Enterprise COllaboration and INteroperability (COIN) Platform: Two Case Studies in the Marine Shipping Domain

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Abstract. Enterprise Collaboration and Enterprise Interoperability are two key aspects of networked enterprises, which proceed along parallel tracks with rare opportunities to convene, support and influence each other. To resolve this issue we propose the use of the COIN platform, which allows exposure, combination and integration of Web Services to support these aspects in different business sectors. Suitable COIN collaboration and interoperability services were selected based on the requirements analysis performed with Donnelly Tanker Management, our industrial partner in Cyprus. These services adhere to requirements of the shipping sector, such as negotiation of voyage terms, trusted information sharing, document management and user management. Using COIN, a web-based enterprise system was created that supported two case studies. Useful results were obtained by marine experts, which revealed the positive impact of the platform in managing and reducing the time to execute these processes.

Keywords: Web-based Enterprise Systems, Web Services, Enterprise Collaboration, Enterprise Interoperability, Web-based Business Processes.

1 Enterprise Collaboration and Interoperability

Two fundamental aspects of networked enterprises [1] are Enterprise Collaboration (EC) and Enterprise Interoperability (EI). Juncal et al. [2] state in their work that although these key aspects are independent, in most occasions they are simultaneously present. First, EC signifies the business perspective and identifies the enterprises (mainly SMEs) process. This process allows setting up and managing cross-enterprise business relations in response to business opportunities. On the other hand, EI originates from ICT and identifies the capability of enterprise software and applications to be integrated at the level of data, applications, processes and models of each enterprise. These aspects proceed along

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parallel tracks with rare opportunities to convene and mutually influence each other. Hence, research in EC lacks support of innovative and advanced ICT, while research in EI lacks concreteness and real-life business applications [3].

The COIN research project examined and investigated this problem to design, develop and prototype an open, self-adaptive service platform that offers business collaboration and interoperability services. Foremost, the COIN platform offers EC and EI services developed during the course of the project in the form of Web Services. These services were developed taking into consideration their applicability in various business sectors [3]. Secondly, the COIN service platform enables the exposure, combination, integration and use of these services in different business sectors.

The availability and adoption of innovative COIN ICT services by business consumers is expected to foster and promote interoperability amongst collaborative enterprises to support various business forms such as supply chains and business networks [4]. Furthermore, the open and modular architecture of the COIN platform permits the addition of newly developed services by service providers. The open, self-adaptive nature of the platform allows also the customisation of existing resources (e.g. when applied to a specific business domain), to develop additional highly-specialised services. Thus, the key goal was to promote via the COIN service platform the notion of "Software as a Service" (SaaS) [5] to support the vision: "Interoperability and collaboration services will become a pervasive knowledge and business utility at the disposal of European networked enterprises from any industrial sector and domain" [6].

In this work the key task is to study and extract important business requirements, which necessitate the support of COIN services for advancing collaboration and interoperability in the marine shipping sector. The second task is to utilise the technical capabilities of the COIN platform to implement marine processes in the form of business pilots that can be executed directly using the runtime environment offered by the platform. The key objective is to execute, validate and establish the efficiency of the COIN service platform in terms of reducing the development time and also in terms of managing more efficiently business processes in the marine shipping sector. In particular, the involvement of the industrial project partner Donelly Tanker Management (DTM)[1] aided in the identification of the business requirements and the development of the pilots by considering highly the business perspective. Hence, ICT-based developments were driven by the business requirements. Two business use cases that lack support of ICT capabilities were identified and analysed, so as to select a subset of baseline and innovative services offered by the COIN platform aiding the development and execution of the pilots.

The paper is structured as follows. Section 2 introduces briefly the COIN service platform, while Section 3 presents the Cyprus marine shipping sector, the motivations behind the developments performed and the marine business cases. In the following section we introduce the developed extensions for adapting the selected COIN services strictly to the marine domain. Section 5 presents

[1] `http://www.donnellytanker.com.cy/`

the COIN experience, based on the executions of the pilots. Initial results are presented that outline the business indicators and reveal the benefits obtained based on the feedback received by DTM experts. Finally, Section 6 presents conclusions derived from the feedback received.

2 The COIN Service Platform

The COIN service platform forms the backbone, integrating services for enterprise collaboration and interoperability. It fulfils the COIN objective of providing a pervasive service platform to host Baseline and Innovative COIN services for EI and EC, which can be used by European enterprises for running their business in a secure, reliable and efficient way. The platform is developed on top of the Liferay portal [7], which is an enterprise-based web platform for building technology-oriented, business applications that deliver immediate results and long-term value. Using the COIN platform we have implemented the business use cases using the *ProcessMaker* business process management and workflow software [8] offered by the platform. Via *ProcessMaker* we are able to invoke the necessary Baseline and Innovative COIN services that allow executing the required business tasks of the use cases.

The following COIN services correspond to the essential services as derived from the requirement analysis performed with the project industrial partners:

- Collaboration Visualization Tool (CVT): Formulation and visualization of human collaboration networks, including users and their discovered relations (e.g. joint activities) [9].
- Trusted Information Sharing (TIS): Flexible sharing of business related information (e.g. documents) on the basis of CVT relations [10], [11].
- Interoperability Space Service (ISS): A negotiation tool for exchanging and negotiating business documents in standardized Universal Business Language (UBL) format [12].
- Baseline Communication Services: A suite of services that include Skype call, instant messaging and notification [12].

A detailed description of the COIN platform is out of the scope of this paper and thus interested readers are referred to [6].

3 Introduction to the Marine Business Pilots

3.1 The Cyprus Marine Shipping Sector

In terms of the overall Cyprus economy, the shipping industry is contributing 5% of the Cyprus Gross Domestic Product (GDP). The strength of the marine shipping sector in the country's economy, including both ship management and ship owning, is a result of a number of advantages that Cyprus can uniquely offer: (i) *Excellent geographical position at the crossroads of Europe, Africa and*

the Middle East, (ii) "Open Registry" (one of two countries in the European Union) allowing non-Cypriot citizens to register ships under the Cypriot flag, (iii) advanced maritime infrastructure (two deep sea multipurpose ports in Limassol and Larnaca) and (iv) favourable taxation regime for ship-owners and crew members.

The Cyprus Shipping Registry is classified as the 10th largest fleet globally and the 3rd in the European Union. Limassol is considered the largest third party ship-management centre in the EU and one of the largest in the world (in excess of 130 ship-owning, management and other shipping related companies maintain offices there). Nearly 1,000 ships exceeding 21 million gross tonnages are registered in Cyprus and the Cyprus Shipping Sector employs approximately 4000 people ashore and approximately 40,000 sea farers onboard Cypriot flag ships. The European fleet capacity has significantly increased upon Cyprus accession to the EU, with the island contributing approximately 20% of the EU fleet.

3.2 Motivation for Developments

The business scenarios examined refer to the maritime shipping domain and the processes that need to be executed for the establishment and management of the vessel's voyage, so as to transport specific goods. The primary target is to improve collaboration and interoperability amongst the involved parties of a highly distributed team, which includes charterers, shipping captains, port agents, accountants etc. As stated also in [13], this is possible through service workflows that are collaborative in nature and allow for direct interactions between parties involved. In particular, the goal is to simplify these processes and reduce the time for the accomplishment of these processes. This can be achieved by providing the technological capabilities that simplify complex tasks such as continuous communication between parties typically located in different countries, negotiations of voyage terms, trusted sharing of sensitive documents, etc.

In both use cases various enterprise interoperability and collaboration tasks need to be carried out. These refer to the negotiation of details and terms for the voyage setup, exchanging documents and information related to the marine shipping domain via a trusted and secure sharing method, identifying business relationships and tracking information on past interactions with partners of the marine domain and direct communication of a geographically distributed team. Thus, the use of COIN services, such as ISS and TIS described previously, is essential in both business cases.

In this work the necessary developments for adapting the ISS and TIS services were performed, in order to achieve integration and use successfully these services from the implemented workflows. This was required since both services accept as input specific data formats. Foremost, the ISS service accepts input data in the form of standardised UBL documents to enable negotiation tasks in marine processes, while the TIS service accepts data in XML format, so as to enable the sharing of documents in the marine processes in a secure and trusted way. In particular, the development of extensions to COIN services is motivated by: (i) the need to achieve integration with the Da-Desk system used in the marine

domain by transforming its legacy format to the UBL format and (ii) to achieve the adaptation of the UBL format, using existing UBL fields, so as to support specific marine information included in standardised documents. Therefore, the introduced extensions to COIN services would contribute to the simplification of the marine processes and the reduction of the processes execution time.

In order to generate the input required from the COIN ISS and TIS interoperability services in the appropriate format and thus support integration with these services, the needed extensions were developed in the form of transformation scripts. These scripts were implemented in the form of PHP based templates (i.e. transformation scripts) and were assigned as triggers to the necessary tasks of the developed workflows. When the trigger associated to a task is executed, the data derived from the completed fields of the form are transformed to the respective UBL and XML data formats. Three different transformation scripts have been defined for the two use cases. Each script is executed upon completion of the specific task to which each script is assigned as a trigger.

3.3 Overview of the Business Use Cases

The marine shipping use cases described next define the processes that are currently executed without the necessary technological support, which will allow reducing their execution time and simplify their management.

Workflow 1 - Negotiations between United Product Tankers (UPT) and Charterers for the pre-fixture queries and the voyage's fixture accomplishment

The establishment of a vessel's voyage is a highly complex procedure. The complexity is due to the involvement of several parties that must communicate with each other before any action is performed. The most important action that has to be completed before the beginning of a vessel voyage is the preparation of the recap. The recap is the outcome of negotiations and logical amendments agreed between UPT and charterers, for the decision of which charterers will get involved in the trip. These negotiations are done following formatted documents, called "standard charter party forms". The aim of these negotiations is the formulation of the final recap document. The recap includes all the negotiation results and it is used by the DTM operators as a "guide" for the successful execution of the vessel voyage. The formulation of the recap document is a process that requires the continuous communication between UPT and charterers during the negotiations phase. In addition, the recap should be forwarded to the vessel's captain via the DTM operators. The operator and the vessel captain follow the voyage instructions included in the recap document and the DTM operator confirms that the vessel captain is aware of these details and any updates during the trip.

Workflow 2 - Creation of the Proforma Disbursement Account

This business scenario refers to the steps undertaken by the DTM operator, port agent and the captain for the formulation of the Proforma Disbursement Account (PDA). After the selection of the right port agent (by the DTM operator), the initial PDA is created as a result of the negotiations between the operator and the agent. The PDA is then shared amongst the involved parties and the DTM operator is responsible to establish direct communication between the captain and the appointed agent. The appointment is setup using the DA-Desk legacy web system (including inputting manually the PDA contents) and thus a notification is sent to the accounting department about the agent appointment for settling the agent's fees. At the same time the port agent and the captain communicate directly in order to achieve smooth completion of the voyage while sending daily updates to DTM operator. Upon completion of the voyage the port agent sends the final PDA to the DTM operator. The operator "closes" the voyage in DA-DESK legacy system.

4 Extensions to COIN Services

The examined processes are currently carried out in an ad-hoc way that involves the exchange of information and documents for the voyage establishment and management using emails, telephone calls and facsimile. Only the second use-case involves the use of the Da-Desk legacy system, which refers to a notification management system. Hence, this ad-hoc procedure creates the following issues: *(i) the actors needed to be highly trained and acquainted with the process to avoid errors and omissions, (ii) difficulty in management and coordination of these highly interactive and mostly dependent tasks, (iii) a huge volume of emails is created for each case (actors are typically involved in different voyages), which makes it difficult to handle the vast amount of information and (iv) slow response time due to email overkill or because a person might not be available for a telephone call.*

The COIN platform provides a portal that allows users to login, develop, execute and monitor processes based on their access privileges. Hence, with the aid of the COIN service platform, two marine processes have been implemented in the form of workflows. These workflows are developed using the platform's capabilities by modelling visually electronic forms, implementing document (e.g. PDF, DOC) generation templates, associating standard input forms to tasks that allow uploading and sharing documents, invoking COIN services using code triggers, etc. These forms, templates and code triggers are associated with different tasks of the processes and each task is assigned to a user or a group of users. Using this approach it is possible to execute the business processes using the runtime environment of the platform.

The only requirement is to develop extensions (i.e. transformation scripts) to COIN services in order to support data transformations. This is required in order to associate these extensions with specific tasks of the processes, so as to

transform the data completed using electronic forms to the standardised UBL data formats required as input by the COIN ISS and TIS services. In this way these services can be invoked at the subsequent tasks. Finally, integration with the Da-Desk legacy system can be also achieved via these transformation scripts.

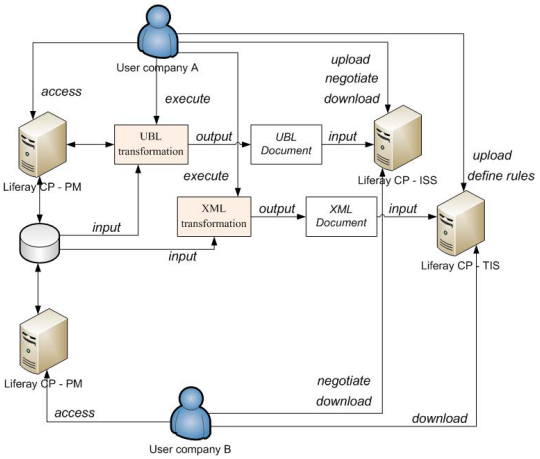

Fig. 1. Extensions to COIN Services

Fig. 1 showcases the developed extensions and the interaction of the user with these extensions, so as to facilitate integration with COIN services. The required extensions are developed in the form of transformation scripts assigned to specific tasks of the processes. Two extensions are developed in the case of the first workflow, since it uses both the ISS and TIS services. For the second workflow, presented in detail in the following section, one extension is developed, since it uses only the ISS service. In this section, we present one of the developed extensions due to space limitations. This extension refers to the script that transforms the PDA form data to the UBL data format required as input by the ISS service. This transformation script is associated with the Recap negotiation task (i.e. Create PDA) of the modelled workflow illustrated in Fig. 2.

The UBL specification was studied in order to identify data fields, which allow representing the PDA document in the form of UBL data. On the basis of the identified data fields (i.e. BillOfLading.xsd) the transformation script is defined in the form of PHP code shown partly in Listing 1. For instance, the first two lines of the script generate the UBL tag **"p2:IssueDate"** shown in Listing 2. Moreover, the following two lines of the script allow retrieving the data from the PDA form (i.e. **@@pda-issue-date**) and appending the data value retrieved to the UBL output shown in Listing 2. Using the same reasoning the rest of the transformation script is defined as shown in the following lines of Listing 1 and the corresponding output is generated as illustrated in Listing 2.

Listing 1. PDA transformation script.

```
$item = $dom->createElement("p2:IssueDate"); // create UBL tag
$root->appendChild($item); // append tag name

$text = $dom->createTextNode(@@pda-issue-date); // retrieve data and create text node
$item->appendChild($text); // append value

$shipment = $dom->createElement("p4:Shipment"); // create UBL tag
$root->appendChild($shipment); // append tag name

$item = $dom->createElement("p2:ID"); // create UBL tag
$shipment->appendChild($item); // append tag name

$name1 = @@vessel_name; // retrieve data from PDA form
$name2 = @@pda_ref; // retrieve data from PDA form
$str = "$name1 - $name2"; // concatenate data

$text = $dom->createTextNode($str); // create text node
$item->appendChild($text); // append value

$item = $dom->createElement("p2:DeclaredCustomsValueAmount"); // create UBL tag
$shipment->appendChild($item); //append tag name

$currencyID = $dom->createAttribute("currencyID"); // create UBL attribute node
$item->appendChild($currencyID); // append attribute node name

$currencyIDValue = $dom->createTextNode("EUR"); // create text node
$currencyID->appendChild($currencyIDValue); // append attribute node value

$text = $dom->createTextNode(@@customs_clearance); // retrieve data and create text node
$item->appendChild($text); // append value
```

Listing 2. Generated UBL format of the PDA document.

```
<p2:IssueDate>
2011-06-25
</p2:IssueDate>
 <p4:Shipment>
   <p2:ID>
   Mount Olympous - tt1234tt
   </p2:ID>
   <p2:DeclaredCustomsValueAmount currencyID="EUR">
   212
   </p2:DeclaredCustomsValueAmount>
```

The resulting UBL document allows using the COIN ISS service in the subsequent task of the process. As illustrated in Fig. 1, user A is able to upload and apply rules for negotiating the details of the PDA document. User B is also able to use the ISS service to view the PDA document (see Fig. 6) and modify the rules in case user B does not agree with the terms of user A. Once agreement is reached, the two users are able to download the finalised charter party document. It is important to note that the COIN platform and the ISS, CVT, TIS and Baseline Communication services are deployed on top of the Liferay portal.

5 The COIN Experience

The application of the described tools of the COIN platform are demonstrated and evaluated in this section through a reference to the *Creation of the Proforma Disbursement Account* case study. The test-bed environment for the scenario was

prepared and executed at the premises of Donelly Tanker Management in Limassol, Cyprus. A number of COIN tools are exploited for the PDA creation as detailed next. The workflow modelled in Process Maker highlights five distinct sub-processes with individual tasks as illustrated in Fig. 2. Each task is associated with electronic forms, triggers, input and output documents, as well as with a user or a user group.

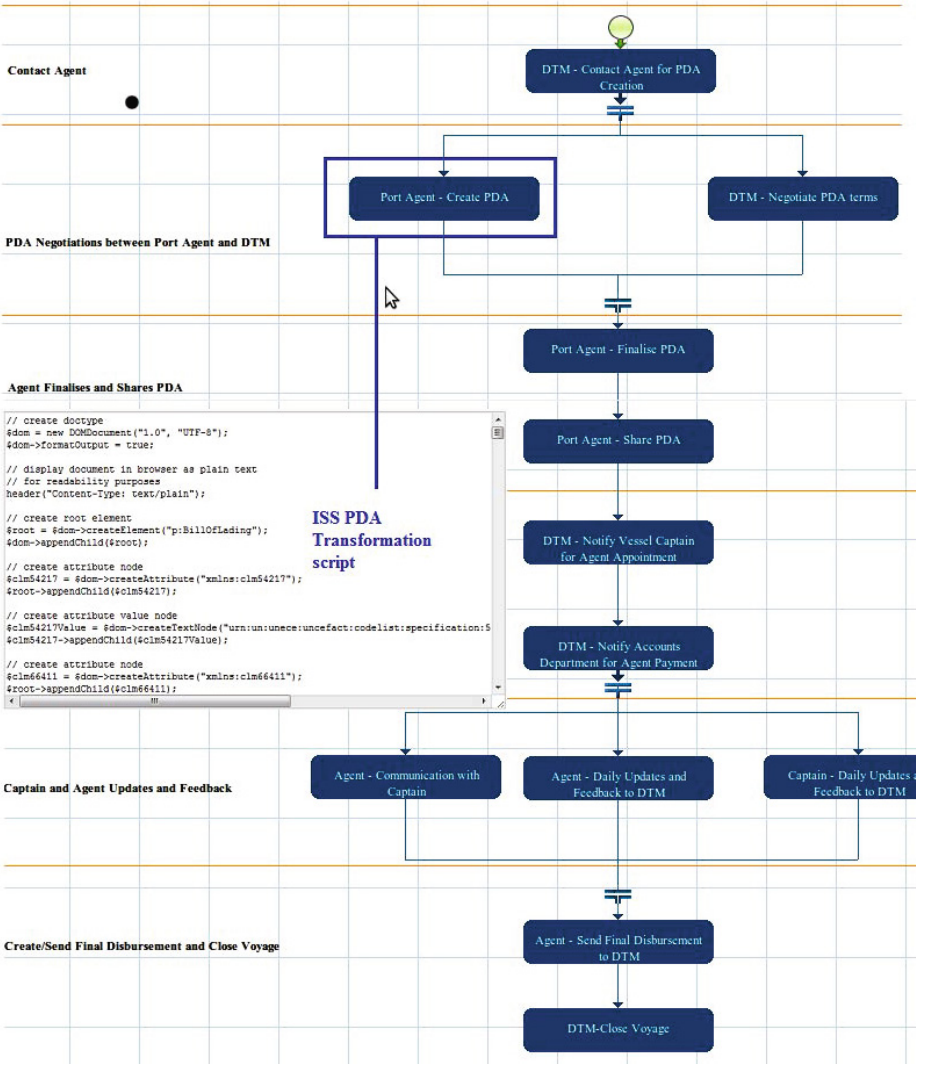

Fig. 2. Extensions to COIN EI services for the second business use case

In the first sub-process, i.e. *Contact Agent*, DTM uses the platform with the aim to identify an appropriate agent for the specific voyage. Using COIN this

is achieved through COIN CVT service accessed as a Web application. CVT enables the selection of the optimal agent for the scope of "voyage management" based on past interactions and collaborations recorded between the DTM operator and port agents. The selection is based on: 1) the partner property that reflects the agent's "skill level" and 2) the link property between the two parties, i.e. "personal trust". Both are visualised in relation to the scope of "voyage management". In Fig. 3 the skills of agent "Evans" are higher than those of agent "Smith'. The same applies for personal trust and, therefore, agent "Evans" is appointed as the most suitable partner. The DTM operator is then able to contact the agent and make an assignment for the specific task.

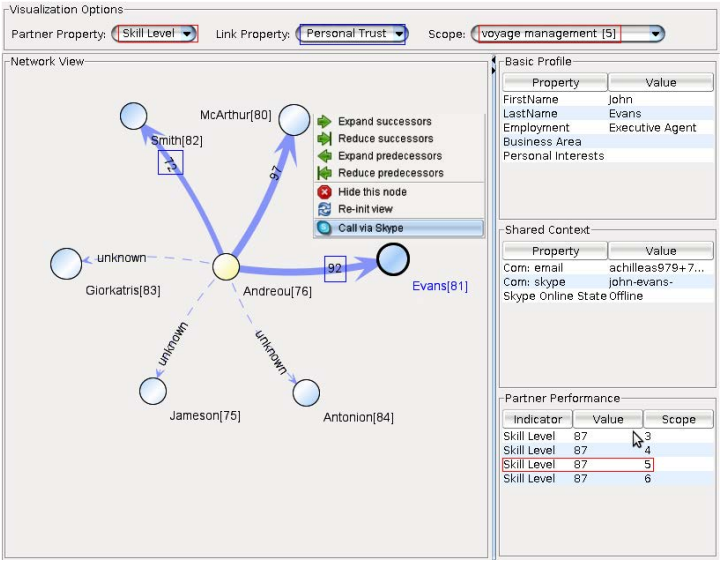

Fig. 3. Port agent selection through CVT

Using COIN the next step of PDA creation is performed by the port agent using an electronic form (Fig. 4). The form is completed by the agent and the transformation script (see Fig. 2) associated to the task is executed upon submission, generating a UBL-based PDA document. This format is uploaded into the COIN ISS. The DTM operator is notified that the negotiation task is pending and accesses the ISS service (Fig. 5). If the operator agrees to the terms, the agent is notified and a settlement is reached. Otherwise, the terms are changed until an agreement is reached. At the same time the involved parties are able to communicate via COIN Baseline communication services (i.e. Skype, email and instant messaging) in order to complement the actions of the ISS service and improve the efficiency of the negotiation process.

The next tasks are to finalise and distribute the PDA document. Hence, as presented partially in Fig. 6, the agreed terms are generated by the ISS service

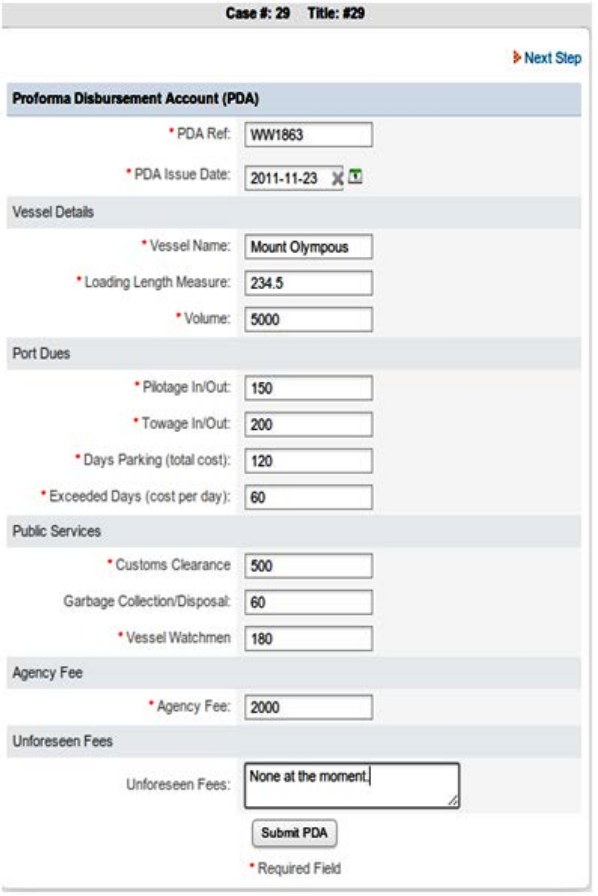

Fig. 4. PDA electronic form

in the form of a document. The PDA is then exported in PDF format and shared using the platform capabilities. Note that in the current scenario the use of the COIN TIS service is not necessary, since the PDA needs to be made available to all participating partners. The PDA distribution to the DTM operator, the vessel's captain and the DTM accountant is performed through ProcessMaker. The subsequent tasks are executed by the DTM operator, which is responsible for notifying the captain and the accounts department about the agent appointment and the agreed PDA terms. Instead of relying on email and fax documents along with DA-Desk, the Baseline Services are used for communicating with the captain, the agent and the accountant. For the accountant selection the CVT service can be exploited similarly as in the port agent selection case.

The following tasks (i.e. *Captain and Agent Updates and Feedback*) are executed in parallel through COIN Baseline Communication services. The next task is the responsibility of the port agent, who needs to modify the PDA in case

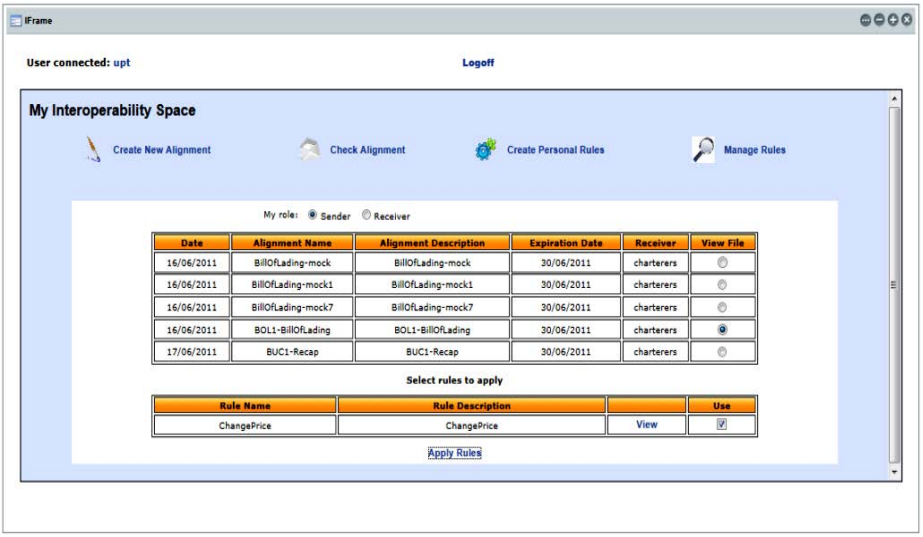

Fig. 5. Using the COIN ISS service

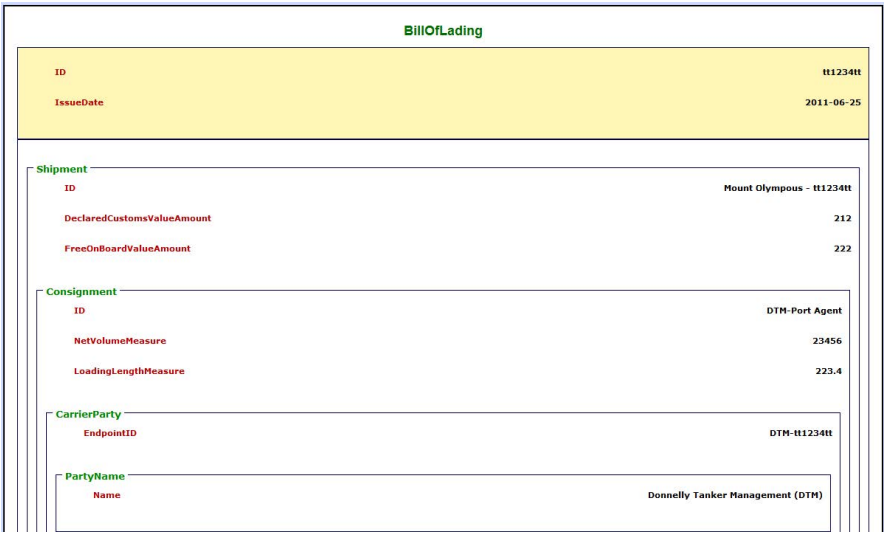

Fig. 6. Output document of the COIN ISS service

unforeseen situations have been encountered during the voyage loading, transport and discharge procedures. Through COIN all actions involve electronic versions of the final disbursement account with all parties being immediately aware of any changes performed. The final step is to close the voyage in DA-DESK. Note that the DA-DESK legacy system needs to be used at specific steps of the process and its usage is enabled via the data transformations.

Table 1 summarizes the differences in the exploited tools between the standard procedure followed for the PDA preparation, where common communication means are used, and the COIN-based procedure. Through the described scenario it has been observed that the exploitation of the COIN platform reduces the time needed for the communication between the parties and assists in avoiding errors, whereas the search for trusted port agent or an accountant becomes more efficient. These advantages were verified through the remarks stated by the DTM employees that participated in the evaluation and pointed out the overall simplification of the distribution and the negotiation process. As attested also in the food industry factories case study [14], the use of information technologies (i.e. enterprise collaboration and interoperability services) replacing routine communication operations reveal essentially a decrease of expenditures including elimination of human work. Consequently, in the COIN world all actions are performed electronically reducing the effort required for preparing and faxing multiple hard copies, while the COIN communication services are highly interactive and provide means for direct communication. Approximately 25% and 28% efficiency improvement was obtained respectively by recording the time needed to execute the business processes (i.e. workflows 1 and 2); 11 and 10 executions were performed respectively.

Table 1. Tools employed in PDA creation

Step	**Standard tools**	**COIN tools**
Contact Agent.	phone, email	CVT
PDA Negotiation.	hard copy, fax, phone, email	electr. PDA, ISS, Baseline Communication Services
PDA Finalization and Distribution.	hard copy, fax, phone, email	PDF, ProcessMaker
Captain and Account's Department Notification.	phone, email, fax	Baseline Communication Services, CVT
Updates and Feedback.	phone, email, fax	Baseline Communication Services
Final Dibursement and Close Voyage.	hard copy, fax	Baseline Communication Services

6 Conclusions

The goal of this work is to utilise and evaluate the efficiency of the COIN platform in terms of supporting processes in the marine domain. Hence, two business use cases were identified, analysed and implemented in the form of pilots. Moreover, the necessary extensions to COIN TIS and ISS services were developed in the form of transformation scripts. This was performed in order to facilitate the transformation of the electronic forms data to the required data formats

accepted as input by these services. The pilots provided the capability to evaluate the efficiency of executing the marine processes through the use of the COIN platform and its services. These processes were executed directly by the project industrial partners, which aided in quantifying the efficiency improvement in terms of reducing the time to carry out these processes. The feedback of the participating DTM employees has revealed that the COIN platform and its offered services can assist, accelerate and support efficiently organizational workflow processes. Thus, COIN has proven a necessary companion towards the transition of enterprises to fully ICT-based operations.

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