



**HAL**  
open science

## A Platform to Support Collaboration and Agility in Logistics Web

Raphaël Oger, Frederick Benaben, Matthieu Luras

► **To cite this version:**

Raphaël Oger, Frederick Benaben, Matthieu Luras. A Platform to Support Collaboration and Agility in Logistics Web. IPIC 2016 - 3rd International Physical Internet Conference, Jun 2016, Atlanta, United States. hal-02123699

**HAL Id: hal-02123699**

**<https://hal.science/hal-02123699>**

Submitted on 8 May 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## **A Platform to Support Collaboration and Agility in Logistics Web**

Raphaël OGER<sup>1</sup>, Frédérick BENABEN<sup>1</sup> and Matthieu LAURAS<sup>1</sup>

1. University of Toulouse – Mines Albi, Industrial Engineering Center, Campus Jarlard, Route de Teillet, 81013 Albi, France

Corresponding author: [frederick.benaben@mines-albi.fr](mailto:frederick.benaben@mines-albi.fr)

### **Abstract:**

*Since time immemorial, collaboration between entities (people, companies, states, etc.) is our world strength. However, this collaboration efficiency is always limited by our technology development speed. One of the current challenges is the difficulty to make interoperate different entities having their communication based on new information technologies (mainly because of the great diversity of these new information technologies). So, our research ambition is to define main concepts and an architecture for Mediation Information Systems (MIS). Firstly, MIS ables to make interoperate a multitude of different entities in order to allow them to reach common goals. Secondly, MIS being agile (i.e., being able to detect unexpected events and adapt in response). Finally, MIS implementing these two previous characteristics in an as automated way as possible (i.e., using as less human actions as possible). In this paper, we summarize the MISE (Mediation Information System Engineering) approach aiming to reach our MIS ambition, and we introduce the third iteration of this project. Finally, we illustrate our results using a logistic domain use case: French drug deliveries to pharmacies.*

**Keywords:** *Mediation Information System, Agility, Collaboration, Knowledge Management, Internet of Everything*

## **1 Introduction**

The Physical Internet (PI) has been introduced recently to solve the Global Logistics Sustainability Grand Challenge (Montreuil, 2011). Montreuil et al. (2012) affirm that introducing a new infrastructure such as the PI generates an intense wave of innovative change in business models. This is notably due to the very high level of collaboration that PI implies. Actually, PI consists in a Global Logistics Web (Montreuil et al., 2012) that interconnects all the logistics services through the encapsulation of the goods in smart modular containers (PI-containers) and the use of open logistics facilities (PI-hubs) (Ballot et al., 2012).

Such Logistics Web goes beyond the development of usual Supply Chain networks known in the literature. But to reach this goal, PI should enhance the strategic role of communications and information technologies all along the Supply Chain (Montreuil et al., 2012). As described by (Sallez et al., 2016), PI-containers and PI-hubs must be active to perform adequately in the

Logistics Web. This activeness consists in continuously (i) transmitting data that will be (ii) interpreted in order to (iii) support decisions. In our research work, we suggest to make a parallel between those PI objectives and the current literature on *Internet of Everything*. Basically, *Internet of Things* can support the data transmission issue, while *Internet of Knowledge* and *Internet of Services* can support the data interpretation and the decision-support issues respectively.

This idea has been made concrete through the MISE (Mediation Information System Engineering) project. This project is dedicated to provide a support framework for collaborative situation by deploying agile mediation information system (MIS) among partners. Obviously, due to its strong collaborative nature, the Logistics Web is a preferred field of application for MISE, even if other application domains have also been developed (e.g. Crisis Management or Healthcare Management). The general principle of the MISE approach is structured according to three steps:

1. *Design of collaboration model*: this level concerns the gathering of knowledge about the considered collaborative situation in order to instantiate concepts of the so-called collaborative metamodel (concerning mainly environment of the collaboration, objectives of the collaboration, partners and services of the collaboration).

2. *Deduction of collaborative behavior model*: the second step deals with the automated deduction of collaborative processes, based on the knowledge collected at the previous level. Schematically, the aim is to select and organize partners' services according to objectives and environment of the collaboration.

3. *Deployment of the appropriate Mediation Information System (MIS)*: the previously deduced business behavior (processes) is translated in a technical behavior (workflows) in order to be implemented. The goal is mainly to match services with activities and data with information.

Furthermore, these three steps are used in an agile framework, which deals with detection of evolution and adaptation of behavior. Performing agility of MIS is based on data (*i.e.*, event in an event-driven architecture) analysis (*i.e.*, according to the received event, is the situation in line with what is expected?) and on behavior adaptation (by invoking step 1, step 2 or step 3 depending on the nature of the event analysis). On a technical point of view, MISE project is based on a Service Oriented Architecture (SOA) paradigm and MISE tools are deployed as web-services on an Enterprise Service Bus (ESB).

In this paper, we illustrate concretely the way MISE might be used thanks to a Logistics Web application dedicated to the agile drug deliveries to French drugstores. Practically, a delivery area is watched through an Event Driven Architecture (EDA) platform, in order to gather all events (from sensors, services, people, devices, and in a very near future PI-containers) in order to build and maintain a global picture of that area. According to some unexpected (or expected) changes (such as an unexpected emergency order, a lot of GPS data showing that a lot of vehicles are stopped, some abnormal values of temperature sensors, etc.), the MISE platform could start the behavior deduction based on (i) information concerning the situation (risk, facts, etc.) and (ii) information concerning delivery means (resources, lead-times, etc.) both extracted from the global picture. Thanks to the implementation step a MIS may be deployed among the stakeholders (drugstores, transportation provider, wholesalers, manufacturers, etc.). Agility of this MIS could be performed thanks to models based on the global picture. Practically, we develop a specific and realistic drugstores' delivery scenario that shows how the MISE system could support the concepts of PI and Logistics Web.

The second section of this article provides an overview of the three iterations of MISE projects, their links, their specificities and their logical structure. Third section presents specifically the MISE 3.0 iteration and the associated features for each step of the MISE structure. Fourth section presents the example of the drugstores delivery. Finally, the fifth section concerns conclusion and perspectives about the MISE approach.

## 2 MISE iterations

### 2.1 General overview of the MISE approach

This overall MISE approach might be seen as a dive into abstraction layers based on model-driven engineering [5]. Even if there are some differences and specific features, each of the three iterations of MISE project is structured according to the three previously presented steps and the associated agile framework. Furthermore, on a technical point of view, these iterations are all centered on SOA principles and on web-services. The following picture illustrates the global MISE approach (three steps in an agile framework) and underlines schematically the specificities of first and second iterations:

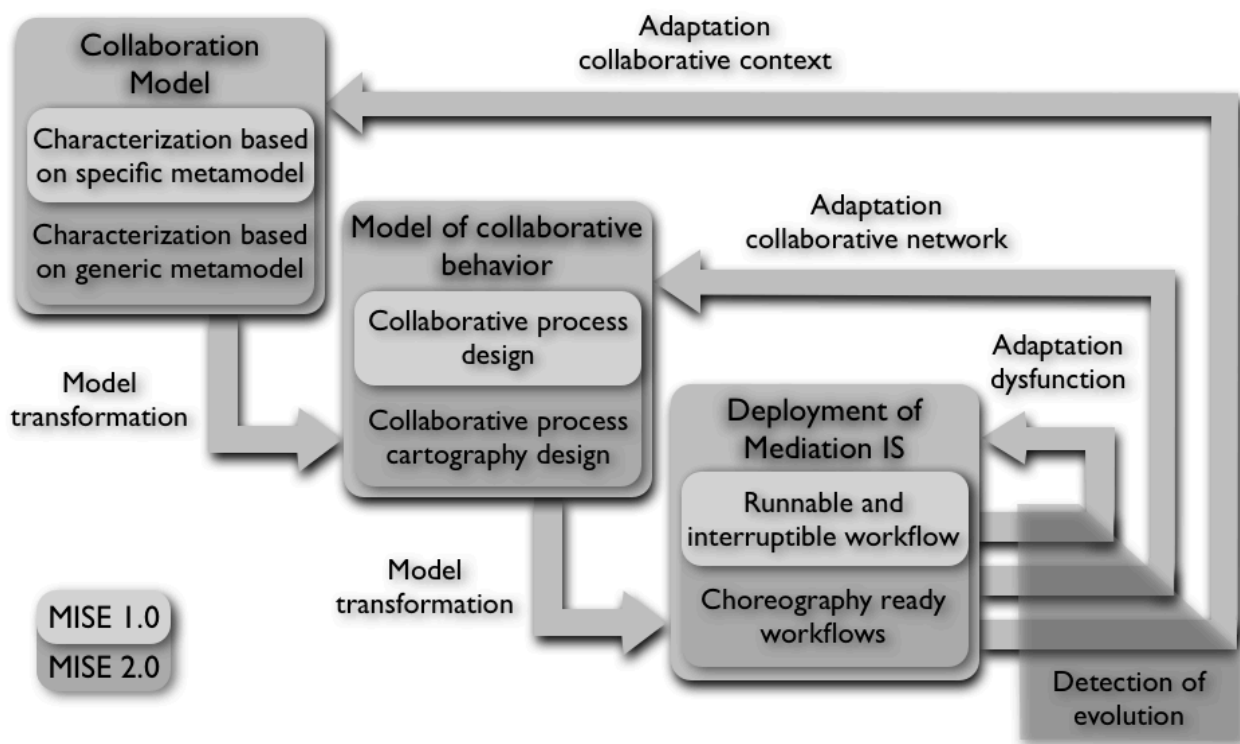


Figure 1: MISE project overall structure including MISE 1.0 and MISE 2.0 iterations

On the previous figure, the three steps of MISE approach are represented from MISE 1.0 and MISE 2.0 perspectives. The *three steps* of MISE structure are presented in a waterfall sequence together with *detection* mechanism and *adaptation* loops. For every step, both first MISE iterations specificities are mentioned. It is crucial to notice that there are in fact four “so-called” steps in the MISE approach, but, in the previous big picture, the first three steps (dedicated to design-time) are presented as boxes while the last one (dedicated to run-time) is represented through the three looping arrows.

## 2.2 MISE 1.0 and MISE 2.0 articulation

MISE 1.0 uses domain specific metamodels (crisis management, manufacturing, etc.) to gather the knowledge in a meaningful collaborative situation model. That knowledge is extracted and transformed (according to [2] and [7]) to provide one single appropriate collaborative process dedicated to support the characterized (thanks to the gathered knowledge) collaborative situation. An additional knowledge concerning information about technical services (applications or functions) is then imported to define how activities of this collaborative process model may be concretely achieved and orchestrated. Once that additional knowledge integrated, the process model is transformed into a workflow model that can be run (thanks to an ESB and its workflow engine). There are several drawbacks with that first MISE iteration. Most important ones are the following:

- The use of domain specific metamodels does not allow the approach to be relevant for any kind of collaborative situation. Furthermore, there are several associated knowledge bases (one per metamodel), which cannot be used conjointly. Consequently, the concerned knowledge elements and the embedded behavioral schemes should be duplicated (or abandoned).
- Deducing one single collaborative process is not very relevant. First, most organizations are structured according to *decisional*, *operational* and *support* processes (ISO 9000-2001 recommendations [10]). Consequently, it would be significant to structure the deduced behavior according to that schema and to obtain processes covering *decisional*, *operational* and *support* views.
- The transition from business process (embedding business activities and business information) to technical workflows (concerning technical services and technical data) is quite raw: the way the technical description of services is integrated in workflow models is automated (through model transformation) but the precise selection is manual.
- Concerning agility (defined as “*detection + adaptation*”), if the adaptation functionality is assumed by the service-oriented structure, which allows to invoke design-time services at any required moment (in order to re-define the appropriate behavior), the detection functionality is fully manual, based on human analysis of reports and information coming from the situation.

Considering the previous elements, MISE 2.0 aims at reusing MISE 1.0 results and adding some new features. Therefore, one single metamodel representative of all collaborative situations) has been defined [4], avoiding the need for a new metamodel for every situation. This metamodel, the instances of the associated ontology (*i.e.*, the ontology structured according to this metamodel) and associated deduction rules (defined from concepts of the considered metamodel and dedicated to deal with instances of the associated ontology) can hence be used in any collaborative situation. This structural improvement reduces the first listed drawback. In addition, MISE 2.0 uses an objective typology to deduce a complete collaborative process cartography including several processes, which are typed as *decisional*, *operational* and *support* processes. This point tackles the second drawback. Besides, semantic reconciliation mechanisms have been injected (as described in [3]) in order to deal with the transition from business processes to technical workflow (*i.e.*, the third drawback of the previous list). This improvement uses semantic annotations of business activities on the one hand and of technical services on the other hand, in order to select the most appropriate

subset of technical services to ensure the behavior described by the considered business activities. Based on semantic annotations of information, these research results also provide on-the-fly data translation in order to assume correct orchestration of the selected technical services. Finally, an event-driven architecture (including a complex-event processing tool [11]) is added to the service-oriented structure of the MIS. This improved technological platform provides two main interests. The first one concerns choreography of multi-processes. Deducing a collaborative process cartography implies to be able to orchestrate each workflow but also to manage the coordination of these workflows. Workflow orchestration is assumed by the SOA structure while coordinating several workflows is assumed by the EDA structure (through choreography). The second one concerns the detection part of agility. Services (but also other devices or sensors) are able to send events. These events might be used by the system to detect any unexpected situation. This diagnosis mechanism is a solution to reduce the fourth identified drawback [12]. The following table summarizes the specificities of MISE 1.0 and MISE 2.0.

MISE 1.0 and MISE 2.0 are associated with some concrete application fields. For instance, ISyCri project concerns MISE 1.0 in crisis management context [6], while ISTA3 project concerns MISE 2.0 in manufacturing scope [13].

*Table 1: Specificities of first and second iterations according to steps of MISE approach*

	<b>MISE 1.0</b>	<b>MISE 2.0</b>
<b>Collaboration Model</b>	Domain specific metamodels have been defined, depending on considered business fields (crisis management [6], manufacturing context [7])	One generic metamodel, dedicated to all types of collaborative situations has been defined (including external layers, enclosing domain specific concepts)
<b>Model of Collaborative behavior</b>	One single collaborative process has been deduced from the gathered knowledge.	Decisional, Operational and Support processes have been deduced from the gathered knowledge.
<b>Deployment of Mediation Information System</b>	After manual identification of technical services (or user-interfaces) that would assume identified business activities of the deduced collaborative process, the process is translated in BPEL language in order to be computerizable.	Automatic semantic reconciliation allows selecting subsets of technical services that will be invoked to assume business activities of collaborative processes on a technical point of view. Furthermore, ontological tools ensure "on-the-fly" data conversion [3].
<b>Agility (detection + adaptation)</b>	Detection is a manual task based on the way situation evolves. Once detected a need of adaptation, design-time tools (model editor, process deducing tool, workflow translator) may be invoked on purpose in order to (re)define the collaborative behavior appropriate for the "new" situation.	Detection is based on an EDA. Sensors and services publish their events (reporting on the situation and on workflow progress) that can be used to update situational models. If the current model differs from the expected model, then adaptation must be started based on the same principle than MISE 1.0.

However, there are still drawbacks in the MISE approach that will need to be addressed in the MISE 3.0 iteration. First, MISE 2.0 only focuses on some main drawbacks from MISE 1.0. Second, new features potentially bring new drawbacks that should also be considered. Following section presents these drawbacks and introduces MISE 3.0 as a potential way to reduce them.

### 3 Specific Improvements of MISE 3.0

MISE 1.0 and MISE 2.0 did provide a solution for collaborative situation support by deploying a MIS between heterogeneous organizations. However, even if MISE 1.0 provides a first conceptual backbone and a full suite of tools, even if MISE 2.0 provides some tangible improvements and fixes some critical problems, there are still some concrete research avenues to explore.

### **3.1 Knowledge Gathering: collaboration model**

In MISE 1.0 and MISE 2.0, knowledge gathering is based on a specific filling (by the user) of the instantaneous information available concerning the collaborative situation (its objectives, its specificities and the means available to achieve these objectives). In MISE 3.0, the ambition is to use EDA to continuously gather the knowledge (about organizations and situation) and continuously update the models (describing organizations and situation). The principle is to use an *event market place*, where each service and each device of the considered ecosystem publish its own events (*i.e.*, reports, messages and information describing its status). By watching this *event market place* the system obtains a continuous *image* of the considered ecosystem. Moreover, the collected *events* are used to instantiate a model from the collaboration metamodel and to create the specific instances of this *model* for the current situation. By observing this *model* the system can diagnose any collaboration opportunity (for instance by checking some specific variables or detecting some significant patterns). Furthermore, when diagnosing any collaboration opportunity, the required *collaboration model* is already fulfilled, available and operational, thanks to this event-based principle.

### **3.2 Behavior Design: model of collaborative behavior**

In MISE 1.0 and MISE 2.0 the collaborative process(es) deduction is “binary”: the apparently most appropriate structure of activities is built and is the result of the deduction step. However, MISE 3.0 includes a more soft principle, which (i) provides several models of potential behavior (depending on different options, different priorities and different layouts of relevant activities) and (ii) integrates decision support system to assist the user in selecting the most suitable one.

Regarding the decision support system, an important feature concerns Key-Performance Indicators (KPI). Because, the idea is to deduce not only the adequate collaborative behavior but also the associated indicators. We propose to define two sets of KPI. The first one (inspired by [13]) allows comparing objectively the different scenarios of collaboration (on business and technical points of view) during second and third steps of MISE. The second one consists in designing a performance measurement system able to support the control of the most relevant collaborative workflows (inspired by [9]) during the fourth step of MISE.

Finally, second step of MISE 3.0 deduces several potential business behaviors (collaborative process cartography), the design-time decision support system and its associated KPI (to be used to select the appropriate business behavior, but also the appropriate technical behavior) and the run-time KPI (to support decision-makers to control “manually” the business and technical behaviors).

At the end of this second step, the user obtains (i) a set of design-time indicators defining expected performances, (ii) the adequate collaborative behavior to support the considered situation (collaborative processes selected among the deduced ones thanks to design-time KPI) and (iii) a set of run-time indicators (performance measurement system) to control this collaborative behavior during execution.

### 3.3 Implementation: deployment of Mediation IS

Similarly to second step, in MISE 1.0 and particularly in MISE 2.0, the translation of collaborative workflows (from deduced collaborative processes) is a “binary” task: semantic reconciliation (information/data and activities/services) select the most fitting technical elements to implement the deduced business collaborative behavior. In MISE 3.0, the idea is also to use non-functional requirements extracted from previously deduced design-time indicators during the semantic reconciliation step. By this way, the design of technical workflows (based on services and data) to implement business processes (based on activities and information) rests on functional and non-functional requirements. Concretely, instead of selecting technical services only on the basis of expected function (for instance “weather measurement”), non-functional requirements (such as *response time, reliability, security*, etc.) are also taken into account (for instance “weather measurement within 2s with encoded data”).

### 3.4 Agility: detection and adaptation

This step is really based on the MISE 1.0 and particularly MISE 2.0 principles: detection through EDA system and adaptation through a new run of one of the design-time steps (function of the nature of the problem detected). But in the previous versions of MISE, the detection was based only on a comparison of models (current model differs from expected one). In MISE 3.0, we propose to add to this, a way that allows the decision-maker to detect himself an abnormal situation through the use of the performance measurement system defined in step 2 (run-time KPI). Actually, the interpretation of such system is quite “human” and very difficult to automatize due to the interdependency between KPI. In other words, MISE 3.0 proposes a combination of automatic detection and human detection in order to improve responsiveness (and consequently agility) of the overall collaborative system.

### 3.5 MISE 3.0 synthesis

According to the previous points, the third MISE iteration provides improvements that may be summarized according to the following table:

Table 2: Specificities of the third iteration according to steps of MISE approach

	MISE 1.0	MISE 2.0	MISE 3.0
Collaboration Model	<i>Domain specific metamodels have been defined, depending on considered business fields (crisis management [6], manufacturing context [7])</i>	<i>One generic metamodel, dedicated to all types of collaborative situations has been defined (including external layers, enclosing domain specific concepts)</i>	Based on an EDA, one (or several) systems may be supervised in order (i) to detect any collaboration opportunity and (ii) to be immediately informed of all potential partners status (thanks to a continuous watching of the overall system)
Model of Collaborative behavior	<i>One single collaborative process has been deduced from the gathered knowledge.</i>	<i>Decisional, Operational and Support processes have been deduced from the gathered knowledge.</i>	Deducing several process cartographies (and associated sets of KPI) is a first improvement. Besides, associating a decision-support system (in order to assist the user in selecting the right one) is a second improvement.
Deployment of Mediation Information	<i>After manual identification of technical services (or user-interfaces) that would</i>	<i>Automatic semantic reconciliation allows selecting subsets of</i>	The main feature at this step is to include non-functional requirements in the semantic reconciliation step.



<b>System</b>	<i>assume identified business activities of the deduced collaborative process, the process is translated in BPEL language in order to be computerizable.</i>	<i>technical services that will be invoked to assume business activities of collaborative processes on a technical point of view. Furthermore, ontological tools ensure “on-the-fly” data conversion [3].</i>	Characteristics such as <i>reliability, latency</i> or <i>security</i> might then be taken into account in the workflow definition process in order to improve the quality of the selected technical services. Furthermore, decision-support system should also be integrated in that step in order to support efficiently the final selection.
<b>Agility (detection + adaptation)</b>	<i>Detection is a manual task based on the way situation evolves. Once detected a need of adaptation, design-time tools (model editor, process deducing tool, workflow translator) may be invoked on purpose in order to (re)define the collaborative behavior appropriate for the “new” situation.</i>	<i>Detection is based on an EDA. Sensors and services publish their events (reporting on the situation and on workflow progress) that can be used to update situational models. If the current model differs from the expected model, then adaptation must be started based on the same principle than MISE 1.0.</i>	The most important feature concerns the automated detection of evolution on the base of performance indicators ( <i>i.e.</i> , not only on the base of expected functions but also on the quality of these functions).

### 3.6 Application domains

MISE project, is dedicated to provide a support framework for collaborative situation by deploying an agile mediation information system among partners. Currently, there are mainly three application domains (but there might be much more): support of logistics systems, support of health care systems and support of crisis management systems. The next section presents a use case based on logistics in health domain. We can also illustrate concretely the way MISE 3.0 might be used thanks to the last domain mentioned (crisis management): a geographical area may be watched through an EDA platform, in order to gather all events (from sensors, services, people, devices, etc.) in order to build and maintain a global picture of that area. According to some unexpected (or expected) changes (such as a lot of tweets mentioning the same problem, a lot of GPS data showing that a lot of vehicles are stopped, some abnormal values of temperature sensors, etc.), the MISE 3.0 platform could start the behavior deduction based on (i) information concerning the situation (risk, facts, etc.) and (ii) information concerning rescue means (resource, potential actors, etc.) both extracted from the global picture. Thanks to the implementation step a MIS may be deployed among the potential partners. Agility of this MIS could be performed thanks to models based on the global picture.

## 4 Illustration with the drugstores delivery use case

In this paper we develop the case of French drug deliveries to pharmacies. Actually, in the French context, drugs and over-the-counter medicines are produced by different pharmaceutical companies and distributed through a two-level network composed of wholesalers and pharmacies (see. Figure 2). The French law imposes a minimum stock for each product in a wholesaler’s warehouse. Consequently, in our study we consider no shortage at wholesaler level.

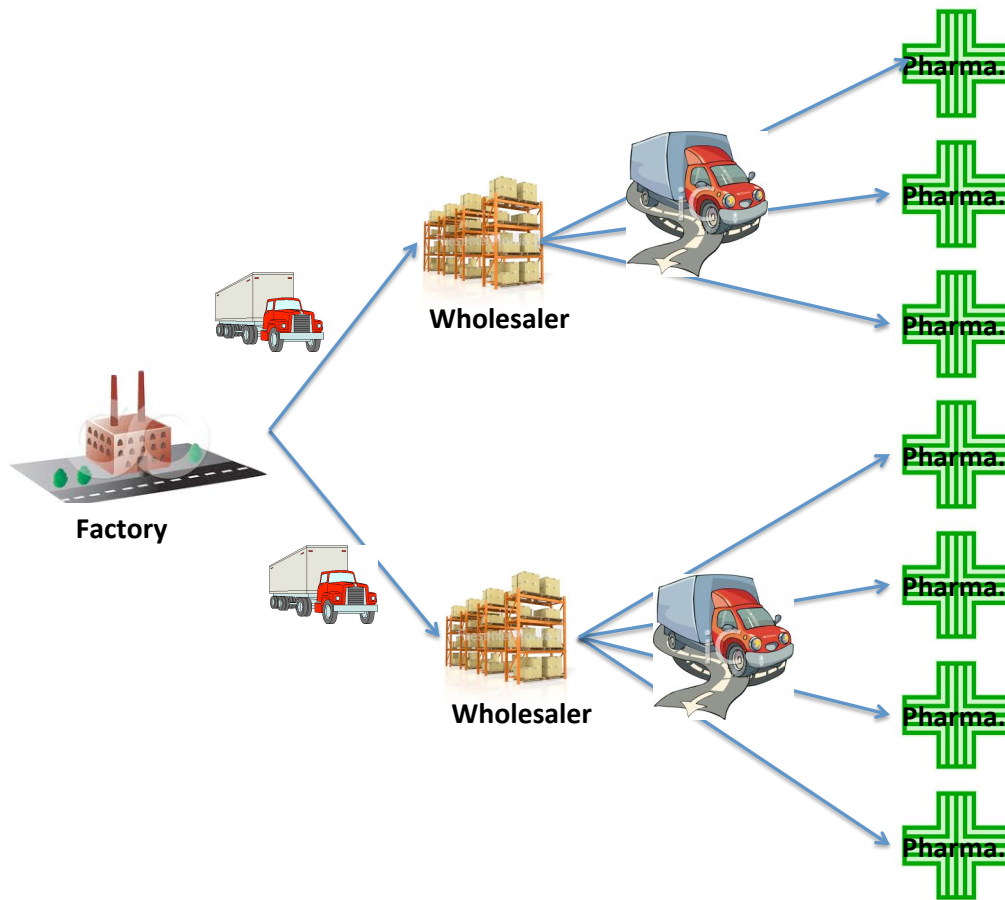


Figure 2: The considered distribution network

In this use case, we focus on products distributed from wholesalers to pharmacies. Each wholesaler supplies pharmacies of a given geographical zone, several times per day. Traditionally, these operations are organized through a set of scheduled rounds. Our idea consists in detecting some key information in order to be able to adapt the wholesaler’s vehicle routes in real time. These data can be considered as “events”. All these events could be defined through taxonomy of event used to identify the different kind of events. This taxonomy of event is presented in Table 3. For each kind of event, we define a structure based on WS-Notification (Web Services Notifications) and RDF (Resource Description Framework). This structure will be used to identify the information contained in the event.

Table 3: Event types

Type of event	Description
Situational	This kind of event is used for information about the situation
Consequences	This kind of event is used to transmit the result of one or a sequence of activities
Activities	This kind of event is used for information about the state of services. A service can be done, in progress or waiting.
Resources	This kind of event is used for information about the resources. The resources can be information or physical objects.

In our case, events should include at least:

- GPS positions (situational event): to assess the traffic situation and/or potential problems during deliveries;
- Pharmacies' inventories (resource event): to assess the priorities in terms of supply;
- Patients' orders (consequence event): to assess the emergencies in terms of demand;
- On-going preparations at wholesaler's warehouse (activities event): to adapt time delivery schedule;
- Etc.

Based on these events, we have to define some rules to be able to adapt the behavior of the system within the platform described previously. In our application case, these rules could be:

- If there is an important traffic jam 1km around a pharmacy then proceed to next pharmacy;
- If the route has to be modified then inform all the pharmacies for the delay;
- If there is an emergency for a drug which is inside the vehicle then proceed to this delivery first;
- Etc.

Here is our scenario example showing the MIS response to an unexpected event:

1. The situation is normal: orders preparations at Wholesaler's warehouses, trucks following their route, pharmacies receiving patients' orders, etc.
2. An emergency order is done at the pharmacy.
3. The MIS is automatically informed of this priority order by the pharmacy information system.
4. The MIS automatically analyze this new event. It detects from the "Model of Collaborative behavior" KPI that if this product is not deliver on time, the resulting overall KPI values will be much worse than if we adapt one truck route in order to meet the demand.
5. The MIS deploys a new MIS workflow in order to give the new route to the concerned truck driver and to give the new information to all stakeholders' information systems (including the truck GPS, etc.).
6. The truck driver adapts his route according to the new one.

In this scenario, the MIS made the truck route adaption possible without any human interaction in between the emergency order and the truck driver route adaptation. And so this fully computerized process would be much faster than a process with human interactions. However, another MIS' "Model of Collaborative behavior" could have been to ask for human approval before sending the new route to the truck driver.

There is an important feature not mentioned in this scenario: the MIS ability to automatically take into account new information source when detected, thanks to communication standards as the ones mentioned previously (WS-Notification and RDF).

## 5 Conclusion

Organizations (of any kind) embedded in today's economic environment are deeply dependent from their ability to take part into collaborations. Consequently, it is strongly required for them to assume the needed interoperability functions: exchange of information, coordination of functions and orchestration of processes. Furthermore, inside these organizations, Information Systems (IS) and computerized systems are assuming both the roles of interface (external and internal exchanges) and functional engine (driving processes and business activities). Therefore, IS, must be supporting the previously listed interoperability functions. The issue is to ensure that partners' IS will be able to work altogether (thanks to these interoperability functions) in order to constitute a coherent and homogeneous set of IS (the IS of the collaborative situation). Providing organizations with methods, tools and platforms able to ensure these interoperability functions makes therefore sound sense.

The MISE project (Mediation Information System Engineering) has been launched in 2004 and is dedicated to provide an approach (and the associated tools) for Mediation Information System (MIS) design. The so obtained MIS should ensure the interoperability functions (transmission of data, sharing of services and orchestration of workflows) in an agile manner. Actually, collaborations are very unstable situations requiring adaptation: context can change (new opportunity, modification of objectives, etc.), network of partners can change (withdrawal or arrival of partner, lack of resource, etc.) or dysfunction during the collaborative behavior can occur (even if context and partners are still the same, something may not happen as expected). Therefore, the MIS should remain well adapted to the potentially changing needs of the collaboration. Two iterations of the MISE project have already been performed. MISE 1.0 is presented in [1] and [2] while MISE 2.0 is presented in [3] and [4]. The third iteration, MISE 3.0, is ongoing and this article aims at presenting how this version intends to support collaborative networks in the Internet of Services.

MISE project, through its three iterations provides a way to concretely connect *Internet of Things* (sensors, devices and any event providers) with *Internet of Knowledge* (ontologies and knowledge management systems) to run *Internet of Services* (technical services connected on the ESB). MISE principle is the following: any organization may be connected to the MIS, thus giving an access to its "public part" (mainly business capabilities and information). Thanks to EDA, all "public parts" of all connected organizations may publish events on the platform. Detecting any collaboration opportunity (thanks to events), the platform could push to potential partners a suggested collective business behavior (as an automatically deduced and selected collaborative process cartography). Once accepted or modified (through a dedicated decision support system), that collaborative behavior could be run onto the MIS (as an automatically generated set of workflows associated with a set of relevant KPI in charge of controlling the collaborative behavior) through orchestration and choreography. During that run-time, events (that are continuously sent to the EDA platform by invoked services and performance monitoring tool) update a permanent "picture" of the collaborative situation. That "picture" and KPI monitoring provide status knowledge useful to detect any adaptation need. If such a requirement appears, the orchestrated/choreographed workflows may be adapted on-the-fly by invoking design-time tools. The following picture illustrates this principle:

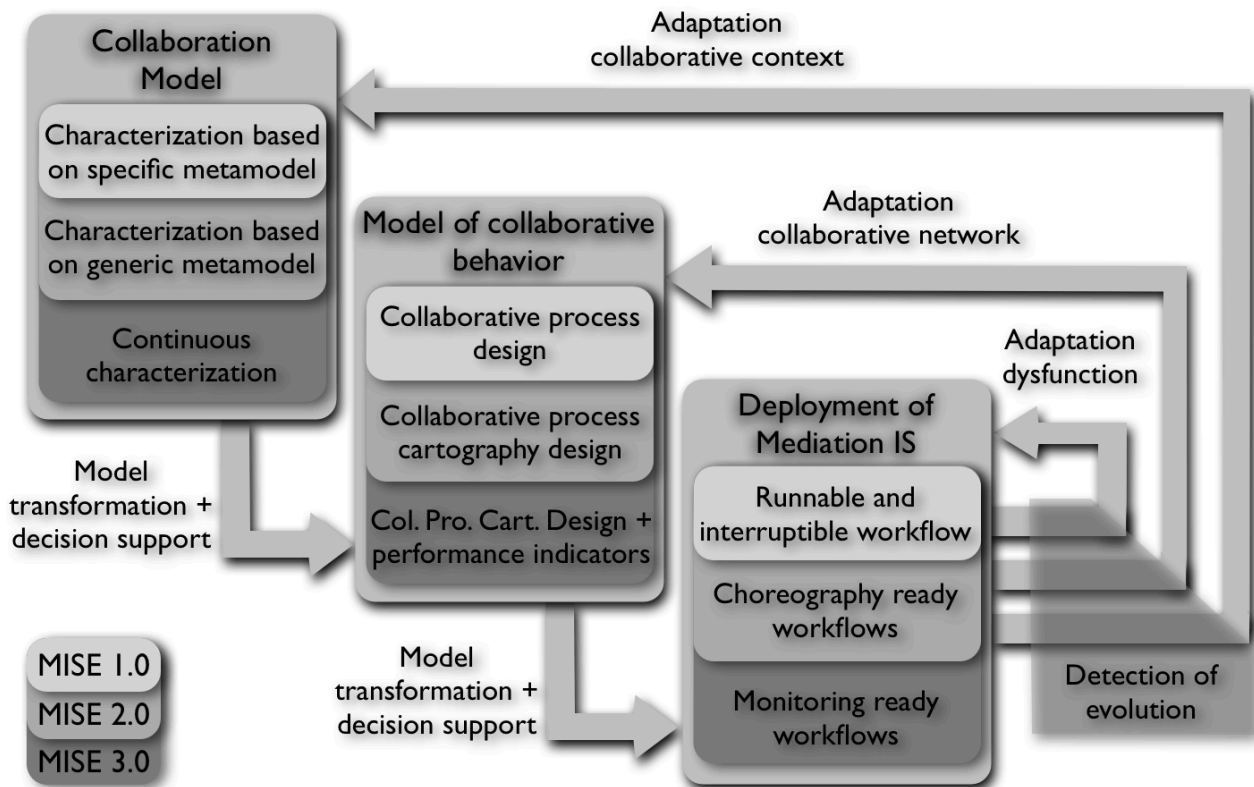


Figure 4: MISE project overall structure including MISE 1.0, MISE 2.0 and MISE 3.0 iterations

Similarly with figure 1, it is important to notice that there are in fact four “so-called” steps in MISE approach (whatever the selected iteration), however, the first three steps (dedicated to design-time) are presented as boxes while the last one (dedicated to run-time) is represented through three looping arrows.

As a conclusion, the MISE platform provides an environment, which allows Logistics Web users to be “hyperconnected” (through topic and content based subscriptions) in order to detect in real-time unexpected events and adapt their behaviors accordingly. One very interesting aspect of that system is the fact that users are not supposed to know each other or even to select the ones they want to get the events from.

## References

- Ballot, E., Gobet, O., & Montreuil, B. (2012). Physical internet enabled open hub network design for distributed networked operations. In *Service Orientation in Holonic and Multi-Agent Manufacturing Control* (pp. 279-292). Springer Berlin Heidelberg.
- Montreuil, B. (2011). Toward a Physical Internet: meeting the global logistics sustainability grand challenge. *Logistics Research*, 3(2-3), 71-87.
- Montreuil, B., Rougès, J. F., Cimon, Y., & Poulin, D. (2012). The physical internet and business model innovation. *Technology Innovation Management Review*, 2(6).
- Sallez, Y., Pan, S., Montreuil, B., Berger, T., & Ballot, E. (2016). On the activeness of intelligent Physical Internet containers. *Computers in Industry*.

1. Touzi, J., Bénaben, F., Pingaud, H., and Lorré, J.-P.: A Model-Driven approach for Collaborative Service-Oriented Architecture design. *International Journal of Production Economics (IJPE)*, Elsevier, Volume 121, issue 1, pp. 5--20 (2009)
2. Rajsiri, V., Lorré, J.-P., Bénaben, F., and Pingaud, H.: Knowledge-based system for collaborative process specification. *Computers in Industry (CII)*, Elsevier, Volume 61, issue 2, pp. 161—175 (2010)
3. Bénaben, F., Boissel-Dallier, N., Pingaud, H., Lorré, J.-P.: Semantic issues in model-driven management of IS interoperability. *International Journal of Computer Integrated Manufacturing (IJCIM)*, Taylor&Francis. DOI:10.1080/0951192X.2012.684712 (2011)
4. Mu, W., Bénaben, F., Pingaud, H., Boissel-Dallier, N., Lorré, J.-P.: A model-driven BPM approach for SOA mediation information system design in a collaborative context. *IEEE International Conference on Service Computing (SCC)*, IEEE, pp. 747--748. IEEE Press. Washington, USA (2011)
5. OMG, MDA Guide Version 1.0.1, omg/2003-06-01, (2003)
6. Truptil, S., Bénaben, F., and Pingaud, H. A Mediation Information System to help to coordinate the response of a crisis. *Pro-VE'10*, Springer. Saint-Etienne, France. (2010).
7. Rajsiri, V., Lorré, J.-P., Bénaben, F. and Pingaud, H. Collaborative process definition using an ontology-based approach. *Pro-VE'08*, Springer. Poznan, Poland. (2008).
9. Rongié, C., Lauras, M., Galasso, F., Gourc, D., Towards a Crisis Performance Measurement System. *Proceedings of Pro-VE'10*, Springer. Saint-Etienne, France. (2010).
10. NF EN ISO 9000 X50-130 Systèmes de management de la qualité. (2005).
11. Etzion, O., Niblett, P.: *Event Processing in Action*. Manning Publications Company (2010).
12. Truptil, S., Barthe, A.-M., Bénaben, F., Stuehmer, R.: Nuclear Crisis use-case management in an event-driven architecture. In *edBPM workshop in conjunction with BPM conference*. Clermont-Ferrand, France. (2011).
13. Lauras, M., Galasso, F., Rongier, C., Gourc, D., Ducq Y. Towards a more effective interoperable solution through an a priori performance measurement system. *Proceedings of PRO-VE'11*, Springer, IFIP. Sao Paulo, Brasil. (2011).