specific performance criterion of the terminal; it will be sought in terms of reduced cost and time and maximize utilization. The Cost-Benefit Analysis will eventually give some safe answers to the central and probably most important question of the CHINOS projects: *in what extent and under what operational conditions the proposed CHINOS technologies at each chosen terminal process will increase its* ***benefits****, reduce its* ***costs*** *and enhance its* ***competitiveness***. All the tasks of this project are dedicated exactly to the actual development of all the suitable new technologies and process reengineering. In that sense, the appropriate completion of the Cost-Benefit Analysis is given a central role for the successful project attempt.

The implemented Cost-Benefit Analysis focused on the following issues:

- Personnel cost,
- Purchase cost
- Installation cost,
- Utilization – availability
- Competitiveness and sustainability *and*
- Level of service in terminals.

Setting up the framework of the Cost-Benefit Analysis involves several steps. The first one deals with the criteria to be used. The criterion of the Net Present Value (NPV) is selected as the main comparison criterion between the "current" and the various scenarios of the CHINOS project. Furthermore, two additional criteria are selected and implemented, which are the Internal Rate of Return (IRR) and the Pay Back Period (PBP). The next Figure shows the implemented Cost-Benefit Analysis procedure including all 3 criteria under consideration. It must be noted that all the above criteria will be incorporated in a same manner in the effort for the conclusion of the specific detailed Cost Benefit Analysis.

The second step deals with the selection of the relevant data needed for the completion of the comparison. The terms "conventional" and "CHINOS" refer exclusively to the technologies used for terminal operations. The NPV calculations will be conducted according to the consortium -defined case studies (the so-called scenarios). *According to these scenarios, the examined terminals will operate under different CHINOS technologies.*

Final Conclusions

CHINOS software components are practically fully developed. It is worth repeating once again that CHINOS software applications and hardware components are already available to enter commercial use, as long as users other than CHINOS members are willing to pay in order to acquire the appropriate hardware, software and the right to use it. The reliability of the system is considered very high, as none of the parties involved has recorded any technical failure beyond the testing phase of the applications. To the extent that almost all CHINOS users can benefit from cost savings, as documented in the previous sections, their competitiveness could be improved to varying degrees. In their broader definition, the objectives can be achieved in varying degrees. In the annual cash flows due to the implementation of CHINOS system, we presented four different implementation scenarios, where the degree of workers redundancy due to the introduced automations varies from 25% to 100% of the maximum estimated possible human wage substitution at this site. In each of the scenarios, the number of devices employed also varies, which means that the system could also be selectively deployed at some checking points, not the totality, according to the decisions of the company.

Dissemination and Use

The CHINOS approach and results of the validation tests were presented during three mirror group meeting, one of which took place in Greece and two in Germany. Participants were Shipping Companies like Maersk and Hapag Lloyd, 3PLs and forwarders like DB Schenker, railway companies, and port authorities like BremenPorts.

A market assessment report and the exploitation plan has been developed. CHINOS was presented on several conferences and mentioned in various articles of magazines and journals. The need of an industry-wide introduction of RFID container tags as a prerequisite for the implementation of some of the CHINOS business processes was emphasized.

Market observation had shown us that we needed more than just a conventional marketing concept to market CHINOS. The success of this project is not primarily a question of technical feasibility but one of overcoming system-related hurdles when introducing the technology to the market. Marketing the technology by setting up "island solutions" at individual customers would not be an option because it would not bring any benefits. The CHINOS project team therefore decided that to go with a marketing concept that would meet all the formal requirements but would not contribute much in the end would not be worth pursuing. Instead, our goal was to develop, pursue and assess approaches that could help us overcome the described network effect and lay the foundation for the future marketing success of CHINOS. The marketing concept we then decide upon would vary depending on which approach we decided to follow.

Regardless of the approach, it definitely made sense to utilize the media we had at our disposal for public relations. It was imperative that we raise the awareness of decision makers.

The CHINOS team found that the majority of the potential users we spoke to were unfamiliar with the functions and possibilities presented by different technologies and therefore had misleading associations with the term RFID as it relates to containers. The CHINOS team used Internet presence, a film on the tests conducted, video animation about processes at a container terminal that had been optimized by RFID, a presentation on the topic which we gave at various events and some articles published in influential trade journals to clarify people's associations with the topic.

Our assumptions about the effectiveness of using a concrete marketing concept have been confirmed in several individual talks with representatives of major companies in the industry and at panel discussions held at conferences and trade fairs. We have come to the conclusion that introducing the CHINOS project at conferences and trade fairs and discussing it with organizations and representatives of the political and corporate worlds would be essential to marketing the product. Without these public relations activities and the feedback they generated, the project would only have had academic value. By engaging in these activities, we have made numerous decision-makers aware of the topic and they have recognized potential for the product. The project team was able to make some valuable contacts and avoid expensive, useless marketing campaigns by applying what we learned about market mechanisms.

The project team analysed the following alternatives as possible approaches:

- Technology provider(s) to pre-finance, set-up and operate system.
- Leading Shipping Company to implement system in their operations
- Terminal operators and loaders to motivate shipping companies to equip their containers
- Forming a consortium (a "commitment platform") to implement the system
- Using political influence to speed up introduction of system.