Final Report for Publication

INTRARTIP Project IN-97-SC.2120

Project : **IN**TERMODAL **TRA**NSPORT
REAL-**T**IME **I**NFORMATION **P**LATFORM

Coordinator: EUROMAR EEIG - IT

Partners:		
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	GTS Multilogistics SA	BE
	Italcontainer S.p.A.	IT
	Ahlers Maritime Services	BE

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User Group

The project team is complemented by a User Group that played a major role during the identification of requirements and the evaluation of the proposed solutions. Members of this User Group are transport mode carriers and operators (like railways, combined transport and road haulage operators, shipping industry), service providers who want to be active in the distribution of information or in the production and distribution of software necessary to access this information and representatives of associations representing the interest of the intermodal community.

2. EXECUTIVE SUMMARY

2.1 PROJECT OBJECTIVES

The INTRARTIP (Intermodal Transport Real Time Information Platform) project is a research and technology development project, partially funded by the European Commission. It aims at designing and experimenting on the field a real time information for supporting intermodal transport.

The platform provides selected and standardised market information useful for organising the delivery of cargo and for settling bookings, trade agreements and contracts as well as information concerning conditions, infrastructures capabilities, routes, facilities, timetables, tariffs, reliability of delivery, etc. This could be envisaged as the first approach to electronic commerce in the transport field.

More specifically the objectives of the INTRARTIP project are:

- To define a *Semantic Framework* for information involved in the pre-contract processes of intermodal transport
- To define an *Open Architecture* for the INTRARTIP Platform
- To implement a *Pilot System*, implementing a number of information services and IT applications. The aim is to evaluate the feasibility of the INTRARTIP concepts.

2.2 TECHNICAL DESCRIPTION

2.2.1 The User Requirements Survey

Part of the INTRARTIP User Requirements has been a survey concerning real time information systems and on-line services in operation nowadays. The identification of the INTRARTIP user requirements has been carried out using a well-defined methodology that has been specifically developed by the INTRARTIP team for the scope of the project. The methodology consists of several steps, covering analysis of the current state of the art, interviews to major European professionals, and final presentation in the User Requirements Workshop.

The requirements' survey resulted mainly in the definition of a number of services that the future INTRARTIP system should support. Services have been grouped in three main categories:

- ***Information Platform Services*** provide a one-stop-shop for information on transport services, allowing interested parties to find quickly and reliably transport services necessary for their deliveries. Three services have been envisaged:

- The *Single-mode Directory*, cataloguing single-mode transport services.
- The *Intermodal Directory*, cataloguing already packaged intermodal services.
- The *Route Builder*, who creates new intermodal services by combining single mode and already packaged intermodal transport services.

- Real Time Services provide users capabilities for booking and ordering transport services, getting immediate confirmation. In addition they bring to the users information on last-moment opportunities, constraints, special offers, etc.:
  - *Case Optimisation* that brings information for identifying the optimal transport solution against actual constrains. This includes special offers, space availability, foreseen strikes, etc.
  - *Booking* that provides a common interface to transport providers legacy systems enabling users to book their services independently of language, location and of connections to transport providers.
  - *Order Entry,* providing a common framework for a standardised entry system.

- **Support Services**. Project requirements have also pointed out the need for transport monitoring information services:
  - *Alarm notification,* to inform operators on out-of plan events occurring during the delivery.
  - *Cargo Tracing and Tracking*, reporting the current position of the cargo along the transport chain.
  - *Statistics* on completed deliveries. This has been considered relevant by a number of interviewees for business development, for creating new attractive proposals, for demonstrating transport capabilities

Also if Support Services appear to be out of the scope of the project, which mainly concerns the pre-contractual activities, they are related to the pre-contract process because they deal with the performance of the selected services.

2.2.2 The Semantic Framework

After the requirement analysis had been finished a beginning was made with the semantic framework design. that is composed of :

- A *data model* to address the information to be exchanged.
- A *service architecture* to address which services (or applications) may evolve in the future in order to provide users with such information.

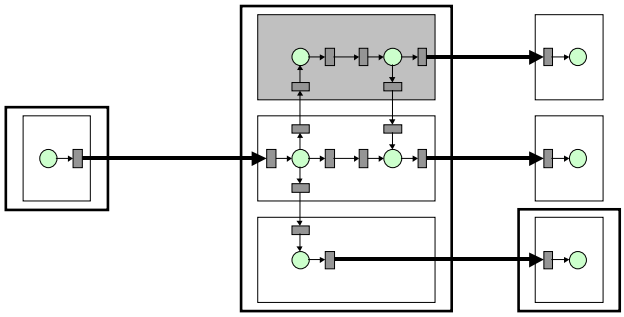
There is a connection between the two because a service (or application) has input and output data flows that can be defined as a view on the data model.

2.2.2.1 The methodology

The starting point was formed by the results of the INTRARTIP User Requirements and the State of the Art analysis. Next it was made an inventory of relevant (official or de facto) standards that were to be incorporated in some way into the semantic framework. This resulted in the INTRARTIP Standards Platform. Among them are for example the United Nations Trade Data Element Directory, but also the results of other European projects like Osiris. Furthermore we defined a list of stakeholders and started interviewing them on a one-to-one basis. As a result we had a fairly good view of the basis on which the semantic framework should be designed.

2.2.2.2 The data model architecture

The data model is the nucleus of the semantic framework and defines the information to be exchanged among e-commerce partners and applications. We elaborated on some essential component:



- **Composition of transport services:** Elementary transport services (movement or storage services) can be build to make a chain if you use mode interface services to connect them.
- **Suitability of transport services:** Transport services offer specific types of vehicle space (e.g. a wagon), being able to transport specific types of transport equipment (e.g. container). These in turn are able to contain specific types of goods – which may be dangerous.
- **Progress tracking:** Transport services take place between nodes and along intermediate passage points. We can associate progress markers with these physical connection points but also with other items like administrative procedures.

2.2.3 The System Architecture

The System Architecture describe how the INTRARTIP information platform works; it comprises three components:

- The Service Model
- The Platform Architecture

- Legacy Systems Interface Specification

2.2.3.1 The Service Model

The Service Model defines the services provided by the INTRARTIP platform, specifying the provided facilities and illustrating how the services interact together for providing higher level functionality.

There are eight main services:

- *Interactive Chain Modeller,* to build intermodal transport services by combining several elementary services.
- *Service Browser*, to search for transport services satisfying given search criteria.
- *Chain Builder*, to automate, partially or completely, the process of creating composed transport services.
- *Booking*, to book a composed transport service as a single entity.
- *Tracing and Tracking*, to know the progress status of a shipment
- *Alarm Messaging*, to alarm users when shipments are getting out of their planned progress
- *Statistics*, to collect information on the performance of transport service providers
- *Chain Evaluator*, to asses a service on the basis of statistical data collected during the provision of similar services.

2.2.3.2 The Platform Architecture

The platform includes one or more co-operating web servers. Secure protocols based on X.509 certificates are used to endorse the identity of parties involved in sensitive transactions such as booking.

Users access the platform services using a web browser. When a user contacts a servers, an HTML page is downloaded and used to submit a service request. As soon as the service reply is evaluated it is returned to the user and relevant information is presented. The evaluation of a service may require processing to occur on the contacted server or on other servers of the platform; it may also require legacy systems to be contacted.

XML has been widely adopted for standardising info exchange between system components and external legacy systems, providing a relevant degree of openness. To this purpose, specific DTDs have been developed. XLS has also been adopted to translate XML files into HTML pages: this adds flexibility providing users with different views of the same XML data.

2.2.3.3 Legacy Systems Interface

There are services, like booking or tracing and tracking, that cannot be provided without accessing legacy systems of transport service providers. For instance, to book a transport service, you have to contact the service provider's booking system, submit your booking request and obtain the corresponding booking confirmation. Specific distributed transactions are provided by the INTRARTIP system to support these services, involving more legacy systems in the same transaction whenever required. Transactions are executed according to well-defined protocols based on the XML language.

2.2.4 The Pilots

The INTRARTIP platform can be adopted in different scenarios. For instance, a *global* system can be conceived, offering most of the available intermodal transport services. But other scenarios could be conceived as well, reducing the coverage of the platform to more limited domains. Examples of these scenarios are *community* or *single intermodal supplie*r systems. Moreover, the platform can be used as an *internal information system* by freight forwarders who intend to automate the process of organising shipments. Four pilots has been defined to cover these scenarios:

- *The Belgium pilot*, involving Sequoyah and Ahlers, has tried the INTRARTIP platform in the Freight Forwarder System Scenario. This pilot focus mainly on the Service Browser and the Chain Modeller services, experimenting how much it is effective to organise shipments using INTRATIP.
- *The Italian Pilot*, involving Italcontainer and Sistemi e Telematica, focuses on the Single Intermodal Supplier System. Within this pilot, users are able to build intermodal services by combining Italcontainer transport services with services provided a number road hauliers. Users are also able to book these intermodal services. The overall aim is to demonstrate the effectiveness of the system as an e-commerce tool for transport service providers, which, among other advantages, reduces the overhead associated with paper based bookings.
- *The French and Spanish pilots*, involving the communities of Valencia and Marseilles, tried the INTRARTIP platform in the Community System scenario as a first step towards a Global System.

2.3 RESULT AND CONCLUSIONS

The following are the major result and summarising documents from INTRARTIP:

- A survey of the state of the art in the topic areas of the project has been completed

- A survey of user requirements that, according to a well defined methodology resulted in a consistent and European widely validated list of user requirements and associated constraints for the INTRARTIP platform.
- The Semantic Framework, that defines information involved in the pre-contract processes of intermodal transport
- The INTRARTIP System Architecture
- The INTRARTIP Pilot System
- The Pilot Trial and Evaluation
- The INTRARTIP Demonstration System
- The INTRARTIP Expansion Plan

Therefore, it is possible to conclude that the INTRARTIP project activities are terminated and its expected results were achieved.

2.4 COLLABORATION SOUGHT

The INTARTIP Consortium will exploit the result by itself.

2.5 EXPLOITATION AND DISSEMINATION PLANS

The project consortium decided to delay dissemination and exploitation activities at the end of the development stage of the pilot system to protect the intellectual properties of the partners.

During the project two workshops were organised to exchange views with other professionals:

- User Requirements Workshops in Brussels on June 29th 1999
- Final Workshops in Brussels on on February 28th 2000

During the development, the project was presented at the following conferences:

- Seattle (Washington – U.S.) on June 25th 1999
- Harbour, Maritime & Industrial Logistic Modeling & Simulation,
- Genoa, 17 September 1999
- Transport Research Conference, Paving the Way for Sustainable Mobility
- Lille, 8 & 9 November 1999

In addition, two INTARTIP newsletters were published and disseminated to European professionals

Dissemination and exploitation activities were also carried out by partners in several informal meetings in Belgium, France, Italy and Spain. Furthermore, dissemination and exploitation activities are continuing; for instance the INTRARTIP project was presented at the KETJU Seminar that will be held in Helsinki on February 10, 2000.

From the point of view of the final users we envisage three main exploitation scenarios, “Transport Operator Virtual Moll”, “Forwarder System” and “Community System” each of them includes:

- Many transport operators
- Origins and Destinations all across Europe
- All the Transport Modes
- Access through public communications networks (the Internet)

2.5.1 Transport Operator Virtual Moll Scenario

This scenario is a particular application of the INTRARTIP System. In this case it’s only one Transport Operator who offers its services to its clients. The characteristics of this scenario are:

- Only one transport operator offering its services
- Only the origins and destinations offered by the transport operator
- Transport Modes offered by the transport operator
- Access through the networks the transport operator is connected (usually the Internet)

Transport Operator Virtual Moll scenario is suitable to include all the services proposed for the INTRARTIP System, because the system is the same as the general one but in the case that all the transport services are offered by the same operator.

2.5.2 Forwarder System Scenario

This scenario is a particular application of the INTRARTIP System. In this case the system is used internally by a Forwarder to organise its own shipments. The characteristics of this service are:

- Only one forwarder in the system, it’s the only information client and information provider.
- The origins and destinations are the ones that the forwarder works with
- Transport Modes used by the forwarder
- Access through the networks the forwarder uses to implement its private network

Forwarder system is a very particular one, because it is to be used by a single company to build its Transport Chains. Even within an single company, most of the services defined for the complete INTRARTIP System are suitable to be included in the Pilot for this scenario. The only exception could be the Booking Service, but it can be used as an internal Order Entry Service.

2.5.3 Community System Scenario

This scenario is a particular application of the INTRARTIP System. In this case a community of transport uses the system. A community of Transport is a group of actors (transport operators, forwarders, terminal operators, etc.) around a transport platform or node, this platform or node can be an airport, a port, a railway terminal, a road logistic platform, etc.

The characteristics of this service are:

- Many transport operators, but all of them working around the same node
- All the transport services are with origin, destination or transit point on the same node
- Transport Modes are the ones supported by the node
- Access through the private community network and maybe through public networks

Community System scenario is suitable to include all the services proposed for the INTRARTIP System, because the system is the same as the general one but in the case that all the transport services realised through the same node.

3. PROJECT OBJECTIVES

3.1 THE CONTEXT

With the volume of road transport forecast to double before the year 2010, the official policy of the European Union is to stimulate an increase of the market share of intermodal transport. In fact, the adoption of diverse transport modes such as rail and short sea shipping are envisaged as a way to improve the quality of life and to reduce pollution. Indeed growing of railway transport will be reducing road traffic across Europe while short sea shipping will provide a less polluting and more cost effective transport mode.

The following success factors have been identified for increasing the market share of the intermodal transport services:

- Cost-effectiveness
- Quality of service
- Lower external costs
- Lowered break-even distance (< 500 km)

Further analysis of the information exchange in intermodal transport shows the following characteristics:

A number of diverse modalities are involved, each with its own terminology and regulatory framework.

This creates a complex network of small and large organisations, each with its own culture, organisation, and degree of automation.

The intermodal business is very international.

Integration of different transport modes (maritime, road and railway) is therefore a major focal point to achieve these results and Information Technology is one of the instruments that can be used towards this objective. The aim of the INTRARTIP project is to develop a common framework for Intermodal Information Systems such that information on the intermodal transport can be exchanged easily, effectively and promptly providing, at the end, such a kind of integration.

Accurate knowledge is fundamental to improve intermodal transport processes; however, considering the above, many problems exist to get such accurate information, e.g. on the current position of cargo in the logistic chain. Once containers and other intermodal transport units (swap bodies, semi-trailers)enter the transport chain, the client has to trust his service provider who is depending also on subcontractors, which in turn may depend on other subcontractors. This chain of interdependencies makes it difficult to assess the anticipated or existing logistic situation based on objective information. Information exchange is often restricted to adjacent customer or provider pairs. Therefore a transport operator currently is only able to logistically control the operation through the establishment of commercial relationships based on trust.

3.2 THE ORIGINAL VISION

The INTRARTIP project is intended to create an open and globally accessible platform providing *information services able to support the pre-contract stage of the intermodal transport*. The pre-contract stage information services provide market information useful for organising the delivery of cargo and for settling trade agreements and contracts, including infrastructures, transport services available, etc. as well as information related to the usage of these services : routes, conditions, facilities, timetables, tariffs, reliability of delivery, etc.

These services lead to a platform based on an information network where a number of nodes act as Information Providers, Information Clients, Application Providers and Service Providers. These nodes are inter-connected by a communication network. A node of the network could hold more roles ; for instance a node can act as an Information Provider and an Information Client or an Information Provider can also act as Application Provider. (see Figure 1)

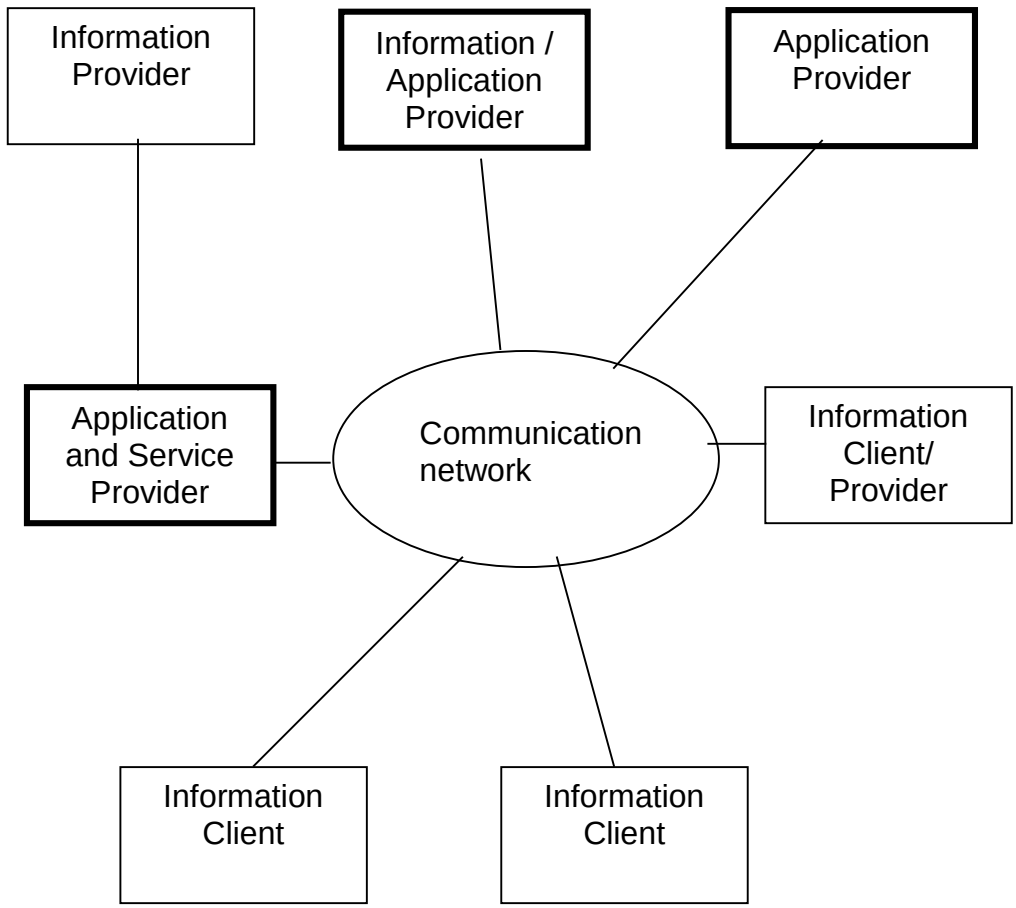


Figure 1 - Model of the Intermodal Information Platform

Below a description of the introduced notions follows:

Information Providers are computing systems operated by the intermodal transport providers : they provide information used in the pre-contract and in the post-contract processes of the intermodal transport.

This information, whenever available, is extracted from existing information systems by using specific *Application Drivers* which translate common data access requests coming from Information Clients according to the information system specific interface. These Application Drivers are downloaded through the network to Information Clients so that they can access information managed by the existing information systems.

Application Drivers can be supplied directly by the Information Provider (in this case the provider is called Information and Application Provider) or can be downloaded from Application Providers.

Information Clients are also computing systems which are, however, operated by clients of the intermodal transport providers ; these can be export and import companies or intermodal transport providers which take advantage of services provided by other transport operators for providing their own services. Information Clients execute application packages which actually access the Information Providers systems for providing higher level functionality according to the business of their users.

Application Providers are nodes of the network acting as repositories for standardised application packages and building blocks as well as for Application Drivers ; Information Clients can download such software components on demand and start to use them immediately. This is aimed to enormously simplifying the access to the information network above all for small and medium enterprises. In addition, these nodes can also operate as gateways able to connect Information Providers which are not equipped with a link to the communication network.

Again, the application packages operated on the Application Providers can be existing information systems or building blocks which will be designed during the project for allowing non-automated information client to access the Information Providers.

3.3 A SAMPLE SCENARIO

The following example is illustrative of how intermodal information can be collected and exchanged.

3.3.1 The actors and systems involved

Two railway companies (see figure 2), Railway1 and Railway2, such as SNCF or Ferrovie dello Stato deploy two information systems managing route, timetables, available slots and tariff data. These information systems have been operated since several years on different computing platforms, providing different functionality and using different data format.

Railway1's Information System is connected to the Internet and its Application Driver is directly available. Railway2's information system, on the contrary, operates on a mainframe system and it is not directly connected to Internet. A service company was appointed recently to connect the proprietary network of Railway2 to

Internet through their own systems. The same company was also appointed to develop and to make available on the Internet the Application Driver necessary for accessing Railway2's information system.

InterApp, a provider of transport applications, is also connected to the network; among the other, this company has developed an application for organising an intermodal shipment door to door, called Shipment Organiser.

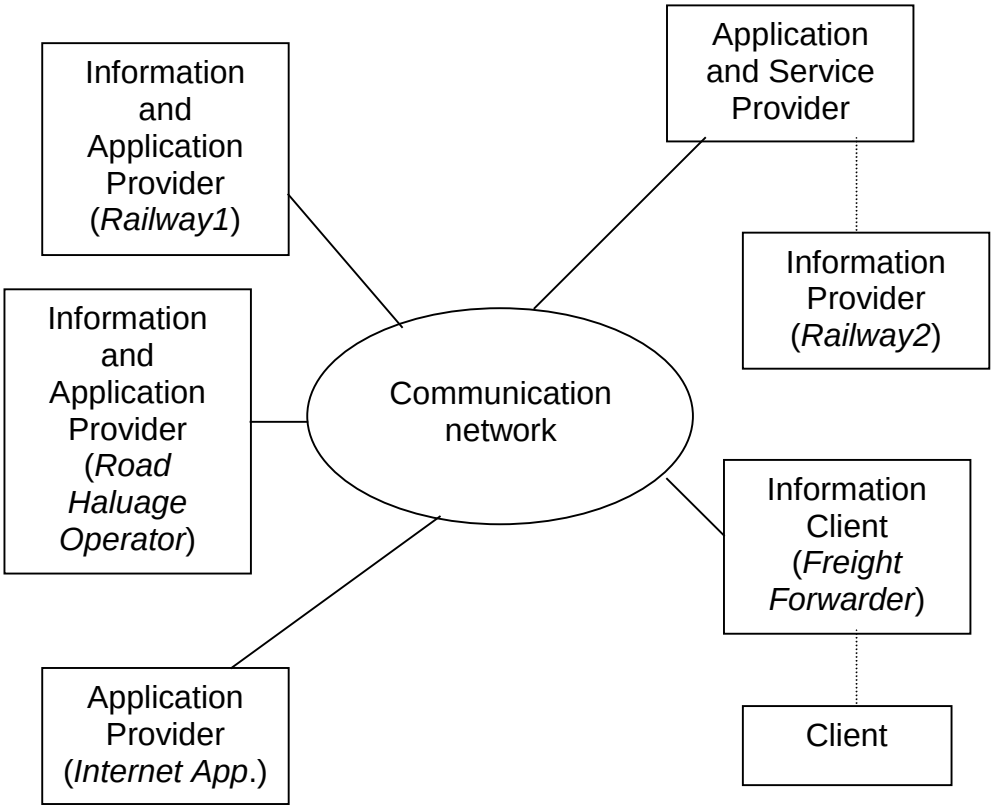


Figure 2 - Example Scenario

A road haulage operator is also connected to the Internet. It deploys an information system which can be accessed by Information Clients through an Application Driver which is directly available on the road haulage operator's server.

The group of actors is completed by a Freight Forwarder who provides intermodal transport unit (like containers) transport within the context sketched above.

3.3.2 A Scenario to Organise Transport from A to B

The Freight Forwarder has been requested by a client to send a container from origin A which is served by Railway1 to destination B which is served by Railway2. However, a truck service is necessary for transferring the container from the origin to the nearest Railway1 station and from Railway2 station to the destination.

The Freight Forwarder operates a PC, connected to the nearest Internet provider by a modem. When the Freight Forwarder starts to organise the voyage, he connects to Internet, accesses the InterApp's Web server and downloads the Shipment Organiser application. He enters the specification of the voyage in the Shipment Organiser's Voyage form and the application starts to access transport service providers information system for collecting relevant information, such as timetables for trains, conditions, available slots, etc. This information is searched over the Internet using an approach similar to the Internet search engines, so that all the information related to the actual voyage are identified and collected.

Necessary information is so collected from Railway1, Railway2 and the Road Haulage operator systems. Access to Railway1's information (as well as to the Road Haulage Operator) system is done by downloading the Application Driver from Railway1's server and by calling the appropriate service of the information network. Access to Railway2's information system occurs by downloading the appropriate driver from the service company and by accessing the information system through their gateway.

At the end, the information for organising the voyage has been collected and presented in a standardised way to the Freight Forwarder, who, after evaluating several possibilities, decides to book the space on Railway1 and Railway2 trains and to send an order to the Road Haulage operator.

This example is illustrative of how the proposed information network can effectively support the intermodal transport processes by combining and interconnecting existing systems with newly developed applications. It also highlights how a plurality of organisations can co-operate independently, each one with its products, services and expertise, based on the open, globally accessible platform framework that the project proposes. Finally, it illustrates that the information network will provide a single entry point through which all the application and information can be activated and collected.

3.4 SPECIFIC PROJECT OBJECTIVES

The overall objective of the INTRARTIP project is to set the basis for the creation of a multi-regional real-time information network which will provide a set of open and globally accessible information services to support the multimodal transport operators. This is aimed to enhance the competitiveness of the European intermodal transport sector by improving the conditions for use and integration of information technology through out the intermodal transport chain.

The proposed network will be providing *information services to support the pre-contract stage of the intermodal transport* ; these services, which will be useful for organising the

delivery of cargo, for settling trade agreements and contracts as well as for enhancing the marketing of intermodal transport services.

In this framework, the scope of the INTRARTIP project is twofold : first the creation of a conceptual definition of the full information network and second, based on this definition, the creation of a working prototype in which a representative portion of the network services will be implemented to demonstrate the full network feasibility.

Concrete objectives of the first mission are :

- Arrive at a *Common Semantic Framework* for the information involved in the intermodal transport, which defines how this information is exchanged among Information Providers and Information Clients and which form the basis for consistency of information across the intermodal chain ; this should be built on commonly accepted standards.
- Arrive at a new *Open Architecture* for the information services and the associated information systems operated.

Concrete objectives of the second mission are :

- Arrive at a *Pilot System* on which a number of key information services are implemented as IT applications that conform to the framework and architecture defined above. This system will be used for evaluating the feasibility of the INTRARTIP approach through a field trial carried out by the users forming in the project consortium.
- Arrive at a *Demonstration System* which will be used for disseminating the project results to a wider audience of potential users.

The objectives of the project were following a user driven approach to ensure that the provided solutions reflect current business practice. On the one hand, end users are incorporated in the project team to have a direct user involvement. On the other hand, a user group was established providing the broad scale response that is necessary to prepare standardisation effort and for the validation of the results..

4. MEANS USED TO ACHIEVE THE OBJECTIVES

This chapter describes the methodologies used to achieve the project specific objectives discussesd in the previous chapter.

4.1 REQUIREMENTS IDENTIFICATION METHODOLOGY

The identification of the INTRARTIP user requirements was carried out using a well defined methodology defined by the project team, documented in an internal paper and thoroughly applied along the user requirements identification process.

The methodology is based on the following steps :

1. Analyse the state of the art in the topic fields of the project
2. Interview major European professionals on the topic areas of the project in order to find the business problems that affect the current business practices and deployed system ; from this identify a first collection of INTRARTIP user requirements.
3. Integrate the INTRARTIP user requirements, classify them and identify conflicting requirements
4. Held the User Requirements Workshop, to eliminate whenever possible conflicting requirements and refining them
5. Carry out a second campaign of interviews to confirm with European professionals the final set of the identified requirements and to capture quantitative measures on the importance of the identified user requirements.

The following sections give a short description of these five phases.

4.1.1 State of the Art

The analysis of the state of art in the topic fields of the INTRARTIP project has been carried out along two main directions:

1. current situation of the intermodal transport : types of organisations, their roles and documents exchanged ;
2. similar systems that are currently used, such as air passengers booking systems.

The first direction deeply analysed the document exchange between intermodal operators. This was considered important because it shows not only information exchanged but also the underlying organisation of the global intermodal community.

According to the second direction, we carried out a survey of existing systems. The survey have been split in three sectors:

- Intermodal information systems and services with open access, such as Internet based, on-line services.

- Intermodal information systems and services with restricted access, such as services provided over restricted access Intranet networks.
- Information systems and services not designed for the intermodal field but providing facilities similar to the ones proposed by the INTRARTIP project.

4.1.2 First Campaign of Interviews

The objective of the first campaign of interviews was to identify a first, possibly rough, set of user requirements. Requirements were identified at each user site and no integration activity was carried on requirements coming from different users. Specific objectives of this campaign were:

- Identify pre-contract process requirements
- Collect information for preparing the Common Semantic Framework
- Collect information on existing systems (used platforms, data available, etc.) useful for designing the System Architecture

The major effort in the preparation of these activities was the development of a framework that should have guaranteed as much as possible uniformity in interviews which have to be carried out all over Europe by several project engineers in parallel. This framework is built around:

- a clearly defined set of activities to be carried out for each interview
- common information material on the INTRARTIP project
- a questionnaire for remembering questions to be answered and for noting in a standardised way the results of the interview and the requirements identified
- recommendations and support material for guiding the interview and for stimulating active discussion.

The following activities have been carried out for each interview:

1. Introduce the INTRARTIP project using the prepared presentation
2. Obtain basic information about the interviewee.
3. Identify potential requirements by using the questionnaire and prepared the examples of services.
4. Define and specify user requirements and information flows.
5. Verify the information gathered.
6. Use a business case in order to confirm the requirements gathered.
7. After the interview, elaborate the results according to the format given.

Before initiating interviews, the list of interviewees has been prepared and carefully evaluated in such a way to have a good level of coverage either from the geographical point of view either from the categories of intermodal operators.

4.1.3 Integration of the User Requirements

This was an interactive process that started after a first group of interviews were completed and lasted till the end of the preparation of the User Requirements document. It consisted in:

- Gathering the results from individual interviews
- Analysing them in detail
- Combing that requirements in the general framework that were emerging from this incremental activity
- Reviewing the already processed interview, in order to verify that the current generic model was still adequate.

Output of this process was a set of user requirements as they resulted form interviewees.

4.1.4 User requirements Workshop

On June 30th, 1998 an INTRARTIP User Requirement Workshop was held in Brussels. Almost seventy professionals all over Europe attended at the workshop.

The User Requirements Workshop was conceived in order to group together the interviewed professionals, to present them the result of the survey, to highlight the conflicting requirements and to create a round table around which user needs and requirements could be harmonised and refined.

Output from this workshop greatly contributed to the definition of the user requirements.

4.1.5 User Requirement Confirmation

After the User Requirements Workshop, the project team felt the necessity to verify with interviewees the user requirements that have been defined by the user requirement combination process and to have quantitative results on the importance and other relevant attributes associated with user requirements.

To this scope, the User Requirements Confirmation has been prepared. Interviewers came back to already interviewed professionals and explained them:

- the identified business requirements
- the identified generic requirements and
- the adoption problems.

They also asked for:

- user requirements priorities;
- what generic requirements are associated to business requirements;
- what problems are associated to business requirements.

4.2 SEMANTIC FRAMEWORK METHODOLOGY

The semantic framework was developed with a re-engineering approach in mind. The data model structure is of a very generic nature and can store information on transport services of all kinds and their combination into transport chains.

The Semantic Framework is composed of:

- A set of Entity Relationship Diagrams (ERD), describing graphically the entities taking part in the model and their relationships.
- A dictionary of the model entities, detailing the attributes composing each entity.
- A dictionary of the entities attributes, including also reference to standards defining such elements when applicable. This should provide a common terminology for data items, which has been envisaged as one of the most relevant aspects during the User Requirements Workshop.

The starting point was formed by the results of the INTRARTIP User Requirements and the State of the Art analyses. Next, we made an inventory of relevant (official or de facto) standards that were to be incorporated in some way into the semantic framework. This resulted in the INTRARTIP Standards Platform. Among them are for example the United Nations Trade Data Element Directory (UNTDED), but also the results of other European projects like OSIRIS.

Furthermore we defined a list of stakeholders and started interviewing them on a one-to-one basis. Consequently, we had a good view of the basis on which the semantic framework should be designed.

Afterwards, the development of the data models took place and a number of associated concepts:

- Automated chain builders in co-ordination with interactive design by the user.
- Mechanisms to compose transport services into combined services.
- Usage of standardised services for transporting transport equipment & goods.
- Generic way of tracking progress of transport.
- Management of allocated space available on vehicles.
- Usability definitions where vehicle types match transport equipment & goods types.
- Opportunities to define transport concepts.
- Availability of transport services (line oriented or not).
- Various pricing mechanisms can be applied.
- Various kinds of services can be defined (insurance, rental, storage, packing, repair).
- Enforced rules can be overruled always by individual users.
- Company and contact information follows UNTDED standards.
- Goods and consignment descriptions follow UNTDED standards.
- Booking information follows UNTDED standards.

Finally these models were verified either internally among developers either with the users already interviewed.

4.3 PILOT SYSTEM DESIGN METHODOLOGY

The Pilot system design proceeded through the following steps:

1. The service to be implemented in the pilot were selected, taking into account either project constrains either service convenience for users.
2. A number of exploitation scenario for the INTRARTIP project were identified.
3. Based on the results of the above steps the pilots were defined, identifying the scope, the users involved and their role.
4. Finally, the Pilot System Architecture has been laid out, defining the pilot components to be procured or to be developed.

4.3.1 Selection Methodology

The Methodology used to select the INTRARTIP services to implement is based in a SWOT Analysis. This kind of Analysis compares, all together, the Strengths, Weaknesses, Opportunities and Threats (SWOT) of the business process that is going to be analysed.

The selection Methodology is going to be done as a four-step Analysis:

- The first step is to list the Strengths, Weaknesses, Opportunities and Threats of the Whole System.
- The second one is to analyse which of those Strengths, Weaknesses, Opportunities and Threats are applicable to each Services defined for the INTRARTIP System.
- Next Step is to make a figure with four quadrants locating in it each Service according to the results of the second step. This figure is the Boston Matrix.
- The last step is to define the scenarios where the INTRARTIP System can be used and to extract conclusions of the SWOT analysis for each one of them.

4.3.2 INTRARTIP Scenarios

The following exploitation scenario were identified for the INTRARTIP system:

- *Global European-wide system*
  The Global European-wide System scenario is the complete INTRARTIP System as it is described in project documents. This scenario includes:
  - Many transport operators
  - Origins and Destinations all across Europe
  - All the Transport Modes
  - Access through public communications networks (the Internet)

All the services of the INTRARTIP System are suitable to be implemented in this scenario. As it resulted from the general SWOT analysis, all services are suitable to be included in this scenario.

- *Single Transport Service Provider System*
  This scenario is a particular application of the INTRARTIP System. In this case it's only one Transport Operator who offers its services to its clients. The characteristics of this scenario are:
  - Only one transport operator offering its services
  - Only the origins and destinations offered by the transport operator
  - Transport Modes offered by the transport operator
  - Access through the networks the transport operator is connected (usually the Internet)

  This scenario is suitable to include all the services proposed for the INTRARTIP System, because the system is the same as the general one but in the case that all the transport services are offered by the same operator.

- *Forwarder System*
  This scenario is a particular application of the INTRARTIP System. In this case the system is used internally by a Forwarder to organise its own shipments. The characteristics of this service are:
  - Only one forwarder in the system, it's the only information client and information provider.
  - The origins and destinations are the ones that the forwarder works with
  - Transport Modes used by the forwarder
  - Access through the networks the forwarder uses to implement its private network

  Forwarder system is a very particular one, because it is to be used by a single company to build its Transport Chains. Even within an single company, most of the services defined for the complete INTRARTIP System are suitable to be included in the Pilot for this scenario. The only exception could be the Booking Service, but it can be used as an internal Order Entry Service.

- *Community System*
  This scenario is a particular application of the INTRARTIP System. In this case a community of transport uses the system. A community of Transport is a group of actors (transport operators, forwarders, terminal operators, etc.) around a transport platform or node, this platform or node can be an airport, a port, a railway terminal, a road logistic platform, etc.
  The characteristics of this service are:
  - Many transport operators, but all of them working around the same node
  - All the transport services are with origin, destination or transit point on the same node
  - Transport Modes are the ones supported by the node
  - Access through the private community network and maybe through public networks

4.4 PILOT EVALUATION METHODOLOGY

Trial activities began with the definition of the trial and evaluation methodology. This methodology was based on the ISO 9126 standard: in fact, we can say that the purpose of trial and evaluation activities is to evaluate the quality of the INTRARTIP system.

To evaluate the quality of IT systems the International Standards Organisation (ISO) has developed a standard named ISO 9126 which mainly defines the quality characteristics of software product. ISO 9126 sets out six quality characteristics, which are intended to be exhaustive:

- Functionality
- Reliability
- Usability
- Efficiency
- Maintainability
- Portability

Each quality characteristic also comprises a number of sub-characteristics; for instance, functionality comprises Suitability, Accuracy, Interoperability, Compliance, and Security.

Scope of the trial is to evaluate these quality characteristics of the INTRARTIP system. There are several techniques for evaluating these quality characteristics; they can be summarised as follows:

- Questionnaires
- Checklists
- Interviews
- Observations
- “Brainstorming” meetings

The questionnaire technique was chosen, with the added possibility to record some observations. In fact, questionnaires are the most powerful tool to record qualitative and quantitative data for assessing the above mentioned quality characteristics. However, users advice and suggestions are another important source of information

Then the questionnaire was developed, identifying a number of questions for assessing the quality characteristics as described in the following table.

Characteristics	Sub-characteristics	Questions
Functionality	Suitability	Are INTRARTIP functionality adapted to your business?
	" "	Are INTRARTIP functions covering all your activity fields?
	Accuracy	Are results obtained after INTRARTIP process accurate?
	" "	Are your queries well performed by the system?
	Interoperability	Can INTRARTIP be used with other systems?
	Compliance	* not evaluated *
	Security	According to you, has INTRARTIP a secure access?
	Maturity	How often does a malfunction occur?

Reliability	" "	How many defaults could you find in INTRARTIP?
	Fault tolerance	If the user makes a mistake, is it possible to go on in the system use?
	" "	If the user makes a mistake, is its work lost?
	Recoverability	If a malfunction occurs, how long does it take to reuse the system?
	" "	If a malfunction occurs, is the work lost?
Usability	Understandability	How long does it take to learn INTRARTIP functions?
	" "	Are the function names clear?
	Learnability	How long does it take to be a expert user of the system?
	" "	How could you qualify INTRARTIP use?
	Operability	According to you, is INTRARTIP simple to use?
Efficiency	Time behaviour	Is it long to have a response from the system?
	" "	Is it long to download system components?
	Resource behaviour	* rate between time behaviour and resource recorded in the user profile *

5. SCIENTIFIC AND TECHNICAL DESCRIPTION OF THE PROJECT

5.1 USER REQUIREMENTS

This chapter describes the results of the user requirement survey that was carried out at the beginning of the project.

During the requirement survey a number of user needs have been identified. These requirements have been categorised in two groups:

- *Business Requirements*
  Which address on problems of the inter-modal transport community. An example is the need for inter-modal transport booking system which actually addresses several business problems such as:
  - The inefficiencies associated with the relevant amount of paper based communications;
  - Sub-optimal usage of cargo handling and transport equipment as a consequence of unreliable and delayed information on transport services to be carried out.
- *Generic Requirements*
  Which horizontally impact business requirements, clarifying and specifying them. For instance, Common Document Structure is a generic requirement that, when associated to the need for a booking system, highlights that a common structure should be used for booking documents, so that the same pieces of information are used by all operators when creating a booking request.

In addition to business and generic requirements we have also identified a number of problems which could potentially hinder the future satisfaction of certain user requirements. Similarly to generic requirements, problems additionally clarify and specify business requirements. However they provide a different perspective, highlighting conditions that should be carefully evaluated to successfully satisfy a requirement.

An example of such a problem is reliability: when associated to a requirement specifying the need for information on offered transport services it highlight that if such information do not reflect real capabilities of the transport service providers they are not useful.

We found that several problems could be easily expressed in terms of generic requirements. For instance privacy of information is a problem that could affect effectiveness of the system. And this problem has been expressed in terms of the Restricted Access generic requirement.

However, we also found that are a number of problems could not be expressed in terms of user requirements. These problems could not be solved by properly developing the system : other specific actions are generally needed, depending on the type of the problem. For instance, resistance to change is such a problem: there is nothing to do in the system development if adoption of the system requires the change of the existing organisation. On the contrary, proper support should be provided when the system in

being introduced. The latter have been named Problems and they have been categorised separately so that proper action could be prepared and started during the project in order to face with them.

5.1.1 Generic Requirements

During the requirement survey a number of Generic Requirements have been identified and associated to Business Requirements. They have been named as follows:

GXX *Name*

where:

- G = Generic requirement label
- XX = Generic requirement number

The identified generic requirements are:

- ***G1*** *Openness.*
  Information services should be available to all inter-modal players. The platform should be conceived as a value-added system. All players in the transport chain should have access the information services offered by the platform, including small and medium-size companies: community of transport professionals, transport operators, shipping agents, shipping lines, traders, as well as manufacturers (transport principals) and all road, rail transport players.
- ***G2 Neutral system***
  When G2 is associated to a business requirement, the INTRARTIP system shall transparently transfer to the requesting user the information returned by information providers. When this does not occur, severe harms are caused to some of the information providers. For instance, when information on offered transport services are searched, commercial interest of transport service providers could be harmed if information on services provided by them are not transferred to the user.
- ***G3 Easy access***
  Access to the network should be conceived in such a way that users can easily connect to the platform. This imply that friendly user interface should be adopted but also that installation and administration efforts should be very reduced as well as regularly available computing platforms and support devices should be needed to connect the network. Easy access is a main feature implying reliability and confidentiality of the information (when necessary), with no constraint to the user.
- ***G4 Restricted Access***
  Access to open systems should always be restricted to avoid harms deriving from the dissemination of confidential information. G4 implies that information associated with the relevant business requirement is confidential and access to it should be restricted. Restricted access also cover situations where different information should be provider depending on the user who is requesting it.
  Transport service providers (railways companies, road haulage operators, multimodal transport operators, shipping lines, and other

single-mode transport operators) filter the information about their service according to the interlocutor.

- ***G5 Common Document Structure***
  Different structures are often used for the same transport document. For instance, we found that almost any customer use a different document structure when booking a transport service, missing adding and providing information in different forms. This causes that information is often missed or incomplete, which, in turn, give rise to inefficiencies in transport operations. To avoid this, transport documents should be structured in a common way, including all the necessary information using a standardised approach.

- ***G6 Common Terminology***
  The inter-modal field is very international, diverse modalities are involved, each with its own terminology and regulatory framework and a complex network of small and large organisations are present, each with its own culture, organisation, and degree of automation. This implies that very different terminologies are usually used making difficult operators to understand easily each other. A common terminology is indeed necessary to avoid these problems.

- ***G7 Compatibility with existing systems***
  Major inter-modal players already have their own information systems which sometime take advantage of complex communication networks with a world-wide coverage. They are willing to exchange information as long as this integration does not imply the need to modify their internal systems.

5.1.2 Problems

During the requirement survey a number of Problems have been identified and associated to Business Requirements. They have been named as follows:

PXX *Name*

Where:

- P = Problem label
- XX = Problem number

The identified problems are:

- ***P1 Reliability***
  There are requirements that can't be met if Information provided for fulfilling a given requirement needs to be reliable in order to meet the said requirement. Most business requirements demand for reliable information; however, when it is said that a requirement has a reliability problem, it means that if the information obtained is not reliable, the requirements could not be fulfilled. Reliable information means that information has a reliable content, including correctness, avoidance of information duplication, timeliness, and unambiguous interpretation; it has also to be distributed in a reliable manner, including dependability of service of the system and technologies involved.

- ***P2 Critical Mass***
  A dissemination problem appears when there is a need for a basic critical mass of inter-modal players to participate in a given service in order to make business sense. For example, to obtain useful information on available inter-modal services it is needed that most of the companies providing such services provide to the platform information on their offer.
- ***P3 Legal***
  If any requirement or information flow has a legal problem, this means that there are regulations that should be defined or harmonised in order to meet the requirements.
- ***P4 Time Bounded Information***
  We understand that a requirement or an information flow has a time problem when the associated information is valuable only during a certain interval of time and when this interval has expired the information is useless.
- ***P5 Resistance to Change***
  This states that the associated requirement implies the change of business processes that have been established for a long time.
- ***P6 Cost information***
  The costs associated with using the system are a major issue and a price scheme based on the services offered should be carefully evaluated.

At the end it could be useful to mention two kind of problems not common to all users but important to be taken into account:

- *Identification*; the following points are important in particular:
  - Use of standardised codes: Within combined transport the available standardised ISO coding mechanisms should be used. A good example is the Intermodal Transport Unit (ITU) codes. ITU have to be approved before they are allowed to be transported by combined transport. They receive various codes (BIC-code/UIC-number). Depending on the partner, one or the other code is in use, creating difficulties during tracing activities.
  - Availability of unified and consistent information: Unified and consistent information should be available in order to identify wagons and ITU's. Numbers of wagons and their basic technical characteristics can be adapted during each maintenance when technical changes are carried out. Each organisation has got its own basic data - a potential problem during weight checks etc. There is also no central repository of ITU's. Even U.I.R.R. members disagree on lengths and weights of ITU's.
  - Identification of transport sessions: In much the same way various actors should identify transports in the same way. Railway carriers treat the wagon or the train as the unit (of invoicing), while operators and shipping agents take the ITU as such. This implies that the Bill of Lading identification number (LVI-number) is not sufficient as reference to a transport session. One Bill of Lading refers to all transports within a train of to various ITU's on a wagon. This creates confusion during checks and invoicing. An additional problem is that

each departure terminal is being assigned a set of LVI-numbers. Sometimes the numbers are all used up within a couple of months and as a result multiple instance of the same number occur. The unique identifying function of the LVI-numbers is only guaranteed in combination with the departure station and the period during which it was assigned.

- *Complexity*; the following points are important in particular:
  When information exchange between customer and supplier takes place in an anonymous manner through a medium like internet (as opposed to verbal communication like the telephone), a lot of information has to be defined explicitly which normally is added by the supplier because he knows the profile of his customer. One example of this is the type of ITU that has to be defined explicitly when making a booking. In a conventional situation the operator can enter this customer specific information. One solution to this problem could be the possibility to define customer profiles within closed user groups. However even then we have to better train employees to deal with the fact that they have to process a lot more information in an explicit way

5.1.3 Business Requirements

5.1.3.1 UR01 : Information Platform Services

An Information Platform is needed to provide manufacturers, forwarders and other interested parties with information on transport services available on the market. The aim is to provide a one-stop-shop for information on available transport services, so that interested parties may organise door-to-door transport operations in a more efficient way.

- *UR01.1 : Single-mode Directory*
  This is a directory of available single-mode transport services that catalogues services available on a European base together with their relevant specifications and the operators who provide them. This information should be accessible easily, using a search engine able to identify interesting services using the specified transport requirements as selection filters.
- *UR01.2 : Intermodal Directory*
  This is a directory of available intermodal transport services that catalogues packaged intermodal services available on a European base together with their relevant specifications and the operators who offer them. This information should be accessible easily, using a search engine able to identify interesting services using the specified transport requirements as selection filters.
- *UR01.3 : Route Builder*
  Using information contained in the Single-Mode and Intermodal Directories, a route builder is needed which helps in creating new door-to-door intermodal transport chains, composed of single mode and packaged intermodal transport services.

5.1.3.2 UR02 : Real Time services

To complete the organisation of a delivery a number of real-time information services are needed which have been conceived for getting advantage of late opportunities, such as special offers and for booking and ordering transport services.

- *UR02.1 : Case Optimisation*
  Once the feasible routes and related operators have been identified, the optimal solution has to be selected against actual constrains such as special offers, space availability, foreseen strikes, etc.. There is a need for obtaining information on such constraints so that the delivery of goods could be optimised.
  This will be useful both for clients and transport service providers. In fact, clients could obtain more flexibility and better conditions ; transport service providers, for instance, could optimise full loading of transport vehicles by proposing appropriate special offers.
- *UR02.2 : Booking*
  There is a need to simplify booking operations and to speed up all the associated administrative procedures. Moreover, it is of great relevance the planning of transport operations and cargo spaces in order to optimise the internal processes. To achieve this requirement, it would be necessary to identify and establish common procedures for the different transport operators and provide an automatic mechanism for carrying out such procedures. The resulting system is expected to operate as a common interface that interacts directly with intermodal operators booking systems.
- *UR02.3 : Order Entry*
  This is the final step of the pre-contract phase authorising the whole process. Interviewees have pointed out demands for standardised orders and immediate orders acceptance. The order service allows to share information about the state of the order (progress, checking, correct dispatch). The information is protected and checked, so it is kept a security level in the communication system and, in particular, between the customer and the information system of the intermodal transport operator.

5.1.3.3 UR03 : Support Services

The project requirements have pointed out the need for transport monitoring information service, in particular for tracing and tracking, statistics and alarm notification. While these are strictly out of the scope of the INTRARTIP project, which has been limited to the pre-contract phase, they are still important as they have strong relationships with the pre-contract processes.

- *UR03.1 : Alarm notification*

Alarm notification allows to inform all operators tacking part in the purchasing hierarchy that is created for performing a given shipment about out-of plan events that occurs during the delivery. This purchasing hierarchy extends up to the final client. Whenever an out-of-plan event is detected, the information about it goes up in the hierarchy till the point where a successful recovery action can be initiated. If no such action could be initiated, the alarm is transferred up to the final client.

- *UR03.2 : Cargo Tracing and Tracking*
  Real time information about the position of the cargo has been envisage a critical requirement by most interviewees. This problem is classified as critical specially during the inter-change between different transport mode.
- *UR03.3 : Statistics*
  Availability of statistics on deliveries that have been completed has been considered relevant by a number of interviewees. Statistics have been considered relevant for the following reasons :
  - business could be development having available statistic information on one's performance
  - new attractive proposals could be identified, by looking at global transport statistics
  - statistics could be used for demonstrating proposed capabilities
  - the improvement of the internal processes could be guided by activities performance results.

5.2 SEMANTIC FRAMEWORK

The semantic framework is logic fundament of the INTRARTIP system. It is a data model integrating all information relevant for an e-commerce platform for pre-contract intermodal or point-to-point transport. It has been developed with a re-engineering approach in mind. The data model structure is of a very generic nature and can store information on transport services of all kinds and their combination into transport chains. It is developed according to a number of concepts of which some are illustrated below.

5.2.1 The conceptual base of the semantic framework

The model has been designed according to a number of concepts:

- *Automated chain builders in co-ordination with interactive design by the user.*

It is fundamental to our approach that automated solutions for transport chains can always be adjusted by human interference. We therefore use an **interactive chain modeller** that can hand out a task to a **transport chain builder** to automatically design (a part of) the transport chain. The result can always be manipulated again manually. We can also look ourselves for individual transport services throught the **transport service browser**. Once we have decided on the transport chain we can book the individual services through the **booking and order entry facility**.

- *Mechanisms to compose transport services into combined services.*
  Transport services can be composed in order to make door to door services. Please refer to the next paragraph for an extensive description of the concept.
- *Usage of standardised services for transporting transport equipment & goods.*
  Transport services are descriptions of services offered on the market. Such services can be used (we then get a transport service use) for the transportation of goods items which are placed in transport equipment. It also possible to use a composed transport service use made of individual services that are standardised while at the same time the composed service is not standardised as such.
- *Generic way of tracking progress of transport.*
  With each transport service we can associate a sequence of progress markers that can be seen as milestones beyond which progress can be made when the transport service is used. A passage point is a physically evident progress marker, e.g. in case of a train passing a number of railway stations. But also administrative milestones can be used like the approval of certain documents. When a transport service is used we associate a status with every progress marker in that chain. The status shows the estimated and actual date/time of progress. In this way we can trace the progress of a transport service use and see whether any delay is occurring.
- *Management of allocated space available on vehicles.*
  When a transport service is used we have to allocate the vehicle space available to a transport service (we then define the vehicle space allocation). We then make use of storage locations present in this type of vehicle space and how much carrying capacity is available through these storage locations in order to store specific transport equipment types. This offers possibilities to control vehicle and storage location availability.
- *Usability definitions where vehicle types match transport equipment & goods types.*
  Specific types of vehicle spaces and transport equipment may be used to carry certain types of goods (indicated by the commodity class of the goods and whether a particular dangerous goods class is applicable). In this way we can restrict the search space to transport services that have vehicle spaces at their disposal able to transport these goods and the transport equipment containing them.
- *Opportunities to define transport concepts.*

On top of the transport service and transport service use entities we have created an even more abstract layer, the transport service concepts. These concepts can be composed in the same way as transport services. In this way we can define characteristics of transport chains like the necessity to include pre- and on-carrier haulage services. Or we can define new logistic concepts like the ones resulting from the OSIRIS project. In the end is a more effective definition of transport services by providers and a more efficient search engine for clients.

- *Availability of transport services (line oriented or not).*
  In order to make proper planning possible we have to use some mechanism to define time schedules for line oriented services. A service line schedule defines such a schedule during a certain validity period. It consists of a number of elements that indicate a possible time that the service starts and how long it takes. We then can add information on the days of the week or days of the month that this departure time is valid and exception dates when the departure is not available. For services that are not line oriented (like a haulage service) we simply indicate in the service availability the period that the vehicle spaces mentioned for this transport service are available. Such a vehicle space can both be a nominated vehicle space like a vessel with a unique identification but also an indication about the vehicle space capacity that tells us how many vehicle spaces of a specific type are available.
- *Various pricing mechanisms can be applied.*
  In general each standardised service or specific applicable service contract has a charge schedule. Such a pricing schedule has two important types of components. A charge method defines what is the basis of the pricing, e.g. the weight of the goods items or the number of containers. A charge bracket defines the applicable price according to this pricing method if the amount is between certain limits.
- *Various kinds of services can be defined (insurance, rental, storage, packing, repair).*
  The data model provides for different kinds of services. Next to transport services that have to planned as being part of one logistic chain (moving goods, storing goods, packing goods, repairing transport equipment) we also have supporting services like insurance and transport equipment rental services.
- *Enforced rules can be overruled always by individual users.*
  In the model we can store a lot of information about transport concepts, types of vehicle spaces, types of transport equipment, types of goods, etc. We also are able to store relationships between them making it possible to define strict restrictions on whether we can make use of transport services. In order to make it possible to work with the model in non ideal circumstances we have created the possibility to enter types that are not standardised. For such types the user has to consider himself whether certain restrictions are in place. They cannot be enforced by the system.
- *Company and contact information follows UNTDED standards.*

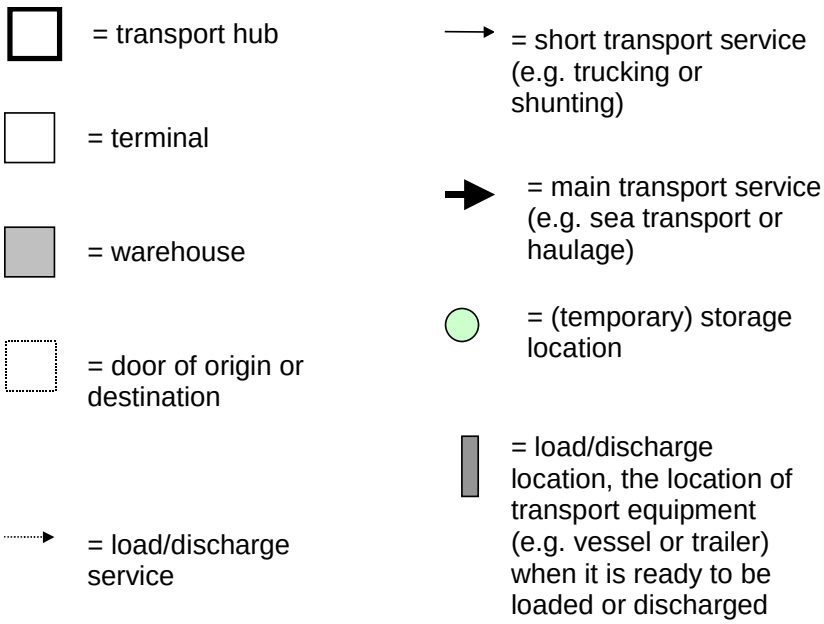
The company and contact information follows the standards of most EDIFACT messages in which a certain party or firm (NAD) can be represented by a number of contact information (CTA) and each of them can be reached through a number of communication contacts (COM).

- *Goods and consignment descriptions follow UNTDED standards.*
  The goods and consignment information follows the standards of most EDIFACT messages in which a consignment (CNI) contains a number of transport equipment (EQD) and goods items (GID). The goods are placed in the transport equipment though a split goods placement (SGP).
- *Booking information follows UNTDED standards.*
  The data elements found in the booking messages (IFTMBC, IFTMBF, and IFTMBP) are distributed over the entities in the data model. Most of the can be found in the entities transport service use, consignment, goods items, transport equipment, split goods placement, charge schedule, and monetary amount.

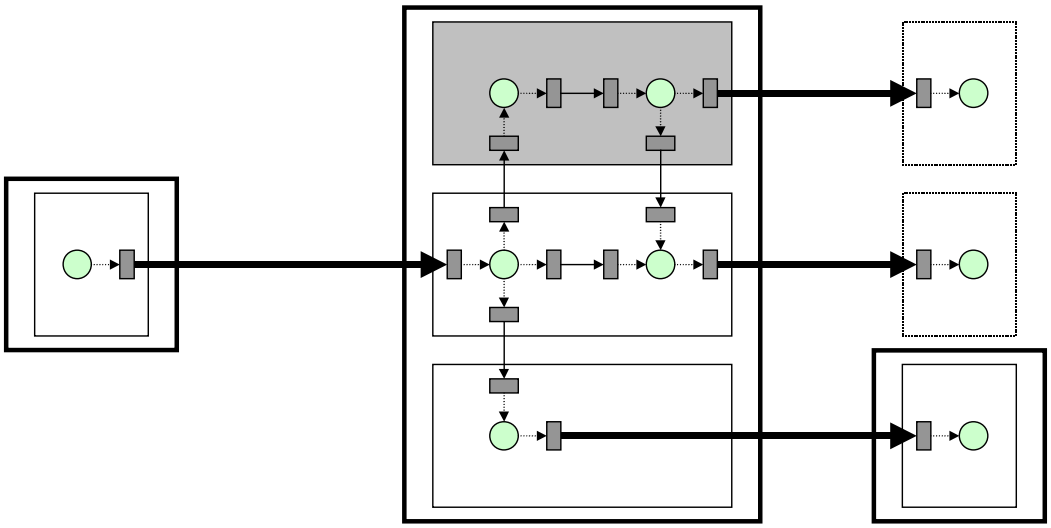
Each of these concepts resulted in specific choices regarding the data model architecture and the design of the service model.

5.2.2 The transport service composition concept

Below follows a general model of how the different types of transport services can be composed information services. We use the following symbols:

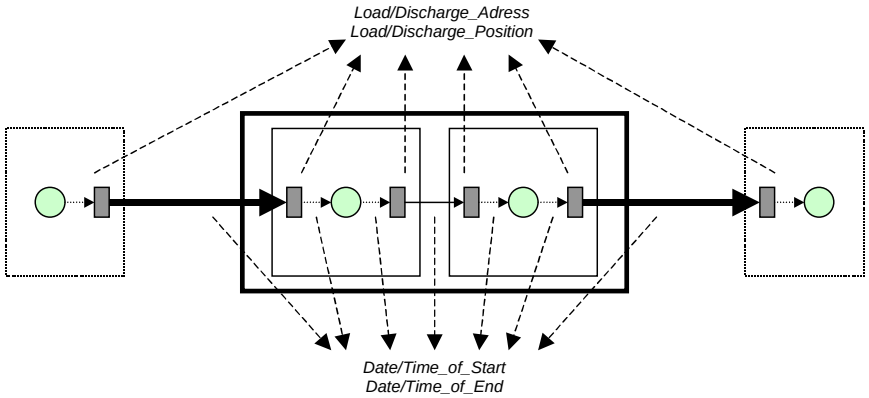


The following figure shows how these elements can be used to construct chains of services.

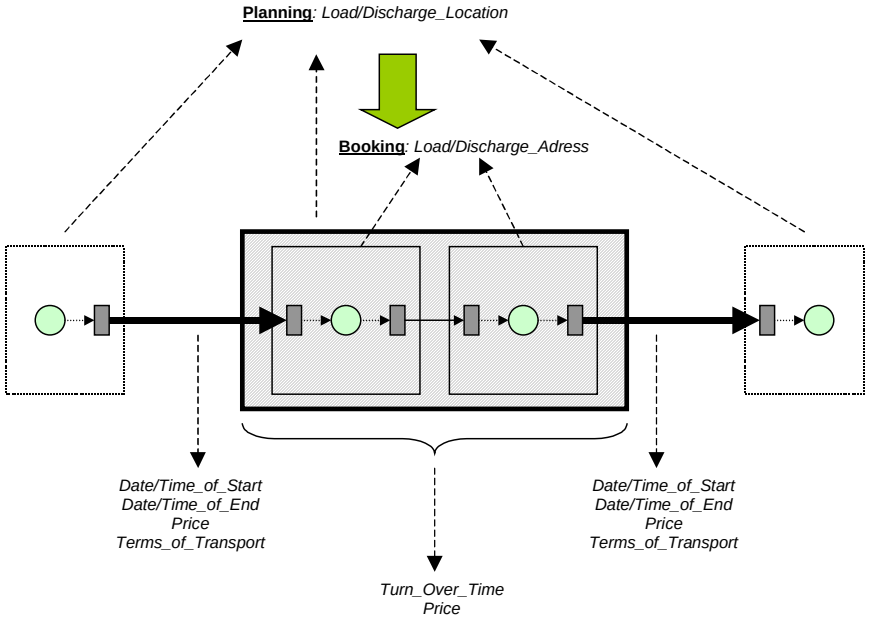


The figure does not show all possibilities but at least you get an idea of the way these possibilities result from constructing the symbols in a particular way. For planning purposes a warehouse is but a terminal on which goods are stored for a longer period of time and under certain conditions.

In the operational stage every transport service is characterized by the attributes *Date/Time_of_Start* and *Date/Time_of_End* for time related information and *Load/Discharge_Adress* and *Load/Discharge_Position* for location related information (the 'Position' refers to the exact physical position within the terminal or door 'Adress' where the operation starts or ends). We do use the generic terms 'Start'/'End' in stead of the specific 'Departure'/'Arrival' or 'Load'/'Discharge' in order to use the same mechanism for movement, storage, packing, and repair activities.

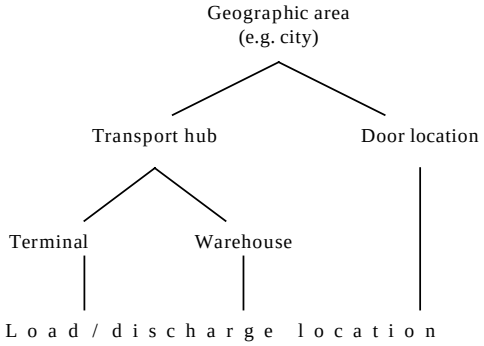


During the pre-contract stage the relevance of these attributes changes because of the fact that load/discharge services and short transport services are scheduled on a very short term basis by the associated operators and not by the intermodal operators organizing the overall transport. Besides the exact positions on the terminals are (manually or automatically) received by the transport equipment drivers once they enter the terminal. This can be visualized as follows:



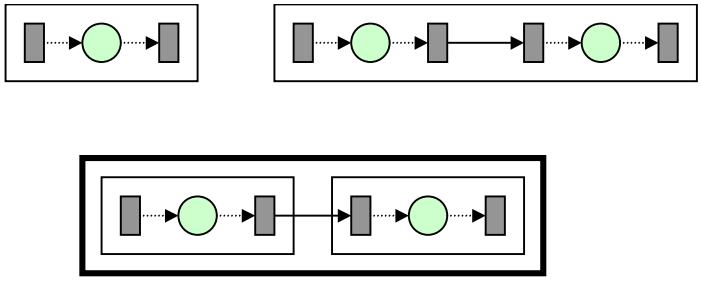
Now we can easily define the concepts as they occur in the semantic framework:

- A node is a particular geographic area, transport hub, terminal, warehouse, door location, or load/discharge lcoation. Terminals and warehouses are located within transport hubs. Load/discharge locations are located within terminals, warehouses, or door locations:

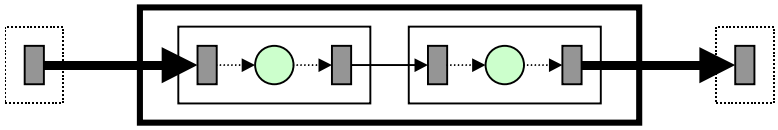


- An elementary transport service is a main transport service directly connecting two load/discharge locations. During the pre-contract stage it is enough to know the node (hub, terminal, door) containing the load/discharge location. A movement services moves the goods between two different nodes. A storage service stores the goods at one node (a warehouse).

- An interface service is a combination of load/discharge services and possibly short transport services taking place at a terminal/warehouse or between terminals/warehouses in the same hub.



- Two elementary transport services an one interface service can be connected in order to construct a composed transport services, and so on.



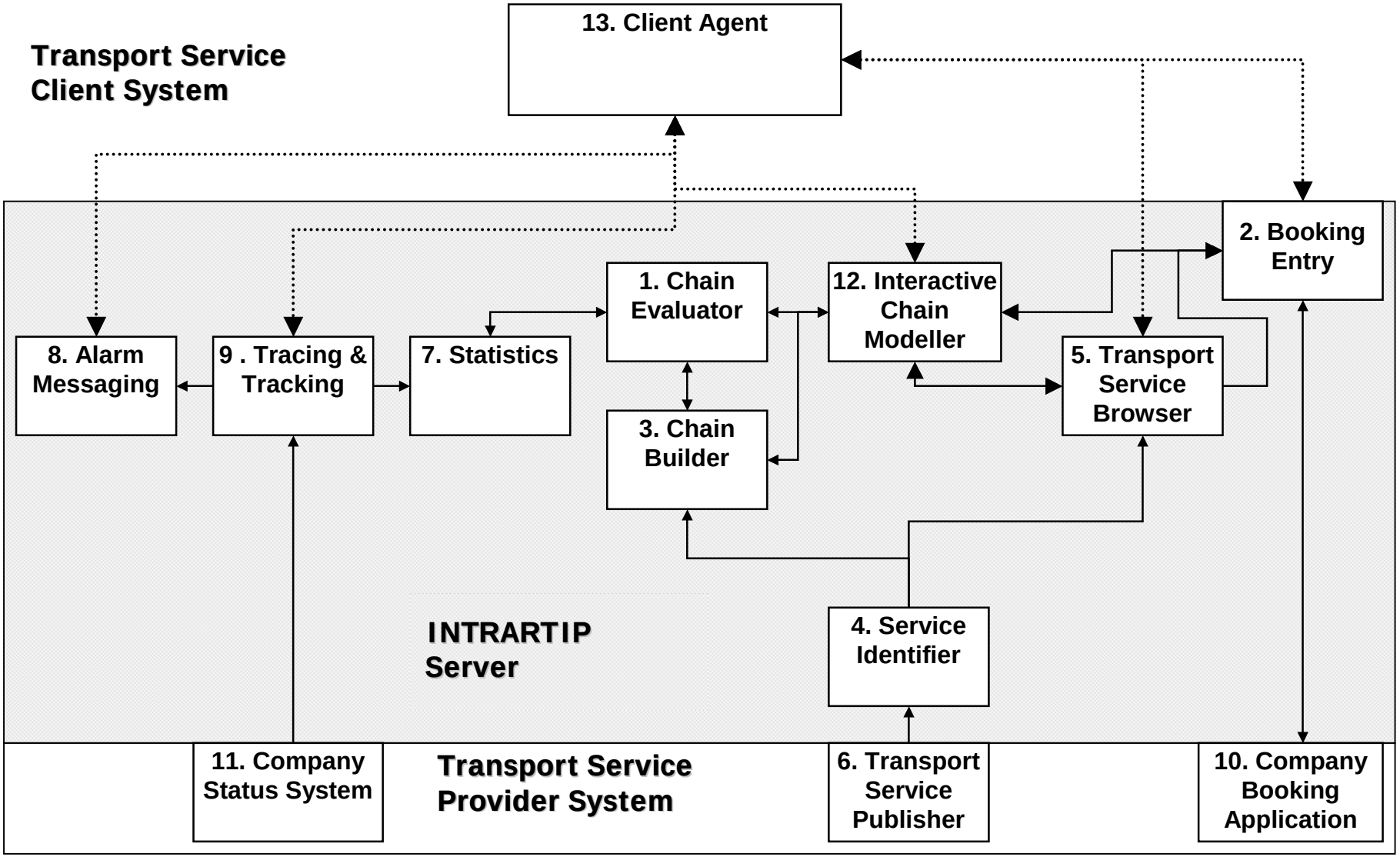
5.3 INTRARTIP SERVICES

From the INTRARTIP Semantic Framework and according to the user requirements, a number of information services have been determined according to user requirements gathering process. The information services meets the demand of services able to make available at the clients information about transport services and their structure, real time knowledge of the transport status and overall statistics on the transport chain. The data model sets up a standardised structure for information exchange between providers and clients. The INTRARTIP platform is therefore composed by these information services:

1 Transport Chain Evaluator
2 Booking and Order Entry Facility
3 Transport Chain Builder
4 Transport Service Identifier
5 Transport Service Browser
6 Transport Service Publisher
7 Transport Statistic Service
8 Transport Alarm Messaging
9 Transport Tracing and Tracking
10 Company Booking Application
11 Company Status Application
12 Transport Interactive Chain Modeller
13 Transport Client Agent

5.3.1 Service Architecture

In the following chart, all the services are depicted with the corresponding interactions.


13. Client Agent
Transport Service Client System
2. Booking Entry
1. Chain Evaluator
12. Interactive Chain Modeller
8. Alarm Messaging
9 . Tracing & Tracking
7. Statistics
5. Transport Service Browser
3. Chain Builder
INTRARTIP Server
4. Service Identifier
11. Company Status System
Transport Service Provider System
6. Transport Service Publisher
10. Company Booking Application

5.3.2 Service Description

5.3.2.1 Generic block presentation

Every block representing a service is presented according to a table. Here below you can find a generic explanation of what is the table composed of.

Block Nbr	Acronym and Name of the Block
General description	Describes the basic function of the service in the system
Semantic Framework	Mentions its position according to the INTRARTIP semantic framework general
Objectives	Explains what is the role of the block within the INTRARTIP System for the final user.
Inputs	Defines the inputs of the block (Origin and nature)
Outputs	Defines the outputs of the block (Destination and nature)
Processing	This part explains how the inputs are transformed in outputs.
Connection	Here are presented the other block with which the block is connected

5.3.2.2 Transport Chain Evaluator

Block Nbr 1	TRE Transport Chain Evaluator
General description	To evaluate a certain transport condition based on statistic (historic) information and current information about transport equipment and transport nodes and infrastructure. Transport conditions describe certain aspects of a transport chain. In that way we are free to manually define a transport condition and thereby define the focus of the evaluation. We could for example only evaluate the firms offering the transport services. Or we could evaluate the quality of direct connections between France and Germany. Evaluation can mainly done in two ways: (i) by chain simulation, and (ii) by chain analysis.
Semantic Framework	Transport Service Use
Objectives	This service is a component of the TRM. According to preference profile , , the system builds a transport chain using the TRB but only restores the time evaluation without any details about the chain parts.

Block Nbr 1	TRE Transport Chain Evaluator
	The TRE is the quality indicator of the transport chain chosen. INTRARTIP is not only a quantitative system (capacity, scheduling) but also a qualitative one with the transport chain evaluator. Because the transport chains chosen are evaluated according to historic information. The transport chain delivered at the end to the transport service client is evaluated and the transport service client can chose in full knowledge of the fact.
Inputs	**Equipment Infrastructure Status (From TTT):** Description of the current status of infrastructure and equipment; these can be represented by: (1) a NODE together with an assessment of that node; (2) a NOMINATED VEHICLE SPACE and an assessment of it, including whether it is delayed on the transport service use it is currently available for and whether this may delay the next uses of transport services it is going to be involved in. **Transport statistics (From TSS):** Description of value of a certain statistic parameter; this can be represented by: (1) a description of the set of situations to which the statistic parameter applies (e.g. represented by a NODE to define all transport service uses that pass through that node, or represented by FIRM to define all transport service uses sold by that firm, or represented by a TRANSPORT SERVICE itself, etc.); (2) a description of the statistics parameter itself (e.g."average delay", etc.); (3) the value of the parameter. **Transport Condition (From TRM):** Description of a specific condition of the chain of transport services built so far and used to comply to the transport service request; this can be represented by a TRANSPORT SERVICE USE referring to a TRANSPORT SERVICE or chain of TRANSPORT SERVICE's and a specific time ("Requested_Date/Time_of_Start") to use it. It is clear that the automatic transport chain builder normally will not evaluate related information like the NODE's to pass through etc.
Outputs	**Transport Statistics Request (To TRB):** Description of a certain statistic parameter for which a value is required; this can be represented by: (1) a description of the set of situations to which the statistic parameter applies (e.g. represented by a NODE to define all transport service uses that pass through that node, or represented by FIRM to define all transport service uses sold by that firm, etc.) (2) a description of the statistics parameter itself (e.g. "average delay", etc.). **Equipment/infrastructure status request (To TTT)**: Request for the current status of infrastructure and equipment; these can be represented by:

Block Nbr 1	TRE Transport Chain Evaluator
	(1) a NODE; (2) a NOMINATED VEHICLE SPACE. **Transport condition evaluation (To TRE):** Description of an evaluation of a specific condition of the chain of transport services built so far; this can be represented by a rating value to be agreed on.
Processing	The TRE tests the value of the transport statistics and of the equipment infrastructure status with the value of the transport condition and the result of those tests are a transport condition evaluation provided to the TRB and to the TRM.
Connection	TSS Transport Statistics Services TTT Transport Tracing and Tracking TRB Transport Chain Builder TRM Transport Interactive Builder

5.3.2.3 Booking and Order entry facility

Block Nbr 2	BOF Booking and Order entry facility
General description	A central booking facility that translates transparently to company specific booking applications; bookings can be cancelled which is a reason to enter the interactive chain modeller again with as argument the currently devised chain in order to change it toward a feasible chain again.
Semantic Framework	Transport Service Use
Objectives	The BOF acts as a converter between the TMA and the CBA. With this block, the INTRARTIP system is able to finalise the pre-contract stage from the transport chain design to the contract finalisation by a booking.
Inputs	**Provisional booking (From TMA):** Description of the provisional booking made by the user; these can be represented by a CONSIGNMENT (together with the GOODS ITEM's, TRANSPORT EQUIPMENT's, SPLIT GOOD PLACEMENT's, and CARGO DESCRIPTION's involved) as well as by the TRANSPORT SERVICE USE that is used to carry it out. It includes the "Requested_Date / Time_of_Start" and "Requested_Date / Time_of_End" attributes that represent the timing requested for the transport service use to be booked. **Firm booking (From TMA):** The booking confirmation contains the same information as the provisional booking but includes more detail. **Booking Confirmation (From CBA):** The booking confirmation contains the same information as the provisional and firm booking but additionally

Block Nbr 2	BOF Booking and Order entry facility
	defines: (1) The VEHICLE SPACE ALLOCATION's that represent the mapping of transport equipment on the vehicle space available in the transport service use booked. (2) The MONETARY AMOUNT's that represent the price to be paid (under which conditions) for the transport service use booked. (3)The "Planned_Date / Time_of_Start" and "Planned_Date /Time_of_End" attributes that represent the timing assigned to the transport service use booked. (4)The "Booking_Reference_Nr" attribute assigned to the booking. **Cancel booking (From CBA)** :The booking confirmation contains the unique identification of the TRANSPORT SERVICE USE that was booked but is being cancelled. This unique identification is determined by the CONTACT INFORMATION (and thereby the FIRM selling the transport service) and the "Booking_Reference_Nr" attribute.
Outputs	**Provisional booking (To CBA):** Description of the provisional booking made by the user; these can be represented by a CONSIGNMENT (together with the GOODS ITEM's, TRANSPORT EQUIPMENT's, SPLIT GOOD PLACEMENT's, and CARGO DESCRIPTION's involved) as well as by the TRANSPORT SERVICE USE that is used to carry it out. It includes the "Requested_Date / Time_of_Start" and "Requested_Date / Time_of_End" attributes that represent the timing requested for the transport service use to be booked. **Firm Booking (To CBA):** The booking confirmation contains the same information as the provisional booking but includes more detail. **Booking Confirmation (To TMA):** The booking confirmation contains the same information as the provisional booking but includes more detail. **Cancel booking (To TMA):**The booking confirmation contains the unique identification of the TRANSPORT SERVICE USE that was booked but is being cancelled. This unique identification is determined by the CONTACT INFORMATION (and thereby the FIRM selling the transport service) and the "Booking_Reference_Nr" attribute.
Processing	The BOF block translates the provisional booking and the firm booking in the proper format for an integration in the CBA. The BOF blocks translates the Booking confirmation and the booking cancellation in the proper format to be displayed in the TMA
Connection	TMA Transport Client Agent CAB Company Booking Application

5.3.2.4 Transport Chain Builder

Block Nbr 3	TRB Transport Chain Builder
General description	Just like the interactive chain modeller can be used to build chains interactively, the chain builder does the same (in so far as possible) automatically. However it is important to stress that the architecture leaves it possible to evaluate, change and extend the found results in an interactive fashion by going back to the interactive modeller again. The builder uses the individual transport services identified by the "Transport service identifier".
Objectives	The TRB is the Block which builds the transport chain from the services proposed by the transport services operator according to the request, the profile and the conditions issued from the other INTRARTIP components.
Semantic Framework	Transport Service Use
Inputs	**Transport Chain Request (From TRM)** (1) Description of the origin and the destination of the transport; these can be represented by a NODE of type TERMINAL or by the address fields of a FIRM in case of a door address. (2) Description of the goods to be transported; these can be represented by several GOODS ITEM's being placed though SPLIT GOODS PLACEMENT's in several TRANSPORT EQUIPMENT's and occurring on a CONSIGNMENT. **Transport Preference Profile (From TRM):** Description of the preferences of the user; these can be represented by (multiple instances of) one or several of the following entities: A FIRM as a preferred supplier of services, a preferred SERVICE CONTRACT, a preferred SERVICE, a preferred SERVICE TYPE, etc. We should be able to express our preference or dislike for every type of information. **Transport condition evaluation (From TRE):** Description of an evaluation of a specific condition of the chain of transport services built so far; this can be represented by a rating value to be agreed on. **Transport Service (From TSI):** Description of a transport service that matches the transport service request; this can be represented by a TRANSPORT SERVICE.
Outputs	**Transport chain (To TRM):** Description of the chain of transport services used to comply to the transport service request; this can be represented by a TRANSPORT SERVICE USE and more specifically by a MOVEMENT or by a COMPOSED TRANSPORT SERVICE USE; the latter describes a chain of MOVEMENT's (and REPAIR's, PACKAGING's, and STORAGE's) linked together with INTERFACE's. **Transport Condition (To TRE):** Description of a specific condition of the chain of transport services built so far and used to comply to the transport service request; this can be represented by a TRANSPORT SERVICE USE

Block Nbr 3	TRB Transport Chain Builder
	referring to a TRANSPORT SERVICE or chain of TRANSPORT SERVICE's and a specific time ("Requested_Date/Time_of_Start") to use it. It is clear that the automatic transport chain builder normally will not evaluate related information like the NODE's to pass through etc. **Transport Service Request (To TSI):** (1) Description of the origin and the destination of the transport; these can be represented by a NODE of type TERMINAL or by the address fields of a FIRM in case of a door address. (2) Description of the goods to be transported; these can be represented by several GOODS ITEM's being placed though SPLIT GOODS PLACEMENT's in several TRANSPORT EQUIPMENT's and occurring on a CONSIGNMENT.
Processing	The TRB is block has two main functions: ▪ Building requests from entered data ▪ Testing values from request **Building request function:** The TRB merges the values of the transport preference profile and of the transport chain designs to build a transport service request and a transport condition request. **Testing results from request:** The TRB tests the value of the transport service and of the transport condition evaluations with the values of the transport service request. The results of this test is the transport chain provided to TRM.
Connection	TRE Transport Chain Evaluator TSI Transport Service Identifier TRM Transport Interactive Chain Modeller

5.3.2.5 Transport Service Identifier

Block Nbr 4	TSI Transport Service Identifier
General description	Provides an insight in the individual services available; based on two possible principles: (i) the constant crawling of the web for XML files with predefined and structured content, or (ii) the construction of a central database that is fed by messages as soon as there is a change in the services offered.
Semantic Framework	Transport Service

Block Nbr 4	TSI Transport Service Identifier
Objectives	*Create an intermediary level between the database and processors. This structure allows the information provider to propose two main types of answers (specific or generic) from a single database structure .*
Inputs	**Transport service specification (from D1):** Description of a set of transport service that are offered by an operator; this can be represented by a set of TRANSPORT SERVICE's (offered by a FIRM). **Transport Service Request (From TRB):** (1) Description of the origin and the destination of the transport; these can be represented by a NODE of type TERMINAL or by the address fields of a FIRM in case of a door address. (2) Description of the goods to be transported; these can be represented by several GOODS ITEM's being placed though SPLIT GOODS PLACEMENT's in several TRANSPORT EQUIPMENT's and occurring on a CONSIGNMENT. **Transport service class (From TSB):** (1) Description of the search profile of the user; these can be represented by (multiple instances of) one or several of the following entities that limit the search space to transport services (or other, see below) provided by a FIRM, according to a SERVICE CONTRACT, of a certain SERVICE TYPE, from and/or to a specific NODE, having vehicle space of a certain VEHICLE SPACE TYPE, indirectly being able to carry a certain TRANSPORT EQUIPMENT TYPE and goods of a certain COMMODITY CLASS and/or DG CLASS, etc. We should be able to limit the search space to transport services (not) related to this class description. (2) We also have to indicate what kind of information we are searching for: In this case we want to select a group of transport services.
Outputs	**Transport Service (To TRB):** Description of a transport service that matches the transport service request; this can be represented by a TRANSPORT SERVICE. **Transport Service Group (To TSB)**: Description of the group of transport services searched by the browser; these can be represented by a set of TRANSPORT SERVICE's.
Processing	The TSI tests the transport service request and the transport class values with the transport specifications extract from the database. The results of the tests is a transport service sent to the TRB and a transport service group to the TSB.
Connection	D1 Transport service specification Database TRB Transport Chain Builder TSB Transport Service Browser

5.3.2.6 Transport Service Browser

Block Nbr 5	TSB Transport Service Browser
General description	A transport service class may entail transport services but also firms, terminals (or other nodes) involved in transport services. Based on such a class definition one can browse through a list of services found. The browser uses the individual transport services identified by the "Transport service identifier".
Semantic Framework	Transport Service Use
Objectives	The TSB provides to the transport service client a transport service group. This transport service group is a set of transport services matching the transport service class criteria that the transport service client can refine by browsing along to the services selected. The TSB has to be considered as a customise option to build a transport chain from a transport service group.
Inputs	**Client Chain Design (From TMA):** Description of the design of a chain of standardised transport services that can be used to comply to transport service request that may occur regularly; this can be represented by a COMPOSED TRANSPORT SERVICE; this describes a chain of MOVEMENT SERVICE's (and REPAIR SERVICE's, PACKAGING SERVICE's, and STORAGE SERVICE's) linked together with INTERFACE SERVICE's. **Transport Preference Profile (From TMA):** Description of the preferences of the user; these can be represented by (multiple instances of) one or several of the following entities: A FIRM as a preferred supplier of services, a preferred SERVICE CONTRACT, a preferred SERVICE, a preferred SERVICE TYPE, etc. We should be able to express our preference or dislike for every type of information. **Transport service class (From TMA):** (1) Description of the search profile of the user; these can be represented by (multiple instances of) one or several of the following entities that limit the search space to transport services (or other, see below) provided by a FIRM, according to a SERVICE CONTRACT, of a certain SERVICE TYPE, from and/or to a specific NODE, having vehicle space of a certain VEHICLE SPACE TYPE, indirectly being able to carry a certain TRANSPORT EQUIPMENT TYPE and goods of a certain COMMODITY CLASS and/or DG CLASS, etc. We should be able to limit the search space to transport services (not) related to this class description. (2) We also have to indicate what kind of information we are searching for: In this case we want to select a group of transport services.
Outputs	**Transport service class (To TSI):**

Block Nbr 5	TSB Transport Service Browser
	(1) Description of the search profile of the user; these can be represented by (multiple instances of) one or several of the following entities that limit the search space to transport services (or other, see below) provided by a FIRM, according to a SERVICE CONTRACT, of a certain SERVICE TYPE, from and/or to a specific NODE, having vehicle space of a certain VEHICLE SPACE TYPE, indirectly being able to carry a certain TRANSPORT EQUIPMENT TYPE and goods of a certain COMMODITY CLASS and/or DG CLASS, etc. We should be able to limit the search space to transport services (not) related to this class description. (2) We also have to indicate what kind of information we are searching for: In this case we want to select a group of transport services. Transport Service Group (To TRM and TSI): Description of the group of transport services searched by the browser; these can be represented by a set of TRANSPORT SERVICE's.
Processing	The TSB block has two main functions: ▪ Building requests from entered data ▪ Testing values from request **Building request function:** The TSB merges the values of the transport preference profile, (of the transport service class) , of the transport chain designs to build a transport class request. **Testing results from request:** The TSB tests the value of the transport service group with the values of the transport service class and the transport preference profile. The results of this test is the transport service group provided to TRM.
Connection	TMA Transport Client Agent TSI Transport Service Identifier TRM Transport Interactive Chain Modeller

5.3.2.7 Transport Service Publisher

Block Nbr 6	TSP transport Service Publisher
General description	An application used by a transport service provider in order to publish his services in a format agreed to be acceptable by the "Transport service identifier".
Semantic Framework	Transport Service Use
Objectives	This application is dedicated to the transport service operators to publish their transport offer towards a huge population of potential users by only

	entering once their service specifications in the INTRARTIP system. This application generates an xml files which up-dates the service data-base.
Inputs	**Transport services specifications(From Transport Service Operator):** Description of a set of transport service that are offered by an operator; this can be represented by a set of TRANSPORT SERVICE's (offered by a FIRM).
Outputs	**XML file (To D1):** Description of a set of transport service that are offered by an operator organized according to a defined format to be integrated in the Transport Service Specifications Database.
Processing	The TSB converts the data provided by the transport service operators into an XML files whose DTD (Data Type Document) has been defined according to the new semantic framework.
Connection	D1: Transport Service Specifications Database

5.3.2.8 Transport Statistics Service

Block Nbr 7	TSS Transport Statistics Service
General description	To provide specific statistic parameters on request; based on historical data provided by the "Transport tracing & tracking".
Semantic Framework	Transport Service Use
Objectives	In the pre contract stage, these statistics on activities of transport operators may be determinant for the choice of the chain. They can be an important component of the trust that a user can put in an transport operator. *On an other hand, this service can be useful, during or after the transport stage, to compare results of past shipments.*
Inputs	**Transport Statistics Request (From TSC):** Description of a certain statistic parameter for which a value is required; this can be represented by: (1) a description of the set of situations to which the statistic parameter applies (e.g. represented by a NODE to define all transport service uses that pass through that node, or represented by FIRM to define all transport service uses sold by that firm, etc.) (2) a description of the statistics parameter itself (e.g."average delay", etc.). **Historic tracking/tracing information (From TTT):** Overview of the progress of past transport services uses; this can be represented by a list of PROGRESS MARKER's and the “Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers passed; it is important to add information on the NODE's, FIRM's, TRANSPORT SERVICE's, etc. involved.
Outputs	**Transport statistics (To TRE and TSC):** Description of value of a certain

Block Nbr 7	TSS Transport Statistics Service
	statistic parameter; this can be represented by: (1) a description of the set of situations to which the statistic parameter applies (e.g. represented by a NODE to define all transport service uses that pass through that node, or represented by FIRM to define all transport service uses sold by that firm, or represented by a TRANSPORT SERVICE itself, etc.); (2) a description of the statistics parameter itself (e.g. "average delay", etc.); (3) the value of the parameter.
Processing	The TSS tests the transport Statistics request value with the historic tracking tracing information and provides the transport statistics to the TRE and the Transport service client.
Connection	TTT Transport Tracing & Tracking TRE Transport Chain Evaluator

5.3.2.9 Transport Alarm Messaging

Block Nbr 8	TAM transport alarm messaging
General description	To generate alarm messages regarding a specific shipment according to a profile defined by a user; based on status information retrieved form "Transport tracing & tracking".
Semantic Framework	Transport Service Use
Objectives	*Within the pre contract stage, the aim is to define partners and operators in order to build the more appropriate chain both in terms of time or costs.* *In this way, any information suppose to change the execution of the transport chain is immediately available for the user in order to allow him to react and if it is necessary to modify items of the transport chain.*
Inputs	**Shipment (from TMA):** Description of the CONSIGNMENT that has to be checked in order to provide for automatic messaging. **Shipment status (from TTT):** Indication of the progress of a CONSIGNMENT; this can be represented by a list of PROGRESS MARKER's and : (1) the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers already passed; (2) the "Estimated_Date/Time_of_Progress" of the STATUS'es referring to progress markers not yet passed. **Alarm message profile (from TMA):** Description of the situations when an alarm message has to be generated; this can be represented by a list of

Block Nbr 8	TAM transport alarm messaging
	PROGRESS MARKER's and the maximum allowed difference between the "Estimated_Date/Time_of_Progress" and "Actual_Date/Time_of_Progress" of the STATUS'es referring to these progress markers for a specific CONSIGNMENT.
Outputs	**Shipment (To TTT):** Description of the CONSIGNMENT that has to be checked in order to provide for automatic messaging. **Shipment alarm message (To TMA):** Indication of a situation where for a specific PROGRESS MARKER the maximum allowed difference between the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS referring to this progress marker for a specific CONSIGNMENT has been exceeded and in what amount.
Processing	Comparison of shipment status value (from TTT) related to a determined shipment (from TMA and to TTT) with the alarm message profile (from TMA) related to this shipment. If the test of shipment status value with the shipment alarm profile is positive, then a shipment alarm message is sent to TMA.
Connection	TMA (Transport Client Agent) TTT (Transport Tracing & Tracking)

5.3.2.10 Transport Tracking and Tracing

Block Nbr 9	TTT Transport Tracking and Tracing
General description	To provide status information on request regarding a specific shipment; to provide status information on equipment and infrastructure; provide historic data gathered in the past; based on information retrieved from company specific applications.
Semantic Framework	Transport Service Use
Objectives	This service is not exactly in the INTRARTIP scope but it seems very interesting for users that the follow up of their shipment could be available in the same system. *According to the users requirements, the tracking or tracing possibility that an transport service operator could offer, would be an important factor of choice!*
Inputs	**Shipment (From TMA):** Description of the CONSIGNMENT that has to be checked in order to provide for automatic messaging. **Shipment status (From CSA):** Indication of the progress of a CONSIGNMENT; this can be represented by a list of PROGRESS MARKER's and

Block Nbr 9	TTT Transport Tracking and Tracing
	(1) the "Estimated_Date / Time_of_Progress" and Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers already passed; (2) the "Estimated_Date/Time_of_Progress" of the STATUS'es referring to progress markers not yet passed. **Equipment/infrastructure status request (From TRE):** Request for the current status of infrastructure and equipment; these can be represented by: (1) a NODE; (2) a NOMINATED VEHICLE SPACE.
Outputs	**Shipment (To CSA):** Description of the CONSIGNMENT that has to be checked in order to provide for automatic messaging. **Shipment status (To TAM):** Indication of the progress of a CONSIGNMENT; this can be represented by a list of PROGRESS MARKER's and (1) the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers already passed; (2) the "Estimated_Date/Time_of_Progress" of the STATUS'es referring to progress markers not yet passed. **Historic tracking/tracing information (To TSS):** Overview of the progress of past transport services uses; this can be represented by a list of PROGRESS MARKER's and the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers passed; it is important to add information on the NODE's, FIRM's, TRANSPORT SERVICE's, etc. involved. **Equipment/infrastructure status (To:TRE)** Description of the current status of infrastructure and equipment; these can be represented by: (1) a NODE together with an assessment of that node; (2) a NOMINATED VEHICLE SPACE and an assessment of it, including whether it is delayed on the transport service use it is currently available for and whether this may delay the next uses of transport services it is going to be involved in.
Processing	The TTT tests the shipment request value with the one received from the CSA and provides a shipment status related to the shipment request. It also provides according to the same way an historic tracking / tracing information to the TSS. The TTT tests also the equipment/ infrastructure request from TRE with the Shipment Status from the CSA.

Block Nbr 9	TTT Transport Tracking and Tracing
Connection	TAM Transport Alarm Messaging TMA Transport Client Agent TSS Transport Statistics Service TRE Transport Chain Evaluator CSA Company Status application

5.3.2.11 Company Booking Application

Block Nbr 10	Company Booking Application
General description	The effect on available transport capacities should be taken into account when a booking is made.
Semantic Framework	Transport Service Use
Objectives	This block connects the INTRARTIP system and the transport service operator booking applications.
Inputs	**Provisional Booking (From BOF):** Description of the provisional booking made by the use can be represented by a CONSIGNMENT (together with the GOODS ITEM's, TRANSPORT EQUIPMENT's, SPLIT GOOD PLACEMENT's, and CARGO DESCRIPTION's involved) as well as by the TRANSPORT SERVICE USE that is used to carry it out. It includes the "Requested_Date /Time_of_Start" and "Requested_Date / Time_of_End" attributes that represent the timing requested for the transport service use to be booked. **The booking Confirmation (From BOF):** the booking confirmation contains the same information as the provisional booking but includes more detail.
Outputs	**The booking Confirmation (To BOF):** the booking confirmation contains the same information as the provisional booking but includes more detail. **Cancel booking (To BOF):**The booking confirmation contains the unique identification of the TRANSPORT SERVICE USE that was booked but is being cancelled. This unique identification is determined by the CONTACT INFORMATION (and thereby the FIRM selling the transport service) and the "Booking_Reference_Nr" attribute.
Processing	The CBA integrates the provisional booking and the firm booking translated by the BOF. The values of those two requests are testes in the CBA and if the test is positive, the result is a booking confirmation and if the test is negative the result is a booking cancellation.

Block Nbr 10	Company Booking Application
Connection	BOF Booking and Order entry Facility

5.3.2.12 Company Status application

Block Nbr 11	Company Status Application
General description	To provide company specific status information on request regarding a specific shipment.
Semantic Framework	Transport Service Use
Objectives	This block connects the INTRARTIP system and the transport service operator status applications.
Inputs	**Shipment (From TTT and CSA):** Description of the CONSIGNMENT that has to be checked in order to provide for automatic messaging.
Outputs	**Shipment status (To TTT and CSA):** Indication of the progress of a CONSIGNMENT; this can be represented by a list of PROGRESS MARKER's and : (1) the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers already passed; (2) the "Estimated_Date/Time_of_Progress" of the STATUS'es referring to progress markers not yet passed.
Processing	The CSA tests the shipment value from TTT with the one coming from the transport service operator and sends as a results the shipment status related to the shipment coming from the transport service operator.
Connection	TTT Transport Tracing and Tracking CBA Company Booking Application

5.3.2.13 Transport Interactive Chain Modeller

Block Nbr 12	TRM Transport Interactive Chain Modeller
General description	To provide the user with an easy-to-use interface to construct a transport solution in order to match a specific transport service request; the result of this construction process is a transport chain encompassing all possible services; an existing transport chain can be modified when there is a problem or a possible optimisation; the preference profile should limit the

Block Nbr 12	TRM Transport Interactive Chain Modeller
	search space with respect to customer specific preferences; segments of the transport chain may be constructed automatically based on input from the "Transport chain builder"; such results may further be altered or extended by interactively looking for transport services with the "Transport services browser"; meanwhile one can always evaluate the chain built so far through the "Transport chain evaluator" that evaluates a certain characteristic of the chain.
Semantic Framework	Transport Service Type
Objectives	In front of the multitude of transport services operators, sometimes users (shippers or forwarders) get some trouble to find the best transport solution in a short time. The transport chain modeller provides the user, according to preference profile definition, a simulation and estimation of his transport chain taking in charge the exhaustiveness of transport services offered.
Inputs	**Transport Statistics Request (From TMA):** Description of a certain statistic parameter for which a value is required; this can be represented by: (1) a description of the set of situations to which the statistic parameter applies (e.g. represented by a NODE to define all transport service uses that pass through that node, or represented by FIRM to define all transport service uses sold by that firm, etc.) (2) a description of the statistics parameter itself (e.g. "average delay", etc.). **Transport chain (From TRB):** Description of the chain of transport services used to comply to the transport service request; this can be represented by a TRANSPORT SERVICE USE and more specifically by a MOVEMENT or by a COMPOSED TRANSPORT SERVICE USE; the latter describes a chain of MOVEMENT's (and REPAIR's, PACKAGING's, and STORAGE's) linked together with INTERFACE's. **Transport Condition Evaluation (From TRE):** transport condition evaluation: Description of an evaluation of a specific condition of the chain of transport services built so far; this can be represented by a rating value to be agreed on. **Transport Service Group (From TSB):** Description of the group of transport services searched by the browser; these can be represented by a set of TRANSPORT SERVICE's.
Outputs	**Transport Chain (To TMA):** Description of the chain of transport services established thus far to comply to the transport service request and in need for adjustment; this can be represented by a TRANSPORT SERVICE USE and more specifically by a MOVEMENT or by a COMPOSED TRANSPORT SERVICE USE; the latter describes a chain of MOVEMENT's (and REPAIR's, PACKAGING's, and STORAGE's) linked together with INTERFACE's. **Transport Condition (To TRE) :** Description of a specific condition of the chain of transport services built so far and used to comply to the transport

Block Nbr 12	TRM Transport Interactive Chain Modeller
	service request; this can be represented by one of the following information: (1) a TRANSPORT SERVICE USE referring to a TRANSPORT SERVICE or chain of TRANSPORT SERVICE's and a specific time ("Requested_Date/Time_of_Start") to use it. (2) one of its components if we are dealing with a COMPOSED TRANSPORT SERVICE USE; (3) related information like one of the NODE's to pass through, one of the FIRM's supplying a service, the TRANSPORT SERVICE TYPE (and its components), the VEHICLE SPACE TYPE of the vehicle where the transport equipment is put in, etc., etc. **Transport Chain Request (To TRB):** (1) Description of the origin and the destination of the transport; these can be represented by a NODE of type TERMINAL or by the address fields of a FIRM in case of a door address. (2) Description of the goods to be transported; these can be represented by several GOODS ITEM's being placed though SPLIT GOODS PLACEMENT's in several TRANSPORT EQUIPMENT's and occurring on a CONSIGNMENT. **Transport Preference Profile (To TRB):** Description of the preferences of the user; these can be represented by (multiple instances of) one or several of the following entities: A FIRM as a preferred supplier of services, a preferred SERVICE CONTRACT, a preferred SERVICE, a preferred SERVICE TYPE, etc. We should be able to express our preference or dislike for every type of information. **Transport Service Class (To TSB):** (1) Description of the search profile of the user; these can be represented by (multiple instances of) one or several of the following entities that limit the search space to transport services (or other, see below) provided by a FIRM, according to a SERVICE CONTRACT, of a certain SERVICE TYPE, from and/or to a specific NODE, having vehicle space of a certain VEHICLE SPACETYPE, indirectly being able to carry a certain TRANSPORT EQUIPMENT TYPE and goods of a certain COMMODITY CLASS and/or DG CLASS, etc. We should be able to limit the search space to transport services (not) related to this class description. (2) We also have to indicate what kind of information we are searching for: In this case we want to select a group of transport services.
Processing	The TRM block has two main functions: ▪ Building requests from entered data ▪ Testing values from inputs **Building request function:**

Block Nbr 12	TRM Transport Interactive Chain Modeller
	The TRM generates a transport condition request (to TRE) and a transport service class request (TSB) by merging the transport preference profile, the transport service request and the Client chain design values. **Testing results from request:** It merges the transport chain values, the transport service group values and the transport condition evaluation to provide the transport chain to the TMA.
Connection	TMA Transport Client Agent TRE Transport Chain Evaluator TSB Transport Service Browser TRB Transport Chain Builder

5.3.2.14 Transport Client Agent

Block Nbr 13	T.M.A. Transport client agent
General description	A transport service request is stored by the user and followed by calling the interactive route modeller. After developing a transport chain the associated individual transport services are booked. Alarm messages and tracking results for individual shipments may result in an internal alarm status for the transport scenario as a whole and may be a reason for corrective actions.
Semantic Framework	Transport Service Type
Objectives	This service directly focused on the Transport Service client needs because from the transport service request all the other transport requirements types are defined as the transport preference, the transport profile. Those parameters are transmitted to the proper components. This service comprises also a display function in order to aware the transport service client in case of transport perturbation or to inform him about the shipment evolution.
Inputs	**Shipment alarm message (From TAM):** Indication of a situation where for a specific PROGRESS MARKER the maximum allowed difference between the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS referring to this progress marker for a specific CONSIGNMENT has been exceeded and in what amount. **Shipment status (From TTT) :** Indication of the progress of a CONSIGNMENT; this can be represented by a list of PROGRESS MARKER's and (1) the "Estimated_Date / Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to progress markers

Block Nbr 13	T.M.A. Transport client agent
	already passed; (2) the "Estimated_Date/Time_of_Progress" of the STATUS'es referring to progress markers not yet passed. **Transport Chain / Client Chain Design (From TRM):** Description of the chain of transport services established thus far to comply to the transport service request and in need for adjustment; this can be represented by a TRANSPORT SERVICE USE and more specifically by a MOVEMENT or by a COMPOSED TRANSPORT SERVICE USE; the latter describes a chain of MOVEMENT's (and REPAIR's, PACKAGING's, and STORAGE's) linked together with INTERFACE's service. **Transport Service Group (From TSB):** Description of the group of transport services searched by the browser; these can be represented by a set of TRANSPORT SERVICE's. **Booking Confirmation (From BOF):** The booking confirmation contains the same information as the provisional booking but includes more detail. **Cancel Booking (From BOF):** The booking confirmation contains the unique identification of the TRANSPORT SERVICE USE that was booked but is being cancelled. This unique identification is determined by the CONTACT INFORMATION (and thereby the FIRM selling the transport service) and the "Booking_Reference_Nr" attribute.
Outputs	**Shipment (To TAM, TTT):** Description of the CONSIGNMENT that has to be checked in order to provide for automatic messaging. **Alarm message profile (To TAM):** Description of the situations when an alarm message has to be generated; this can be represented by a list of PROGRESS MARKER's and the maximum allowed difference between the "Estimated_Date/Time_of_Progress" and "Actual_Date / Time_of_Progress" of the STATUS'es referring to these progress markers for a specific CONSIGNMENT. **Transport Chain (To TRM):** Description of the chain of transport services established thus far to comply to the transport service request and in need for adjustment; this can be represented by a TRANSPORT SERVICE USE and more specifically by a MOVEMENT or by a COMPOSED TRANSPORT SERVICE USE; the latter describes a chain of MOVEMENT's (and REPAIR's, PACKAGING's, and STORAGE's) linked together with INTERFACE's services. **Transport service class (To TSB)** (1) Description of the search profile of the user; these can be represented by (multiple instances of) one or several of the following entities that limit the search space to transport services (or other, see below) provided by a FIRM, according to a SERVICE CONTRACT, of a certain SERVICE TYPE, from and/or to a specific NODE, having vehicle space of a certain VEHICLE SPACE TYPE, indirectly being able to carry a certain TRANSPORT EQUIPMENT TYPE and goods of a certain COMMODITY CLASS and/or DG CLASS, etc. We should be able to limit the search space to transport

Block Nbr 13	T.M.A. Transport client agent
	services (not) related to this class description. We also have to indicate what kind of information we are searching for: In this case we want to select a group of transport services. **Transport Preference Profile (To TSB and TPP):** Description of the preferences of the user; these can be represented by (multiple instances of) one or several of the following entities: A FIRM as a preferred supplier of services, a preferred SERVICE CONTRACT, a preferred SERVICE, a preferred SERVICE TYPE, etc. We should be able to express our preference or dislike for every type of information. **Client chain designs (to TSB):** Description of the design of a chain of standardised transport services established thus far to comply to transport service request that may occur regularly and in need for adjustment; this can be represented by a COMPOSED TRANSPORT SERVICE; this describes a chain of MOVEMENT SERVICE's (and REPAIR SERVICE's, PACKAGING SERVICE's, and STORAGE SERVICE's) linked together with INTERFACE SERVICE's. **Provisional booking (To BOF):** Description of the provisional booking made by the user; these can be represented by a CONSIGNMENT (together with the GOODS ITEM's, TRANSPORT EQUIPMENT's, SPLIT GOOD PLACEMENT's, and CARGO DESCRIPTION's involved) as well as by the TRANSPORT SERVICE USE that is used to carry it out. It includes the "Requested_Date / Time_of_Start" and "Requested_Date / Time_of_End" attributes that represent the timing requested for the transport service use to be booked. **Firm booking (To BOF):** The booking confirmation contains the same information as the provisional booking but includes more detail.
Processing	The TRM block has two main functions: ▪ Building requests from entered data ▪ Testing values from inputs **<u>Building request function:</u>** The TMA builds shipment requests, alarm message profile, transport service request, transport preference profile, transport chain from entered data by the Transport Service Client. **<u>Displays values from outputs:</u>** The TMA displays the elements received by the other blocks. those elements are the shipment alarm message (From TAM), the shipment status (From TTT), the transport chain (From TRM), the transport service group (From TSB), the booking confirmation and the booking cancellation (From BOF).
Connection	TAM Transport Alarm Messaging TTT Transport Tracing Tracking

Block Nbr 13	T.M.A. Transport client agent
	TSS Transport Statistics Service TRM Interactive Chain Modeller TSB Transport Service Browser BOF Booking and Order Facility

5.4 SYSTEM ARCHITECTURE

The INTRARTIP platform intends to create an open, globally accessible and comprehensive set of information services able to support the pre-contract stage of the intermodal transport. The pre-contract stage information services provide market information useful for organising the delivery of cargo and for settling trade agreements and contracts, including infrastructures, transport services available, as well as information related to the usage of these services: routes, conditions, facilities, timetables, tariffs, reliability of delivery, etc.

These services lead to a platform based on an information network where a number of nodes act as Information Providers (IP) or Information Clients (IC); these nodes are inter-connected by a communication network that relies on the Internet support for the basis communication features.

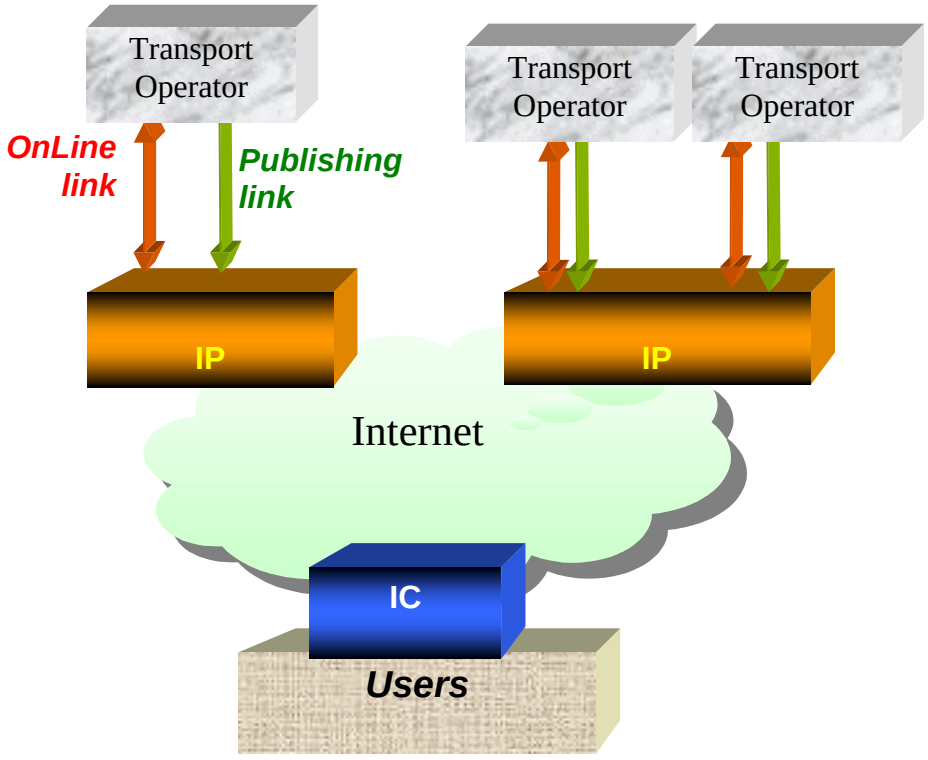


Figure 5-1: Overall architecture

- Information Providers
  They are interfaces to existing legacy systems operated by the intermodal transport operators: they provide information used for evaluating the services requested. This information, whenever available, is extracted by using specific *OnLine Links,* which translate common data access requests coming from Information Clients according to the information system specific interface. These *OnLine Links* are downloaded through the network to Information Clients so that they can access information and submit requests typically for booking, ordering tracing and tracking. Available services provided by the transport operators are published over the network by mean of specific *Publishing Links* which state a standard specification format for transport services. The system includes many IP's each of them interconnects one or more operators by mean of a customised interface. Different operators can be grouped together either by their service type or geographical position.

- Information Clients
  They are also computing systems, which are, however, operated by clients of the intermodal transport providers. These can be export and import companies or intermodal transport providers, which take advantage of services provided by other transport operators for providing their own services. Information Clients execute application packages, within an environment, the Transport Client Agent, accessing the Information Providers systems through a higher level functionality. The clients can download such software components on demand and start to use them immediately. This is aimed to enormously simplifying the access to the information network above all for small and medium enterprises.

Such a combination of clients and server of information means to establish a global repository for standardised transport specifications and common way for using them. For example, a client may construct its own intermodal composed service choosing single transport services form the repository; then he is able to value the chain making every single service operative by a direct communication with the information system of the involved operators.

This mechanism is really transparent both from the point of view of the final users and the provider:

- the repository filled by Publishing Links is a standard description of different kind of services that free the client to face with different ways to describe supplied services.
- The OnLine Link set up a communication with different information systems without they have the need to know the reason why the user is requiring the service, or which is the chain they are participating to.

The Figure 5-1 depicts a schema of the overall architecture:

- Information providers stand on the upper side and they can play three different roles connecting to the system:
  - they can publish their available transport services accessing the system through the Publishing Link,
  - or they can accept and confirm booking requests from the system through an OnLine link.

- The same type of OnLine Link can also be used for establish a permanent connection bringing up the needed features to supply a real time service for tracing and tracking.

- Information clients standing at the lower side, use the services included in the Transport Client Agent that is formed by a set of single component each of them devoted to a specific service.
- The true INTRARTIP platform consists of an HTTPS server demanding the user requests to the server components: Search Engine, Chain Builder, Booking Server, Tracing Server, Alarm Server, Statistic Server and Chain Evaluator.

The Table 5-1 shows how the components of the INTRARTIP Architecture cover the services devised in the Service Specification. The requested services are listed in rows, while the components of are grouped in columns according to their position inside the architecture; a different background colour makes this gathering clear. Cells with solid background tell us that the service in the row is performed by the component at the columns. For example, the service “Booking and Order Facility Entry” is implemented by two components: the Booking and Order entry and the Booking Server. Form this table it is also obvious how the Transport Client Agent involves all the client side components, while on-line Links are in charge of managing the booking, statistics, tracing and tracking.

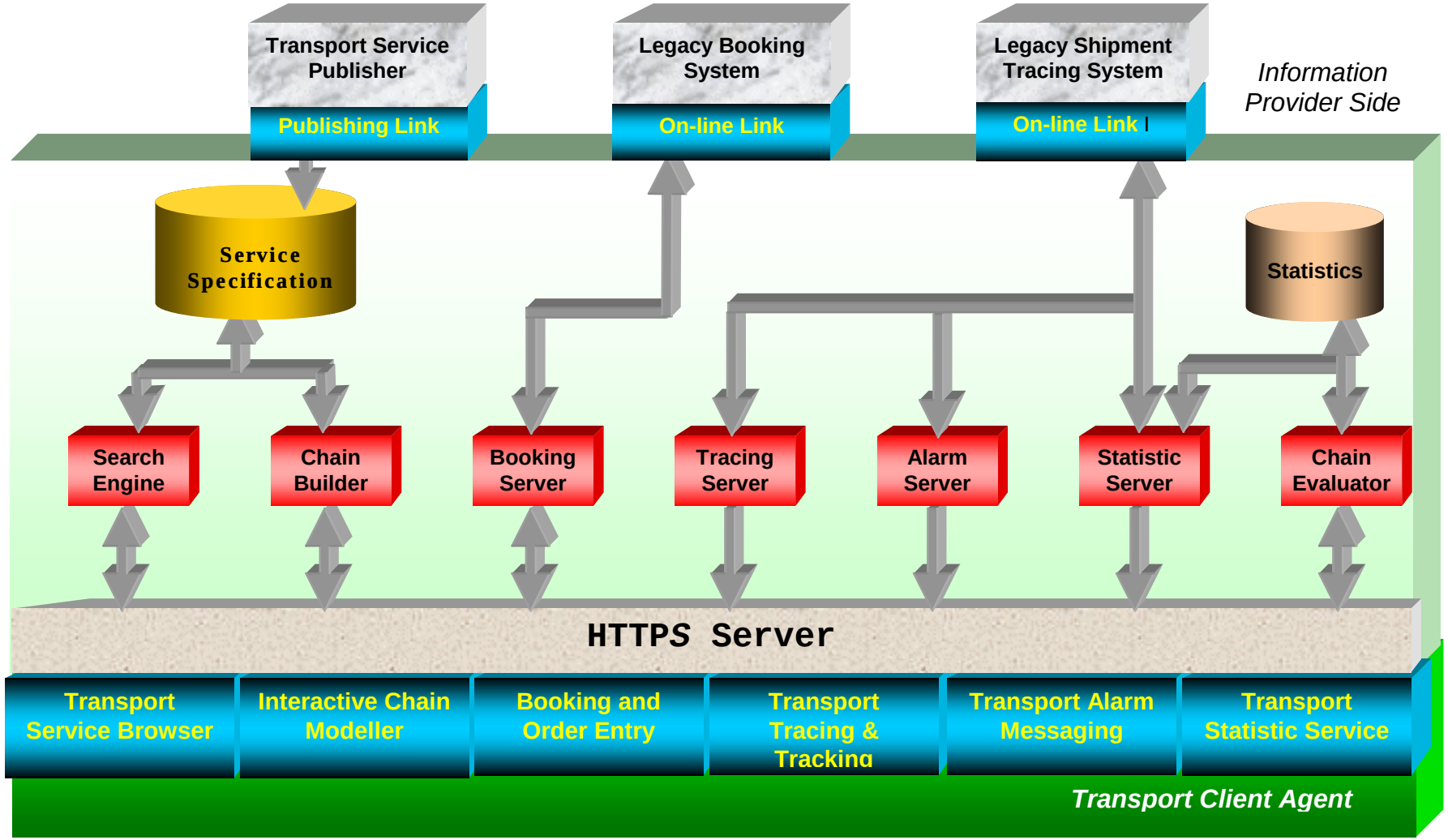


Figure 5-2 : Detailed architecture

	Client side						Provider Side		Platform						
Components of the architecture / Identified Services	Transport Service Browser	Interactive Chain Modeller	Booking and Order Entry	Transport Tracing & Tracking	Transport Alarm Messaging	Transport Statistic Service	Publishing Link	OnLine Link	Search engine	Chain Builder	Booking Server	Tracing Server	Alarm Server	Statistic Server	Chain Evaluator
01 – Transport Chain Evaluator															■
02 – Booking and Order Facility Entry			■								■				
03 – Transport Chain Builder										■					
04 – Transport Service Identifier									■						
05 - Transport Service Browser	■														
06 – Transport Service Publisher							■								
07 – Transport Statistic Service						■		■						■	
08 – Transport Alarm Messaging					■								■		
09 – Transport Tracing and Tracking				■								■			
10 - Company Booking Application								■			■				
11 - Company Status Application								■							
12 – Transport Chain Interactive Modeller		■													
13 – Transport Client Agent	■	■	■	■	■	■									

Table 5-1 Service -System Components Mapping

The architecture includes a communications layer between information provider and information client. Available services to the client are grouped into an environment named Transport Client Agent (TCA) that is in charge of manage the communication features like web browsing, security, user authentication and so on. Each single service works as a “pluggable” component of this framework.

On the other side, the INTRARTIP architecture has three interfaces to the Information Providers establishing the two kind of links on-line link and publishing link.

Inside the system, the provided services are implemented by mean of the main servers: the Repository Server, the Booking Server and the Messaging Server. These servers co-operate with a standard HTTP server that interfaces the Transport Client Agent supplying a standard web environment. All the collected specifications about transport services are stored into a Service Specification Repository.

5.4.1 Links with legacy systems

The connection between the providers and the INTRARTIP platform relies on two types of link interfaces: publishing link and online link. While the former is a one way connection conveying information into the service specification repository, the latter is a composed framework able to couple up *pluggable* interfaces designed on purpose to meet the demand of the existing system.

5.4.1.1 Publishing Link

Information to be published by the service provider has to be structured according a common agreed schema that is stated inside the INTRARTIP project. This schema guides all providers to supply their information the same way to build a repository with standard representations of the stored services. Operations available to the final user are the followings:

1. Register as new user. The transport operator selects a transport operator type from a list showing supported types by the system and subscribes himself to the service. This way, only known users may access the system sending their descriptions. The user has to activate this process only once to let him known to the system.
2. Download a DTD description: through an easy to use graphic interface, the user is guided to supply interesting features about his services. Depending on the type of service the appropriate template has to be selected from the repository; this kind of template is the DTD itself. The publishing interface sends it to the client application that processes it to set up the graphic layout in which the user can fill in the data.
3. Fill in a description form. Once the DTD has been processed, a graphic interface is available to the user to be filled in with interesting data. By mean of such graphical interface it is possible to obtain help on line information about the meaning of the data to be supplied, restricted values of some fields, fields that are either mandatory or optional and so on.

4. Upload a new service specification. As the description is complete, the user can send it to the repository as an XML file which is well-formed and whose structure is valid against the DTD previously downloaded.
5. Edit an existing service specification. With the same mechanism used for creating new service specification, it is possible retrieve an existing XML file and its corresponding DTD

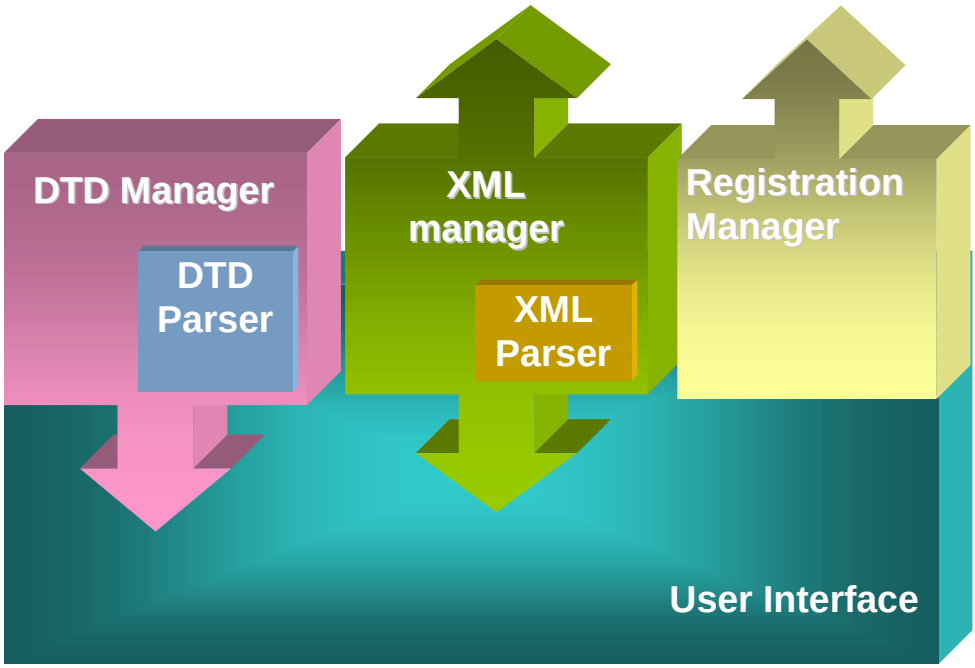


Figure 5-3 : Publishing link architecture

The user interface relies on three components:

- Registration manager that connect the users to the system verifying his identity and providing an account into the repository.
- DTD manager that downloads the concerning DTD making it available to the interface employing a DTD parser. This component supplies a representation in memory of the DTD hiding to the interface the grammar and format details.
- The XML manager contains a XML parser to manipulate XML files establishing a transparent link between the user interface module and the repository. This way, XML documents can be easily managed together with storing/retrieval features.

5.4.1.2 Online Links

The INTRARTIP projects wants to pursue the aim of the integration between existing legacy systems, therefore the system has to provide a set of interfaces with most common information system architecture.

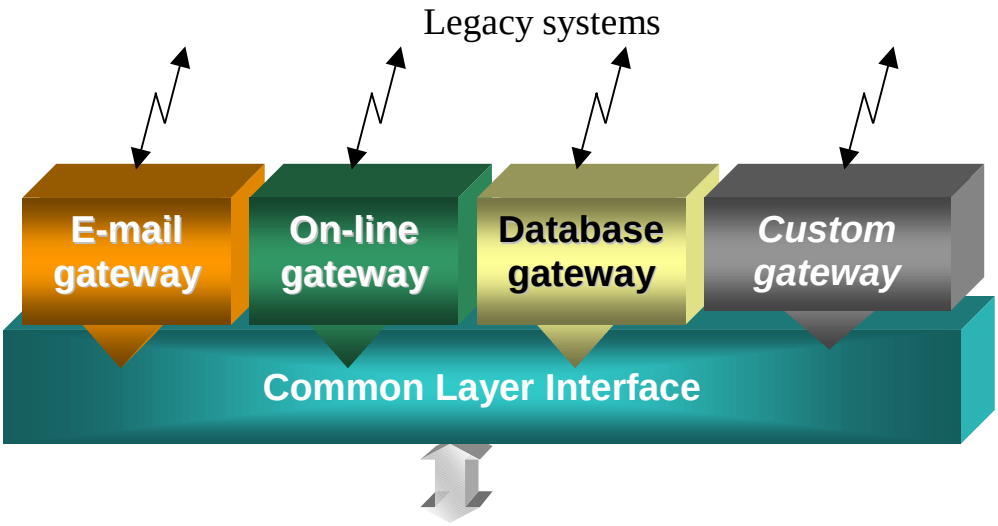


Figure 5-4: Online link architecture.

The Common Layer Interface is standard architecture to access the on-line services on the provider information system. Due to the wide variety of existing systems it is necessary to provide a custom interface that settles a common agreed protocol for each provider. Nevertheless it is possible to think these interfaces as gateway components working inside the layer and group them into three main categories:

- e-mail gateway that uses standard e-mail protocols to set up a communication having a high degree of compatibility with existing system, though this protocol could not be considered as a real on-line link.
- On-line gateway establishes a direct inter-process communication with the information system of the provider. Such a solution needs software developed on purpose and a rigid well-agreed exchange protocol, but has the great advantage to be a real on-line connection between the provider and the INTRARTIP platform.
- A third category employs a connection to the database on the provider information system. This solution can take advantage form standard DBMS, like ODBC protocol, and yields a real time connection able to keep data up to date.
- In case of future need, the common layer framework allows to easily develop new components implementing other kind of protocols.

5.4.2 Information Client Architecture

On the user side, IC interface is a common framework that contains the available services

- Transport Service Browser
- Interactive Chain Modeller

- Booking and Order Entry
- Transport Tracing and Tracking
- Transport Alarm Messaging
- Transport Statistic Service

These components are act as user interfaces working inside a standard Internet browser; that gives the chance to reach a large base of users without deploying heavy software applications on the client platform. On the other hand, security requirements are meet using a secure HTTP protocol connection.

In order to realise a high degree of compatibility with internet browser available on the market, each service can be access through HTML pages whose contents are generated dynamically on the server depending on the user request.

The graphic presentation of the data relies on a smart combination of standard scripting features (like JavaScript) and add-in Java applet, makes it possible to produce pleasant user interface without overloading the local CPU and the network connection with sophisticated plug-in software (like ActiveX component or Java “Swing” graphic interfaces).

Information exchanged between the client and the server follow standard interfaces defined using DTD descriptions: that allows taking advantage of the power of XML structure. XML features are also running on the client side by mean of add-in software like Java applets that provide basic functionality such as data processing, document creation, editing, storing and retrieval.

5.4.3 Information Provider Architecture

Seven main components take part in the platform each of them in charge of serving the corresponding client interface; such components work as background processes with no direct user interface.

From the Information Provider side, the connection with these servers is made by mean the Publishing links and Online links, which encapsulate all needed features regarding the security, authentication, common interface and so on.

The Transport Client Agent is a set of user interfaces widely available all over the world through a standard WEB interface, that is the reason why the servers work together with a HTTPS connection providing secure protocol for data communication. As the user interface is a set of HTML pages, the HTTPS server browses the Service Specification Repository allowing the user to navigate through the available pages. Specific information requests made by the clients are switched to the servers with a well-known mechanism like Java Servlet and the response is sent back to the client in a dynamically generated HTML page.

All the servers manage data exploiting the benefits of XML language. Each document exchange over the network satisfy a specific DTD defined by the standardisation authority in charge of administrate the INTRARTIP platform.

5.4.3.1 Search Engine

The Service Repository Specification organises offered services in a tree structure in which the user can navigate and select the desired services expanding the relevant details. In order to present requested data in a way compatible with the most common platforms, all the information is sent to the client as HTML forms which may encapsulate XML data whose presentation is demanded to the client using pluggable XML translators.

As the catalogue of available services comprises a wide range of type of services, a simple searching mechanism allows the user to filter desired information against simple selection criteria. Such an engine relies on the features of the XML documents stored in the repository and can run queries on data exploiting the tree structure of each registered service provider. The querying mechanism is fulfilled employing a XML query language support inside the search engine.

5.4.3.2 Chain Builder

Besides the usual exploring of tree data structure, the user can finalise his browsing activities in a chain composed by single services selected with the Service Browser. It is also possible to store the created transport chain in the repository editing it later for subsequent updating. Such a chain can also be “fired”, causing a burst of booking requests directly to involved service providers.

The chain builder maintains a working space for each registered user in which it stores currently working chains and provides communication with booking server to start the booking phase.

Like the Service Browser, all the graphic interfaces provided by the Chain Builder is implemented using standard HTML forms and, if necessary, XML data unit packed into HTML forms.

5.4.3.3 Booking Server

This server collects the transport opportunities from the provider through the online link and represents them in a standard format aiming the user to supply only the concerning data by mean of the Booking and Order Entry interface.

The online link interface builds up a uniform representation of the booking interface of each provider and the server manages all needed features: protocol for order acquisition and confirmation, authentication of users, security, digital signature and so on.

When the booking server works together with the chain builder it also supplies transaction features to allow the booking of the whole chain by managing the booking of each single service. This distributed booking follows a two-phase commit algorithm to ensure a correct management of multiple distributed transaction. Figure 5-5 depicts the interaction between the booking server and, for example three different companies that are involved in a booking of a composite transport service:

1. The booking server receives a booking request of a transport service supplied by different operators.
2. Inside the request data, the server can identify which legacy booking systems have to be involved in the operation, and ask them for a provisional booking request waiting for a confirmation. From the point of view of the server all the different kind of legacy are treated the same: customisations are demanded to the OnLine links.
3. Once each provisional request has been confirmed, the server send to each legacy the concerning firm request, that is the real request of transport service, waiting for the confirmations.
4. In case of success of each booking request, the server sends back to the client the confirmation of the whole booking request. In the other cases, an error message will rise up specifying the fail of the operation and the reason why it happened.

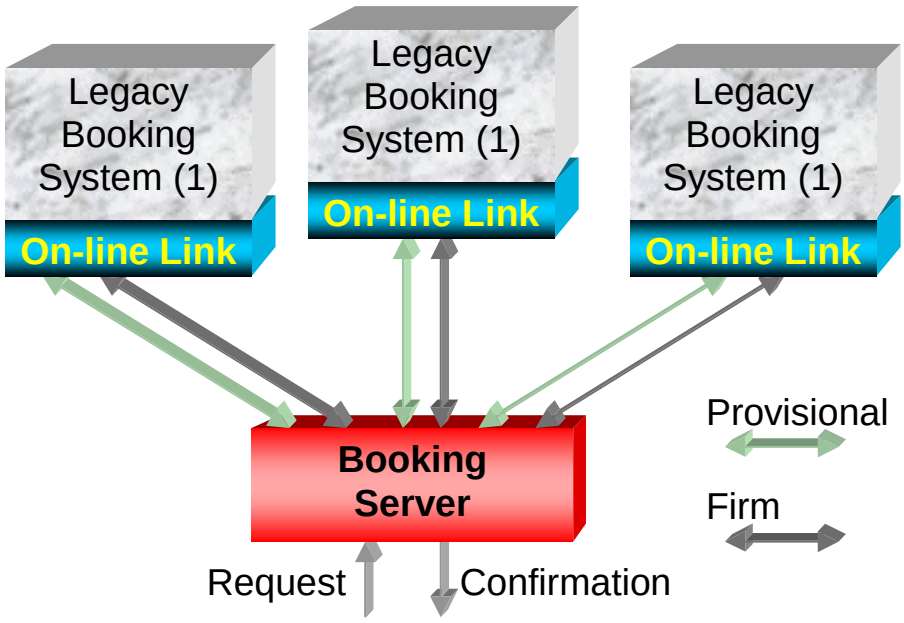


Figure 5-5 : Two phase commit booking

5.4.3.4 Tracing Server

The tracing server exploits the connectivity services of the online link gathering information about the shipment status. The Transport Tracing and Tracking interface, the user can access the system to get relevant data concerning the current shipments, retrieved using the order information as used in the booking phase. The use of an HTTPS protocol together with authentication features guarantees no one other the owner can view restricted data about shipments.

5.4.3.5 Alarm Server

The same way as standard shipment data, also alarm are collected directly form information providers through the usual mechanism involving an online link and an alarm server. In order to facilitate the management of such conditions, the carried out alarms are available to the user through the Transport Alarm Messaging interface that groups them into categories.

5.4.3.6 Statistic Server

As the shipments go on the statistics server gathers reports telling the story of each transport and collects then into a repository of statistics available for further inquiries. The statistic server follows the standard data model stated by the online link, and is able to infer summarising patterns that can represent the value of a transport service.

5.4.3.7 Chain Evaluator

Once the statistics are collapsed into standard descriptions, the chain evaluator produces evaluations of composed transport services; in such way the user can compare different services and check for the quality of a single service.

5.5 PILOT SYSTEMS

5.5.1 Pilots

This chapter contains the Pilot description for the services that have been selected in the INTRARTIP System.

The aim of the INTRARTIP system (Intermodal real time Information platform) is to accelerate the market mechanisms leading to a contract between a transport service client and a transport service operator.

As the modality of issuing a transport contract depends on the market configuration (demand and offer level), the INTRARTIP system will be tested all over Europe according to several possible use scenarios (see section 4.3.2).

Four pilots have been defined, one for each of the country involved in the project. In addition, the pilots are buit around different use scenariors.

Each pilot is defined by:

- The definition of a demonstration scenario ; it will be used to demonstrate and evaluate the system,
- The users involved in the scenario,
- A list of the major components of the system, specifying their characteristics, and a reference to the high level requirements they cover. Functions to be provided, the hardware and software computing platforms, the network interconnections and etc. are also described. IT systems currently operating in the pilot sites are considered to reduce investment as much as possible.

5.5.1.1 Spain Pilot

Valencia Port Community is, and has been for long, interested in the development and application of new Information Technologies. As a guide for a effort, and under the Valencia Port Authority, the “Consejo de Tecnologías de la Información del Puerto de Valencia” (CTTII). CTTII involves the main actors of intermodal transport across and around the Port of Valencia, it represents the initiative of the Port Community on Information Technologies.

The Valencia Port Community is interested on giving a complete multimodal transport service offer through one single media. That media can be an Intranet / Extranet involving Port of Valencia network.

Actually Port of Valencia offers some applications:

- **Compas**: It’s an EDI system for the Shipping Agents to send Cargo manifests to the Port Authority and to the Customs, and for the Customs Agents to send Customs Declarations. It’s post contract work.
- **Vessel Traffic Management**: It’s an EDI and local applications combined system to manage the arrival, berthing, departure, and other operations of the vessels in the Port.
- **Port Consultation**: It’s a BBS system to access get information about the sea transport offer of the Port and about the ships confirmed to arrive to Valencia.

The actual information offer is centred on the transport media and on the post contract stage of the transport. Only the Port Consultation system offers pre-contract information, but only about Maritime Transport and with limited information. A new system offering a complete set of Multimodal Transport offer and goods movement Information and is needed to achieve the next objectives:

- Agility: in the transit of the goods from the origin to the destination.

- Infrastructure Optimisation: as less time the goods are at each node of a Transport Network, more goods can transit that node.
- Efficiency: by decreasing transaction time and transaction costs.
- Competitiveness: if the clients can access to real time information about the transport offer, they can select better the transport and be mote competitive.
- Safety: with the ability to be alarmed in case of perturbation during the transport process.

5.5.1.2 Italian Pilot

Italcontainer currently controls movements for 80% of containers traversing the Italian railway system. It covers all of the Italian destinations while international destinations are reached through Intercontainer, which is laid with the most important European railways. It has 13 agencies spread over the Italian territory: Ancona/Falconara, Bari, Bologna, Genova, Gioia Tauro, La Spezia, Livorno, Napoli, Padova, Roma, Torino, Trieste e Verona.

Italcontainer initially started operations as a railway operator to become an intermodal operator especially in the container field. According to this direction, it entered agreements and established specific companies in order to be able to provide its customers (shipping lines, shippers, forwarders) with global door-to-door services.

In this scenario, the pilot that will be set-up in Italy will be centred on Italcontainer. Its scope is to demonstrate how intermodal transport services could be offered and purchased through the Internet, improving the efficiency of the pre-contract processes and of the post-contract processes as well.

The pilot system will be offering on the Internet the transport services provided by Italcontainer including intermodal services obtained by combining several elementary services offered not only by Italcontainer by also by its sister companies.

5.5.1.3 France Pilot

The Marseilles Port community wants to develop a global information offer to develop its attraction towards potential customers and to strengthen its position towards its concurrents.

The new information offer is made of transport applications set up on the Marseilles Port Authority Intranet. Nowadays, the applications set up on this intranet are exclusively "post contract" with three major applications:

- **Protis:** Protis is a value added telecom system that allows port authority and customs to exchange data and messages confidentially and safely. Protis is hooked up to computers terminals and minitels that most users operate in order to track goods physically, administratively and for customs purposes. Protis is the Port Cargo Community System (PCCS)

- **Escale:** Escale is a computer system for managing vessel calls in port in Marseilles and in Fos and is a network used by agents, refineries, port assistance companies, Port authority operation department. Escale afford a constant and permanent monitoring capability of the Physical, financial, technical and commercial situation of vessels using Marseilles and Fos.
- **Marnet Manifest Information Service:** Marnet Manifest Information Service allows a user to enter manifest information, and generate manifest data in a standard EDIFACT format according to a cheap and easy access thanks to the internet.

The actual information offer is dedicated to the operational aspects of the port activity. Up today, the New Information and Communication Technology have been used to facilitate the operational tasks linked to the physical movement of goods.

A new system available for all Marseilles Port Professionals, allowing them to publish their transport offer or to select a transport chain can increase their competitiveness.

Objectives:

- Efficiency: by decreasing transaction time and transaction costs.
- Reactivity: by a continual up dating of the transport offer and an immediate access to it.
- Reliability: by an evaluation of transport chains (each proposed transport chain is evaluated thanks to statistics received by transport operators).
- Safety: with the ability to be alarmed in case of perturbation during the transport process.
- Dynamism: by enhancing natural market forces.

5.5.1.4 Belgium Pilot

The objective of the pilot is twofold:

- *Semantic framework validation:*
  Validate whether the *data structures* proposed within the semantic framework can be used for the specification of provided transport services (see pilot component “Service specs acquisition”) as well as their use in order to organise door to door transport by building chains from these services (see pilot component “Transport organisation”).
- *Tools validation:*
  Validate whether the *tools* developed for transport service publishing (*service specs acquisition system*), transport service browsing (*service browser system*) and chain modelling (*interactive route builder system*) can be used in practice.

The rationale behind these objectives is determined by the type of actor that Ahlers Maritime Agency is. It is a company involved in organising highly irregular transport scenarios and using a multitude of different transport service providers. As a result:

- Automated booking procedures are very difficult to implement due to the amount of providers that Ahlers works with.
- Improved organisation and use of information (i.e. more effectiveness) during transport scenario design is more important than the efficiency with which to carry out the administrative formalities.

Because Ahlers works with a large group of (different types of) transport providers they provide for a good tested to validate the expressive power of the semantic framework to specify all kinds of transport service and how to build chains from them.

5.5.2 Pilot Architecture

5.5.2.1 Requirements

There are two major requirements for the Pilot Architecture:

- The Pilot Architecture should be compliant with the INTRARTIP System Architecture defined in [A1];
- The Pilot Architecture should include all the services that have been selected for implementation
- The Pilot Architecture should be compliant with the definitions of the pilots agreed with the users.

The first requirement identifies several sub-requirements, which could be grouped in the following classes:

- The technological platform to be used
- The pilot system components to be included
- Interface specifications with external systems

The second requirement, on the contrary, identify the information services or the functions that the Pilot System should support. They are:

- *Transport Service Browser*
  It provides users the capability to search for transport services that satisfy given search criteria.
- *Interactive Chain Modeller*
  It provides users an easy-to-use interface for constructing an intermodal transport service composed of several interconnected transport services. There are basically two modes for combining services into composed services: sequential mode and the parallel mode.

- *Booking Facility*
  It provides users the capability to book and to cancel single mode and intermodal transport services. Transport services to be booked could be entered from scratch, could be the result of a search undertaken using the Transport Service Browser or could be a chain built using the Interactive Chain Modeller.

Finally, the third requirement defines different scenarios where the pilot will be experimented, in addition it adds details on the external systems to be connected and the associated interface requirements.

5.5.2.2 Overall Pilot Architecture

The overall pilot architecture is depicted in Figure 5-6 and it has been designed taking into account the requirements referenced in section 5.5.2.1.

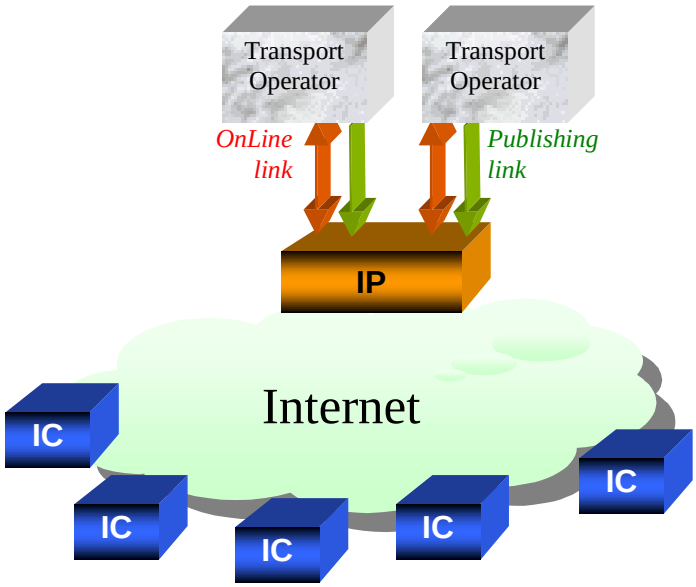


Figure 5-6 - Overall Pilot Architecture

The Pilot System comprises an Information Provider, several Information Clients and a number of Transport Service Providers Legacy Systems. Information Clients communicate with the Information Provider using the Internet; the legacy systems are all connected to the Information Provider and are accessed by the information Provider to reply to Information Clients requests.

The Information Provider is a computer system permanently connected to the Internet that operates as a server system: it receives service requests from Information Clients and returns the corresponding replays. It provides the core functionality of the system:

- It receives from the transport operators the specifications of the offered services: the publishing link is used for this purpose.
- The service specifications are stored internally and are available for search. Searches are submitted by users using Information Clients.
- Service specifications are also searched for building intermodal chains, which are stored for later used inside the information Provider.
- Transport services, either searched in the Information Provider database, either composed using several elementary services, either entered from scratch, can be booked by information Clients. The actual bookings are performed by the information Providers, that, in turn, dispatches booking requests to the Transport Operators Legacy Systems.

Information clients are also computer systems operated by the users of the INTRARTIP system; they are connected to the Internet and a standard Internet browser, such as Netscape Navigator or Internet Explorer, is used to access the services provided by the information Provider.

5.5.2.3 Information Provider architecture

The internal architecture of the Information Provider is show in Figure 5-7. It is basically a simplified version of the Information Provider Architecture as it is defined in the INTRARTIP System Architecture. It is simplified from two points of view:

- It supports only the services that have been selected for implementation
- Interfaces with other information Provider have been removed, as the pilot just includes one information Provider.

The architecture is based on a secure HTTP (named HTTPS Server in Figure 5-7) server, which supports authentication of the Information Provider and Information Clients by means of a key certification mechanism. This is relevant, as booking transactions should guarantee that the involved parties are clearly identified to themselves.

The SSL (Secure Socket Layer) protocol is used for achieving these requirements. SSL has been designed by Netscape Communications and many of the functions provided are part of the newly defined IPv6.

A number of HTML pages are stored in the Information Provider system; using these pages the Information Clients can enter service requests and obtain service replays. Services are actually processed by three application servers: the Search Engine, the Chain Builder and the Booking Server.

Service requests entered by users are sent to the Information Provider by the local Internet browser. They are received by the HTTP server and forwarded to the proper application server for execution.

Service requests directed to the Search Engine and by the Chain Builder are executed locally and replays are sent back by ad-hoc created HTML pages. On the contrary, services requests sent to the Booking Servers need co-operation with the legacy systems in order to be completed.

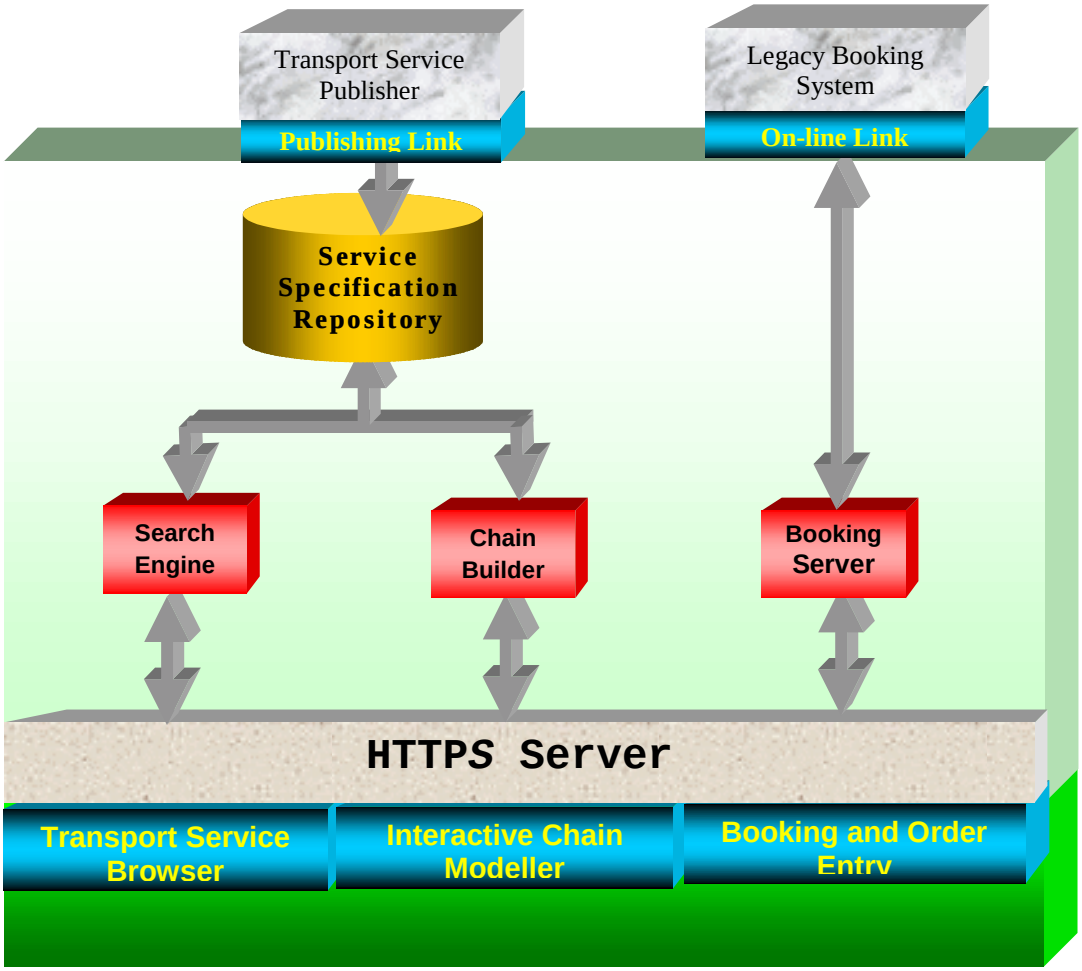


Figure 5-7 Information Provider Architecture

When the Booking Server receives a booking request, it decomposes it in several elementary booking requests that are sent to the proper legacy systems for confirmation. A two-phase commit protocol is used in such a way that all or none elementary services result booked. Communication with the legacy systems occurs again using a secure protocol, in such a way that the identity of the two parties is clearly identified.

- *Publishing link*
  Transport Service Specifications are sent to the Information Provider system by transport operators participating to the pilot by mean of a standalone application deployed on their system. Such application guides the operators to fill in the forms that build up the description of the standard services as stated in the System Specification. The graphic interface allows the operator to specify his services without being aware of XML structure of the document and the other technical issue involved in the transmission of the data. This concept is depicted in Figure 5-8

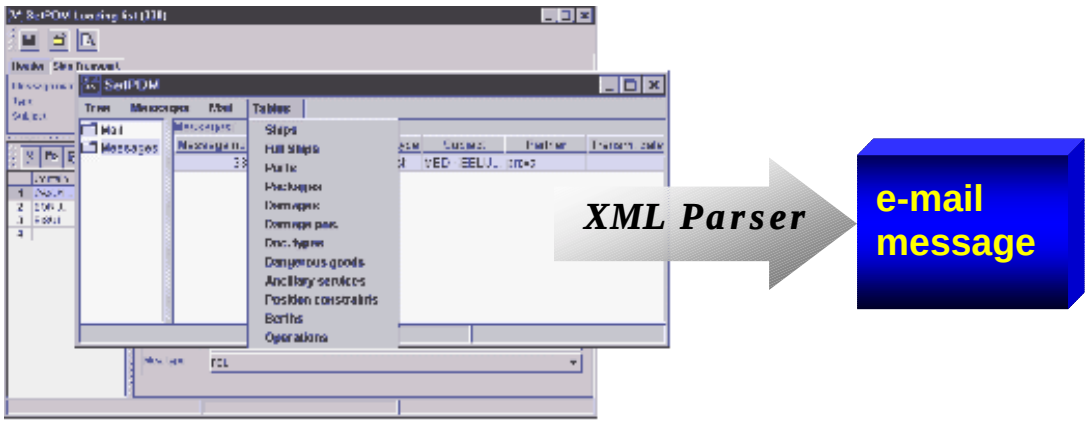


Figure 5-8: Publishing application

As a result of filling activities an e-mail message, containing the XML description of the services, will be produced and it will be sent to the INTRARTIP System via standard Internet e-mail channels. Encryption features will also guarantee the confidentiality of the transmitted information.

- *Booking interface*
  As on of the main goal in INTRARTIP architecture is the standardisation of the interfaces with Legacy systems, the booking interface is compliant with a set of functions that specify a standard booking service (see Figure 5-9).

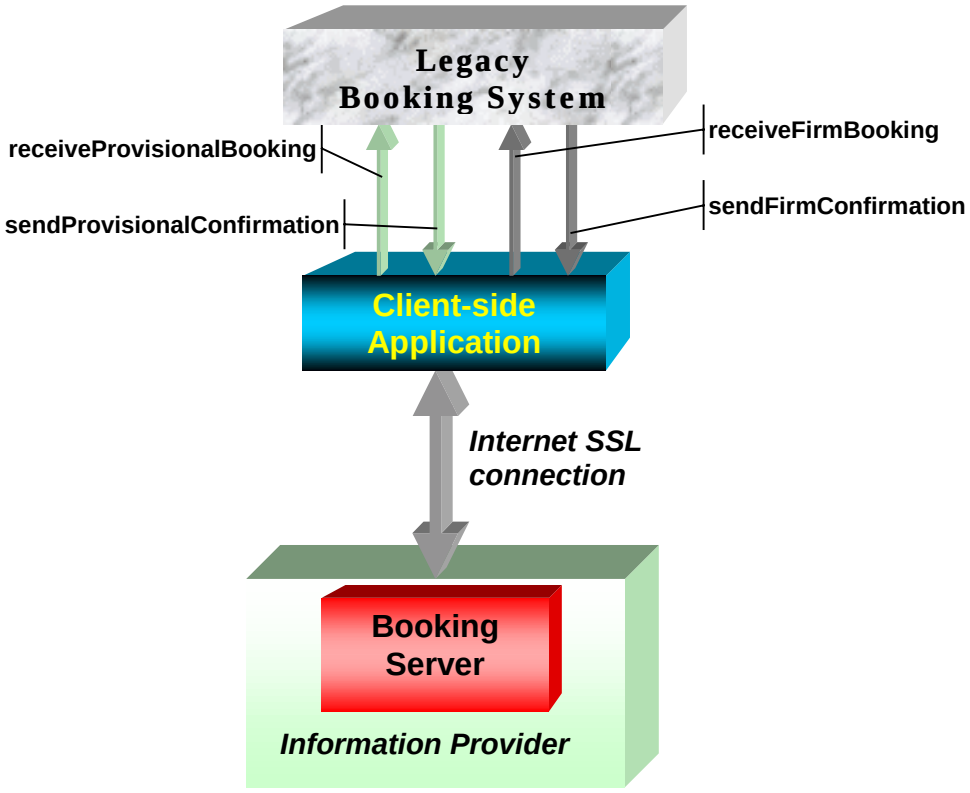


Figure 5-9: Booking interface

This set of functions is made available at the operator side by mean of client application running as a server on the legacy system providing the following set of interfaces:

- `receiveProvisionalBooking`
- `receiveFirmBooking`
- `sendProvisionalBooking`
- `sendFirmBooking`

The distinction between Firm and Provisional make the architecture able to manage a two phase commit algorithm when the booking server interacts with more than one legacy system in order to provide a distribute booking mechanism.

Information exchanged during a booking have also been standardised in a XML structure, so each legacy system can exploit the benefits of using a standard interface for specifying data involved in the operation. The client-side application manages the XML document implementing the standard Document Object Model (DOM) API to get and put data in a XML tree structure. The interfaces `receiveProvisionalBooking` and `receiveFirmBooking` returns a document in which the legacy application can easily navigate by mean of DOM API, while `sendProvisionalBooking` and `sendFirmBooking` accept as input a document built following the same mechanism. This way the client-side application hides implementation details to the legacy application, feel it free to manage XML date without being aware of their transmission to the INTRARTIP system.

The connection between the booking server and the client-side application provides a secure link exploiting the feature o the SSL standard protocol.

6. CONCLUSIONS AND RECOMENDATIONS

6.1 EVALUATION

The evaluation conclusion is based on the framework provided by the guidelines of the ISO 9126 standard. The evaluation conclusion is the synthesis of the collection of all the questionnaires filled in by the pilots. The conclusion of the INTRARTIP Pilot Trials and Evaluation Report describes the INTRARTIP platform according to four dimensions which are its:

- Functionality
- Reliability
- Usability
- Efficiency

This way of proceeding appears the more logical after the report of results pilots after pilors and partners after partners.

6.1.1 Functionality

The functionality of the INTRARTIP system is evaluated by the five first questions of the questionnaire in order to know if the system is adapted to the activity of the users, if it covers all their activity fields and if the interaction between the user and the system is satisfactory.

After compilation of all the answers to the questionnaires, the INTRARTIP functions have been evaluated as being adapted to the business of the different companies involved in the INTRARTIP pilot trials.

The INTRARTIP functions have been presented as covering widely the activity fields of the pilots. Some pilots precised that some functions like tracking and tracing or pricing should be added to the pilot system.

The accuracy of the INTRARTIP process appears as a weak point for the functionality evaluation of the system. A significative part of the pilots agreed to say that the information provided by the system is not accurate and should be refined. This point is the result of the noticing by the users that some modifications have to be done concerning the data control, the commodity, the dangerous cargo and the locations description.

Regarding the query process, a contradiction is appearing with the previous point. It means that the INTRARTIP query forms match all the expectations of the users but that the results don't give them satisfactory information.

The functionality of the INTRARTIP system can be considered as high because the majority of the pilots declare that INTRARTIP could be used with other systems. This last point demonstrates that there is a need of Information and Communication

Technology application dedicated to the pre-contract phase of intermodal transport process.

As a conclusion, the functionality of INTRARTIP can be estimated as being important but could be deeply increased by some modifications on the Transport Service Publisher which allows to collect all the specifications of a transport service. This module is presented as the most strategic one.

6.1.2 Reliability

The reliability of INTRARTIP has been evaluated from the final users establishing if the technical solutions adopted to build the INTRARTIP platform support the application in the best possible way.

According to the answers collected from the users, INTRARTIP doesn't appear as a secure system because of the use of the Internet. The different pilots are asking for a stronger authentication than the one proposed for the on line applications. The INTRARTIP system suffers about the unsecured feeling that provide the internet use.

The other questions related to the reliability demonstrate that the INTRARTIP system is reliable and can support the work continuity of a user despite the occurrence of a user error and of a system malfunction. In addition to this, the time to reuse the system after an incident is very acceptable.

The INTRARTIP system can be qualified as reliable in its use but has to make some progress concerning its access through the internet, especially for booking data.

6.1.3 Usability

The usability has been estimated in order to know if the use of the INTRARTIP system is accessible for its user. The INTRARTIP system can be qualified as easy to learn (less than 4 hours for the majority), as easy to be appropriated by the user (less than 8 hours). There is a consensus to describe INTRARTIP as a very user friendly system.

6.1.4 Efficiency

The efficiency of the INTRATIP system has been estimated by the measurement of the time response of the system regarding its process and download times.

The efficiency of the INTRARTIP system could be estimated as being not satisfactory with an average download time evaluated to 5 minutes and a process time estimated as too long.

The efficiency of the INTRARTIP system will increase in the future due to the evolution of the internet baud rate.

In conclusion, the INTRARTIP system is:

- Functional with the reserve of some modifications

- Reliable in case of system malfunction or user error
- Usable because of a good ergonomics
- Not sufficient because of process and download times too long. This point can be easily overcome thanks to an appropriate internet connection and a common computer equipment.

6.2 POTENTIAL USERS OF INTRARTIP

From the point of view of the final users we envisage three main exploitation scenarios, “Single Transport Operator System Scenario”, “Forwarder System” and “Community System” each of them includes:

- Many transport operators
- Origins and Destinations all across Europe
- All the Transport Modes
- Access through public communications networks (the Internet)

6.2.1 Single Transport Operator System Scenario

In this case it’s only one Transport Operator who offers its services to its clients. The characteristics of this scenario are:

- Only one transport operator offering its services
- Only the origins and destinations offered by the transport operator
- Transport Modes offered by the transport operator
- Access through the networks the transport operator is connected (usually the Internet)

Transport Operator Virtual Moll scenario is suitable to include all the services proposed for the INTRARTIP System, because the system is the same as the general one but in the case that all the transport services are offered by the same operator.

6.2.2 Forwarder System Scenario

In this case the system is used internally by a Forwarder to organise its own shipments. The characteristics of this service are:

- Only one forwarder in the system, it’s the only information client and information provider.
- The origins and destinations are the ones that the forwarder works with
- Transport Modes used by the forwarder
- Access through the networks the forwarder uses to implement its private network

Forwarder system is a very particular one, because it is to be used by a single company to build its Transport Chains. Even within an single company, most of the services defined for the complete INTRARTIP System are suitable to be included in the Pilot for this scenario. The only exception could be the Booking Service, but it can be used as an internal Order Entry Service.

6.2.3 Community System Scenario

In this case a community of transport uses the system. A community of Transport is a group of actors (transport operators, forwarders, terminal operators, etc.) around a transport platform or node, this platform or node can be an airport, a port, a railway terminal, a road logistic platform, etc.

The characteristics of this service are:

- Many transport operators, but all of them working around the same node
- All the transport services are with origin, destination or transit point on the same node
- Transport Modes are the ones supported by the node
- Access through the private community network and maybe through public networks

Community System scenario is suitable to include all the services proposed for the INTRARTIP System, because the system is the same as the general one but in the case that all the transport services realised through the same node.

7. ANNEX 1

7.1 LIST OF PUBLICATIONS, CONFERENCES, PRESENTATIONS

During the project two workshops were organised to exchange views with other professionals:

- User Requirements Workshops in Brussels on June 29th 1999
- Final Workshops in Brussels on February 28th 2000

During the development, the project was presented at the following conferences:

- Seattle (Washington – U.S.) on June 25th 1999
- Harbour, Maritime & Industrial Logistic Modeling & Simulation, Genoa, 17 September 1999
- Transport Research Conference, Paving the Way for Sustainable Mobility Lille, 8 & 9 November 1999
- Ketju Seminar, Helsinki, 10 February 2000

In addition, three INTARTIP newsletters were published and disseminated to European professionals

7.2 REFERENCES

[1] “Technical Annex”, 21 November 1997

[2] “User Requirements”, August 1998 (Project Deliverable D1)

[3] “System Specification”, March 1999 (Project Deliverable D2)

[4] “Pilot Design”, March 1999 (Project Deliverable D3)

[5] “Pilot Trial and Evaluation Report”, December 1999 (Project Deliverable D6)