Technical and operational specifications for a CSCW transport system

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Abstract:

This deliverable describes the basic specifications for a CSCW (Computer Supported Cooperative Work) system in transport as developed in the COREM project.

Within COREM, five applications have been developed supporting the cooperative resource management in transport. These five applications have been created using a common methodology which is generic and therefore can be used for comparable applications in the transport sector.

Within COREM, a model for CSCW in transport had been defined on two levels: on the cooperation types (shared workspace, horizontal, vertical) and on the cooperation functions (preparation of cooperative actions, performance of cooperative actions, monitoring of cooperative actions) with the identification of useful technologies for all these categories. All COREM demonstrators have been developed based on this common theory.

This deliverable summarises this common theory and the concepts which have been chosen in order to meet the requirements for CSCW systems in transport as well as the lessons learnt during the specification and development phases.

Keyword List: Resource Management, Cooperation, CSCW, Transport, Development
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1 Executive Summary

This deliverable describes the basic specifications for a CSCW (Computer Supported Cooperative Work) system in transport as developed in the COREM project.

Within COREM, five applications have been developed supporting the cooperative resource management in transport. These five applications have been created using a common methodology which is generic and therefore can be used for comparable applications in the transport sector.

Within COREM, a model for CSCW in transport had been defined on two levels: on the cooperation types (shared workspace, horizontal, vertical) and on the cooperation functions (preparation of cooperative actions, performance of cooperative actions, monitoring of cooperative actions) with the identification of useful technologies for all these categories. All COREM demonstrators have been developed based on this common theory.

This deliverable summarises this common theory and the concepts which have been chosen in order to meet the requirements for CSCW systems in transport as well as the lessons learnt during the specification and development phases.
2 Introduction

Computer supported cooperative work (CSCW) aims at the improvement of cooperation between people by supporting their tasks with telematics systems. CSCW is a science covering technical, socio-economic, workflow, organisational, psychological and financial aspects.

The requirements for the creation of cooperative systems in transport are steadily increasing; cooperation along the transport chain is necessary in order to support logistics concepts (e.g. just-in-time production) in the best possible way and therefore offer a high quality service to the customers.

Cooperation in transport requires the information exchange between the members in the transport chain - not only of operational data but already information concerning the planning stage. Based on this information - mainly generated by a resource management function or system - the cooperation partner can improve his resource management and planning and can negotiate about optimal schedules for all cooperation partners.

This is where the COREM project starts. The cooperation in resource management within a company (between different departments) and between companies have been thoroughly investigated. For the development of the COREM prototypes a common classification of cooperative actions and functions have been fixed.

This classification can be used for similar CSCW problems in transport and shall therefore be distributed to the public.

2.1 Main objective of the COREM Project

In the future it will be more important in the transport sector than it is today to set up flexible and complete transport services. This is necessary to be competitive on national and international markets and to satisfy the different requirements of the customers in a short time with the possibility to offer them new logistics services.

The communication between the various elements of the business processes and the complete superset of information at every time is of great importance for such a flexibility. The goal must be the interconnection of the participants of the whole business process.

Traditional resource management tasks can be found in each company. Such tasks will be performed either manually, based on the experience of the planner or assisted by tailor-made EDP systems. The solution is an optimisation (if at all) of the function the planner has to perform.

But with new logistic systems and the growth of thinking in a more global way than in local pieces as before, the need for solutions to overcome the isolated solutions and optima is rising.

Cooperation gets a role which becomes more and more a key factor in logistics. But software development up to now has not kept pace with this development. If software systems are connected, in most cases it is only a file transfer link as in most EDI applications. For co-operative communication the phone is still the main medium.

COREM wants to introduce a totally new approach: to define a model which is applicable for all kinds of resource management tasks and based on this system to develop a link between these components to enable co-operative resource management work. Therefore COREM has to point out, what is a resource management system, how does it work, and who works with it in which way.
Based on these results, resource management systems may be connected to each other to support co-operative resource work. COREM's approach is to separate different types of cooperation, to show how they work and how they interact in their way of cooperation.

### 2.2 The COREM pilot applications

In the COREM project we have five pilot applications in two countries, Germany and Greece. The German pilot applications are

- **EKB Container Logistics (EKB) pilot application** is dealing with co-operative resource management in a trucking company that has branch offices in several cities. The resource managers will manage the common resources using the same application working with a central database.

- **EKB Container Logistics - Bremer Lagerhaus-Gesellschaft (EKB-BLG) pilot application** brings co-operation into operations between a trucking company and a port operator company. The companies will exchange information about container transports in advance in order to balance the workload of each company and to decrease the share of failed transport attempts.

The Greek pilot applications are

- **The KEFALINE application** supports the intra-company cooperation between the order processing and the resource management departments through the use of an information system which supplies both the order processing and the resource management tasks.

- **KEFALINE - Port of Herakleion (KEFA-HER) pilot application** is a resource management system for container truck transports from Crete to Athens. A ferry reservation system is created in order to make it possible to cooperate directly with transportation companies. A customer can thus place a reservation automatically and ask for information about the status of a reservation at any time.

- **The CALLITSIS (CAL) pilot application** is dealing with container management inside Piraeus port. It helps the container operators and transportation companies to locate their containers in the port. In addition the system supports the cooperation between the main premises of the shipping agent and its branch in the port.
These applications can be classified as the following table shows:

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Fig. 2-1: Classification of COREM pilot applications

2.3 Generalisation of resource management problems

Whenever one looks at logistical functions - either within a company or in a transport chain - there is one aspect tackled always: RESOURCE MANAGEMENT. The form of resource management may vary from application to application but the principle is always the same.

A resource manager has on one hand certain resources he can employ, on the other receives certain orders he has to perform. His main task is to assign orders to resources with respect to some (mostly economical) targets.

Some examples for practical resource management functions in the logistics area shall show the principle:

1) Transport

Fig. 2-1: Resource Management in transport area

Whenever cargo has to be transported from a location to another (order) someone has to determine the vehicle and the route the vehicle shall drive. In road transport the operation of the whole truck fleet can be optimised by scheduling the routes and by assigning a truck to each route. As result of
the assignment (cargo to truck) the resource manager gets a rotation schedule of each truck with its cargo.

2) Machine employment

![Machine Employment Diagram]

Fig. 2-2: Resource Management in machine employment area

The assignment of orders to production machines (e.g. in car manufactories) with respect to time restrictions, capacity limitations and other factors will be performed by producing an optimal production plan for the whole factory. After the assignment of an order to a machine the resource manager gets a booking schedule, which shows, which machine is occupied by which order at what time.

3) Store keeping

![Store Keeping Diagram]

Fig. 2-3: Resource Management in store keeping area

The resources the store manager has to manage is the yard with its storage areas (i.e. 1-8) which may be a container terminal. Orders are to determine where to put a certain container if it has to be stored. The result of the assignment (container to a storage area in the yard) is a loading schedule, which shows which capacity of a storage area is used at which time.

Due to the similarity of resource management tasks it seems to be obvious to develop one abstract model for any of these problems.
Because of the philosophy of developing a universal application system the objects to be defined must be very general on an upper layer while at the adaptation on a certain application the special attributes must be added.

Basic components in the system are:

- Orders from a client,
- Resources, which could be scheduled,
- Schedule as the assignment of the orders to one or many resources.

The orders have attributes as

- Earliest time of start
- Latest time of start
- Earliest time of completion
- Latest time of completion
- Type of resources required
- Place of start
- Destination place etc.

The resources have among others attributes as

- type
- speed
- capacity
- restrictions

The schedule contains information how (at which time, with which duration, at which planning status) the orders are assigned to the resources.

Derived from the common basic structure for all resource management problems may be presented in one general common model:
On the one hand you will find a client, who gives his Client Order to the resource management system. This Client Order will be served by an order processing process, which will separate the arrangement data from the instruction data.

The assignment of an instruction from the instruction database (Instruction DB) to a resource from the resource database (Resource DB) can be done by the planner manually or automatically with certain optimisation algorithms in the background. In all cases the planner will see the impacts of the planning process (result of the evaluation function, resource occupation) in a schedule database (Schedule DB). While making the decision which instruction will be given to which resource the resource manager may get information from external resource management partners or he can get other not specified constraints as news from other parties, which will have influence on his decision.

Finally, the operation process will fulfil the scheduling in the schedule database by giving a feedback. So the resource manager is able to get information at any moment of his scheduling.

Fig. 2-4: Resource Management system architecture
3 The cooperative approach in resource management/Cooperation types

For understanding the co-operative approach it is necessary to point out the main functionality of a resource management system. On the one hand the resource management process operates with instructions and on the other hand it operates with resources to arrange both into one scheduling. While making his decision the resource manager is influenced by other constrains.

Cooperation demands for links between resource management systems, i.e. one planner can see the impacts of the planning of the other on his own situation immediately and can interactively discuss some rearrangement which would lead to a better solution - may be not for every single planner, but for the whole logistic system.

Based on the link between two resource management systems it is possible to separate two basic links: the internal link and the external link.

While using internal links it is necessary that two partners use the same application at the same moment (simultaneously cooperation: Type 1) or the same data or a subset of the common data at the same moment (horizontal cooperation: Type 2). In case of external links (vertical cooperation:
Type 3) both partners work with their own application and their own data at different time, but both resource management systems were linked in that way, that the results of one system has influence on the other system.

Concerning this classification the software architecture is different.

### 3.1 Horizontal cooperation (Type 1 and Type 2)

Assume a resource management system where there are planners assigning equipment (e.g. trucks) to transport orders.

![Fig. 3-7: Cooperative Resource Management Type 1 and Type 2](image)

In case of simultaneous cooperation (Type 1) both planners are working at the same time with the same application. The cooperative resource management process is based on the principle: "What you see is what I see" by using CSCW techniques like telepointing and video conferencing.

In case of horizontal cooperation (Type 2) both planners are working with the same data or a subset of the data (i.e. one planner is responsible for the export transports, one planner is responsible for the import transports by using the same trucks for export and import). The cooperative resource management process is now responsible for the common access to the same data and the selected access to the private data.

### 3.2 Vertical cooperation (Type 3)

If the outcome of one planner's work is generating follow-up orders for another planner this can lead to vertical cooperation.
Now the cooperation is located in the data modification and transmission between the two resource management systems.

This type of cooperation means not only the exchange of existing information, but also the exchange of planning results. These planning results of the upper layer will be the basis for the lower layer, which means that the outputs from the first planner become inputs for a second one. In the other direction, status information as agreements or requests for changes are flowing.
4 Types of cooperative actions

The cooperative actions in inter-company cooperation can be classified into three classes:

A: Preparation of action (looking for information that you are going to need)
B: Cooperative action (really doing some planning or messaging)
C: Monitoring the situation (in order to see if you have to do something)

First phase, phase ‘A’, is used when a resource manager is checking what are the possibilities of his cooperation partner to provide some service for him. In other words, the resource management system of one partner sets some constraints to the possibilities of the other partners. For example, the resource manager of a trucking company could check which ships arrive today in order to choose which containers he will pick up from the port. In this case the port is constraining the choices of the trucking company since all ships have not arrived yet. The A functionalities are needed for planning future actions.

The cooperative action itself, phase B, means that a company is giving some instructions to the other company. Such instructions are dealing with a transport happening in near future. In other words, when something is changed in the instruction database of the receiver, we are talking about phase B. For example, the resource manager of the trucking company informs the port that a container delivery will arrive today at 16.00 o’clock. Another possible case would be a cancellation of a previously announced transport.

In phase ‘C’, the resource manager monitors the situation and tries to find out what is happening to his transport. He is also checking if there is a need of modifying already given orders. For example, a resource manager of a trucking company is checking if his truck has already left the port in order to approximate when the truck will be free for the next transport.

4.1 Communication functionalities

The information content of phases A and C (preparing and monitoring) is more or less meant to be read once and then used in planning and controlling transports, but the data is not entered into database for future use. On the other hand, in phase B we are sending new data or orders to the
other partner. This information will be then processed further by the receiving partner and finally inserted into his database or his database will be modified according to the instructions contained in the message.

For this reason, messages for the B functionality must be structured and standardised. In our COREM solution we use EDI systems for type B messaging, since a structured message protocol makes it easier to process the data in the messages. A dedicated communication system will be used for type B communication. On both sides the current resource management software will be changed in order to comply with the new functionality.

The functionalities of type A and C deal with more unstructured information. Examples of this information are ship timetables or information about current job queue at port. A WWW service using Internet will be used to create these functionalities. World Wide Web is a modern communication tool which is well suitable for these phases of inter-company cooperation. It is especially suitable for querying functions, but it can also be used for entering data.

The usage of a company’s WWW service can be restricted for the company’s business partners only. By using that kind of system, an Intranet, we get the benefits of the openness of Internet while ensuring data security.

A WWW system makes it much easier for a company to change the service provided by the company, because the company does not have to change anything on the other partner’s side. New functions can simply be added to the company’s own WWW server. The other cooperative partner then sees the changes when he next time uses the service.

It should also be mentioned that using WWW technology does not always mean using a WWW browser program. The same communication protocols can be built into the software used for resource management. This means that big clients can use the same message as input for the functions in the resource management program and small clients see it as a visual WWW service.

The WWW solution makes it possible that new customers and smaller companies can more easily utilise the service without investing into a private communication system. They can enter their data through a visual WWW page while big companies use the EDI system for data entry.
5 Topics to be considered for cooperative systems in transport

The form of cooperation in COREM needs a lot of data which could not be handled e.g. with traditional CSCW technologies like a common drawing board. In COREM, the cooperation is mostly performed on a high conceptual level: keeping other parties informed about the current operative plans and on the changes affecting their planning and operation.

The cooperation between different parties usually requires not only general information about the other’s intentions but also detailed information about his operational plans. This forces us to work on two detail levels:

- We have to tell the cooperative partner details about what we are currently planning to do, so that he can verify the planned actions. This forces us to be able to transfer detailed information about plans between cooperative partners. The most applicable communication solutions are either database replication, synchronisation of databases or EDI messages.

- We must have methods to notify the cooperative partner about changes in operative plans that might have effects on his/our plans. The partner should be able to react to those changes as soon as possible, so he must be about those changes. The most suitable solutions are messaging systems, either an E-Mail solution or an integrated notification feature.

The COREM experience shows that certain topics have to be considered when developing CSCW applications in transport.

5.1 The principles of the COREM Approach

5.1.1 The COREM approach for intra-company cooperation

EKB and KEFALINE applications, both concern INTRA-company cooperation between persons and departments.

The reason for the suffering INTRA-company cooperation is the lack of effective communication between persons who should have the ability to work on the same data in order to avoid the delays that paper based and manually interchanged information introduces.

The solution is INTRA-company cooperation sharing the same data (Type2 cooperation). This type of cooperation has been clearly described in Deliverable D4.04 concerning system architecture.
One of the most important issues is here: HOW TO GET AWARE that one of the colleagues had planned or decided something which may influence my own work or planning? Although all data may be in the database this is a passive way, i.e. the planner has to take the initiative and to look for information.

For example, E-Mail is used in the COREM EKB prototype to notify the other planners about changes that affect them. Each planner (resource manager) receives an E-Mail message which will be generated automatically by the system telling him/her about the change. The message already contains most of the relevant information about the details of the change.

5.1.2 The COREM approach for inter-company cooperation

Cooperation between different companies, inter-company cooperation, requires more flexible cooperative systems than intra-company cooperation. This is usually Type 3 cooperation as the companies usually have different resource management systems.

In inter-company cooperation two or more resource managers and resource management systems from different companies cooperate in order to increase the efficiency of the transport operations.
As the resource management systems in different companies are different, the software enabling the cooperation must comply with that. For this reason a database replication system can not work. We need to define what kind of cooperative actions will be taken and how these actions will be done.

The potential of environmental and socio-economic benefits that can be achieved by the inter-company cooperation is quite clear. The overall goal of the inter-company cooperation is to optimise the whole transport chain, not only the operations of one company. This can be most effectively realised if the partners cooperate and exchange information before the transport starts. One of the main goals in the inter-company co-operation is to clarify the “restrictions” set by one partner (class A, preparation phase). A good example of this kind of co-operation is the ability to check if a certain ship has arrived to port or if a certain container has been unloaded from ship.

This kind of co-operation can be realised in two different ways:

- Interactively, real-time: the resource manager of one company can go to the other company’s resource management system and do the check by himself. (e.g. using a WWW service connected to the database).

- Batch process, message queue: The resource manager can send an information request which will then be checked either automatically or manually. This can be done by sending a special pre-notification of a suggested container transfer. The other partner will then check the availability of the requested container and send either a confirmation or a rejection response.

Both of these methods enable us to verify the plans before the transports have started.

### 5.2 Organisational view

Before starting to consider technical solutions, the organisational agreements between the cooperative partners have to be taken.

As from the past, each part of the transport chain was used to have a limited view on his task to perform and did not think about the others. Fears about competition, fears about creating too close links reducing the operational freedom, blaming other partners in the chain if something goes wrong, etc. have been quite common in the transport business.

Cooperative resource management requires a new way of thinking: to inform other partners and to negotiate finding improved solutions for all of them.

It is essential that benefits for all cooperation partners must be apparent and substantial. Only then we can achieve meaningful cooperation.

In EDI, in most cases big service providers (ports, shipping companies) force their partners to report e.g. orders in an electronic way. They can do this because the partners have contracts with them.

In one of the COREM pilots, the German inter-company pilot, the situation is quite different: truck operator and container terminal operator do not have any contractual link! Nevertheless, they agreed on cooperation because the benefits are evident for both of them.
5.3 Technical view

On the technical level, the first separation has to be made if an application will be developed from scratch or if existing applications have to be „made cooperative“.

Most of the systems are built on a client/server architecture based on a relational database management system (RDBMS).

5.3.1 Intra-company cooperation

For cooperation type 1 usual CSCW tools such as common drawing boards may be suitable. The COREM applications did not contain any type 1 application.

As a basis for type 2 applications a common data store must be available. This could either be a physical central (e.g. company-wide) database or a virtual central database, e.g. realised with the replication concept offered by some of the suppliers of relational database management systems.

Additionally, the critical question „How to get aware?“ have to be answered. Although all data may be in the database this is a passive way, i.e. the planner has to take the initiative and to look for information. Here, an additional tool could be the use of E-Mail enabling the immediate awareness of the planner if he shall be forced to act.

5.3.2 Inter-company cooperation

In inter-company cooperation EDI is the most common tool if systems are existing on both ends. But EDI is just a method how to communicate so that several layers have to be treated:

- Definition of messages
- Integration of messages

If this is not the case there are several possibilities:

- Direct link to the EDP system of the cooperation partner (terminal)
- WWW link to the EDP system of the cooperation partner.

5.3.2.1 Definition of messages

For the definition of messages, the decision for using EDIFACT standards seems to be quite obvious because this is forming a world-wide standard in message exchange.

But also there several steps have to be performed which may take a lot of time:

- Identification of a suitable message
- Check if all necessary information can go there
- Identify which items should be used
- Identify the common understanding of the data items (e.g. reference numbers).

In the German inter-company pilot, where this discussion had been performed together with the WISDOM project, this procedure took about one year!
In the Greek pilot, proprietary messages are being used to book and exchange reservation status information between the ferry reservation system and the transportation companies.

5.3.2.2 Integration of messages

Even if this first step, the definition of messages, had been successfully performed, this forms only part of the total solution.

Many people stop thinking further when the messages have been defined, but the remaining task is also quite essential: how to create the link to the inhouse system, i.e. how to generate the messages resp. how to integrate the messages into the inhouse systems? Automatic EDI is mentioned in several places, but how to do?

Most EDIFACT converters perform a nice translation from flat file to flat file, but the problem with the integration to relational databases had been solved only partly. The generation may be easy (creating appropriate database views) but the integration is not self-evident: incoming data must be checked with the database (e.g.):

- an order contains the name of a shipping company,
- it must be checked if this shipping company is existing in the database
- if there is one match, the unique key for this record has to be linked with the message
- if there is more than one match, a user has to decide
- if there is no match, a new record has to be inserted, etc.

For the realisation in COREM several tools have been used to solve this problem:

- a conversion tool called OSIS (Open Systems Interconnection Software) to establish the link between the relational database of EKB and EDIFACT as well as to link the input/output database with the operational database
- a generic data model input/output database as developed in the BOPCom project (Baltic Open Port Communication) in DG VII has been used for the EKB/BLG pilot.
- For the CAL application a conversion layer has been developed and built into the application to update the relational database from the flat input files (e.g. hand-held terminal and declaration files). Additionally, special DCOM servers have been developed to provide remote view (from the computers at the main premises) of the container's history.

5.4 Operational view

5.4.1 Interaction between existing systems and the new systems

We have to integrate the new systems into the old systems that support the core business of our company partners. The new systems must be integrated into the old systems so that the usability and functionality of the existing system does not decrease. This means that the new systems must be
designed as add-on parts to the existing EDP systems in two companies. The existing systems must be altered to support the new functions that the COREM application modules offer.

Respectively we must design the COREM modules to fit into existing systems on our pilot sites, although it means reducing the transferability of the COREM modules. The developed functional concept still remains transferable and similar systems can be built into other similar situations.

In daily operation, it is extremely important that CSCW solutions will be integrated into existing operational systems because

- no planner would like to enter his planning data into a new, different system (e.g. for time and stress restrictions)
- otherwise these systems will not be accepted by the users and therefore will never surpass the test level.

5.4.2 Transparency of procedures

The operational procedures must be clear and transparent, i.e. the planner has to know exactly how the cooperation partner will take his decisions so that he can undoubtedly interpret the responses.

The procedures have to follow the workflow of the users in the best suitable way.