A web based tool for emergency management in the maritime industry

Peik Jenssen

Det Norske Veritas, N-1322 Høvik, Norway

Peik.Jenssen@dnv.com

David Jaramillo

Germanischer Lloyd, Vorsetzen 32, D-20459 Hamburg, Germany

jmo@germanlloyd.org

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Abstract

The EU funded research project MARVIN (EP29049) have developed a software tool to operate Virtual Enterprises in the maritime industry, more exactly in the field of emergency management and repair of ships. The tool, which is given the working title of *Maritime Enterprise Integration Tool* (MEIT) supports web-based co-operation using state of the art multi-agent technology. The tool includes a work flow management system to communicate administrative, technical as well as commercial data. The MARVIN solution is based on thin client technology.

1. Introduction

Emergency response services are typically an area that may benefit from new information and communication technology (ICT). The EU project MARVIN (EP29049 - Maritime Virtual Enterprise Network) has developed a web-based communication tool to support collaboration within emergency response, repair and maintenance of ships. The tool is given the working title Maritime Enterprise Integration Tool (MEIT). The overall goal of the project is to increase safety at sea and reduce repair and maintenance time and costs. The tool includes structured work processes and use multi-agent technology to facilitate fast and reliable co-operation among the actors. The MEIT gives the actors easy and fast access to information, makes it possible to reliable communication and exchange even of complex data and assists complex operations through a work flow management system.

This presentation focuses on the technology and procedures, which has been investigated within the MARVIN project to develop a web-based communication platform supporting the operation of ad-hoc virtual enterprises in emergency situations.

2. The MARVIN project

The project started in 1998 and runs until the end of 2001. There are 10 partners from four European countries, representing some of the key actors in the maritime industry.

The project has developed prototypes of the central software (MEIT) and interfaces with the commercial partners' software systems. The remaining work is validation of the system and planning of exploitation of results.

3. Marvin scenarios

Within the MARVIN project two scenarios have been used for analysis of business processes, identification of user requirements and implementation of the prototype software solution: *Emergency Repair (ER)* and *Planned Maintenance (PM)*.

As illustrated in Figure 3-1, the Emergency Repair scenario comprises three different phases: (1) *Salvage*, (2) *Pre-docking* and (3) *Repair*.

The first phase, which represents the focus of this paper, comprises all processes involved in an Emergency Response situation after a maritime casualty has occurred. A detailed description of both MARVIN scenarios can be found in [2] .

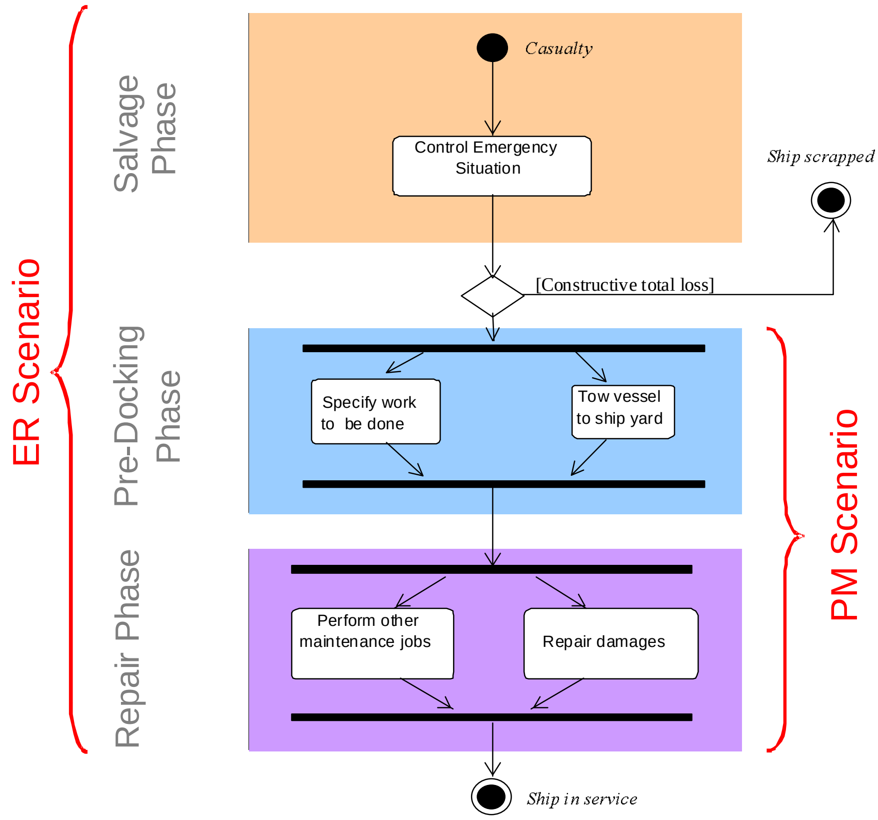

Figure 3-1

3.1 Scope of the Emergency Repair scenario

For analysis purposes and considering required simplifications, a grounding situation was chosen as casualty type. Grounding may for instance occur as consequence of one of the following reasons:

- Over-reliance by watch keeping officers on the automated features of the integrated bridge system.
- Failure in the functionality of modern navigation aids.
- Human factor (e.g. watch keeper falls asleep due to lack of adequate rest).
- Damage in the steering system of the vessel.
- Underestimation of extremely bad weather conditions (Storm, Hurricane, etc.).
- Serious machinery breakdown.

In reality a large variety of emergency repair scenarios may occur. It is not the task of MARVIN to provide and treat a comprehensive list of those. The scenarios in MARVIN only serve the purpose analysis of processes, identification of user requirements and validation of the implemented software solution. Therefore, just typical processes were selected and viewed at a high level of abstraction.

In MARVIN's Emergency Repair scenario the *Salvage Phase* is initiated with the occurrence of the casualty. It comprises all the salvage operations to re-float the vessel until the emergency situation is under control. This is the case, if no further risk for damage or pollution is expected from the stability/strength condition of the vessel or other factors influencing the situation (e.g. the vessel in towed from the dangerous zone to a safe place).

3.2 Involved Actors

The involved actors in the salvage phase are the *Ship Crew* (SC), the *Shipowner* (SO), the *ER-Company* (ERC), *the Salvage/Tug Company* (TC) and the *Class Society* (CS). Most of them are represented in MARVIN consortium and will therefore be included in the prototype implementation of MEIT. Two additional parties: the *Insurance Company* (IC) and the *P&I Club* (P&I) were considered part of the scenario only for analysis of processes and data modelling. Since they were not represented in the MARVIN consortium, these actors were not included in the implementation of the MEIT.

Due to simplification of the overall scope of the scenario, other parties like *Maritime Rescue Co-ordination Centres* (MRCC), *Port and Coastal Authorities* (PCA) and *Flag States* (FS), were not included in the scenario neither for analysis nor for process modelling. They are however essential part of a real emergency scenario and should be taken into consideration in a further development of the MARVIN results.

3.3 Data Exchange during Emergency Response

In order to perform the necessary calculations to provide technical assessment during an emergency situation, the ER-Company requires from the damaged vessel detailed information about the casualty occurred and the current condition of the vessel. Currently this information is provided in form of so called "casualty data sheets" which are designed and provided by the ER-Company after the vessel is subscribed to the *Emergency Response Service*. These data sheets are filled in by the master or other designated crew member in case of an emergency and transmitted via fax to the ER-Company.

The data contained in the data sheets correspond to the variable ship data such as loading, cargo and floating condition, as well as to casualty specific information like current geographic position, type of casualty, description of damages, weather and environmental conditions, etc.

In addition to the data provided in the data sheets, the ER-Company may require further technical information like drawings, specifications, reports etc. during the salvage efforts. This kind of data is usually provided either by the ship owner, the ship crew or the classification society.

4 The technical solution

In order to be platform independent, which is easy to install/configure and use, the MEIT is based upon modern web technology. For implementation the project has chosen one of the most recent developments in the field of distributed artificial intelligence, the multi-agent technology, which is designed to be domain independent. The project has also taken into consideration legal aspects, such as encryption, property rights and digital signature in relation to web-based collaboration.

4.1 Architecture of the MEIT

A Virtual Enterprise runs through several phases during its lifecycle as shown in figure 4-1. When a need for co-operation arises, i.e. a business opportunity, an identification phase is entered. In this phase the goal of the co-operation and the co-operation project will be defined. To reach this goal partners who have the relevant core competencies need to be gathered. This is done in the partner search phase. These partners will determine the legal modalities of co-operation and form the Virtual Enterprise based on loose legal frameworks by signing electronic contracts. After the operation phase is finished, i.e. the service had been provided and the goal reached, the partners split up in the dissolution phase. The MEIT will support the respective actors chosen in the business cases during all these phases.

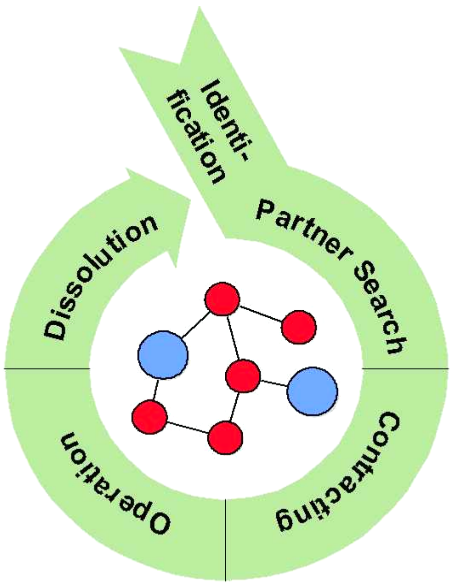

Figure 4-1: Life cycle of a virtual enterprise

4.2 MEIT as multi-agent system

Following the inherent distribution of the problem domain, as shown by the lifecycle of a Virtual Enterprise, the MEIT is designed as a multi-agent system. Each partner company, as well as the customer, will be represented as an agent. An agent – as an autonomous computational element, which exists in the Internet and, which contacts other elements of the Internet – represents the interests and goals of the relevant participant of the Virtual Enterprise. Via the communication between the agents the communication between the different companies, respectively the communication between the customer and the Virtual Enterprise, will be increased and partly automated. Because the agents will also have negotiation and co-operation strategies at their disposal the common goal of the co-operation arrangement will be transparently traced.

4.3 Architecture of the agents

For the agents building up the MEIT a generic and modular approach was selected. The generic characteristic offers the advantage of having a general architecture for all agents. From this results on the one hand a simplification in the communication and co-operation of the agents within the multi-agent-system and on the other hand a reduction of the implementation work by the reuse of the components. If one module is no longer suitable, it can be substituted by a new component. The interfaces to other modules, however, have to be taken into consideration. The substitution of a module could become necessary for instance if a new standard arises which should be supported by the MEIT.

In general the architecture of an agent consists of three layers as shown in Figure 4-2. Each layer itself can be subdivided horizontally into sub-layers and vertically in components with complementary functions. The communication layer comprises the interaction of an agent with other agents, the user and the system. In the networking layer the connectivity of an agent is described, i.e. how the agent establishes communication with the processing layer for reasons of data transfer, data display, reasoning etc. The processing layer includes the reasoning component of the agent and its data management together with the database. Each layer uses the services offered by the one above.

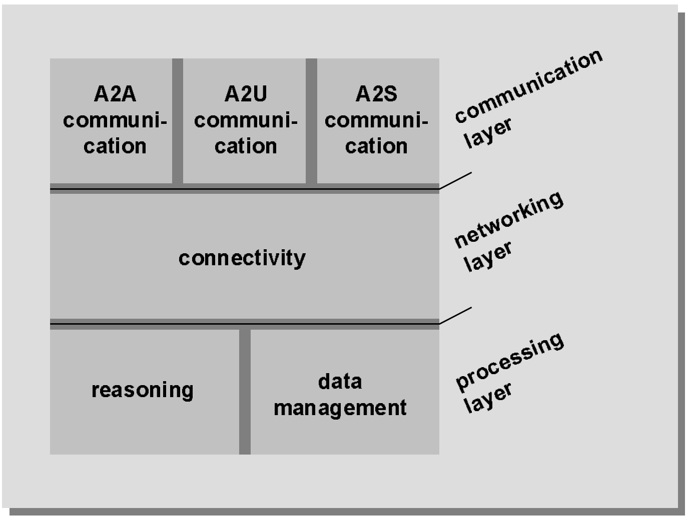

Figure 4-2: Architecture of an agent in the MEIT

4.4 Interfaces to legacy systems

In MARVIN a standard-based infrastructure for the exchange of data is used to integrate the various software applications that the partners use. Each partner uses a tailored application to perform computer-aided tasks and to store the resulting data. These data that originate at one partner site shall be transferred to another application.

4.4.1 Data exchange based on standards

There are two options for the communication between these systems:

In a *point-to-point communication*, the one system is connected directly to the other one. For example, in case those two systems store the data in databases, both databases are connected together through ODBC (Open Data Base Connectivity) connection and exchange the appropriate data using SQL queries. The disadvantage of this method is that the communication is strictly between the two systems.

On the other hand, when applying a *neutral data specification* the data source system exports the information to a standard file format. MARVIN has decided to make use of STEP technology for implementing the data exchange and integration portion the MEIT. STEP is the ISO "*Standard for the Exchange of Product Model Data*" (ISO 10303). The data modelling is achieved using the EXPRESS modelling language, defined within the STEP standard. The actual data exchange is performed by using the so-called part21 (ISO 10303-21), which are human readable instance representations of entities defined in an EXPRESS model.

4.4.2 The data exchange process

According to chosen approach, a STEP part-21 file is produced based on an EXPRESS model that is specific for the corresponding process. Based on that model, a translator is developed to transform the data between a specific proprietary data format and the part-21 representation, and vice versa. After this, the data is transferred electronically via the MEIT to the receiving site and there it is imported (using a STEP translator) to the target system. The advantage of this approach is that the part-21 file is exported only once, and then it can be imported to any other system that understands the EXPRESS model, i.e. for which a corresponding STEP translator has been implemented. Figure 4-3 shows the data exchange based on a neutral format (STEP) as described above.

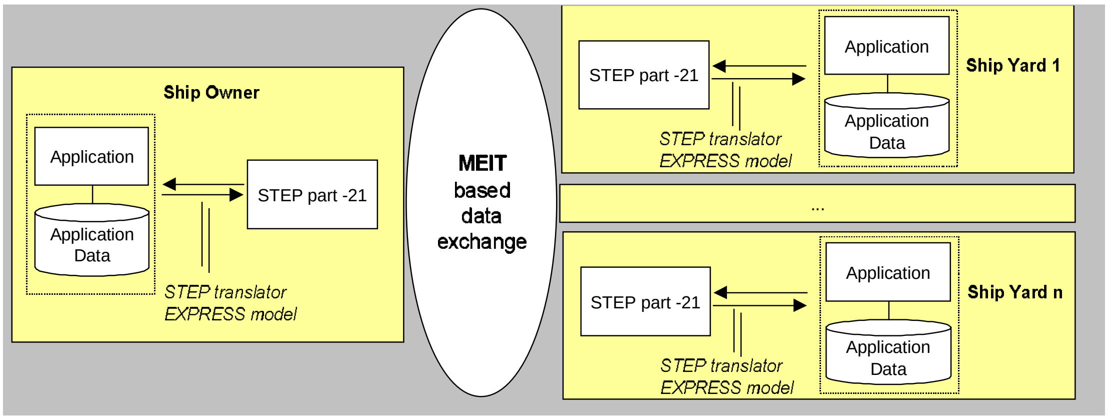

Figure 4-3. Neutral format communication

A drawback of STEP is that software tools required for development and implementation of translators are quite expensive. An alternative to use of part21-based exchange is the use of XML-formatted data. XML, which stands for "eXtensible Mark-up Language", is a mark-up language developed by the World Wide Web consortium (W3C), and which has become rapidly a new standard not only in the field of web-based content management and e-business, but also in the field of data representation and storage. Within the STEP development process there is an initiative concerned with the integration of STEP and XML in the scope of a new STEP part called 10303-28. This approach could be used to "XML-enable" the EXPRESS data models developed in MARVIN.

5 Implementation of First Interface Prototype

The are two relevant sets of data involved in the prototype interface implementation. The *first notification (report)* about the casualty sent by the Ship Crew to the Ship Owner, Emergency Response Company and other interested parties and the *casualty data* transmitted from the ship to the Emergency Response Company. The corresponding data models containing this information are respectively the *Initial_casualty_report* and the *Emergency_response_casualty_report*.

The Initial_casualty_report contains the information sent by the ship crew to interested parties, notifying the casualty. Since this information should be entered and submitted very fast, the data model has been kept as compact as possible. It includes the vessel identification (name, IMO-number etc.), geographic position, the type of casualty, a brief damage description, the date and time of occurrence and the reporting person. The information there, which is common to all reports, is collected into one single entity called *Generic_casualty_data*, and can be easily included or referenced in other casualty reports.

After the first notification, the current casualty data is required by the shore-based Emergency Response Company to analyse the emergency situation, perform the concerning stability and strength calculations and provide advice on corrective actions to re-float the vessel avoiding further damage to the vessel, cargo and environment.

Based on the casualty information the salvage calculations are performed using specialised naval architectural software. During the prototype interface implementation the software program HECSALV of Herbert's Engineering Corp. was used as target system. HECSALV requires for intact and damage stability calculations a so-called *condition file* (CND-file), which contains all information required to defined a loading condition including, grounding specification, environmental influences, etc.

The scope of the interface implementation supporting Emergency Response was the following:

- To generate an intermediate data file based on the information entered in the web user interface of the MEIT.
- To convert the intermediate data file into a STEP physical file according to the EXPRESS schema "Emergency_response_data".
- To translate the STEP physical file to the CND-file format suitable to be used as input to HECSALV.

The interface prototype was successfully implemented and tested. However a very important aspect, which is still missing, is the interface to software systems available on board (loading computers). Entering the current loading distribution by hand during an emergency situation, as it is mostly the case nowadays, is very time consuming and error-prone. This aspect needs be taken into consideration during further development of the MARVIN solution in a commercial version.

6 Security Issues in MARVIN

Any business needs to maintain a degree of security over its information, be it client information, intellectual property protected information or confidential information. Where such a business requires electronic means for data storage, communication, and transmission of data to business partners via the Internet will take place and the consequently security risks increase.

Transmission of confidential information may also be required following the occurrence of an emergency. Depending on the nature of the casualty, certain information regarding the ship may be required by a number of the parties involved in the casualty situation such as the ER-Company, the Salvage Company or the Shipyard carrying out the repairs. For example, in the case of damage to the steel structure, the ER-Company may request additional information on the vessel such as steel drawings and results or data from previously performed strength analysis. Moreover, when a Salvage Company is contracted and becomes part of the scenario, there is also a communication and information process between the Emergency Response Company and the Salvage Company in order to co-ordinate the salvage efforts. These processes may also involve the transfer of information such as results of calculations and ship specific data.

Due to the relative anonymity that an Internet user to a certain extent has, concerns over the identity of the sender of the message and of the integrity of the message also arise. Encryption is a widely used method to ensure the privacy and security of electronic communication.

The MEIT architecture includes both the data management as well as the reasoning component of the agents running on the MEIT server. This has the advantage of increasing the security of the system since as little data as possible is exchanged over the network. The MEIT is secured against illicit access in such a way that only agents will be allowed to read and write data via their reasoning component.

Further security issues like encryption can be implemented in a commercial version of the tool. For example, Java 1.2 provides different interfaces to encode data objects using strong data encryption algorithms, which will get extended in Java 1.3 (expected to be released soon). Since the agents in the MEIT are implemented in Java, it will not be difficult to implement the strong data encryption algorithms that are provided in Java.

7. Conclusions and outlook

MARVIN has developed a software tool that allows fast and precise exchange of data in connection with ship accidents, repair and planned maintenance situations. It is web based and uses multi agent and workflow management systems to facilitate effective search, connecting and collaboration among partners in an emergency or business case.

The project is going into its validation phase during the second half of 2001. During this period we will also look for concrete business ideas and potential partners to bring the results forward. The prototype needs extensions and enhancement before it eventually can be implemented in a business setting. It has been developed and will be validated for some maritime scenarios, but its relevance for other industries should also be investigated.

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Author biographies

David Jaramillo, has an MSc. in Naval Architecture from the University of Hamburg. Since 1996 he is research engineer at GL's headquarter in Hamburg. Mr. Jaramillo has been also involved in several research projects concerning the application of ICT in the shipbuilding industry and the ship classification business.

Peik Jenssen, has an MSc. in Naval architecture and Marine Engineering from the Norwegian University of Science and Technology in Trondheim. Mr. Jenssen is a senior principal research engineer in DNV Research and project manager of MARVIN and other projects within maritime ICT.