Enterprise Collaboration Network for Transport and Logistics Services

A. Luis Osório[1,3], Luis M. Camarinha-Matos[2], and Hamideh Afsarmanesh[3]

[1] Instituto Superior de Engenharia de Lisboa (ISEL), Portugal
lo@isel.ipl.pt
[2] FCT - Universidade Nova de Lisboa, Portugal
cam@uninova.pt
[3] University of Amsterdam (UvA), Netherlands
h.afsarmanesh@uva.nl

Abstract. The development of the Single Window concept (unique access/contact point for composite services) for the multimodal door-to-door freight transport management is a complex endeavour that is being addressed by the European MIELE project. Led by port authorities, the project identified the need for a novel strategy to foster collaboration among stakeholders with a diversity of processes and technology. The multimodal perspective requires a convergence and thus collaboration of maritime, railway, road, and air transport facilities as it is the case for the need of traffic information for a real-time (re)planning if some accident is hindering the current route. This requires that traffic information from different operators is integrated into the freight transport routing planner. Furthermore, a unified coordination and operations management of the existing business processes is lacking. To integrate such contexts, an open enterprise collaboration network (ECoNet) infrastructure is presented and discussed.

Keywords: Collaborative Networks, Logistics Single Window, Service Oriented Architectures.

1 Introduction

The Logistics Single Window (LSW) [2] and Port Community System (PCS) [9] concepts have been developed by the European MIELE project on proposing an IT infrastructure and systems to offer transport and logistics services for a door-to-door freight management. Led by port authorities, the project identified the need for a novel strategy to promote collaboration among stakeholders with a diversity of sizes, processes and technology. This need naturally emerges from the recognized complexity of managing the huge number of business messages, adopting diverse formats (GS1, EDIFACT, DATEX), exchanged by such heterogeneous group of logistics and transport stakeholders. Furthermore, customs and other government agencies are required to be efficient on the enforcement and authorization processes

L.M. Camarinha-Matos and R.J. Scherer (Eds.): PRO-VE 2013, IFIP AICT 408, pp. 267–278, 2013.

in other to make the overall multimodal and cross borders transport process as efficient as possible. The existing single window system for the Portuguese ports (the JUP[1] system) is mainly for the customs and other administration services. The Portuguese participating ports (Lisbon and Leixões) in the MIELE project adopted the development of a PCS as an extended single window accommodating business-to-business messages exchange. These two layered single windows (JUP and PCS) aim to contribute for an efficient movement of cross international borders cargo identified as a bottleneck for international trade and transport [9]. According the EPCSA[2] the PCS is "*pivotal in the Single Window concept and will reduce duplication of data input through efficient electronic exchange of information*" and "*a strategy to aggregates, optimizes, orchestrates, secures supply chain business processes for stakeholders enabling customs to focus on high risk cargo*". The multimodal perspective requires a convergence and collaboration of maritime, railways, road and air transport facilities and stakeholders with their own standards and normalization initiatives. The Intelligent Transport Systems (ITS) area, initially focused on the application of Information and Communication Technologies to the road infrastructures, is moving towards a multimodal approach and specialized areas as freight-ITS and Passenger ITS are being integrated to offer advanced goods transport and mobility services [6].

This trend is contributing for a growing involvement of organizations (from SME to large enterprises) as nodes of collaborative networks (CN) in this sector [1], [2]. As an example, a logistics service provider needs to collaborate with a logistics platform differently from the collaboration with the customs on exchanging legal documents. These distributed collaboration processes [15] are nowadays based on specific software and technological platforms. As suggested in [1], there is a need for a long-term cooperation agreement and adoption of common principles and infrastructure as a preparedness basis for different dynamic collaboration models. One important contribution to a high level abstraction is the ARCON, a reference model for collaborative networks, based on three main dimensions: i) life cycle management, ii) environmental perspectives both endogenous and exogenous, and iii) the intent as different modelling abstractions, as developed by the European project ECOLEAD [4], [5]. The proposed ECoNet and related concepts will be later framed on the ARCON reference model in an attempt to contribute to the consolidation of collaborative networks as a growing multidisciplinary scientific area. The ECoNet framework and infrastructure is an open bridge between the endogenous elements and the exogenous interactions.

The design of the ECoNet framework and infrastructure is motivated by the need to establish a simple and generic strategy to logically connect individual organizations. The collaboration context concept is discussed in [14] as a strategy to capture business collaboration development and management under the three dimensional views: behaviour, level and facet. For partners to integrate such networks they have to adapt their internal systems to access the offered services (proprietary APIs). Disparate internal organization's IT systems, as shown in the Fig.1, need to be connected (usually) through specialized electronic data interchange software

[1] JUP – *Janela Única Portuária*; or Port Single Window (PSW) in English.
[2] EPCSA European Port Community System Association - `http://www.epcsa.eu/`

managing specific collaboration contexts like UN/EDIFACT for order and invoicing electronic messages, DATEX traffic information messages [8], SWIFT banking messages, etc.

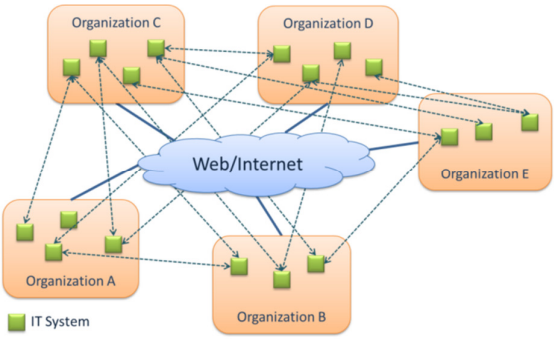

Fig. 1. Organizations manage uncoordinated point-to-point collaborations

Motivated by this difficulty and based on the concept of collaboration layer (CL) proposed and discussed in [16], this paper contributes with one step further by proposing an open generic framework and infrastructure based on the enterprise collaboration manager (ECoM) concept. The ECoM is an implementation of the proposed CL, based on an adaptive suite of services each one tailored to manage a specific collaboration context (CoC). By a collaboration context we mean an application domain where two or more organizations need to exchange electronic messages and coordination on pursuing some business objective. A CoC can embed (abstract) the integration to existing business platforms promoting in this way more peer-to-peer or flat collaborative relations (reduce business dependencies by adopting an open technology strategy). Such open framework establishes the ECoM nodes and makes the enterprise collaboration network (ECoNet) infrastructure.

2 The MIELE Transport and Logistics Single Window Challenge

The MIELE project on a Logistics Single Window (LSW) system, established the following main requirements:

- Shippers are able to source and book door-to-door (D2D) services with operations management and control along the supply chain;
- Definition and operations management of one-stop-shop Business-to-Business (collaborative) processes for logistics services;
- Integration of existing messaging and courier/transport services connecting Clients and Providers based on public and private services;
- Interconnect systems of different actors (carriers, logistics integrators, PCS and other logistics platforms) with the proposed LSW platform;

- Construction of optimized multimodal transport chains based on composition of available services from competing providers;
- There might be Logistic Integrators offering door-to-door transport solutions to customers, based on a pool (registered/trusted) of qualified service providers;
- Specific search and multi-criteria selection for transport and logistics providers (cost, delivery time, environmental impact, and evaluation of suppliers).

The LSW system establishes itself a complex ecosystem of B2B platforms, transport providers, and freight forwarders, needing to ensure interoperability and integration among existing and new technology systems. This raises the need for a minimal set of to guarantee interoperability. Such minimal commitment from a potential participating stakeholder might suggest the creation of a catalogue able to bind the selected services to the provider's technology supporting IT infrastructures.

The registered service providers should be able to publish their services in the LSW and this way be connected to other logistics integrators (composite service providers).

Such Logistic Integrators are able to build their own private networks while they establish compositions of services and related service providers eventually based on geographical or transport means that best fit the customers' needs. As many (competing) LSW platforms may exist, Logistics Integrators and Logistics Service (providers and clients) may be able to rank (qualify) the used services in order to establish a competitive federation of interoperable Logistics Single Window platforms. The Fig.2 shows the result of a call to the track-and-trace service.

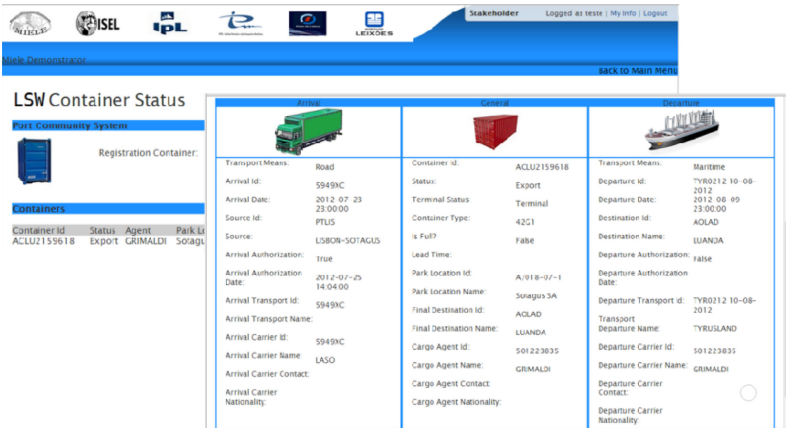

Fig. 2. An example of a container status from the LSW track and trace service

The logistics service users or customers search for simple or composite services according to some selection criteria (capacity, delivery time, cost and service level). The LSW is responsible to manage customer requirements and process them based on routing, ecological footprint, and other criteria considering the registered network of

Logistics Integrators. In a simple scenario and for a better understanding of the LSW capabilities, the first three business cases to be considered are:

1. Business case one:
   i. Apply for the role of Logistics Service Provider (LSP) and Logistics Integrator (LI);
   ii. Qualify as Service Provider and/or Logistic Integrator.
2. Business case two:
   i. Publish services.
3. Business case three:
   i. Apply for a specific logistic integrator network (membership);
   ii. Follow/execute integration procedures.

Dependencies from processes, information models and specific technologies – dependent from system vendors (vendor lock-in) makes the construction of the LSW platform a complex endeavour. In the following sections, a strategy based on the adoption of Collaborative Networks is proposed and discussed.

3 The Enterprise Collaboration Network (ECoNet)

One main objective for ECoNet is to establish a unified and trusted endpoint connecting any organization to a generic collaboration space. Such spaces supports a virtual organizations breeding environment (VBE) based on a minimal preparedness level. It is of the responsibility of the ECoM component to coordinate such participations by playing the role of adaptation/mediation between the companies' internal IT systems and the different collaboration contexts the organization participates in. A simplified SOA modelling language (SoaML) [13] model of ECoM is shown in Fig.3.

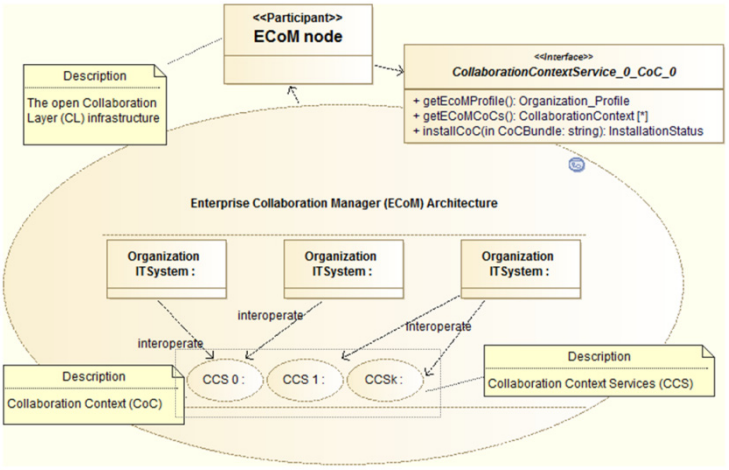

Fig. 3. A simplified SoaML model of an ECoM node

One of the main problems organizations face is the dependency from specific integration products and the lack of a unified management for such electronic business relations. The fast adoption of cloud computing services is deepening dependencies and raising the need for new interoperable frameworks able to support moving between alternative providers. In spite of the new possibilities brought by cloud computing, namely a growing trend for business process outsourcing and proposals to structure service delivery frameworks for communities, ecosystems and business networks [3], interoperability among approaches remains a main issue. Even if each individual subsystem is compliant with well-established operational service level agreement (SLA), the control of the commitments depends on more than one internal IT system, what makes its satisfaction difficult to manage and maintain. Furthermore, different internal IT systems are tightly linked through software adapters managing differently message commitments with different public authorities, implementing different versions of the DATEX message format standard [8].

The fast growing logistics single window (LSW) concept [2] is an application domain where collaboration infrastructures are centred on proprietary business platforms (INTTRA, DHL, GT Nexus). Participating organizations such as logistic providers or customers have to integrate their internal systems (ERP, SCM) following proprietary technology connector/adapters. This emerging complex web of collaboration contexts has been contributing for increasing technology dependencies and a number of other problems such as:

- Computational responsibilities (as IT applications/systems) answering business process requirements tend to establish integrated systems, as complex monolithic and vendor lock-in IT solutions.
- Difficult to join new strategic collaboration contexts as the costs and risks of adaptation discourage new technology developments. This results in a lack of dynamic adaptability to new business opportunities.
- Costs of the required complex IT systems are not compatible with the business risks SMEs are able to take.
- Different, while complementary, collaboration contexts are managed as "IT islands" as key internal IT systems follow proprietary integration strategies to adapt to peer organizations.
- Existing computer engineering abstractions are not powerful enough to develop a business-guided modularization process (processes modelling). Model driven architecture (MDA) [7] approaches are mainly for documenting rather than to be automatically interpreted by execution environments.

The proposed ECoNet abstraction establishes a minimal, context free infrastructure to connect trusted organizations. The network nodes identity management and access to implemented services adopt the results of the European eProcurement PEPPOL project [12]. While this project has been focused on specific collaboration contexts, one important contribution is related to the establishment of a trusted information transport infrastructure recently adopted by OASIS[3] as a new open specification. The specification moved meanwhile to the new BusDox Technical Committee, created to

[3] Advancing Open Standards for the Information Society (`www.oasis-open.org`).

establish a federated network of organizations able to safely and securely exchange documents. Other application specific domain contributions from PEPPOL were considered in specific ECoNet's collaboration contexts as discussed later in the paper.

The BusDox specifications include six main parts: i) the BDEA (Business Document Exchange Architecture), a specification based on the 4-corner model associated to the exchange of business documents; ii) the SMLP (Service Metadata Location and Publishing), a federated, secure, reliable and lightweight organization's addressing mechanism; iii) the START (Secure Trusted Asynchronous Reliable Transport), a reliable, secure and trusted asynchronous messaging system; iv) the LIME (Lightweight Message Exchange), a lightweight secure and reliable messaging protocol; v) a secure, trusted, asynchronous and reliable messaging based on ebMS (ebXML Message Service Specification); and conforming with interoperability tests to enforce specifications adoption. While other parts of the specification might be adopted in forthcoming evolution phases, the ECoNet initial version is based on the Service Metadata Location and Publishing (SMLP) [11]. Any ECoNet enabled organization is registered with a Service Metadata Publisher (SMP). A SMP is itself an ECoNet node and only the root needs to be created manually.

The signed and trusted metadata publisher is based on a minimal CN profile, making possible for peers to establish trusted electronic "conversations" through an existing collaboration context (CoC). Nevertheless, an effort will be developed to match as much as possible the concepts that are being developed by OASIS and, if possible, to contribute for a consensus on structural and modelling decisions.

The ECoNet infrastructure is therefore organized around three main components, as shown in Fig.4:

- Enterprise Collaboration Manager (ECoM) – abstracts a composition of one or more collaboration contexts, where ECoM = $\{CoC_0, CoC_1 \ldots CoC_n\}$, for $n > 0$. Any ECoM must have a system collaboration context that we identify as the Collaboration Context zero (CoC_0);
- Collaboration Context (CoC) – abstracts a specific collaboration and is made of one or more collaboration context services (CCS), where CoC = $\{CCS_0, CCS_1 \ldots CCS_k\}$, for $k > 0$. The collaboration context service zero (CCS_0) is a mandatory (system) service and establishes the CoC entry point;
- Collaboration Context Service (CCS) – abstracts an atomic computational responsibility that can be implemented based on the Cooperation Enabled System (CES) [17] framework. In a first phase the collaboration context services are being implemented on a free technology strategy approach. The access to a CoC is done through its entry point (mentioned above).

To demonstrate the main features of the proposed ECoNet infrastructure, an enterprise chat (ECoChat) is being developed as a specific collaboration context. It aims to put at conversation authorized users from the participating organizations.

The reutilization of common functionalities (CCS services) can be shared if using the cooperation enabled system (CES) framework, making it available as a system service. Nevertheless, a main concern on designing the ECoNet was the simplicity and, as much as possible, maintaining isolation (independency) among collaboration contexts.

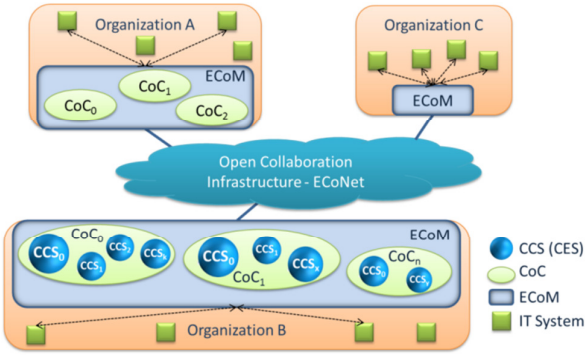

Fig. 4. The main components of the ECoNet infrastructure

4 The Enterprise Collaboration Manager

A Collaboration Context is defined as a set of services under a coordinated choreography on contributing for some valuable (business) objective. Its structure depends on the required services to answer context requirements. The proposed ECoChat demo collaboration context, initially supporting instant messaging, might evolve for an enhanced application if extended to provide audio and video and advanced management features. A collaboration context can be seen also as a collaboration application in the sense it incorporates mechanisms making possible for people or systems to work together for some common objective. It is important to note that openness is limited to the ECoNet infrastructure. Depending on the adopted strategy, a specific collaboration context can be developed and in this case all the network members need to adopt the same IT solution.

In the MIELE project, an open specification for a logistics single window (LSW) collaboration context will be designed and demonstrated. In this case a collaboration context will manage a number of collaboration processes (or services) on cooperating to door-to-door multimodal freight transports.

The Enterprise Collaboration Manager (ECoM) is a composition of one or more collaboration contexts where CoC_0 is the collaboration context zero (or system context), responsible for the establishment of an ECoNet node. In the next abstraction layer the collaboration coordination/context service zero (CCS_0), as mandatory member of CoC_0, has the responsibility to establish the ECoM trusted network (the ECoNet VBE). An organization that wants to adhere to ECoNet should proceed in the following way in order to be part of the ECoNet VBE:

- Access an ECoNet registry directory provider:
  - Register as a new ECoNet node by filling a registration form and by exchanging trusted information (eventually with the need of some legal document from some governmental authority).
  - The new registered node has the possibility to make its profile private or public (modes: secret, private, public). Where secret mean no other organization has access to the profile; private means restricted access ECoNET VBE members; and public means access without any restriction.

- Download the ECoM basic infrastructure or configure the access through a ECoNet service provider based on a cloud computing infrastructure [10]:
  - The basic infrastructure includes the CoC_0 and the respective CCS_0 responsible for the basic services and more precisely for the establishment of the ECoNet VBE;
  - Includes also the ECoChat collaboration context as a reference implementation for a specific collaboration context.

As proposed in [17] the objective of the utilization of CCS services implemented as CES entities is to establish a dynamic adaptable IT infrastructure independent of specific technology frameworks (.NET, JEE, etc.). Nevertheless, considering the underlying complexity associated to the specificities of each collaboration context, the ECoNet framework does not restrict the implementation strategy. However, in a potential later normalization process to promote an open specification for a collaboration context, an adaptive modularity approach needs to be adopted. The main objectives of the adopted ECoNet infrastructure are:

- Provide an integrated management and coordination of collaboration relation;
- A unified representation of specific collaboration contexts based on collaboration context services (CCS);
- An open marketplace for innovative collaboration contexts, e.g. www.econet-cno.org/CoC-marketplace/.

The ECoNet infrastructure is itself organized as a collaboration context where the CCS_0 is responsible to manage a root registry, Fig.5. This registry stores the profiles of registered organizations, those that are members of the ECoNet VBE. The ECoNet specification is what we can mention as the ECoNet collaboration context (CoC_0) normalization process.

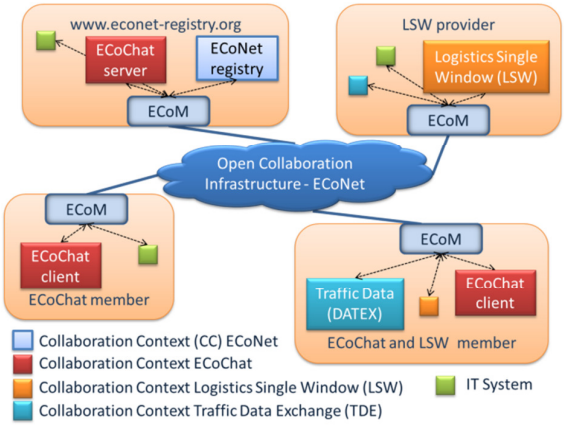

Fig. 5. The Collaboration Contexts ECoNet, ECoChat and LSW

The ECoNet framework is being validated in four main collaboration contexts, as shown in Fig.5:

- The ECoNet collaboration context responsible to establish the ECoNet breeding environment as a trusted collaborative network (CoC_0);
- An organizational network making possible for organization users to exchange messages, develop conversations and meetings and other specialized functionalities;
- Exchange of traffic messages using the DATEX standard and based on the management of contractual commitments (agreed SLAs);
- The collaborative network established by an implementation of the Logistics Single Window (LSW) concept for transportation services considering an integrated management of door-to-door freights.

A first version of an ECoNet organization's profile (ECoM node) is shown in Fig.6.

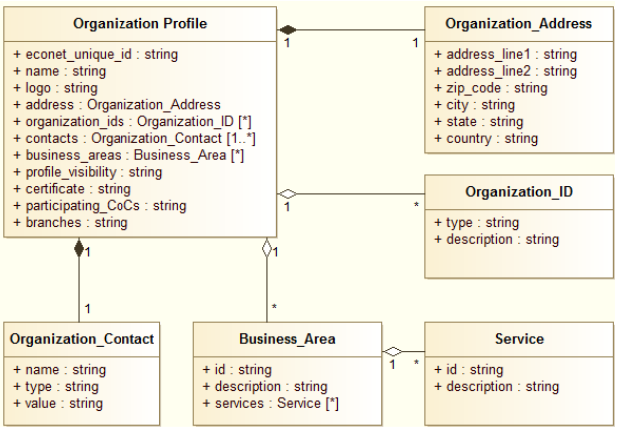

Fig. 6. A first version for the ECoM node profile

Nevertheless, the success of the proposed framework depends on proving key aspects such as:

- Being able to demonstrate a robust dependability strategy considering aspects like security, reliability, scalability, and completeness against the specificities of business requirements depending on specific business domains;
- A development and execution model coping with existing processes and technology dynamics (achievements and innovations) from communication, computer engineering, to business modelling expectations and strategies;
- Adaptive framework accommodating novel process and technology patterns namely to be able to cope with complexity growing holistic (systemic) approaches from sensors/actuators to business intelligence services;

The demonstrators under development (ECoNet system collaboration context, ECoChat, LSW and TDE) will help to validate the initial design and to tune further developments towards an open collaboration (technology agnostic) framework.

5 Conclusions

The growing adoption of process automation, accelerated by the emergence of computing as a utility, is focusing the research challenges into multidisciplinary systemic approaches. In this sense, the Logistics Single Window (LSW) offers a single point of contact for a diversity of stakeholders with their own IT systems. The stakeholders involve port authorities, transport and logistics services providers, customs, shipping agents, freight forwards, road concessionaries, logistics platforms, traffic management centres, to mention only a few. The number and diversity of normalization organizations, business and technology cultures, knowledge bodies, regulation cultures, and other aspects establish a complex ecosystem. Furthermore, it represents a complex endeavour for the computer science and engineering on a balanced and multidisciplinary approach to help to structure such web of heterogeneous stakeholders.

The proposed ECoNet framework and infrastructure, with its Collaboration Contexts (CoC) and Collaboration Context Services (CCS), establishes a trusted Virtual organizations Breeding Environment (VBE) able to manage and coordinate a diversity of collaboration contexts. A reference implementation is being developed for the Logistics Single Window (LSW) and Port Community System (PCS) sample services (MIELE project). To demonstrate the generality of the proposed models two other collaboration contexts are being developed, namely a demo chat application (ECoChat) and a Traffic Data Exchange for the Brisa highway concessionaire. The strategy is to validate the integration of services from a road operator and maritime/ports and logistics related service providers (MIELE stakeholders).

Acknowledgements. This work was partially supported by Brisa Innovation and Technology, and Administration of the Port of Lisbon and Porto, Leixões (APL/APDL) through research and development grants with participation in the European **MIELE** (Multimodal Interoperability E-services for Logistic and Environment sustainability) project. The MIELE project has the participation of INESC-TEC and Porto Business School (PBS), beyond other partners. Reference implementation of ECoNet framework concepts and demo examples has been developed by Paula Graça, Ana Mourato and Tiago Dias. Concepts from the European project **GloNet** were also adopted.

References

[1] Afsarmanesh, H., Camarinha-Matos, L.: A framework for management of virtual organization breeding environments. In: Camarinha-Matos, L., Afsarmanesh, H., Ortiz, A. (eds.) Collaborative Networks and Their Breeding Environments. IFIP, vol. 186, pp. 35–48. Springer, Boston (2005)

[2] Ahn, K.: The study of single window model for maritime logistics. In: 2010 6th International Conference on Advanced Information Management and Service (IMS), pp. 106–111 (2010)

[3] Barros, A., Kylau, U.: Service delivery framework - an architectural strategy for next-generation service delivery in business network. In: 2011 Annual SRII Global Conference (SRII), March 29-April 2, pp. 47–58 (2011)
[4] Camarinha-Matos, L.M., Afsarmanesh, H., Ermilova, E., Ferrada, F., Klen, A., Jarimo, T.: Arcon reference models for collaborative networks. In: Camarinha-Matos, L.M., Afsarmanesh, H. (eds.) Collaborative Networks: Reference Modeling, pp. 83–112. Springer US (2008), 10.1007/978-0-387-79426-6_8
[5] Camarinha-Matos, L.M.: Collaborative networked organizations: Status and trends in manufacturing. Annual Reviews in Control 33(2), 199–208 (2009)
[6] Giannopoulos, A.G.: Towards a european its for freight transport and logistics: Results of current eu funded research and prospects for the future. European Transport Research Review 1(4), 147–161 (2009)
[7] Jackson, E.K., Kang, E., Dahlweid, M., Seifert, D., Santen, T.: Components, platforms and possibilities: Towards generic automation for MDA. In: Proceedings of the Tenth ACM International Conference on Embedded Software, EMSOFT 2010, pp. 39–48. ACM, New York (2010)
[8] Ricardo, R., Costa, C., Lopes, J., Sequeira, N.: Traffic data exchange and publication through the datex protocol. In: Easyway 2nd Annual Forum (2009)
[9] Long, A.: Port community systems. World Customs Journal (2009)
[10] Marinescu, D.C.: Cloud Computing: Theory and Practice. Computer Science Division; Department of Electrical Engineering & Computer Science, University of Central Florida, OrlandoUSA (2012)
[11] oasis bdea. Business document exchange architecture - beda (March 2011)
[12] Olnes, J., Andresen, A., Arbia, S., Ernst, M., Hagen, M., Klein, S., Manca, G., Rossi, A., Schipplick, F., Tatti, D., Wessolowski, G., Windheuser, J.: Electronic signatures for public procurement across europe. In: Pohlmann, N., Reimer, H., Schneider, W. (eds.) ISSE 2008 Securing Electronic Business Processes, pp. 251–261. Vieweg+Teubner (2009)
[13] OMG-SoaML. Service oriented architecture modeling language (soaml) (May 2012)
[14] Orriens, B.: Modeling the business collaboration context (January 2006)
[15] Osorio, L.A., Camarinha-Matos, L.M.: Distributed process execution in collaborative networks. Robot. Comput.-Integr. Manuf. 24, 647–655 (2008)
[16] Osório, A.L., Afsarmanesh, H., Camarinha-Matos, L.M.: Open services ecosystem supporting collaborative networks. In: Ortiz, Á., Franco, R.D., Gómez Gasquet, P. (eds.) BASYS 2010. IFIP AICT, vol. 322, pp. 80–91. Springer, Heidelberg (2010)
[17] Osório, A.L., Camarinha-Matos, L.M., Afsarmanesh, H.: Cooperation Enabled Systems for Collaborative Networks. In: Camarinha-Matos, L.M., Pereira-Klen, A., Afsarmanesh, H. (eds.) PRO-VE 2011. IFIP AICT, vol. 362, pp. 400–409. Springer, Heidelberg (2011)