

	<h1>SocEDA</h1> <p><i>Cloud based platform for large scale social aware EDA</i></p>	
	<p>ANR-10-SEGI-013</p>	



# SocEDA



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# 1. Introduction

## 1.1. Purpose

This use case shows the value added of the SocEDA platform in the context of the response to a nuclear crisis.

With its complex-event processing architecture, French project SocEDA can contribute significantly. The management of the crisis would indeed be facilitated by the increased situational awareness provided by SocEDA's platform for event processing. In addition to that, SocEDA would ensure a timely and adequate diffusion of information to relevant actors.

This use-case consists in the construction of a simulation tool to validate the complex- event processing architecture and the associated platform.

- The first step of the use case was to gather knowledge about the current situation (“as-is” analysis).
- The second step consisted in proposing a structured analysis of the situation, as it would be if SocEDA platform was used to facilitate the management of the crisis. (“to-be” analysis)
- The third step is to build a tool to simulate various collaborative workflows, actors’ behaviour, and event production.

This document aims at describing this third step, the scenarios and the construction of the simulation platform.

## 1.2. List of Acronyms

Acronym	Definition
<b>A</b>	Army
<b>P</b>	Police
<b>O</b>	Office of infrastructures
<b>MF</b>	Meteo France (weather forecast)
<b>RSN</b>	Radiation Survey Network (measures radioactivity)
<b>EDF</b>	Electricité De France (Operates nuclear plants in France)
<b>RNA</b>	Representative of the National Authority (prefect)
<b>F</b>	Firemen

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<b>MEMS</b>	Mobile Emergency Medical Service
<b>WSDL</b>	Web Semantic Description Language
<b>ESB</b>	Enterprise Service Bus
<b>JBI</b>	Java Business Integration
<b>SA</b>	Service Assembly
<b>SU</b>	Service Unit
<b>BC</b>	Binding Component
<b>BPEL</b>	Business Process Execution Language

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## 2. Overview of the Crisis Management Use Case

### 2.1. Context and Background

For this use-case, we are considering a situation in which a large quantity of radioactive substance is accidentally released in the atmosphere, due to a critical accident in a French nuclear plant. The multiplicity and diversity of actors involved, the volume and heterogeneity of information, the critical dependencies between actions as well as the dynamics of the situation make the situation more complex.

As many stakeholders are involved in the crisis management process, discussions with IRSN and ASN, France's public service expert in nuclear and radiation risks as well as with Nuclear plants technical experts or field actors such as firemen are undergoing (see table 1).

Contacts	Employer	Role	Date of validation
Aline Fraysse	ASN	Validation of the trigger event and business processes	October 2011
Mickael Knoll	IRSN	Validation of the trigger event and business processes	October 2011
Wandrille Simonin	EDF	Validity of business processes	October 2011
Florent Courreges	Firemen	Validity of business processes	October 2011

**Table 1 : List of contacts who validated the consistence of the use case**

### 2.2. Low-level Business Process Models (BPMN)

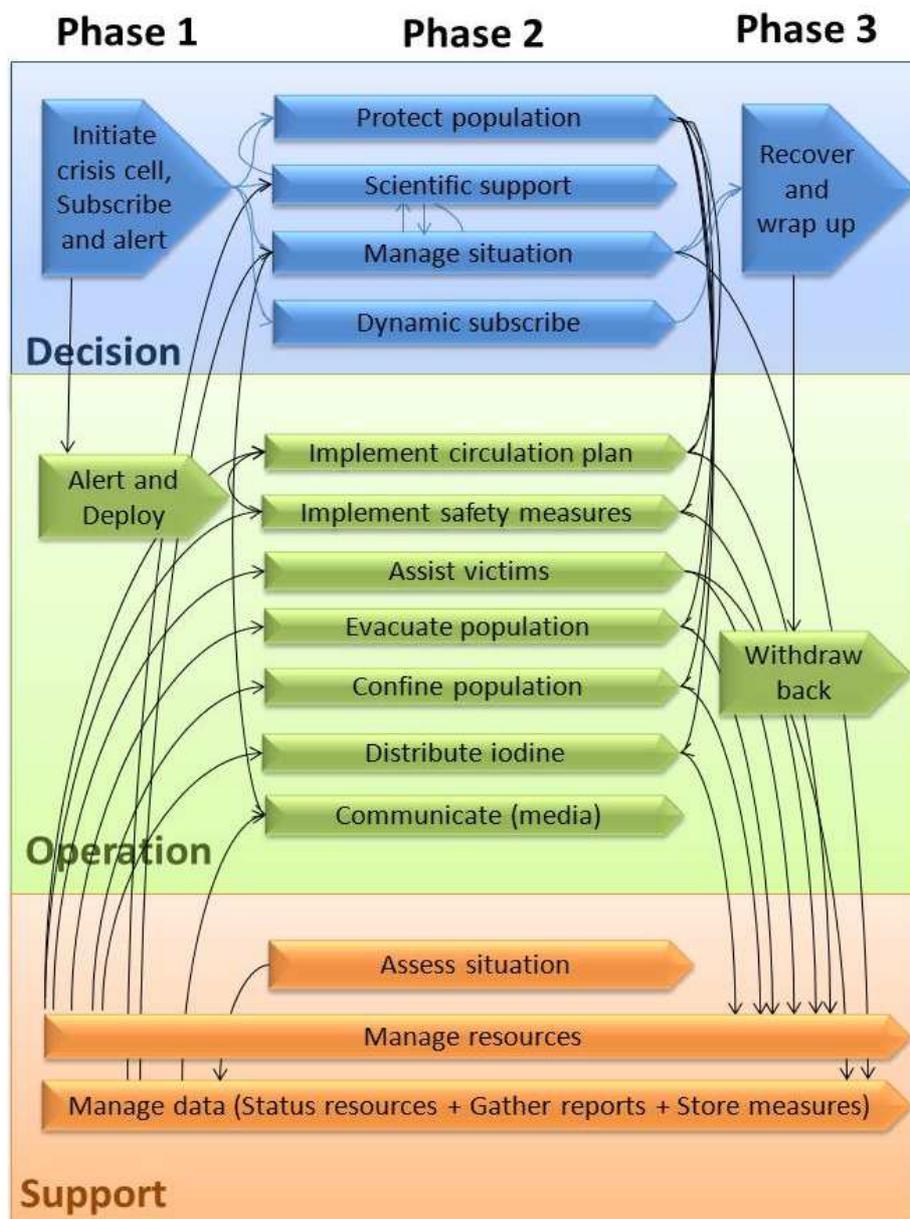
We have chosen to follow a Business Process Modelling approach to implement our research work. Indeed, this choice ensures the coherence into the whole approach. Furthermore, this language is not only strongly aligned with computer implementation of workflows but also structurally event-oriented (events are represented through circles and can be typed). BPMN is so perfectly at the intersection between SocEDA project specificities (event-based) and technical requirements of the demonstration platform to be provided (proximity between BPMN and workflow language).

A short description of the core elements used to design BPMNs is provided in appendix B.

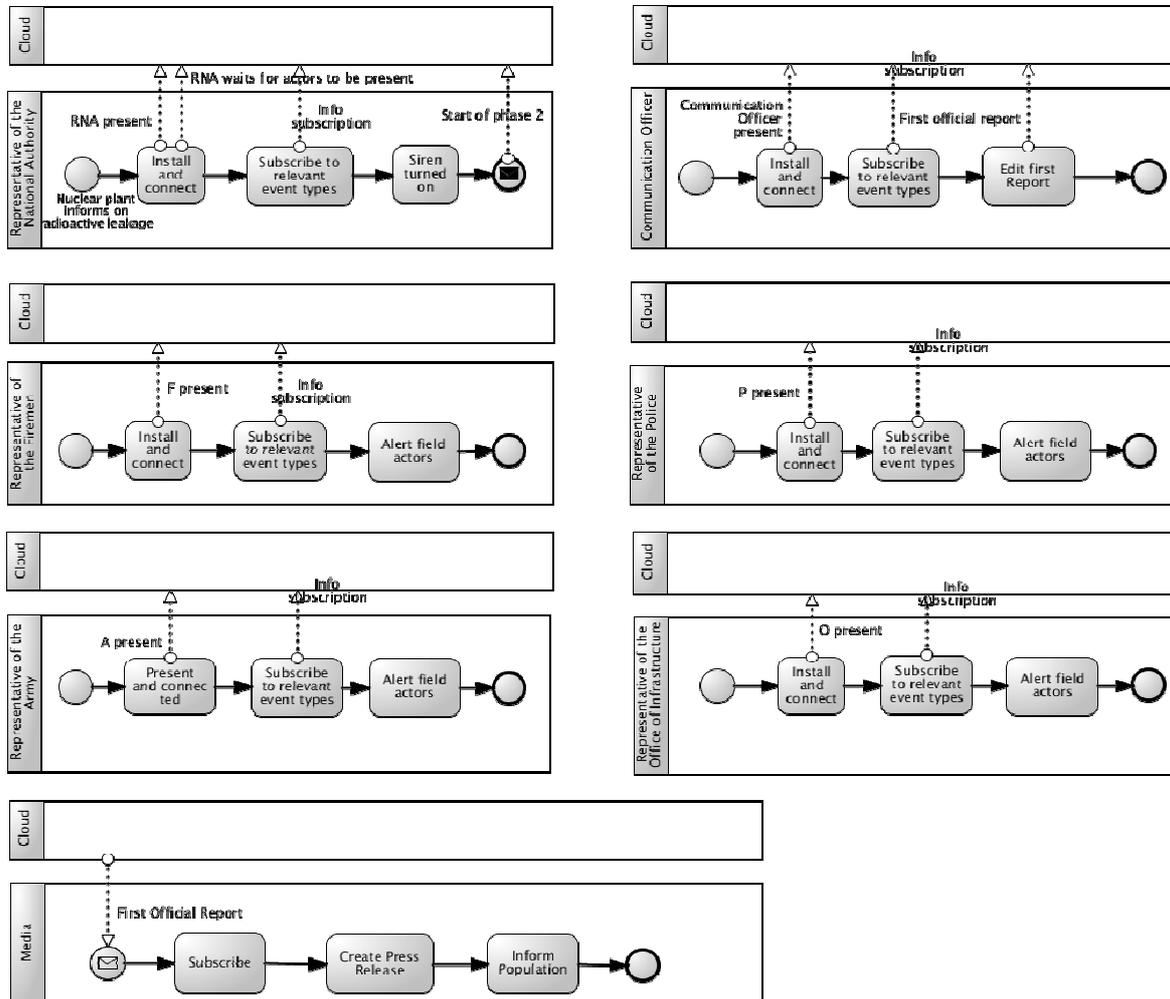
Consequently, in this first step, our objective consists in transforming the three classical levels of business processes that exist in any system (decisional, operational and support processes) in workflows in order to support the agility of both orchestration (internal business processes) and choreography (interactions between actors) of the coordination.

Figure 1 summarises the 18 processes that our previous analysis underlined (see D1.3). Each of those processes is then represented in the form of one or more BPMN. Figures 2 to 20 are the BPMNs built to explain the succession of the activities performed, the actors involved, and the exchange of information during the response to a nuclear crisis. Section 4 links those BPMN with the description of the two scenarios proposed to describe the response to a nuclear crisis.

The list of processes comes from D1.3 (section ToBe Analysis of the Nuclear Crisis Use Case). It is slightly different though, because we increased the level of detail in this deliverable.



**Figure 1 : Overview of processes**



**Figure 2: Initiate crisis cell, alert and subscribe**

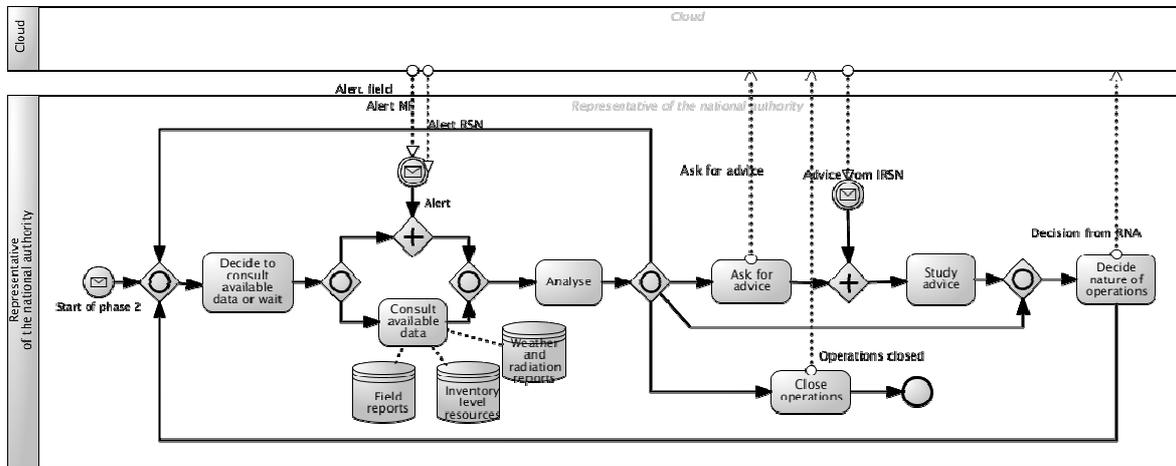


Figure 3: Manage situation

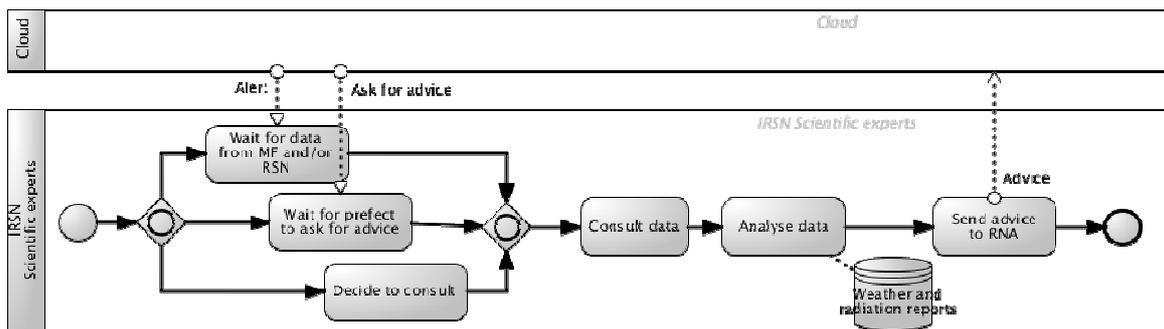
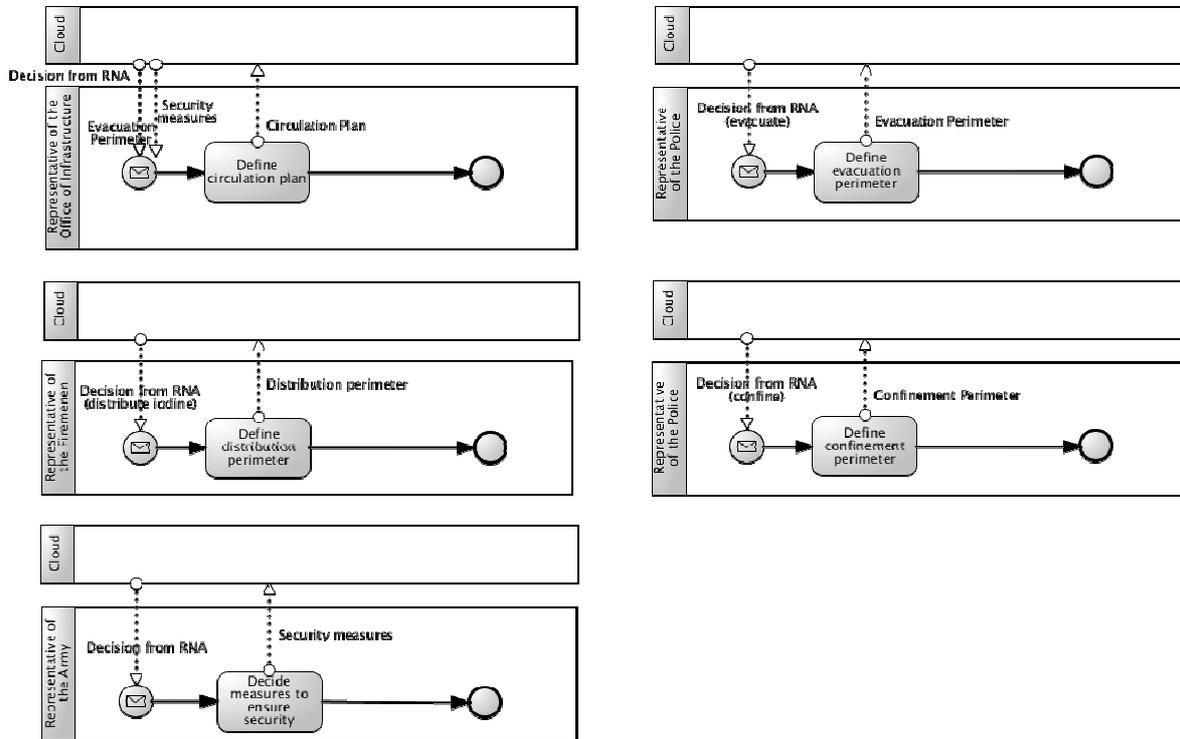
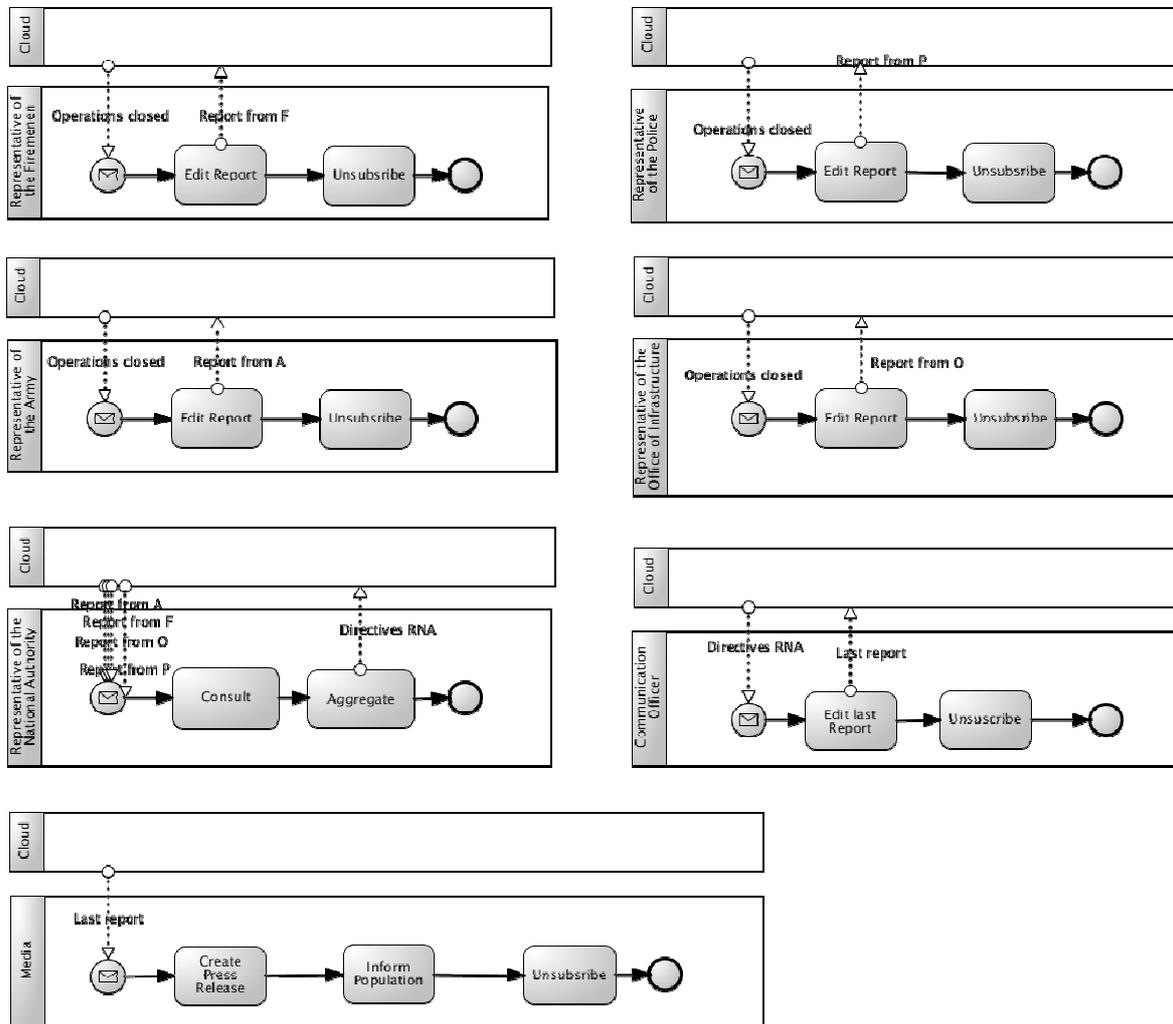


Figure 4: Scientific support



**Figure 5: Protect population**



**Figure 6: Recover and wrap up**

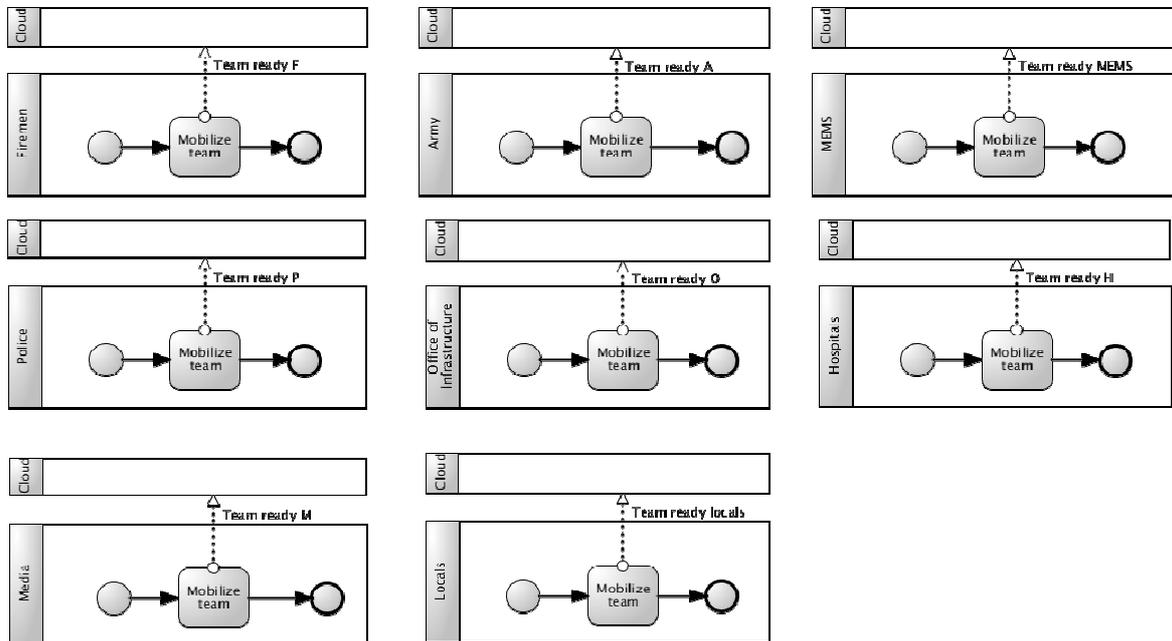


Figure 7: Operation – Alert and deploy

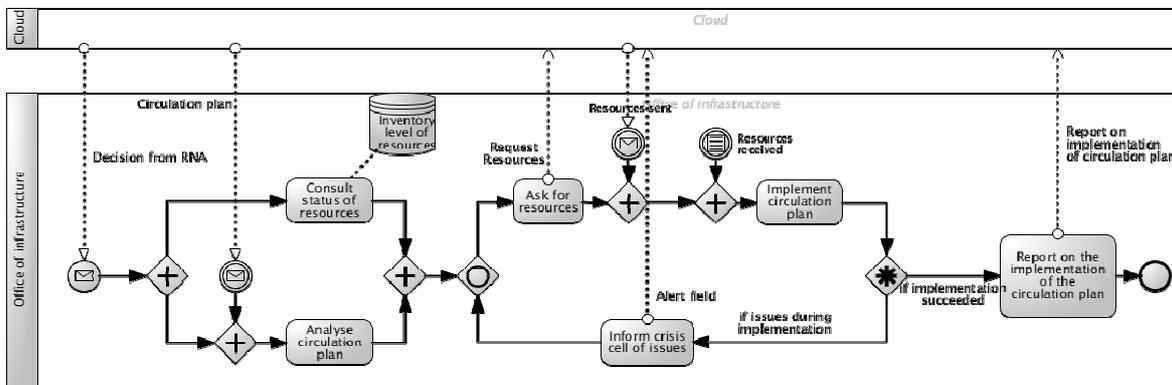


Figure 8: Operation – Implement circulation plan

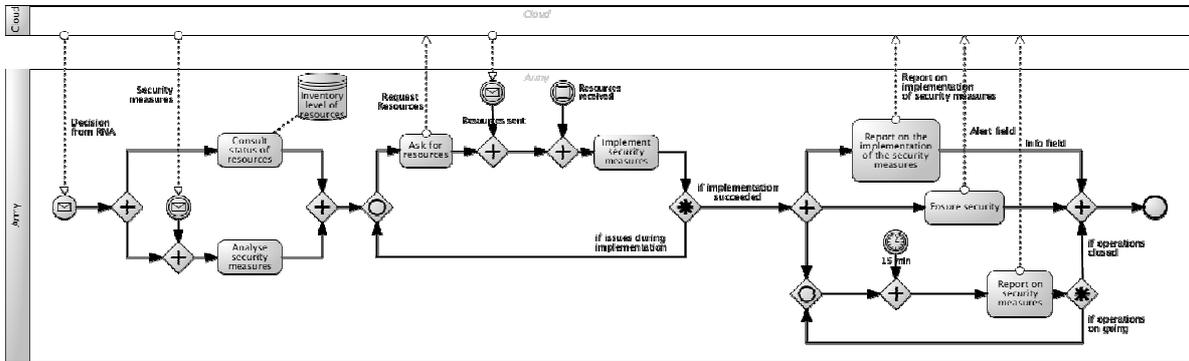


Figure 9: Operation – Implement safety measures

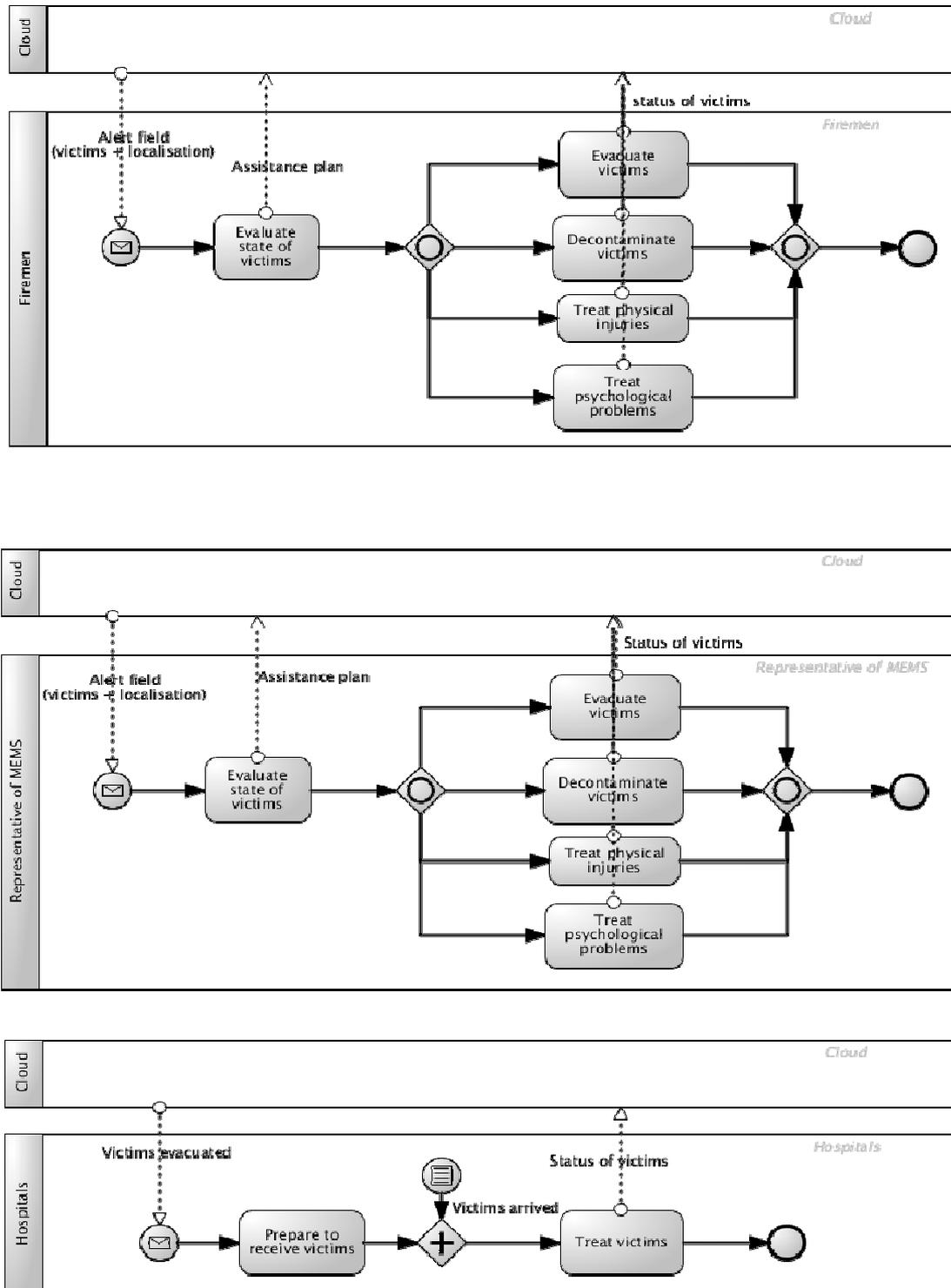


Figure 10 Operation – Assist victims

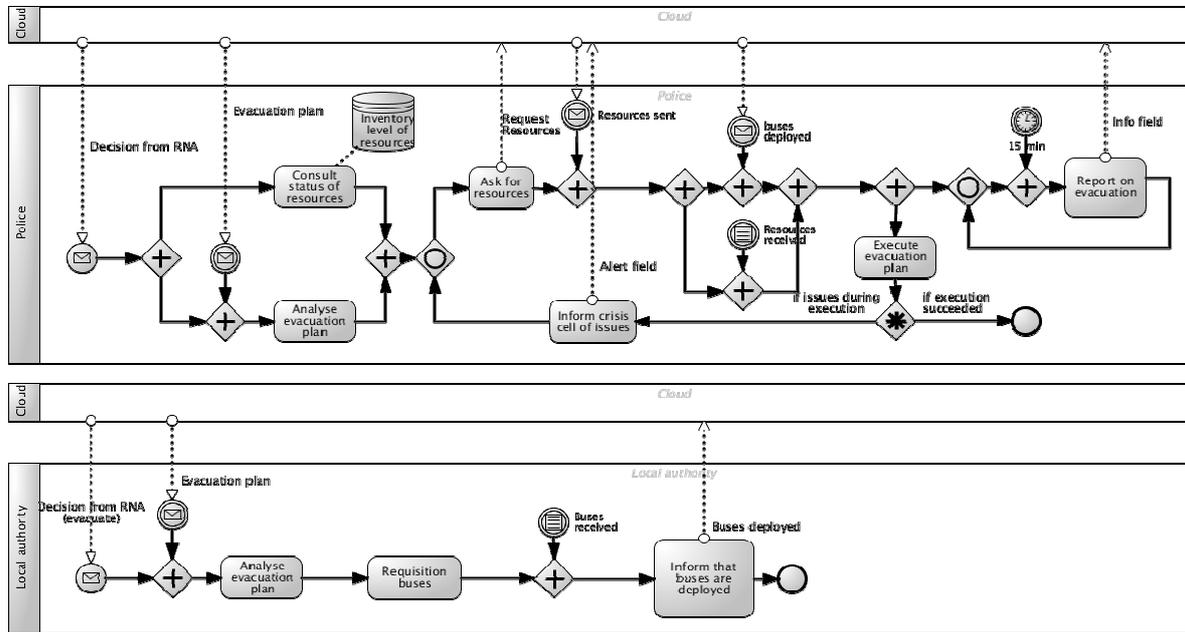


Figure 11: Operation – Evacuate population

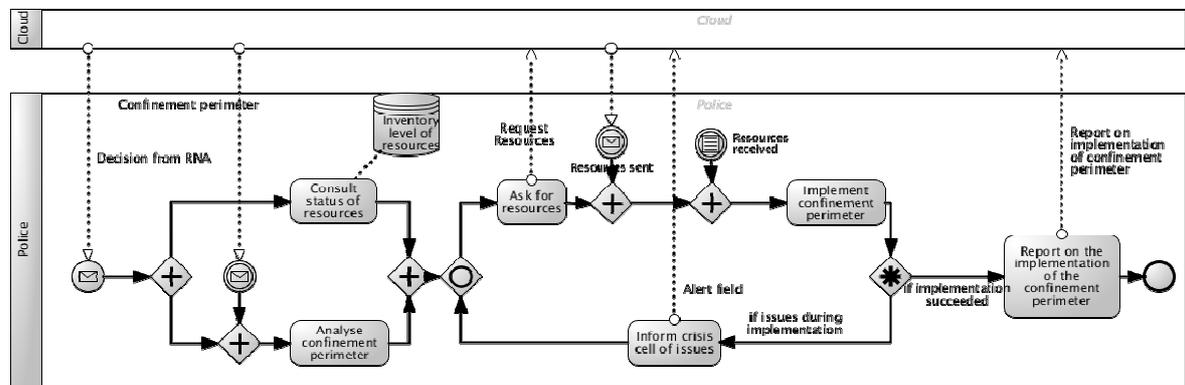


Figure 12: Operation – Confine population

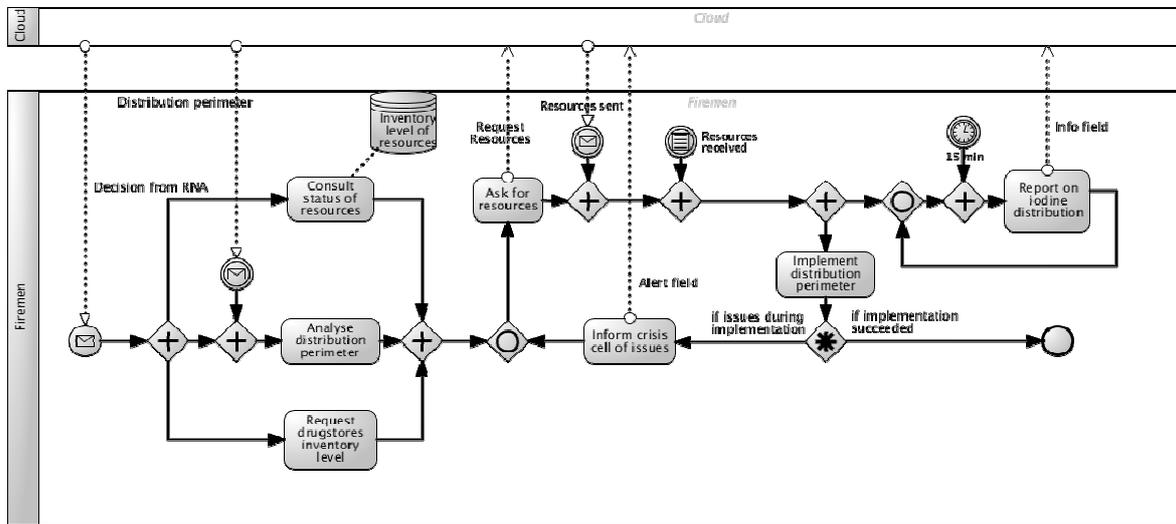


Figure 13: Operation – Distribute iodine

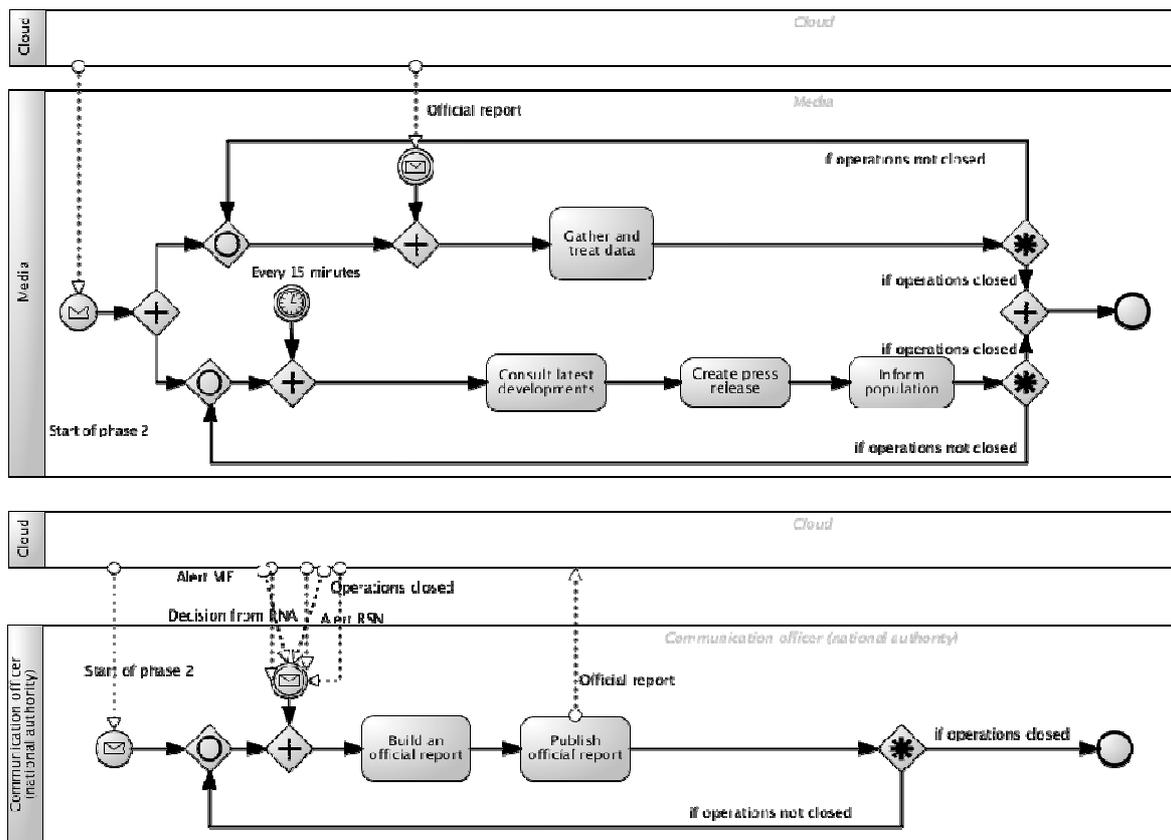
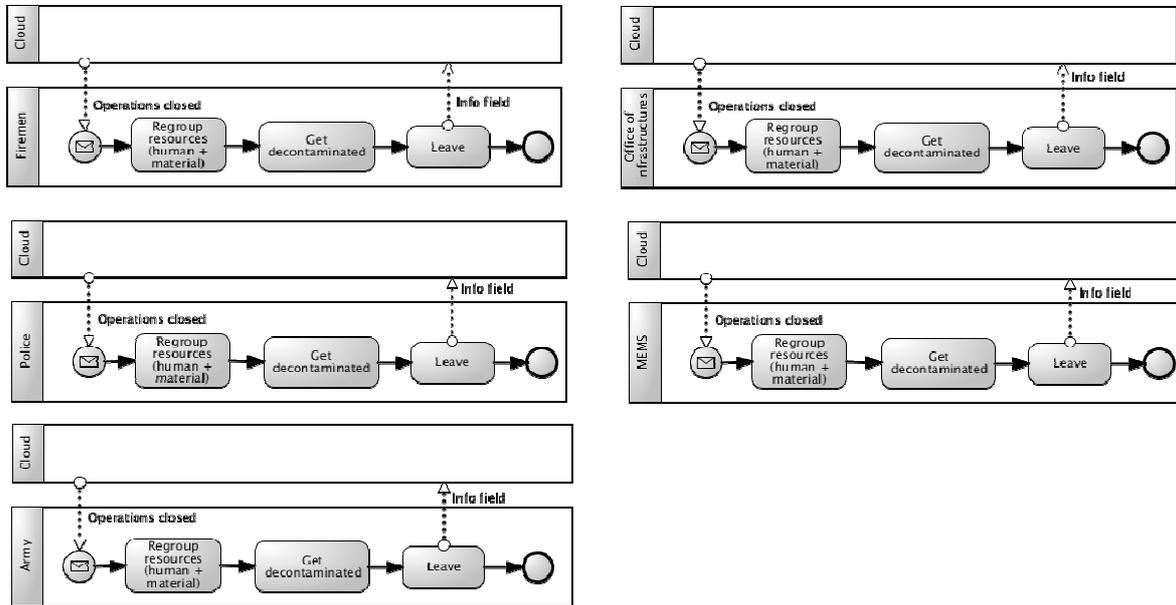


Figure 14: Operation – Communicate (media)



**Figure 15: Operations – Withdraw back**

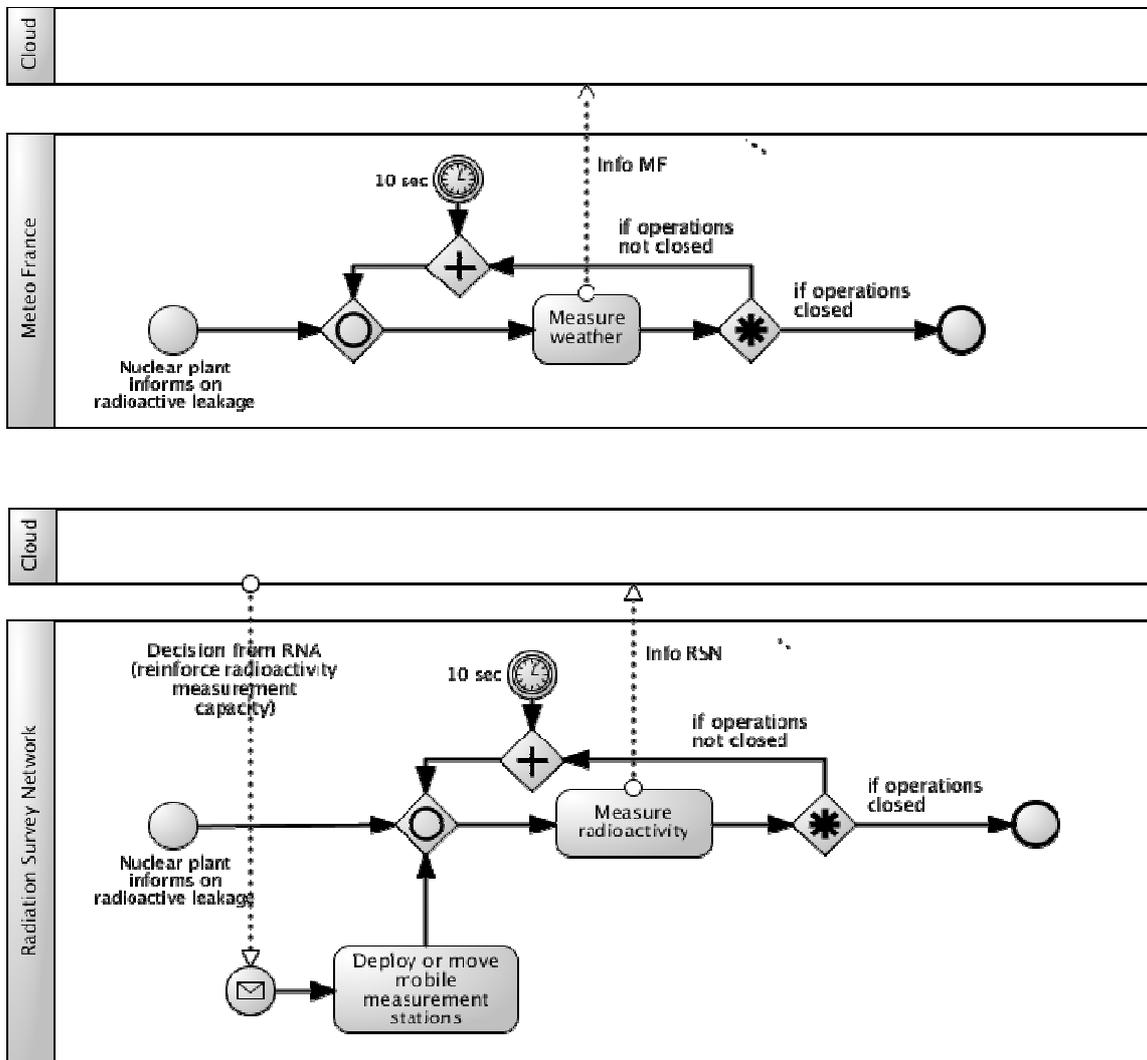
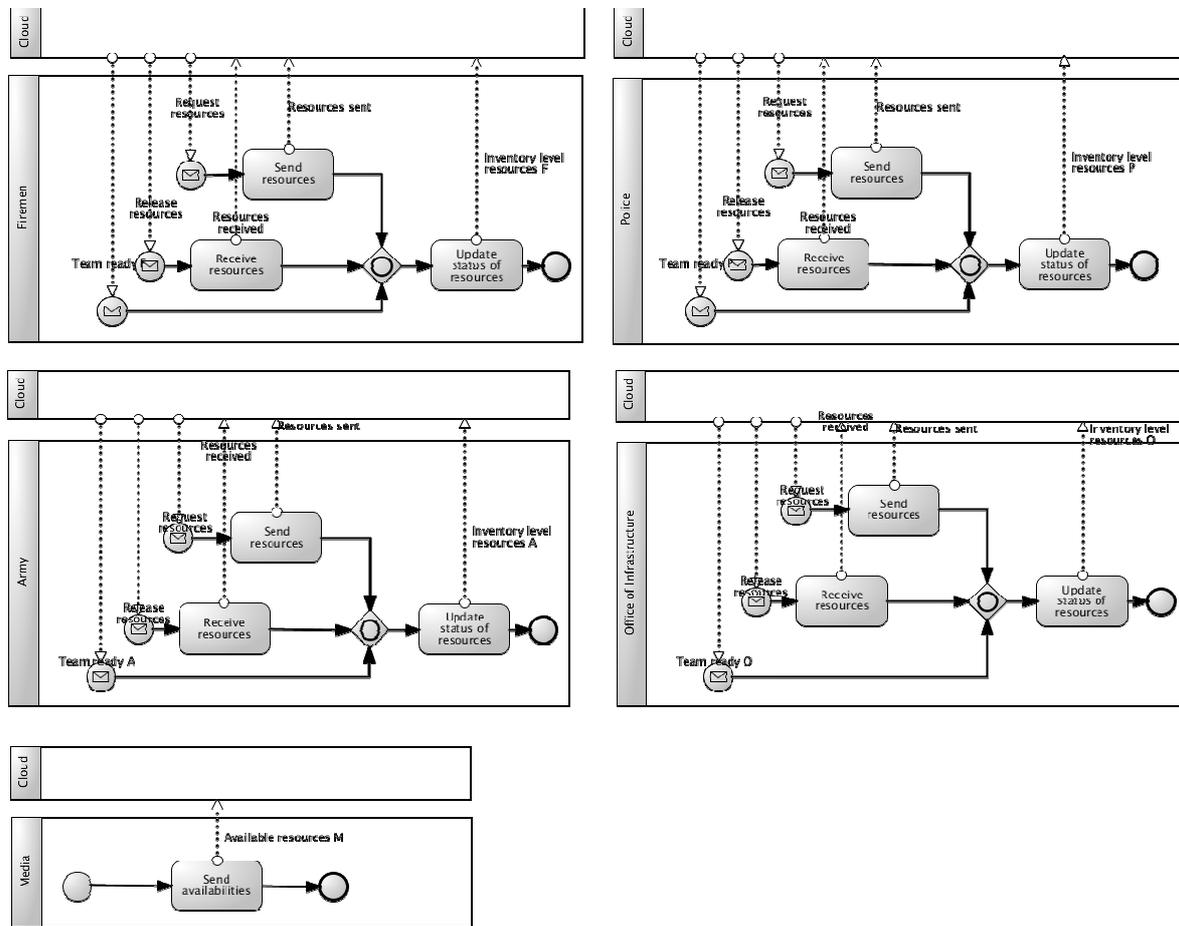


Figure 16: Support – Assess situation



**Figure 17: Support – Manage resources**

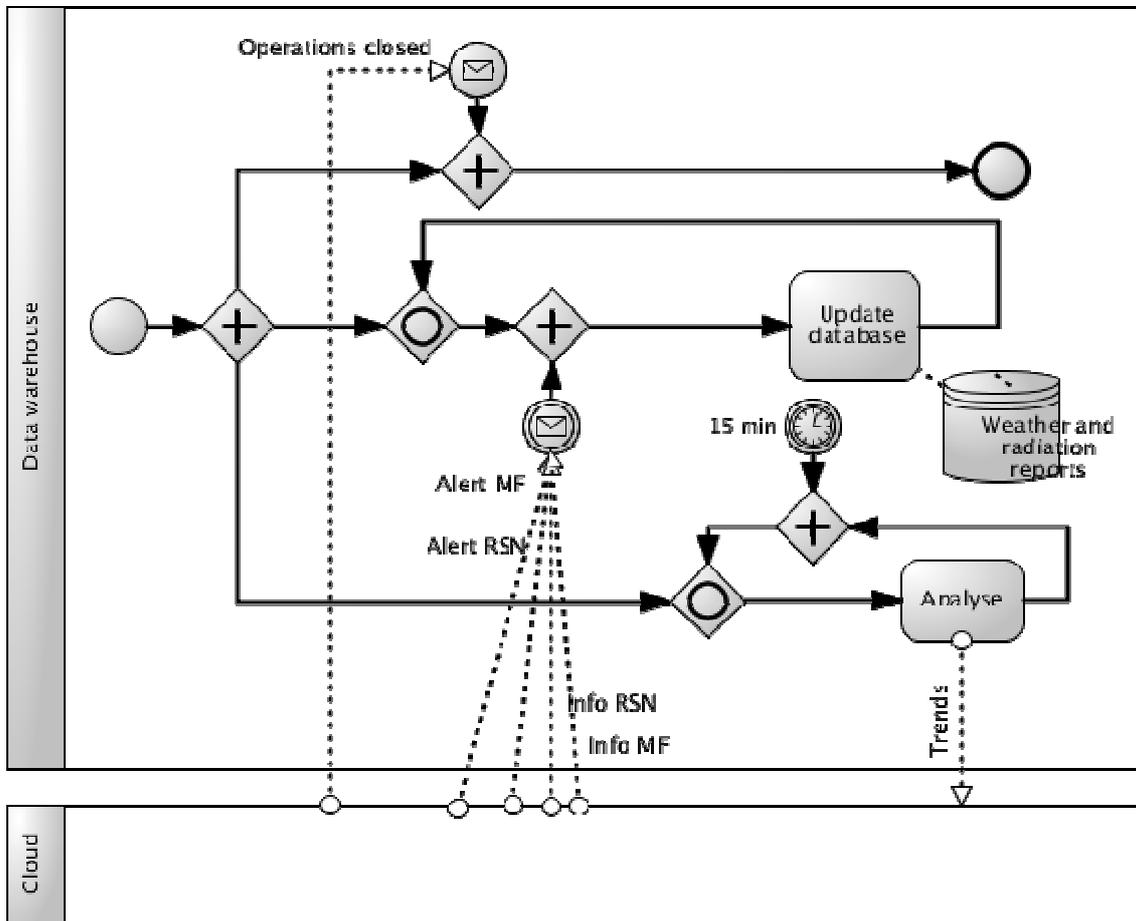


Figure 18 : Support – Manage data

## 3. Technical view of the demo platform

### 3.1. Overview

Basically, the structure of the demonstration platform will be the following: several ESBs will run - thanks to their workflow engine- several workflows (representing decisional, operational or support processes) among several web-services (representing activities of actors that might be invoked in a crisis management context).

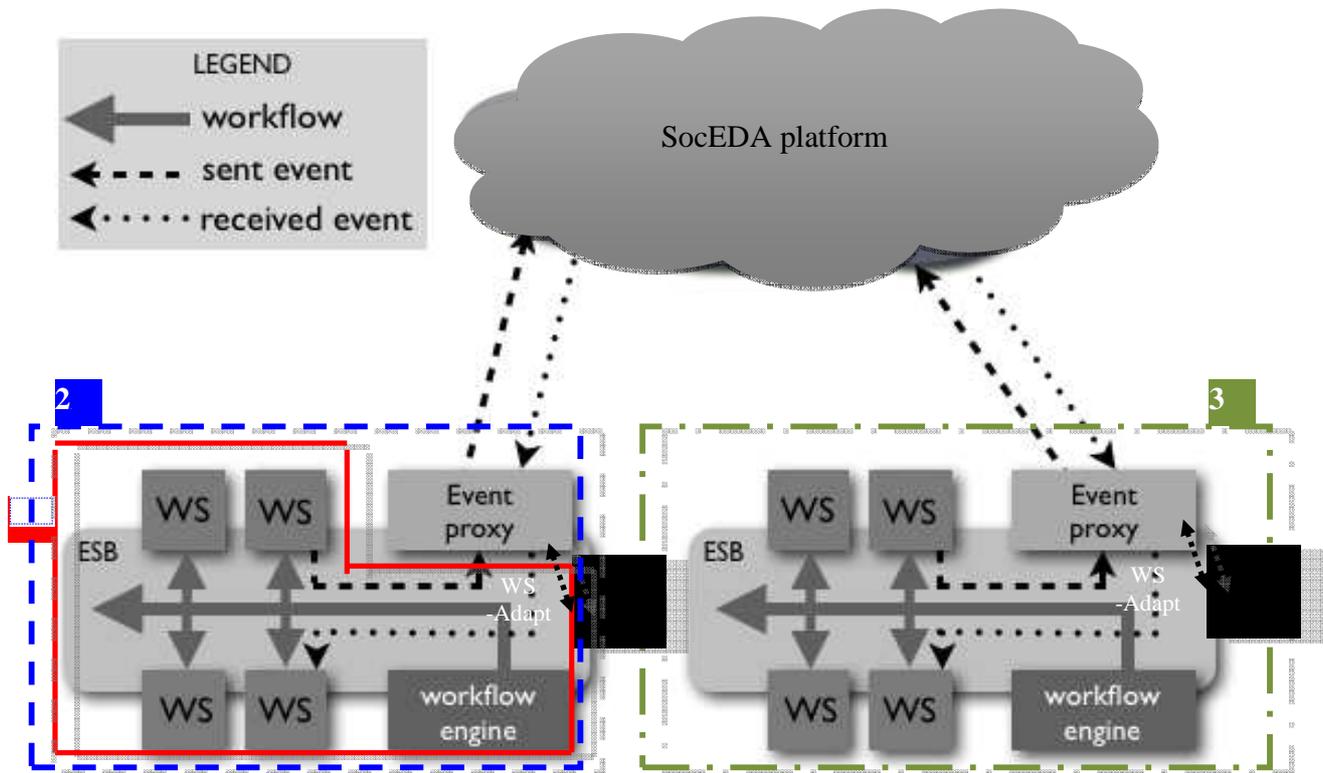
Each web-service will be able to generate events (such as status but also business events like radiation measures or requested resources) that will be sent to a special service of ESB.

This special service (event manager or event proxy) is in charge of gathering events, translating them into an appropriate format and sending them to the cloud platform of SocEDA.

The SocEDA platform can use these events to generate new events and enrich the event market place. The event manager is also in charge of receiving new events from the cloud SocEDA platform in order to send them to the web-services that are subscribers for that type of event.

The following figure illustrates this architecture:

1. Red box (#1): orchestration thanks to the workflow engine between web services inside the ESB
2. Blue box (#2): the event dynamicity through "event manager" (WS-notif to RDF) for in/out events
3. Green box (#3): the adaptation principle through the adaptation service (advice + process editor)



**Figure 19 : Overview of the technical architecture of the simulation platform**

### 3.2. ESB and web services

In SocEDA, the workflow is run on an Enterprise Service Bus (ESB), which is PETALS, developed by the French open source software editor PETALS Link. This ESB is compliant with the JBI standard (also based on JSR208 standard).

The partner's web services and the web services embedded by default on PETALS ESB (e.g., workflow engine, adaptation service, event proxy) are deployed then run on PETALS ESB.

The numerous services are invoked by the bus, according the defined orchestration which is contained into workflow files (run by the workflow engine). These workflows match with the previously designed processes (see part 2 of this document).

Each operation of web service, when it is invoked, sends an event to update its status ("started", "work in progress", "closed", "error").

### 3.3. Event Manager

The event manager is in charge of (i) receiving events (according the WS-Notification specifications (OASIS, 2006)) inside the ESB and translating them into RDF events so that they can be sent to the cloud, and (ii) receiving events (RDF) from outside (i.e. from the cloud) and translating them into WS-Notification events so that they can be sent into the bus and catch by

subscribers (WS).

The event manager is a web services, running on the ESBs (even if it is cloud-located, it is connected to the ESBs). The event manager detects the web services, which are event producers. And the orchestration web services (i.e. the BPEL engine running on the ESB), which are event consumers, subscribe to the event manager in order to receive the events produced by the numerous event producers.

Some business rules are defined in the cloud and not by the event manager: e.g. reports coming from the operational or support processes are gathered in the cloud. The cloud compares the number, location and nature of service required with availabilities and chooses the most relevant actors.

### **3.4. Adaptation service**

Adaptation Service is a service (located in the cloud infrastructure), which might be connected to any operating ESB. It would take as input any event coming from such an ESB (or concerning such ESB). Based on those inputs (events), this service aims at providing a diagnosis concerning the need (or not) of an adaptation. If adaptation is required, then, based on semantic annotations of services, this service provides a recommendation (what should be changed, what could replace any defaulting service, etc.). Concretely, Adaptation Service is related to the analysis of service compositions and to the recommendations (based on situations) of appropriate adjustments to the service parameters and overall process flows.

For instance, the events coming from the radiation survey network could show a new situation: certain cities in the South-East of the plant are probably being unexpectedly affected by the radiation cloud. The traditional process flow would be to inform people in these areas to stay inside their homes, using TV and Radio stations. However, the situation awareness module indicates a new situation in which there is no power in many of these cities. So, Adaptation Service recommends to redeploy police forces in the new areas and inform people using speakerphones.

## 4. Scenarios of Demo

### 4.1. Iterative principle of demo

This part provides some explanations concerning the two steps of the demo dedicated to cover all the identified objectives (suggested objectives are: orchestration, choreography, agility in orchestration, agility in choreography, scalability).

Though it is not easy to imagine this context as a strongly computed environment where services could easily send their events to the clouds, many elements make this use case a relevant illustration for Internet of Services:

- The simulation platform enable to run independent internal business processes (orchestration)
- The simulation platform links various processes, which are running on separate ESB (choreography)
- It can takes into account changes in a single process (agility in orchestration)
- It can take into account the interaction between processes and modify each impacted process if needed (agility in choreography). Those changes are driven by events.
- High volumes of heterogeneous information is exchanged. (scalability)

The heterogeneity of actors is taken into account. Actors involved operate with their own information system, which may already use web services, but may also be fairly basic

All these characteristics make this use case a relevant illustration for Internet of Services, although it is not easy to imagine this context as a strongly computed environment where services could easily send their events to the clouds.

The scenarios will therefore take those considerations into account. They include elements, which enable to demonstrate that SocEDA platform can handle such a complex situation. The match between SocEDA requirements and use case scenarios is developed in section 4.4.

Two scenarios are described:

- One scenario fairly simple, with a limited number of information exchanged and only few changes in orchestration and no change in choreography. This scenario aims at giving a simple example of how the simulation platform is running. To keep this scenario as simple as possible, only some of the activities presented in the first part of this document are detailed and implemented.
- A second scenario, much more complex, with many changes and exchanges of information. This scenario aims at demonstrating that SocEDA platform can be used in

such a complex situation, with great advantages, such as quickness, reactivity and agility.

For those scenarios, we chose a situation, where evacuation of population is recommended.

For information, French legislation recommends:

- To stay indoors if the cumulative dose rate is above 10 mSv.
- To evacuate if the cumulative dose rate is above 50 mSv.
- To ingest iodine capsules if the cumulative dose rate is above 50 mSv. This level has been changed recently to align with international standards.

## 4.2. First Scenario

We consider in this scenario a simple case, where the evacuation of population goes smoothly. There are no victims, no change in wind force or direction, no rain, nor any alert regarding radioactivity level.

Nuclear Plant teams detect a leak between primary and secondary loops, thanks to the alert given by a high pressure sensor in the primary loop. The throttle valve is open and does not respond to losing order, so the teams realize that there is a risk of radioactive leakage in the atmosphere. They alert the responsible of the nuclear plant.

All actions taken within the plant are out of the scope of this study, so from this point, we focus on decisions, operations and support activities outside the plant.

The responsible of the nuclear plant informs the representative of the national authority, who activates the PPI in reflex mode. He also informs the representative of EDF national. A crisis cell is formed.

The crisis cell alerts field actors (firemen, police, army, office of infrastructure...) and ask the radiation survey network (RSN) and Meteo France (MF) for measurements. It alerts the media and set off the siren so that the population can learn that they have to stay indoors and listen to media. (figure 2)

Field actors are ready to deploy. (figure 8)

Regular updates are given to the media, and then to the population. Every 15 minutes, a new point of the situation is provided. (figure 15)

Regular measurements are sent by MF and RSN. Every 15 minutes, actual measures are sent by both MF and RSN. Every 30 minutes, experts from MF forecast the weather, in order to anticipate any change in wind force and direction or any precipitation. (figure 17)

Measurements in this scenario are as follow :

Radioactivity :

Forecasted dose rate after 1day: 60 mSv/j during the first 24h

Measured dose rate : starts at 1 $\mu$ Sv/h at 1 km, then decreases (0,3  $\mu$ Sv/h after 1h, 0,2  $\mu$ Sv/h

after 3h, 0,15 $\mu$ Sv/h after 5h)

Wind Force : 5 m/s constant

Wind direction : NE

Precipitation : none

Those measurements are stored in the data warehouse (figure 19)

With the measurements received from Meteo France and the radiation survey network (RSN), the crisis cell ask for advice from scientific experts at IRSN (figure 3). They analyse all figures available and advise to evacuate population living close to the nuclear plant (within 10km). No confinement order is issued. (figure 4)

The crisis cell, following those recommendations (figure 3), defines both a safety parameter and a circulation plan (figure 5). They ask for their implementation. This is implemented by the army (figure 10)

Field actors receive the circulation plan and the safety parameter defined. They are asked to implement them.

The office of infrastructures provides road signs and vehicles to implement the circulation plan. (figures 9 and 18)

The logistics section of the police sends resources to implement the evacuation perimeter (figure 19). The Police use those resources to make sure that the population evacuates. (figure 12)

To facilitate the evacuation, the representative of the local authority requisitions buses and send them meeting points. (figure 12)

The media inform the population that everybody closer than 10km of the nuclear plant has to evacuate. Instructions are that people with light vehicles can use them and leave, if possible with 4 or 5 person per vehicle. Others can go to assembly points. Children at school are evacuated directly from their school. (figure 15)

The army patrol and control that there is no problem during evacuation. (figure 10)

Despite all efforts to avoid any further complication, a traffic jam occurs along one of the main roads. Indeed, some of the population outside this perimeter decided to leave as well, which incurred a higher number of vehicles than expected. There are no victims, but the road is blocked.

The police inform the crisis cell. (figure 12)

The crisis cell defines another circulation plan (figures 3 and 5), and sends this new plan to the office of infrastructures. They implement it quickly, so no traffic jam occurs. (figure 9)

The army checks that everybody managed to evacuate safely. They confirm that everything is ok and informs the crisis cell. (figure 10)

As no change measures form Meteo France and RSN are foreseen, operations are closed. (figures 7 and 16)

### 4.3. Second Scenario

We consider in this scenario a complex case, where the evacuation of population is required and does not go as smoothly as planned. There are some victims, changes in wind force and direction, and rain.

The root cause of the accident remains the same: Nuclear Plant teams detect a leak between primary and secondary loops, thanks to the alert given by a high pressure sensor in the primary loop. The throttle valve is open and does not respond to closing order, so the teams realize that there is a risk of radioactive leakage in the atmosphere. They alert the responsible of the nuclear plant.

There again, all actions taken within the plant are out of the scope of this study, so from this point, we focus on decisions, operations and support activities outside the plant.

Some of the activities presented in the scenario 1 are kept, other are added due to this complex situation.

The responsible of the nuclear plant informs the representative of the national authority, who activates the PPI in reflex mode. He also informs the representative of EDF national. A crisis cell is formed. (figure 2)

The crisis cell alerts field actors (firemen, police, army, office of infrastructure...) and ask the radiation survey network (RSN) and Meteo France (MF) for measurements. It alerts the media and set off the siren so that the population can learn that they have to stay indoors and listen to media. (figure 2)

Field actors are ready to deploy. (figure 8)

Regular updates are given to the media, and then to the population. Every 3 minutes, a new point of the situation is provided. (figure 15)

Regular measurements are sent by MF and RSN. Every minute, actual measures are sent by both MF and RSN. Every 10 minutes, experts from MF forecast the weather, in order to anticipate any change in wind force and direction or any precipitation. (figure 17)

Measurements in this scenario are as follow :

Radioactivity :

measured dose rate :

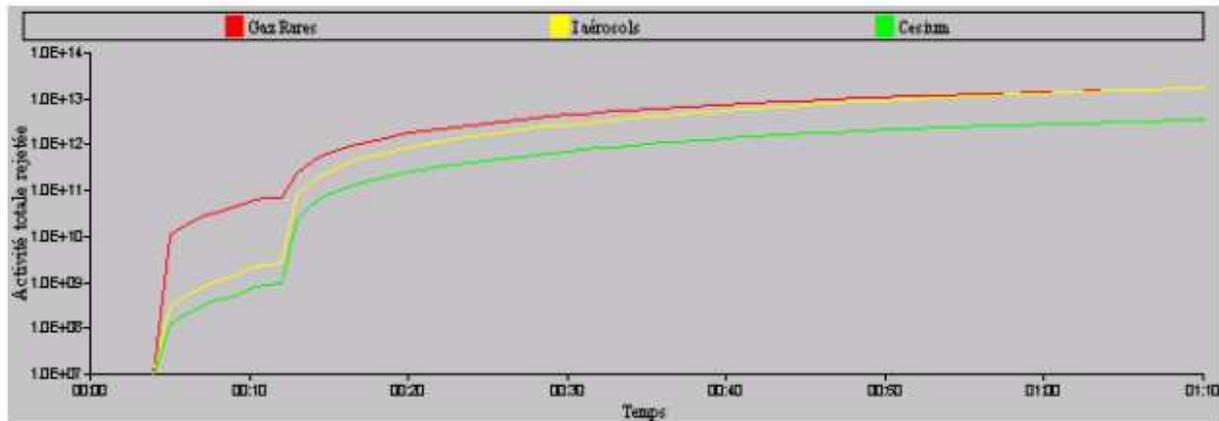


Figure 5 : Scénario RTGV - Cumul rejeté en fonction du temps (Bq)

**Figure 20 : cumulative rejects during the first hour.**

forecasted dose rate : step 1 : between 10 and 49 mSv/h

step 2 : between 50 and 100 mSv/j

Wind Force : 5 m/s at first.

Wind direction : NE

Rain : 2mm/h

Those measurements are stored in the data warehouse (figure 19)

**Step 1 :**

With the measurements received from Meteo France and the radiation survey network (RSN), the crisis cell asks for advice from scientific experts at IRSN (figure 3). They analyse all figures available and advise first to ask population to stay indoors (within 5km) (figure 4).

The media inform the population that everybody closer than 5km of the nuclear plant has to stay indoors. (figure 15)

The crisis cell, following those recommendations (figure 3), defines a safety parameter (figure 5).

They ask for its implementation.

Field actors receive the safety parameter defined. They are asked to implement it.

The army sends resources to implement the safety perimeter (figure 18). Those resources are used to make sure that the safety perimeter is respected. (figure 10)

**Step 2 :**

After 15 minutes, as radioactive measures are still increasing, a higher dose rate is forecasted. (figure 17) IRSN sends a new advice to evacuate population living close to the nuclear plant (within 10km), and ask population living between 10 and 20km to stay indoors. Everybody being closer than 10km for the nuclear plant has to ingest iodine capsules. (figure 4)

The crisis cell, following those recommendations (figure 3), defines both a new safety parameter and a circulation plan (figure 5). They ask for their implementation. They also inform media about those new recommendations for population. (figure 15)

The cloud proposes to the army to subscribe to events of the type "status of operations". Indeed, this type of event was often consulted by them. The Army accepts and add this new subscription. (figure 6)

Field actors receive the order to distribute iodine capsules. They also receive the circulation plan and the new safety parameter defined. They are asked to implement them.

The logistics section of firemen provides vehicles and iodine capsule. (figure 19)

The office of infrastructures provides road signs and vehicles to implement the circulation plan. (figure 19)

The army sends resources to implement the safety perimeter (figure 19). Those resources are used to make sure that the safety perimeter is respected. (figure 10)

To facilitate the evacuation, the representative of the local authority requisitions buses and send them meeting points. (figure 12)

The media inform the population that everybody closer than 10km of the nuclear plant has to ingest iodine and evacuate. (figure 15) Instructions are that people with light vehicles can use them and leave, if possible with 4 or 5 person per vehicle. Others can go to assembly points. Children at school are evacuated directly from their school. (figure 15)

Firemen and MEMS are sent with iodine capsules, to distribute iodine to those, who do not have capsules already at home. Drugstores also supply iodine capsules. (figure 14)

The army ensures and controls that the evacuation goes smoothly. (figure 10)

Despite all efforts to avoid any further complication, a road accident occurs along one of the main roads. Three people are hurt and require assistance.

The police, who was nearby, inform the crisis cell. (figure 9)

The crisis cell defines another circulation plan, (figure 5) and sends this new plan to the office of infrastructures for implementation (figure 9). By the time they implement it, a traffic jam occurs. An alert is sent (figure 9)

An adaptation is required: the army, who is not supposed to be involved in iodine distribution, has to take part in the process (see figure 20).

The army checks that everybody managed to evacuate. They find that it is not going easily, and a traffic jam occurred along the main road.

They inform the crisis cell. Six cars and one bus had an accident. Firemen are sent to assist victims (figure 11). An alternative circulation plan is defined. The crisis cell asks for its implementation. (figures 3 and 5)

Firemen send an alert to the cloud: their resources are not sufficient to cover both iodine distribution and victim assistance. MEMS are too far away to take over victim assistance, so somebody has to replace firemen for iodine distribution.

The office of infrastructures provides new road signs and vehicles to implement the new circulation plan. They remove the old signs to take into account the new plan. (figures 9 and 18)

Victims are transferred to hospital by firemen. Hospital receives and treats victims. Crisis cell decided to send MEMS to support psychologically the people around the accident. (figure 11)

The army checks again that everybody managed to evacuate. They confirm that everything is ok and informs the crisis cell. (figure 10)

As no change measures from Meteo France and RSN are foreseen, operations are closed (figure 3). Every actors create and send its reports on operations. Reports are aggregated by the communication officer. This final report is used by media to inform populations. (figure 7 and 16)

## 5. Technical complements

### 5.1. From BPMN processes to the running workflows

In this section, the overall configuration of the platform will be presented. Secondly, the previously defined scenarios will be used to illustrate this configuration.

The input of this step is a set of ordered business activities, each under the responsibility of an actor. Nevertheless the business activities could not be directly used by the platform, it is necessary to match these business activities with technical services (as an operation of web-services). In the case of a crisis situation, we can consider that a partner's business activity match with exactly one technical service. For the moment, this matching is manually done.

Based on this choice, the partially automated configuration of the technical platform, represented by figure 23, is divided in eight steps for each business process:

- Step 1: The Manual matching operation consists in extracting from a business process, the set of business activities. Then for each business activity, the user has to make the link with an operation of a web-service. If the link already exists, the user has to provide the WSDL file of this web-service. In other case, the business service is added to the list of services that need to be created.
- Step 2: All services, which need to be created, are grouped according to the actor they depend on. Then a WSDL file is created for each identified actor (a lane in the BPMN diagram). Consequently, a web-service could correspond to several business services.
- Step 3: This step consists in generating the BPEL file corresponding to the business process. This step is based on the result of our research work which defines a model driven engineering to transform a BPMN model in a BPEL file based on the WSDLs files and the matching between business activities and web-services operations.

After this step, two operations are realized. The first one, divided in step 4 and 5, consists in generating all the artefacts required to configure an ESB based on JBI standard. The second one, divided in step 6 and 7, consists in creating the web- services.

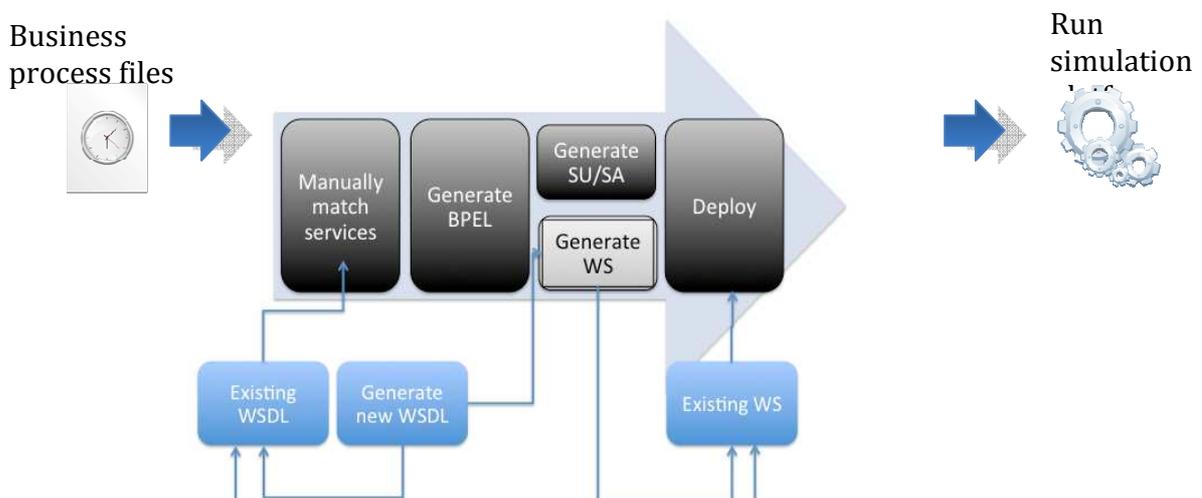
- Step 4: The aim of this step is to generate some artefacts needed to execute the workflow in a JBI environment. It is necessary to generate service Assemblies (SA) and Service Units (SU) to allow the ESB to communicate with any web-service. A SU is composed of the WSDL of the service and a JBI file that defines, in a unique way for the ESB, the web-service. A SA makes the link between a protocol (SOAP, HTTP,...) and the web-services through the SU. So this step consists in creating all the necessary SAs and SUs
- Step 5: This step consists in deploying all the artefacts on the ESB. These artefacts are composed, on the one hand, of all the SAs and SUs created during the previous step, and, on the other hand, all the binding component (BC) needed to communicate with the web-services (one BC per protocol) and the potentially requires service engine (for

instance a workflow engine).

- Step 6: This step uses an internal tool, named WS-Generator, which allows us to create the skeleton of Java Web Services from the BPEL file and all the WSDL files. However, the main functions of the operations are not created; it is the subject of the following step.

It is important to notice that the operations of the generated web services can generate a start event and an end event (same as BPMN meaning).

- Step 7: Our work consists in simulating the execution of a crisis response. Consequently for each operation of a WebService, corresponding to a WSDL file created at step 2, a graphical interface is automatically build. A graphical interface is composed of TextBox for each input and output elements of the operation and the colors of the interface are defined for each actor in a XML file.
- Step 8: At the end of the Step 5 and 7, the simulated crisis response can be launched.



**Figure 21 : Overview of the simulation platform configuration**

## 5.2. Configuration of the demo platform

Basically, the configuration of the demo platform is the same, whatever is the use case. The differences are the list of deployed and invoked web services, the list of workflows, the generated and received events.

Concerning the events, they are typed according the types defined in the previous document

(D1.3):

1. Resources status:
  - Availability: (time; place)
  - Relevance: (skill; quantity)
2. Activities Status:
  - Not applicable
  - Waiting
  - Work in Progress
  - Closed
3. Situational Events:
  - Radioactivity measures: (time; place)
  - Spreading measures (weather): (time; place)
4. Consequences Events:
  - Contamination risks: (time; place)
  - Transportation risks (traffic jam, accidents...)
  - Fire/explosion risks
  - Social/Psychological risks

The web services will only receive the relevant events for them, as it is possible to define an event filter when a web service subscribes to an event producer. It means that the event producer implements at least the Subscribe operation (according to WS-Notification).

We have distinguished two event natures : unique and stream. An unique event is an event only produced as a consequence of the invocation of a technical or human operation (e.g., « report is sent », « people are saved », « fireman is in danger », « operations closed »).

A stream event is produced with a stable frequency, without any constraint like the consequence of the invocation of a technical or human operation (e.g., the measures provide by a wind/temperature captor).

### **5.2.1. First configuration of the demo platform**

In our use case (scenario 1), the workflows have already been presented, in the part 2 of this document. Table 2, in appendix A, describes the deployed and invoked web services (listed per actor) and the produced and received events.

### **5.2.2. Second configuration of the demo platform**

In our use case (scenario 2), the workflows were presented yet, in the part 2 of this document. Table 3, in appendix A, describes the deployed and invoked web services (listed per actor) and the produced and received events.

We can notice that all the operations concerning the distribution of iodine by the Police are not determined and defined at the beginning of the response to the crisis situation. They appear as a consequence of the adaptation step in this scenario.

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## Appendix A: Tables of all WS for scenarios 1 and 2

**BPMN:** name of the processes where the web service's operation is used

**Actor:** name of the actor involved in the process and providing the web service

**Service:** name of the web service

**Operation:** name of the invoked web service's operation

**Event:** type of the received/produced event by the operation, and its nature (unique/stream)

BPMN	Actor	Service	Operation	Event type	unique/stream
Decision_sc1_Dynamic_subscribe	CommunicationOfficer	CommunicationDecisionService	ChangeSubscriptionEventTypes	AdviceToAddNewSubscription, InfoSubscription	Unique
Decision_sc1_Alert_subscribe	CommunicationOfficer	CommunicationDecisionService	EditFirstReport	FirstOfficialReport	
Decision_sc1_Recover	CommunicationOfficer	CommunicationDecisionService	EditLastReport	LastReport	Unique
Decision_sc1_Alert_subscribe	CommunicationOfficer	CommunicationDecisionService	Install and connect	CommunicationOfficerPresent	
Decision_sc1_Recover	CommunicationOfficer	CommunicationDecisionService	Subscribe	DirectivesRNA	Unique
Decision_sc1_Alert_subscribe	CommunicationOfficer	CommunicationDecisionService	Subscribe to relevant event types		
Decision_sc1_Recover	CommunicationOfficer	CommunicationDecisionService	Unsubscribe		
Decision_sc1_Scientific_support	IRSN Scientific experts	IRSNDecisionService	AnalyseData		
Decision_sc1_Scientific_support	IRSN Scientific experts	IRSNDecisionService	ConsultData		
Decision_sc1_Scientific_support	IRSN Scientific experts	IRSNDecisionService	SendAdvice	Advice	Unique
Decision_sc1_Scientific_support	IRSN Scientific experts	IRSNDecisionService	Subscribe	Alert, AskForAdvice	Unique

Decision_sc1_Recover	Media	MediaDecisionService	CreatePressRelease		
Decision_sc1_Alert_subscribe	Media	MediaDecisionService	CreatePressRelease		
Decision_sc1_Recover	Media	MediaDecisionService	InformPopulation		
Decision_sc1_Alert_subscribe	Media	MediaDecisionService	InformPopulation		
Decision_sc1_Recover	Media	MediaDecisionService	Subscribe	LastReport	Unique
Decision_sc1_Alert_subscribe	Media	MediaDecisionService	Subscribe	FirstOfficialReport	
Decision_sc1_Recover	Media	MediaDecisionService	Unsubscribe		
Decision_sc1_Alert_subscribe	Representative of the Army	ArmyDecisionService	AlertField		
Decision_sc1_protection	Representative of the Army	ArmyDecisionService	DecideMeasuresEnsureSecurity	SecurityMeasures	
Decision_sc1_Recover	Representative of the Army	ArmyDecisionService	EditReport	ReportFromA	Unique
Decision_sc1_Alert_subscribe	Representative of the Army	ArmyDecisionService	Install and connect	Apresent	
Decision_sc1_Recover	Representative of the Army	ArmyDecisionService	Subscribe	OperationsClosed	Unique
Decision_sc1_protection	Representative of the Army	ArmyDecisionService	Subscribe	DecisionFromRNA	
Decision_sc1_Alert_subscribe	Representative of the Army	ArmyDecisionService	Subscribe to relevant event types		
Decision_sc1_Recover	Representative of the Army	ArmyDecisionService	Unsubscribe		
Decision_sc1_Dynamic_subscribe	Representative of the Army	ArmyDecisionService	ChangeSubscriptionEventTypes	AdviceToAddNewSubscription, InfoSubscription	Unique
Decision_sc1_Alert_subscribe	Representative of the Firemen	FiremenDecisionService	AlertField		
Decision_sc1_Dynamic_subscribe	Representative of the Firemen	FiremenDecisionService	ChangeSubscriptionEventTypes	AdviceToAddNewSubscription, InfoSubscription	Unique
Decision_sc1_protection	Representative of the Firemen	FiremenDecisionService	DefineDistributionPerimeter	DistributionPerimeter	
Decision_sc1_Recover	Representative of the Firemen	FiremenDecisionService	EditReport	ReportFromF	Unique
Decision_sc1_Alert_subscribe	Representative of the Firemen	FiremenDecisionService	Install and connect	Fpresent	
Decision_sc1_Recover	Representative of the Firemen	FiremenDecisionService	Subscribe	OperationsClosed DistributeIodine (DecisionFromRNA)	Unique
Decision_sc1_protection	Representative of the Firemen	FiremenDecisionService	Subscribe		
Decision_sc1_Alert_subscribe	Representative of the Firemen	FiremenDecisionService	Subscribe to relevant event types		
Decision_sc1_Recover	Representative of the Firemen	FiremenDecisionService	Unsubscribe		

Decision_sc1_Recover	Representative of the National Authority	NADecisionService	Aggregate	DirectivesRNA	Unique
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	AnalyseData		
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	AskForAdvice	AskForAdvice	Unique
Decision_sc1_Dynamic_subscribe	Representative of the National Authority	NADecisionService	ChangeSubscriptionEventTypes	AdviceToAddNewSubscription, InfoSubscription	Unique
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	CloseOperations	OperationsClosed	Unique
Decision_sc1_Recover	Representative of the National Authority	NADecisionService	Consult		
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	ConsultData		
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	ConsultOrWait		
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	DecideNatureOp	DecisionFromRNA	Unique
Decision_sc1_Alert_subscribe	Representative of the National Authority	NADecisionService	Install and connect	RNAPresent, RNAAwait	
Decision_sc1_Alert_subscribe	Representative of the National Authority	NADecisionService	Siren turned on	StartPhase2	
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	StudyAdvice		
Decision_sc1_Situation_management	Representative of the National Authority	NADecisionService	Subscribe	AlertField, AlertMF, AlertRSN, AdviceFromIRSN	Unique
Decision_sc1_Recover	Representative of the National Authority	NADecisionService	Subscribe	ReportFromA, ReportFromF, ReportFromO, ReportFromP	Unique
Decision_sc1_Alert_subscribe	Representative of the National Authority	NADecisionService	Subscribe to relevant event types		
Decision_sc1_Alert_subscribe	Representative of the Office Of Infrastructure	OOIDecisionService	AlertField		
Decision_sc1_Dynamic_subscribe	Representative of the Office of Infrastructure	OOIDecisionService	ChangeSubscriptionEventTypes	AdviceToAddNewSubscription, InfoSubscription	Unique
Decision_sc1_protection	Representative of the Office of Infrastructure	OOIDecisionService	DefineCirculationPlan	CirculationPlan	
Decision_sc1_Recover	Representative of the Office of Infrastructure	OOIDecisionService	EditReport	ReportFromO	Unique
Decision_sc1_Alert_subscribe	Representative of the Office of Infrastructure	OOIDecisionService	Install and connect	Opresent	
Decision_sc1_Recover	Representative of the Office of Infrastructure	OOIDecisionService	Subscribe	OperationsClosed	Unique

Decision_sc1_protection	Representative of the Office of Infrastructure	OOIDecisionService	Subscribe	EvacuationPerimeter, SecurityMeasures		
Decision_sc1_Alert_subscribe	Representative of the Office Of Infrastructure	OOIDecisionService	Subscribe to relevant event types			
Decision_sc1_Recover	Representative of the Office of Infrastructure	OOIDecisionService	Unsubscribe			
Decision_sc1_Alert_subscribe	Representative of the Police	PoliceDecisionService	AlertField			
Decision_sc1_protection	Representative of the Police	PoliceDecisionService	DefineConfinementPerimeter	ConfinementPerimeter		
Decision_sc1_protection	Representative of the Police	PoliceDecisionService	DefineEvacuationPerimeter	EvacuationPerimeter		
Decision_sc1_Recover	Representative of the Police	PoliceDecisionService	EditReport	ReportFromP	Unique	
Decision_sc1_Alert_subscribe	Representative of the Police	PoliceDecisionService	Install and connect	Ppresent		
Decision_sc1_Recover	Representative of the Police	PoliceDecisionService	Subscribe	OperationsClosed DecisionFromRNA, Evacuate (DecisionFromRNA)	Unique	
Decision_sc1_protection	Representative of the Police	PoliceDecisionService	Subscribe			
Decision_sc1_Alert_subscribe	Representative of the Police	PoliceDecisionService	Subscribe to relevant event types			
Decision_sc1_Recover	Representative of the Police	PoliceDecisionService	Unsubscribe			
Decision_sc1_Dynamic_subscribe	Representative of the Police	PoliceDecisionService	ChangeSubscriptionEventTypes	AdviceToAddNewSubscription, InfoSubscription	Unique	
<b>BPMN</b>	<b>Actor</b>	<b>Service</b>	<b>Operation</b>	<b>In</b>	<b>Out</b>	<b>Event</b>
						type
Operation_sc1_Communicate	Media	MediaOperationService	GatherAndTreatData			unique/stream
Operation_sc1_Alert			ConsultLatestDevelopments			
			CreatePressRelease			
			InformPopulation			
			Subscribe			
			MobilizeTeam			TeamReadyM
						unique
Operation_sc1_Communicate	CommunicationOfficer	CommunicationOfficerService	Subscribe			

			BuildOfficialReport			
			PublishOfficialReport	OfficialReport	unique	
Operation_sc1_Evacuate	Police	PoliceOperationService	Subscribe			
Operation_sc1_Withdraw_back			AnalyseEvacuationPlan			
Operation_sc1_Alert			ConsultStatusOfResources			
			AskForResources	RequestResources	unique	
			ExecuteEvacuationPlan	Issue/Success		
			InformCrisisCellOfIssues	AlertField	unique	
			ReportOnEvacuation	InfoField	unique	
			RegroupRessources			
			GetDecontaminated			
			Leave	InfoField	unique	
			MobilizeTeam	TeamReadyP	unique	
Operation_sc1_Evacuate	LocalAuthority	LocalAuthorityOperationService	Subscribe			
Operation_sc1_Alert			AnalyseEvacuationPlan			
			RequisitionBuses			
			InformBusesAreDeployed	BusesDeployed	unique	
			MobilizeTeam	TeamreadyL	unique	
Operation_sc1_Withdraw_back	Firemen	FiremenOperationService	Subscribe			
Operation_sc1_Alert			RegroupRessources			
			GetDecontaminated			
			Leave	InfoField	unique	

			MobilizeTeam		TeamReadyF	unique
Operation_sc1_Withdraw_back Operation_sc1_Alert	Army	ArmyOperationService	Subscribe RegroupRessources GetDecontaminated Leave MobilizeTeam		InfoField TeamReadyA	unique unique
Operation_sc1_Withdraw_back Operation_sc1_Alert	OfficeOfInfrastructures	OfficeOfInfrastructuresOperationService	Subscribe RegroupRessources GetDecontaminated Leave MobilizeTeam		InfoField TeamReadyO	unique unique
Operation_sc1_Withdraw_back Operation_sc1_Alert	MEMS	MEMSOperationService	Subscribe RegroupRessources GetDecontaminated Leave MobilizeTeam		InfoField TeamReadyMEMS	unique unique
Operation_sc1_Alert	Hospitals	HospitalsOperationService	Subscribe MobilizeTeam		TeamReadyH	unique
BPMN	Actor	Service	Operation	In Out	Event type	unique/stream

Support_sc1_Assess_situation	MeteoFrance	MeteoFranceSupportService	Subscribe	InfoMF	stream (10s)
Support_sc1_Assess_situation	RadiationSurveyNetwork	RadiationSurveyNetworkSupportService	Subscribe	InfoRSN	stream (10s)
Support_sc1_Gather_reports Support_sc1_Store_measures Support_sc1_Store_status_resources	DataWarehouse	DataWarehouseSupportService	Subscribe UpdateDatabase	Trends	Stream (15 min)
Support_sc1_Manage-resources	Firemen	FiremenSupportService	Subscribe ReceiveResources SendResources UpdateStatusOfResources	ResourcesReceived ResourcesSent InventoryLevelResourcesF	unique unique unique
Support_sc1_Manage-resources	Army	ArmySupportService	Subscribe ReceiveResources SendResources UpdateStatusOfResources	ResourcesReceived ResourcesSent InventoryLevelResourcesA	unique unique unique
Support_sc1_Manage-resources	Media	MediaSupportService	Subscribe SendAvailabilities	AvailableResourcesM	unique

Support_sc1_Manage-resources	Police	PoliceSupportService	Subscribe				
			ReceiveResources		ResourcesReceived	unique	
			SendResources		ResourcesSent	unique	
			UpdateStatusOfResources		InventoryLevelResourcesP	unique	
Support_sc1_Manage-resources	OfficeOfInfrastructure	OfficeOfInfrastructureSupportService	Subscribe				
			ReceiveResources		ResourcesReceived	unique	
			SendResources		ResourcesSent	unique	
			UpdateStatusOfResources		InventoryLevelResourcesA	unique	

**Table 2 : WS for scenario 1**

BPMN	Actor	Service	Operation	In	Out	Event type	unique/stream
Operation_sc2_Assist	Firemen	FiremenOperationService	Subscribe				
Operation_sc2_Distribute_iodine			EvaluateStateOfVictims			AssistancePlan	unique
Operation_sc1_Withdraw_back			EvacuateVictims			StatusOfVictims	unique
Operation_sc1_Alert			DecontaminateVictims			StatusOfVictims	unique
			TreatPhysicalInjuries			StatusOfVictims	unique
			TreatPsychologicalProblems			StatusOfVictims	unique
			ConsultStatusOfResources				
			AnalyseDistributionPerimeter				
			RequestDrugstoresInventoryLevel				
			AskForResources			RequestResources	unique

				Issue/Success	
			ImplementDistributionPerimeter		
			InformCrisisCellOfIssues	AlertField	unique
			ReportOnIodineDistribution	InfoField	unique
			RegroupRessources		
			GetDecontaminated		
			Leave	InfoField	unique
			MobilizeTeam	TeamReadyF	unique
Operation_sc2_Assist	MEMS	MEMSOperationService	Subscribe		
Operation_sc1_Withdraw_back			EvaluateStateOfVictims	AssistancePlan	unique
Operation_sc1_Alert			EvacuateVictims	StatusOfVictims	unique
			DecontaminateVictims	StatusOfVictims	unique
			TreatPhysicalInjuries	StatusOfVictims	unique
			TreatPsychologicalProblems	StatusOfVictims	unique
			RegroupRessources		
			GetDecontaminated		
			Leave	InfoField	
			MobilizeTeam	TeamReadyMEMS	unique
Operation_sc2_Assist	Hospitals	HospitalsOperationService	Subscribe		
Operation_sc1_Alert			PrepareToReceiveVictims		
			TreatVictims	StatusOfVictims	unique
			MobilizeTeam	TeamReadyH	unique
Operation_sc1_Communicate	Media	MediaOperationService	GatherAndTreatData		

Operation_sc1_Alert			ConsultLatestDevelopments		
			CreatePressRelease		
			InformPopulation		
			MobilizeTeam	TeamReadyM	unique
Operation_sc1_Communicate	CommunicationOfficer	CommunicationOfficer Service	Subscribe		
			BuildOfficialreport		
			PublishOfficialReport	OfficialReport	unique
Operation_sc2_Confine_population	Police	PoliceOperationService	Subscribe		
Operation_sc1_Evacuate			ConsultStateOfResources		
Operation_sc1_Withdraw_back			AnalyseConfinmentPerimeter		
Operation_sc1_Alert			AskForResources	RequestResources	unique
Operation_sc2_Distribute_Iodine			ImplementConfinmentPerimeter	Issue/Success	
			InformCrisisCellOfIssues	AlertField	unique
			ReportOnImplementConfinmentPerimeter	ReportOnImplementationConfinmentParameter	unique
			AnalyseEvacuationPlan		
			ConsultStatusOfResources		
			ExecuteEvacuationPlan	Issue/Success	
			ReportOnEvacuation	InfoField	unique
			RegroupRessources		
			GetDecontaminated		
			Leave	InfoField	unique
			MobilizeTeam	TeamReadyP	unique
			ConsultStatusOfResources		
			AnalyseDistributionPerimeter		

			RequestDrugstoresInventoryLevel			
			AskForResources		RequestResources	unique
			ImplementDistributionPerimeter	Issue/Success		
			InformCrisisCellOfIssues		AlertField	unique
			ReportOnIodineDistribution		InfoField	unique
Operation_sc1_Evacuate	LocalAuthority	LocalAuthority OperationService	Subscribe			
Operation_sc1_Alert			AnalyseEvacuationPlan			
			RequisitionBuses			
			InformBusesAreDeployed		BusesDeployed	unique
			MobilizeTeam		TeamreadyL	unique
Operation_sc1_Implement _circulation_plan	OfficeOfInfrastructures	OfficeOfInfrastructures OperationService	Subscribe			
Operation_sc1_Withdraw_back			ConsultStatusOfResources			
Operation_sc1_Alert			AnalyseCirculationPlan			
			AskForResources		RequestResources	unique
			ImplementCirculationPlan	Issue/Success		
			InformCrisisCellOfIssues		AlertField	unique
			ReportOnImplementationOfCirculationPlan		ReportOnImplemenationOfCirculationPlan	unique
			RegroupRessources			
			GetDecontaminated			
			Leave		InfoField	unique
			MobilizeTeam		TeamReadyO	unique
Operation_sc1_Implement _security_measures	Army	ArmyOperationService	Subscribe			

Operation_sc1_Withdraw_back	ConsultStatusOfResources						
Operation_sc1_Alert	AnalyseSecurityMeasures						
	AskForResources			RequestResources			unique
	ImplementSecurityMeasures		Issue/Success				
	ReportOnImplementationOfSecurityMeasures			ReportOnImplemenationOfSecurityMeasures			unique
	EnsureSecurity			AlertField			unique
	ReportOnSecurityMeasures			InfoField			unique
	RegroupRessources						
	GetDecontaminated						
	Leave			InfoField			unique
	MobilizeTeam			TeamReadyA			unique

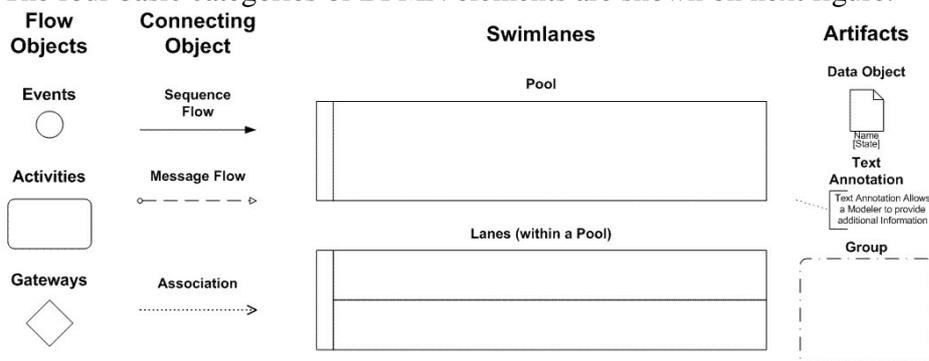
<b>BPMN</b>	<b>Acteur</b>	<b>Service</b>	<b>Operation</b>	<b>In</b>	<b>Out</b>	<b>Event</b>	
						type	unique/stream
Support_sc1_Assess_situation	MeteoFrance	MeteoFranceSupportService	Subscribe			InfoMF	stream (10s)
Support_sc1_Assess_situation	RadiationSurveyNetwork	RadiationSurveyNetworkSupportService	Subscribe			InfoRSN	stream (10s)
			DeployOrMoveMobileMeasurementStations				
Support_sc1_Gather_reports	DataWarehouse	DataWarehouseSupportSevice	Subscribe			Trends	Stream (15 min)
Support_sc1_Store_measures			UpdateDatabase				
Support_sc1_Store_status_resources							
Support_sc1_Manage-resources	Firemen	FiremenSupportService	Subscribe				

			ReceiveResources	ResourcesReceived	unique
			SendResources	ResourcesSent	unique
			UpdateStatusOfResources	InventoryLevelResourcesF	unique
Support_sc1_Manage-resources	Army	ArmySupportService	Subscribe		
			ReceiveResources	ResourcesReceived	unique
			SendResources	ResourcesSent	unique
			UpdateStatusOfResources	InventoryLevelResourcesA	unique
Support_sc1_Manage-resources	Media	MediaSupportService	Subscribe		
			SendAvailabilities	AvailableResourcesM	unique
Support_sc1_Manage-resources	Police	PoliceSupportService	Subscribe		
			ReceiveResources	ResourcesReceived	unique
			SendResources	ResourcesSent	unique
			UpdateStatusOfResources	InventoryLevelResourcesP	unique
Support_sc1_Manage-resources	OfficeOfInfrastructure	OfficeOfInfrastructureSupportService	Subscribe		
			ReceiveResources	ResourcesReceived	unique
			SendResources	ResourcesSent	unique
			UpdateStatusOfResources	InventoryLevelResourcesA	unique

**Table 3 : WS for scenario 2**

## Appendix B : Short explanation on BPMN

The four basic categories of BPMN elements are shown on next figure.



**Figure 22 : Core set of BPMN elements (OMG, 2008)**

According to (White, 2006), An Event is something that “happens” during the course of a business process.

An Activity is a generic term for work that company performs.

A Gateway is used to control the divergence and convergence of Sequence Flow. Thus, it will determine traditional decisions, as well as the forking, merging, and joining of paths.

A Sequence Flow is used to show the order (the sequence) that activities will be performed in a Process.

A Message Flow is used to show the flow of messages between two separate Process Participants (business entities or business roles) that send and receive them.

In BPMN, two separate Pools in the Diagram will represent two Participants.

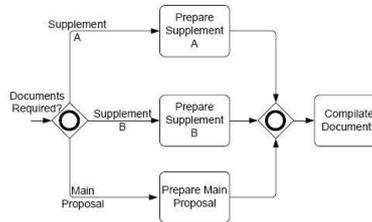
An Association is used to associate data, text, and other Artefacts with flow objects. Associations are used to show the inputs and outputs of activities. A Pool represents a Participant in a Process.

A Lane is a sub-partition within a Pool and is used to organize and categorize activities.

The three main gateways used in this document are inclusive, parallel and complex gateways. Definitions provided by (White, 2006) are the following:

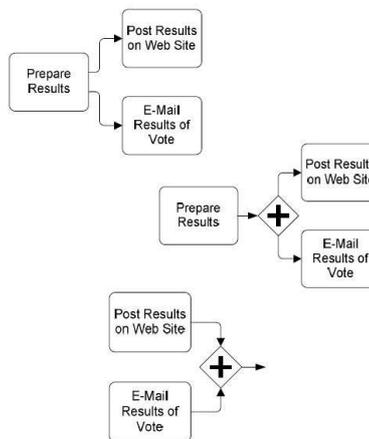
## Inclusive Gateways

- Inclusive Gateways are Decisions where there is more than one possible outcome
- The "O" marker is used to identify this Gateway
- They are usually followed by a corresponding merging Inclusive Gateway



## Parallel Gateways

- Parallel Gateways are places in the Process where multiple parallel paths are defined
  - They are not required for forking in most situations.
  - They can be used for methodological purposes
- The "+" marker is used to identify this Gateway
- The Gateway is also used to synchronize (wait for) parallel paths



## Complex Gateways

- Complex Gateways are Decisions where there is more advanced definitions of behavior can be defined
- The asterisk marker is used to identify this Gateway
- Complex behavior can be defined for both the merging and splitting behavior

