COPE – COMMON OPERATIONAL PICTURE EXPLOITATION

SEVENTH FRAMEWORK PROGRAMME

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Comprehensive Model of First Responder Operations & Concept of Operations

Authors:	Patrick Grommes, TCD
	Rob Hutton, BAE-ATC
	Nick Colford, BAE-ATC
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Summary

This document provides models representing the current systems and structures for incident command. As such it represents the CONOPS of a reference system for the COPE development process. The reference system models are provided as a set of UML diagrams. These diagrams identify operational tasks and the actors involved and their interactions. This document will also be used to motivate changes in the current system and it will be the basis for a human factors analysis and assessment of the proposed set of COPE technologies.

Contents

Abbreviations

BA	Breathing Apparatus
BA ECO	Breathing Apparatus Entry Control Officer
C2	Command and Control
CONOPS	Concept of Operations
COP	Common Operational Picture
COPE	Common Operational Picture Exploitation
CS	Command Support
CSO	Command Support Officer
DO	District Officer
EMS	Emergency Medical Services
EPA	Environmental Protection Agency (Ireland)
FF	Fire Fighter
FR	First Responder
FRS	Fire and Rescue Services
HazMat	Hazardous Material
HF	Human Factors
IC	Incident Commander
ICP	Incident Command Post
ICS	Incident Command Structure
ICT	Information and Communication Technology
KSM	Knowledge Space Model
OC	Operations Commander
PDA	Pre-Determined Attendance
PM	Paramedic
PO	Police Officer
RTA	Road Traffic Accident
SC	Sector Commander
SME	Subject matter expert (usually from an end user organisation)
SMO	Senior Medical Officer
SPO	Senior Police Officer
SOP	Standard Operating Procedures
UML	Unified Modelling Language
WP	Work Package

Glossary of terms

(personnel and structures related to Incident Command)

- BA Emergency Team – on stand by in case of an accident
- BA Entry Control Officer (BA ECO) – a firefighter who is responsible for the safety of all BA wearers on his BA Entry Control Board
- BA Team – a pair of BA wearers, with one Team Leader
- BA Team Leader – a BA wearer with responsibility for leading a BA Team
- BA Wearer – anyone wearing BA
- Command Support Officer (CSO) – firefighter (or higher ranking officer dependent on scale of the incident) designated to support the IC, especially with communications to Control Centre; reference point for additional appliances, manages information flow to and from the IC, records information, .e.g. on IC board or in command wallet, assists IC in liaison with other response agencies and third parties, arranges and manages relief and welfare measures
- Command wallet – used in many UK FRS brigades; functionality comparable to IC board but e.g. includes reference documentation, too
- Control Centre – The Dublin Fire Brigade Control Centre e.g. takes emergency calls and dispatches the response units. As an incident develops over time, the control centre can be contacted e.g. in order to request additional resources or to upgrade the incident and alert more senior officers.
- Firefighter – any FRS personnel; generic term, used in lieu of a specific role term.
- Hose Team – generic term for firefighters with a hose; should be used for external use only as BA Teams should always have a hose too
- Incident Commander (IC) – officer in charge of the Incident
- Incident Command Board (IC board) – used for example in many Irish FRS brigades; whiteboard with predefined fields to record e.g. incident ground information such as tactical mode, sectors, personnel on scene, drawings and sketches of the incident ground
- Operations Commander (OC) – a firefighter put in charge of an "operational" area, which may include several sectors; reports directly to the IC
- Paramedic (PM) – generic term for an actor with primary medical responsibility for casualty care, triage etc. (or EMT - Emergency Medical Technician)
- Police Officer (PO) – generic term of an actor with primary policing responsibility (crowd/bystander control; Incident Ground security; traffic flow etc).
- Pump Operator – operates the pump on an appliance
- Sector – sectorisation allows the IC to delegate areas of responsibility (either geographic/spatial or functional) to other experienced personnel; sectorisation can be numerical with Sector 1 being the area where the first units arrived and other sectors being assigned clockwise around the structure on fire. Functional sectors can include a water sector, responsible

for managing and securing water supply or a BA (breathing apparatus) sector responsible for maintaining BA equipment and having relief crews on stand by.

- Sector Commander (SC) – officer designated as responsible for a sector
- Senior Medical Officer (SMO) – the ambulance-person in charge of the medical effort; interacts directly with the Incident Commander; may be the Incident Commander for medical; non-rescue/fire incidents
- Senior Police Officer (SPO) – the police-person in charge of the police effort; interacts directly with the IC; may be the IC for non-medical, non-rescue/fire incidents

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1 Scope

The task of WP3.1 was to provide a model of current operations, to identify stakeholders in these operations and to build a concept of operations (CONOPS) out of this. To this end, this COPE CONOPS document describes Incident Command (IC) systems that are being put in place at any incident that requires attendance from Fire and Rescue Services (FRS). The system description aims to be as generic as possible, but will have to take into account particularities of FRS in the different nations and regions that have participated in the COPE field studies. Crucial aspects and deficiencies of IC will be identified in this document. It will also indicate steps which should be taken in order to establish and maintain a Common Operational Picture (COP) within the FRS as well as among FRS and other emergency response agencies.

In line with objectives and usage of CONOPS documents in systems engineering (IEEE standard 1362-1998) it is appropriate to broaden the scope of the COPE CONOPS beyond a model of the current system. To facilitate this, this document contains a section that will be gradually amended as the COPE development process continues. It will deal with the proposed COPE solutions for improving and maintaining an appropriate Common Operational Picture on the incident ground and how these solutions transform the current situation into a COPE-improved system. In doing so, findings of this document will be carried over into WP3.3 and WP4. This deliverable documents the state of work achievable until now. Updates depending on the coming work in COPE (technology mapping, scenarios etc.) will be provided as amendments.

1.1 Reference Documents

This document takes IEEE standard 1362-1998 as a basic methodological starting point. However, due to the nature of the system being described not all specifications of the standard are applicable.

This document is closely linked to COPE D2.1 "Use Case Descriptions" and COPE D3.2 "End User Requirements".

Other documents / sources include:

- Alan V. Brunacini (1985). Fire Command. National Fire Protection Agency, Quincy/MA.
- Dublin Fire Brigade Incident Command Training Material
- Feuerwehr-Dienstvorschrift 100 (FwDV100): Führung und Leitung im Einsatz: Führungssystem. Beschlossene Fassung des AFW: 10.03.99 (German Command and Control System and Procedures for FRS)
- Irish Framework for Major Emergency Management (available at: http://www.environ.ie/en/LocalGovernment/FireandEmergencyServices/EmergencyPlanning/PublicationsDocuments/FileDownLoad,796,en.pdf; last accessed 03/07/2009)
- UK Fire Services Manual, Vol. 2, Fire Service Operations, Incident Command issued by HM Fire Service Inspectorate, Publications Section (2002)
- US Unified Command documents (e.g. http://www.osha.gov/SLTC/etools/ics/what_is_uc.html; last accessed: 03/07/2009).

1.2 Objectives of this Document

The primary addressees of this CONOPS document are technology developers in WP5 of the COPE project, CESS as evaluation and demonstration work package leader (WP6), and WP4, the technology mapping process, the interface between human factors and technology development. The human factors work packages WP2 and 3 have been main contributors to this document.

This CONOPS document serves several purposes:
- to present a user-centred view of IC systems
- to identify candidate areas for improvement in current IC systems
- to support a shared understanding of IC systems among COPE partners
- to provide technology developers with a view of information flows within the FRS IC system and among FRS and other agencies' systems
- to enable technology developers to communicate functionalities and benefits of their proposed solutions in an operationally valid context
- to enable subject matter experts / end users to validate COPE assumptions and proposals
- to provide a context for testing and evaluating scenarios.

1.3   System overview

The purpose of the system being developed is to support IC functions and more specifically to enable Incident Commanders to receive and send relevant information from and to relevant locations and actors on the incident ground and to integrate this information into a Common Operational Picture among all relevant response agencies.
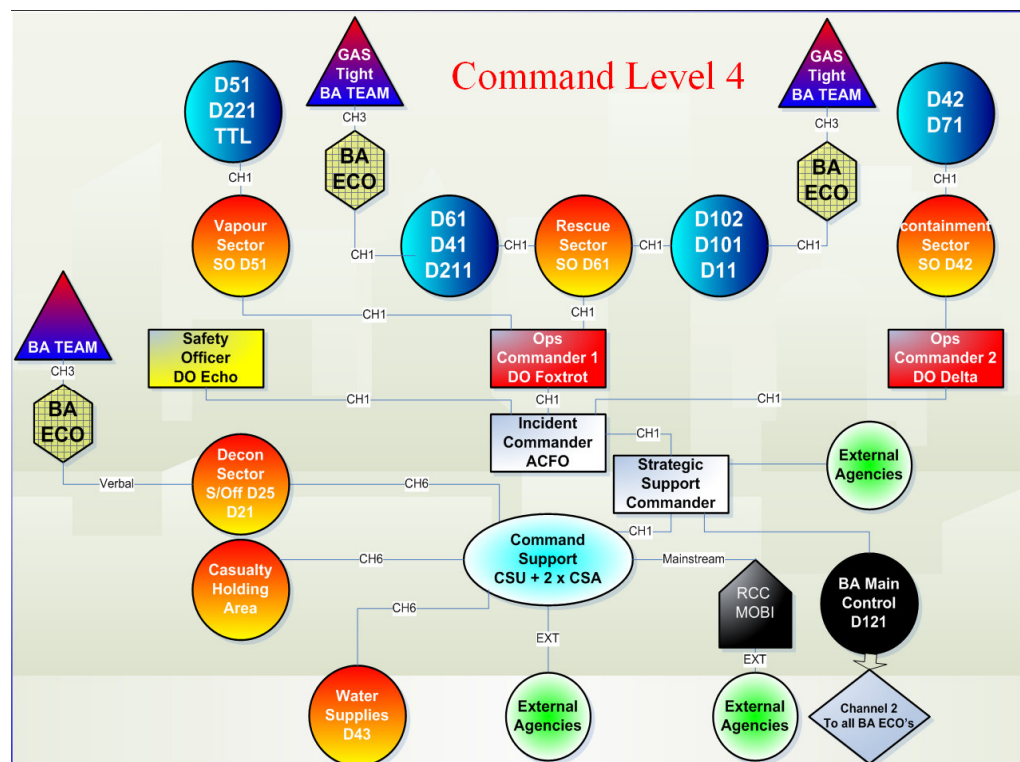

Figure 1. IC structure at incidents (here fire in chemical plant) involving 8+ appliances (diagram courtesy of and ©Dublin Fire Brigade Training Centre).[1]

An example view of actors and lines of communication is given in figure 1 above. The current incident command structures and the various tools and procedures that will be described further down in this document together with the respective information flow and content will be the reference system for the COPE development process. The COPE project takes this reference system and the use of this system by relevant actors as staring point for technology development. The proposed improved system will consist of technology components and subsystems developed and integrated in WP5. Any proposed solution shall better support the existing procedures and ways of working.

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[1] Key to abbreviations: ACFO – Assistant Chief Fire Officer (2nd highest rank in Dublin Fire Brigade); CH1 etc. – radio channels in use between specific actors; CSA – command support appliance, i.e. fire engine exclusively used for CS purposes; CSU – Command support unit, i.e. purpose-fitted CS vehicle; D51 etc. – Appliance with call sign; DO Echo etc. – District Officers of Echo etc. districts; MOBI – mobilisation officer, i.e. officer in charge at the control centre; RCC – regional control centre; SO – Station Officer, i.e. officer in charge of a fire station; S/Off – Sub-Officer, i.e. 2nd in command to SO; TTL – turn table ladder; all other abbreviations see list following the table of contents.

2 Current system and situation

2.1 Background, objectives, and scope

According to the Description of Work , a CONOPS for COPE should describe emergency response as a coordinated effort of all relevant response agencies and other authorities. Such a concept by definition entails coordination among agencies at various command and control levels. Concepts to guide this coordination exist in various formats. One starting point for a generic CONOPS could be an established concept such as Unified Command.

The concept of Unified Command has been developed in the United States in the 1980s in the aftermath of a series of wildfires that revealed serious shortcomings in the interaction and coordination among response agencies at all levels – local, regional, and federal. The core idea has been to provide structures and procedures for inter-agency coordination on the incident ground but also at super-ordinate levels. In the US model this entails that representatives of all relevant response agencies meet at an off-site location and devise overall plans and objectives in response to the incident. These representatives have to be empowered by their agencies to commit resources to the achievement of the set objectives and to exercise command within in their agencies that allows enacting measures to achieve the objectives. Decisions and directives of this overarching command centre are communicated down to the incident ground by the individual agencies' representatives to their incident commanders. These are then responsible for acting on the directives in coordination with the on-site incident command and the other agencies.

The Irish Framework for Major Emergency Management follows a similar approach – as do those of many other countries. However, e.g. as the analysis of German procedures has shown, considerable differences remain and therefore the COPE CONOPS can only be an abstraction based on findings in participating response agencies. And any proposal for a CONOPS, a COP, COPE C2 systems etc. will have to be flexible and adaptable to national and regional specificities when it comes to live applications. Two important features of the Irish Emergency Management Framework are worth mentioning here. There is firstly the Lead Agency Concept. This concept enables response agencies to quickly decide upon the lead agency at an emergency site, which then also implicates what agency will be lead agency at all other levels. Lead agencies are pre-nominated in most cases, so that there is no need for lengthy decision-making processes. With regard to the two COPE scenarios, the RTA with chemical spill and the factory fire potentially involving hazardous materials, the local authority and thereby fire services will be lead agencies. This then implies that at highest level the Department of the Environment will be the lead department. The picture changes if we assume a terrorist attack to be underlying the fire scenario. In this case, An Garda Síochána (Police) and the Department of Justice or in the German case the Ministry of the Interior become lead agencies. Lead agencies in this concept assume overall on-site incident command and are also responsible for dealing with long-term consequences and response measures. The other important concept is that of establishing on-site, local, regional, and national emergency coordination centres. The main logic of this concept is that all response activities should be local and higher level coordination centres have a supporting and monitoring role. This implies a bottom-up approach. Top-down emergency management can of course

be required at any stage but as a default it only occurs in case of major catastrophes like nuclear accidents, infectious epidemic/pandemic scenarios. For COPE this implies that we need to look at systems that support local response but allow to be scaled up or feed into higher command level or the Unified Command (see figure 2 below). Thus the key level for our CONOPS is the operational FR level, controlled on the ground. It is the incident ground (IG) where the COP has to be maintained. The coordination centres provide logistics and deal with long term consequences; they have to make sure that resources are deployed according to the overall demands of the emergency. Key features that COPE is addressing are: distributed command and advanced decision making on the ground.
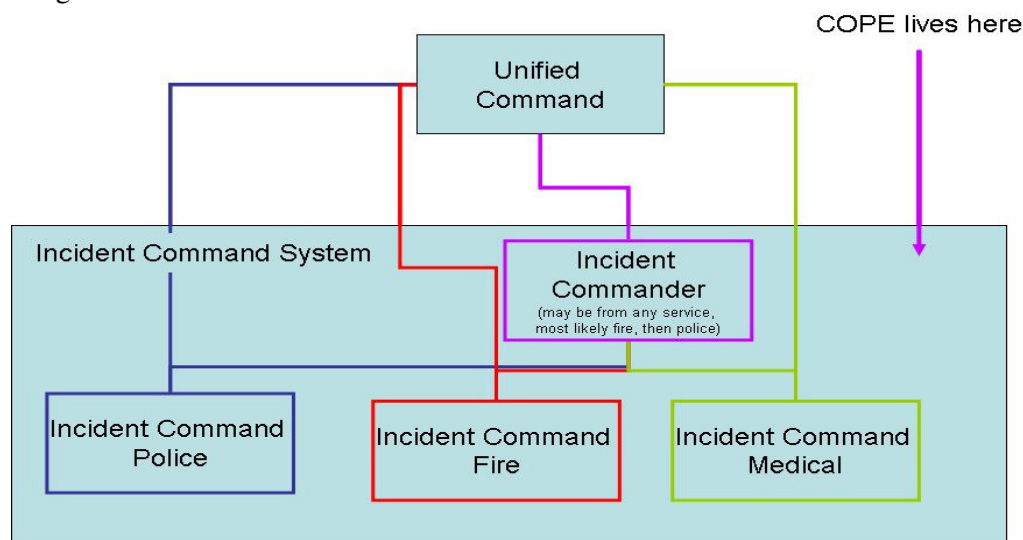

Figure 2. Unified Command and the COPE system.

2.2 Operational policies & constraints – Incident Command Structures

At any incident there is a requirement to apply two types of measures to structure the incident. There is spatial structuring that breaks down the incident ground into manageable geographical and/or functional areas. This type of structuring is called sectorisation. Sectorisation has been described in more detail in COPE deliverable D3.2 "End User Requirements" and will not be discussed any further in this document.

However, sectorisation has implications for the organisational structuring of the incident ground in terms of the command structure that is put in place as each sector requires a dedicated sector commander. This drives the number and type of staff and equipment that have to be called to the incident. Basically, the command structure in operation depends on the number of fire and other services resources that have to be brought to the incident. Resource requirements will initially usually be determined by the first arriving officer when s/he sizes up the incident. Alternatively, it will first be determined when dispatching the initial response if the pre-determined attendance (PDA), i.e. a certain umber and certain types of response vehicles that are required to address specific incident types, exceeds the normal turn out of resources of any given fire station.

In the system in place at Dublin Fire Brigade e.g., the incident command structure is defined by assigning one of four command levels. These command levels in

turn are defined by the number of FRS vehicles attending to the incident. Command Level 1 applies to incidents with a maximum attendance of two FRS appliances. In this case a Station Officer, i.e. an officer who is in charge of one fire station, will be incident commander. If the incident requires only one appliances even a Sub-Officer, i.e. an officer in charge of an appliance crew, can be incident commander. If two or more appliances are required a District Officer (DO), i.e. an officer in charge for a fire district comprising of several fire stations, will be the Incident Commander. The DO's vehicle will become the Incident Command Post (ICP). This will be Command Level 2. Command Level 3 will be declared at incidents requiring five or more appliances. A Third Officer, i.e. an officer with management functions beyond district level, will be Incident Commander. This role is unique to Dublin Fire Brigade. Command Level 4 – see also figure 1 above for an example – will be declared when eight or more appliances are required. In such a case an Assistant Chief Fire Officer or the Chief Fire Officer will be Incident Commander. A purpose-built Incident Command Unit, i.e. a truck carrying a small scale but fully functional operations control room, will be the ICP. This will be the case for any incident requiring six or more appliances. It also has to be noted that at large scale incidents there will most likely be a number of DOs at the scene to take on Operations Command functions, i.e. they will for example be intermediaries between IC and Sector Command. A District Officer or a Third Officer will also be in charge of overall Command Support at level 4 incidents. Command Support mainly deals with communications to the control centre, other agencies and media and the public. As a general rule, the most senior officer at the scene will have overall responsibility for the incident. Furthermore, a higher ranking officer can be called to the scene whenever the current Incident Commander assumes this to be appropriate. However, in both cases the more senior officer may decide not to take on Incident Command. If s/he takes on Incident Command, then the corresponding command level will have to be declared and communicated to the control centre and to all sectors and sector commanders.

In summary, the Incident Command Structure is pre-defined to a certain degree in order to avoid decision-making difficulties or even power struggles and consequential delays at the scene of the incident. It also clearly assigns responsibilities. At the same time, the structure is flexible and allows building up or sizing down the response as required according to the development of the incident. Additionally, declaration of a specific command level gives an indication of the dimensions and seriousness of the incident to everybody involved in responding to it.

2.3 Description of the current situation

This section provides an overview of generic system activities by means of a set of UML use case diagrams. Selected use cases from these diagrams will be framework for the COPE technology development; in other words, any of the solutions proposed by COPE technology developers should address at least one of the use cases depicted in the diagrams provided in this chapter.

2.3.1 Incident Command Use Cases: Organising the incident ground

An actor in UML terms can be a person, an organisation, or any system or object that is involved in the activity captured by the use case. In the diagrams in this

section actors have to be understood as being potentially involved, i.e. the actors shown indicate the maximum number of actor types[2] per use cases.
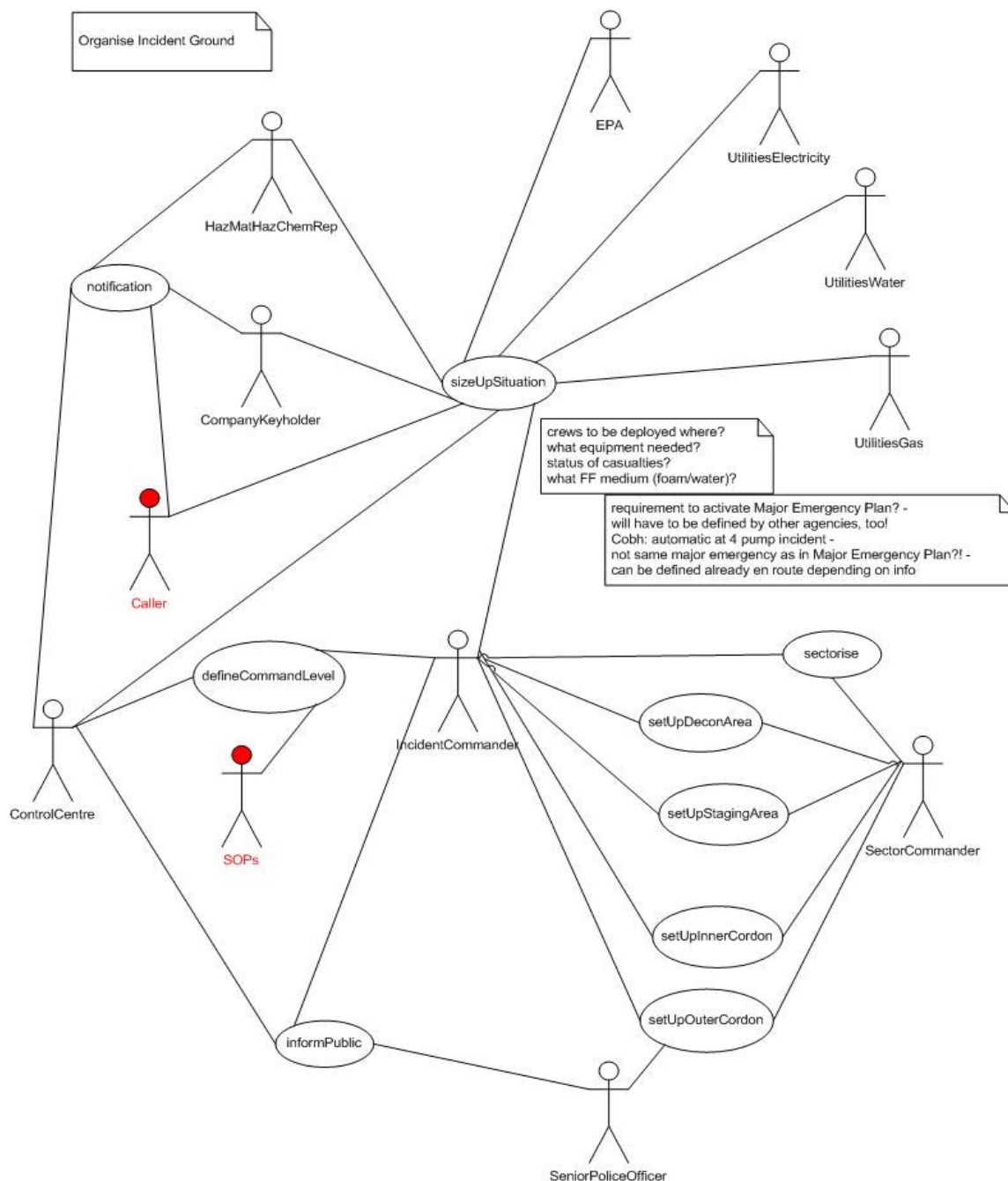

Figure 3. Use Case Diagram: Organising the incident ground.

The use case "sizeUpSituation" potentially involves all the actors depicted above. In this use case diagram representatives of utility companies, the Environmental Protection Agency (EPA) and the assigned company keyholder plus a representative who is knowledgeable about hazardous materials at an industrial site provide information to the Incident Commander. The Incident Commander

determines on the basis of this information what resources will be required including and exceeding those available upon arrival on scene.

The "notification" use case indicates that e.g. a Caller[3] may notify the Control Room of an incident and on the basis of this information company representatives will be informed.

The "defineCommandLevel" use case indicates that on the basis of information available while en route or upon arrival the current incident commander decides on the command level and if necessary informs the Control Room of any changes. The decision will amongst others be guided by standard operating procedures (SOPs).

The "informPublic" use case indicates that based on knowledge available at early stages and at any time from there on there may be a need to inform the public of any threats and hazards. The incident commander takes this decision and communicates it to police and the control room. The control room maybe an intermediary between police and incident command if not already on scene.

The "sectorise" use case indicates that – in most cases – the incident ground will have to be divided into sectors to allow for appropriate command and control and a manageable incident command structure.

The "setUp…" use cases indicate that depending on the situation on the incident ground dedicated areas will have to be set up for certain activities. Not all of these use cases may be required in a single scenario, and also the requirement for setting up a specific area may only arise later in the lifetime of an incident. In this sense use case diagrams are insensitive to time and sequence.

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[3] The "Caller" actor symbol is shown in red, because this actor is either still to be defined in a class diagram or may need to be specified otherwise.

2.3.2 Incident Command Use Cases: Tactical Mode & Risk Assessment

Figure 4. Tactical Mode and Risk Assessment use cases.

The risk assessment and tactical mode use cases indicate that the incident commander has to perform dynamic risk assessment on an ongoing basis and has to assign an appropriate tactical mode to relevant sectors. Risk assessment is being done on the basis of information made available to the incident commander and captured on the incident command board. In some cases risk assessment includes assessing the risk of domino effects or cascading effects. For example, in chemical fire events on the incident ground may have effects on neighbouring

sites and may lead to adverse events there. In some cases information about such potential effects is laid down in documentation such as a folder on hazardous materials and chemical hazards per industrial site. The tactical mode use cases involve sector commanders and/or operations commanders not only as recipients of mode assignments, but they can declare a tactical mode for their sectors autonomously if the situation requires.

The "supportInfoTransferCS" and "supportInfoTransferOC" use cases indicate that depending on the size of the incident and the required command structure Operations Command (OC) and/or Command Support (CS) may require assistance by dedicated firefighters in communicating with other actors. The specific solutions for this issue appear to be different as per country or region. An operations commander will be assigned if the number of lines of communication for the incident commander is no longer manageable. The OC then becomes an intermediary between incident command and sector commanders. In the same way CS manages communication to other agencies on the incident ground and off site.

2.3.3 Incident Command Use Cases: Personnel Management
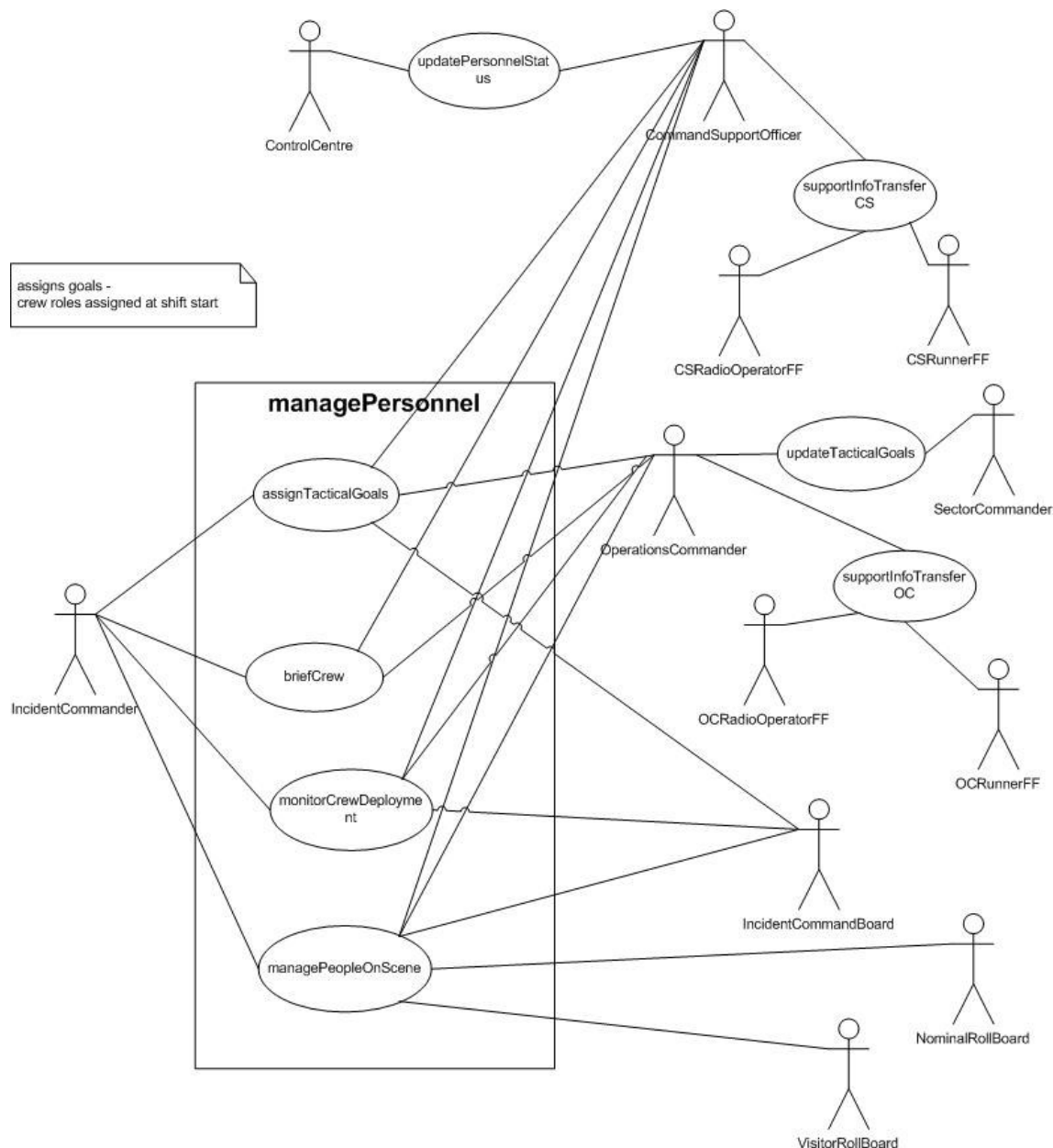
Figure 5. Manage Personnel Use Cases.

The right hand side of figure 5 mirrors the use cases in the risk assessment and tactical mode section. The incident commander's role is more about setting objectives and monitoring on site activities than assigning specific people to specific tasks – with the exception of assigning command and control tasks. In most cases default tasks per individual firefighter will be assigned at the start of the shift, e.g. BA wearer, pump operator. The incident commander also has to have an oversight of who is where on the incident ground. This information is captured on the incident board. The Nominal Roll Board indicates what FRS personnel with what qualifications is on site, whereas Visitor Roll Boards show which non-FRS personnel are on site.

2.3.4 Incident Command Use Cases: Resource Management

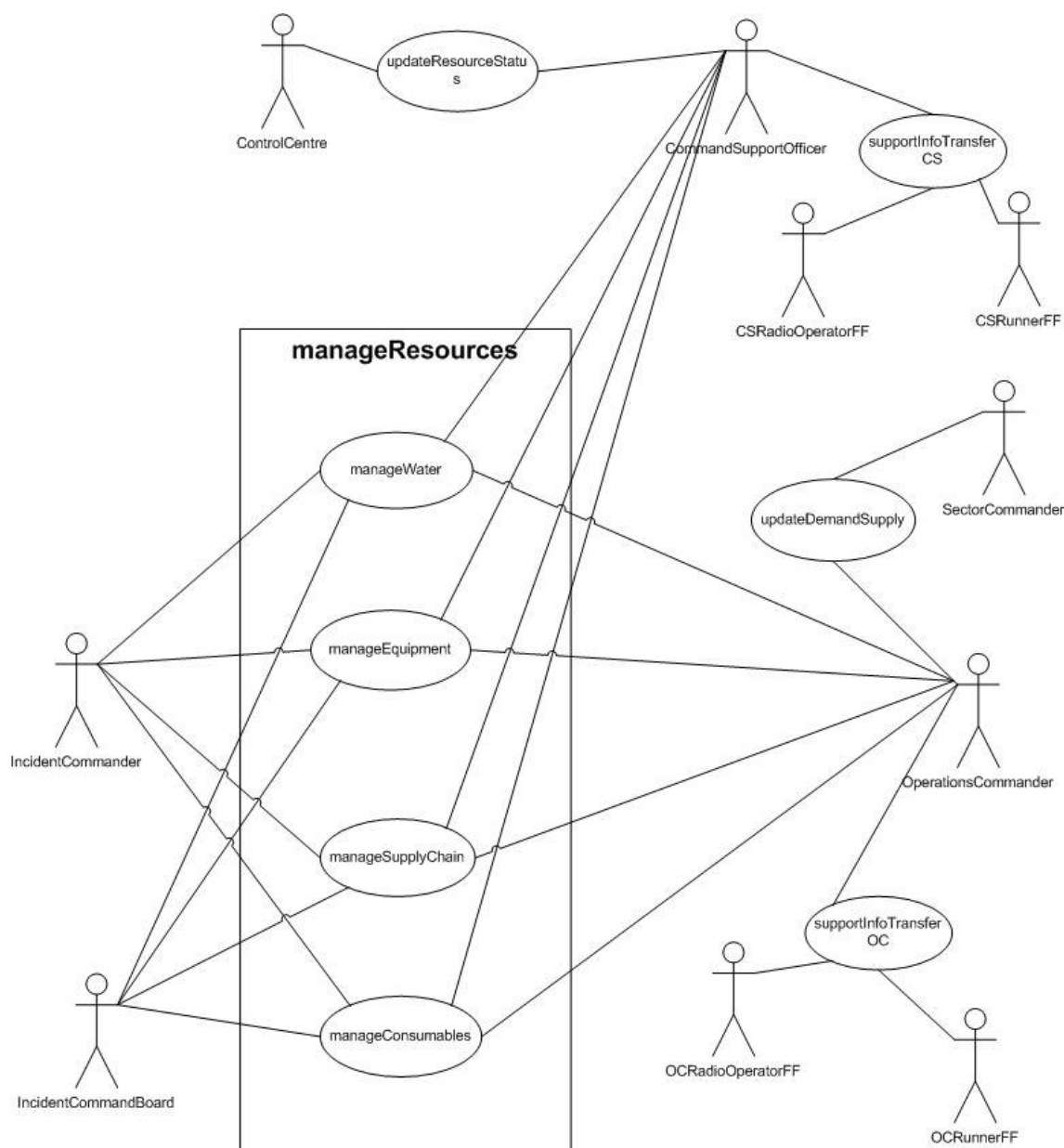*Figure 6. Resource Management Use Cases.*

The resource management use cases depend on information from the frontline. The incident commander – via sector commanders – has to determine the resources status and has to take action to close gaps in resource demand. The control centre may become involved in this if resources have to be ordered from off site sources within the FRS or even from other agencies.

2.3.5 Incident Command Use Cases: Command and Control devolution
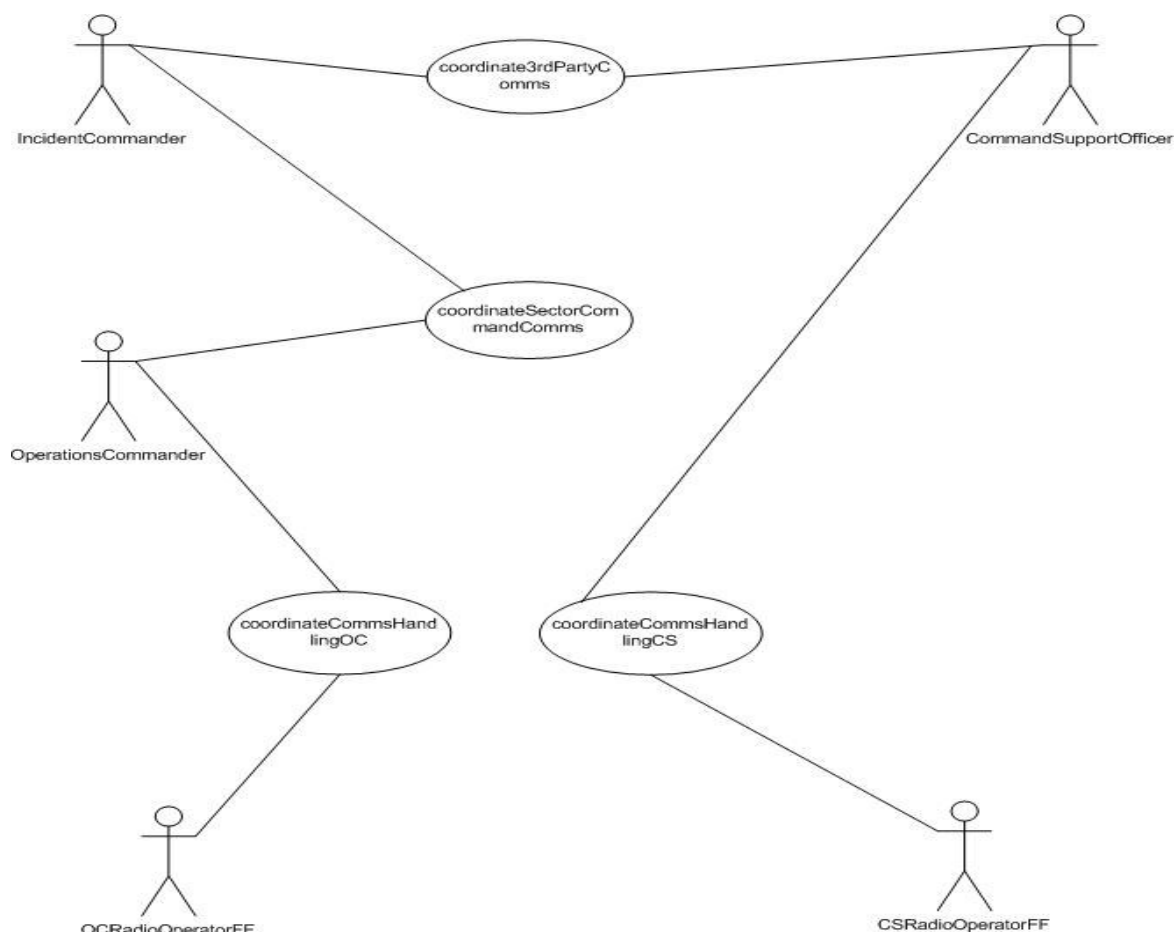
Figure 8. C2 devolution.

The use cases in figure 8 indicate that wherever possible devolution of command and control will be implemented. They also indicate that the incident commander does not always receive first hand information, but information that has been filtered on its way up the command chain. The radio operator actors – who may not be roles assigned in all countries or regions – indicate that lower level command may also be supported by designated actors.

2.3.6 Incident Command Use Cases: Coordination with other agencies
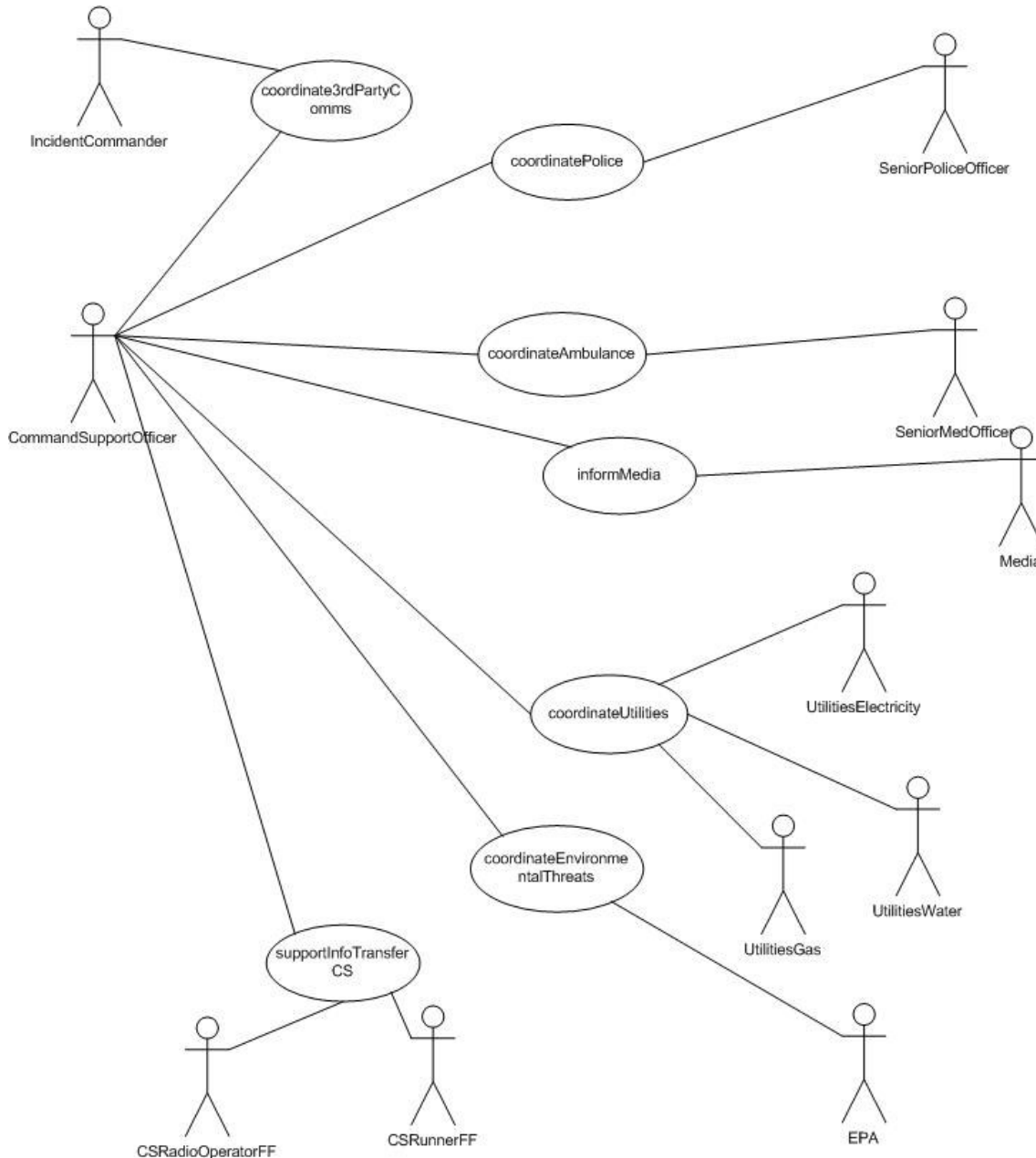
Figure 7. Use Cases regarding coordination with other agencies.

The use cases in figure 7 above indicate the need for coordination with non-FRS agencies. Not all of these use cases will be relevant for the COPE systems, but those relevant will have to be broken down to a more detailed level. They will then serve as a basis for determining the mutual information and coordination requirements among the different agencies. As a special case in the diagram above the "coordinate3rdPartyComms" use case indicates that the responsibility for the actual communication with non-FRS agencies will in many cases be transferred to the Command Support Officer.

2.3.7 Coordination among agencies: FRS and EMS use cases
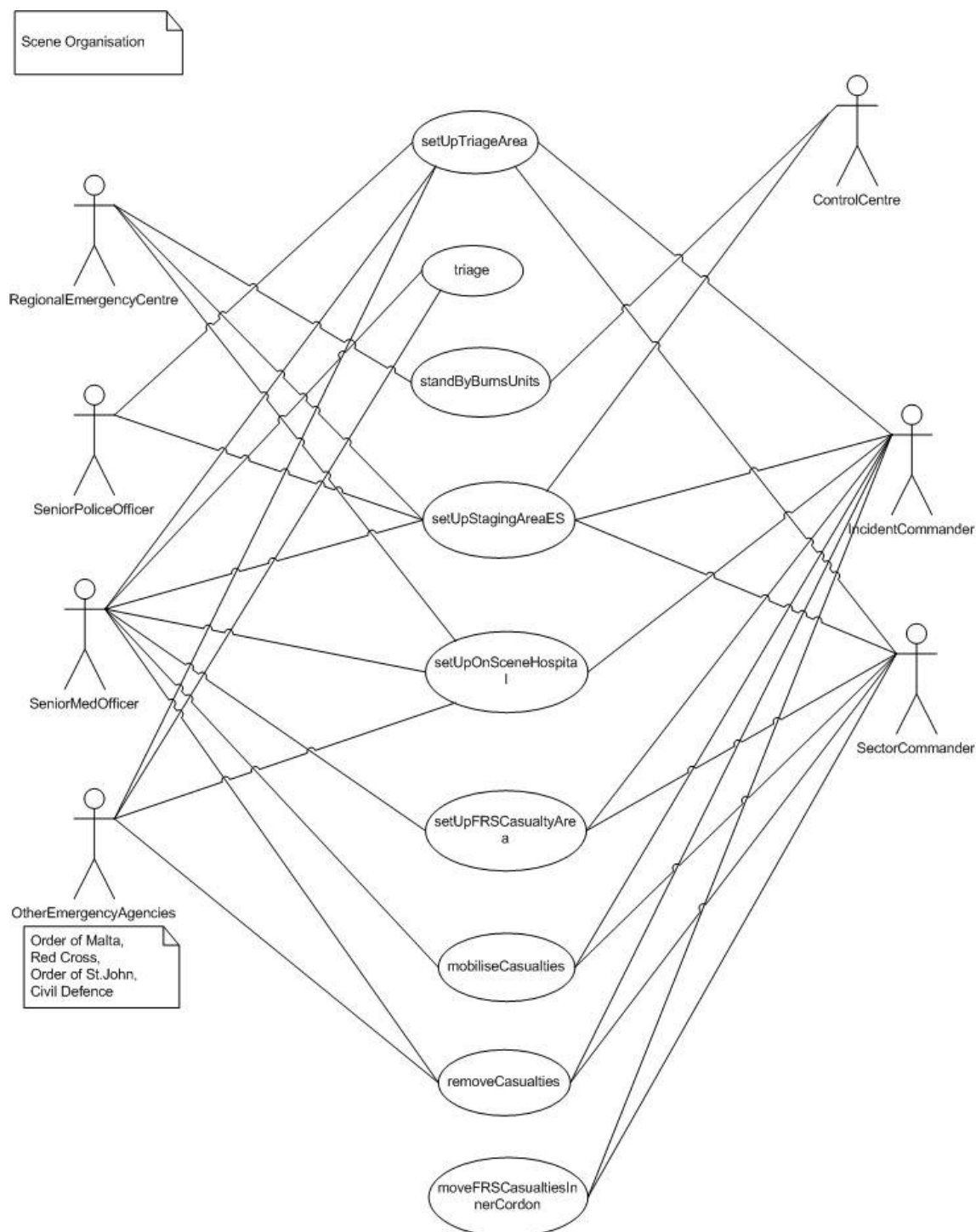
Figure 9. FRS and EMS use cases.

The "setUp…" use cases in figure 9 above indicate what designated areas may need to be set up near the incident ground to deal with any casualties. These activities require coordination among FRS and medical services and may also involve police services when it comes to traffic management and security and/or access control issues. The control centre may be involved in order to be able to e.g. direct additional resources to the right location. The "standByBurnsUnit" use

case may be a special case as it requires higher level emergency management to become involved. Some of the use cases above may directly affect only the medical site, e.g. triage, or the FRS side, e.g. moving fire services casualties from the inner cordon, but it will have to be determined how much the other agency may have to know or may wish to know about these activities. The mobilisation and removal use cases involve the medical services, but to a different degree depending on the situation on the incident ground. Depending on the risk assessment it may either be too dangerous for non-FRS services to enter the inner cordon for rescue services or to the contrary the status of a casualty may require medical attention despite other risks.

2.3.8 Coordination among agencies: FRS and police use cases
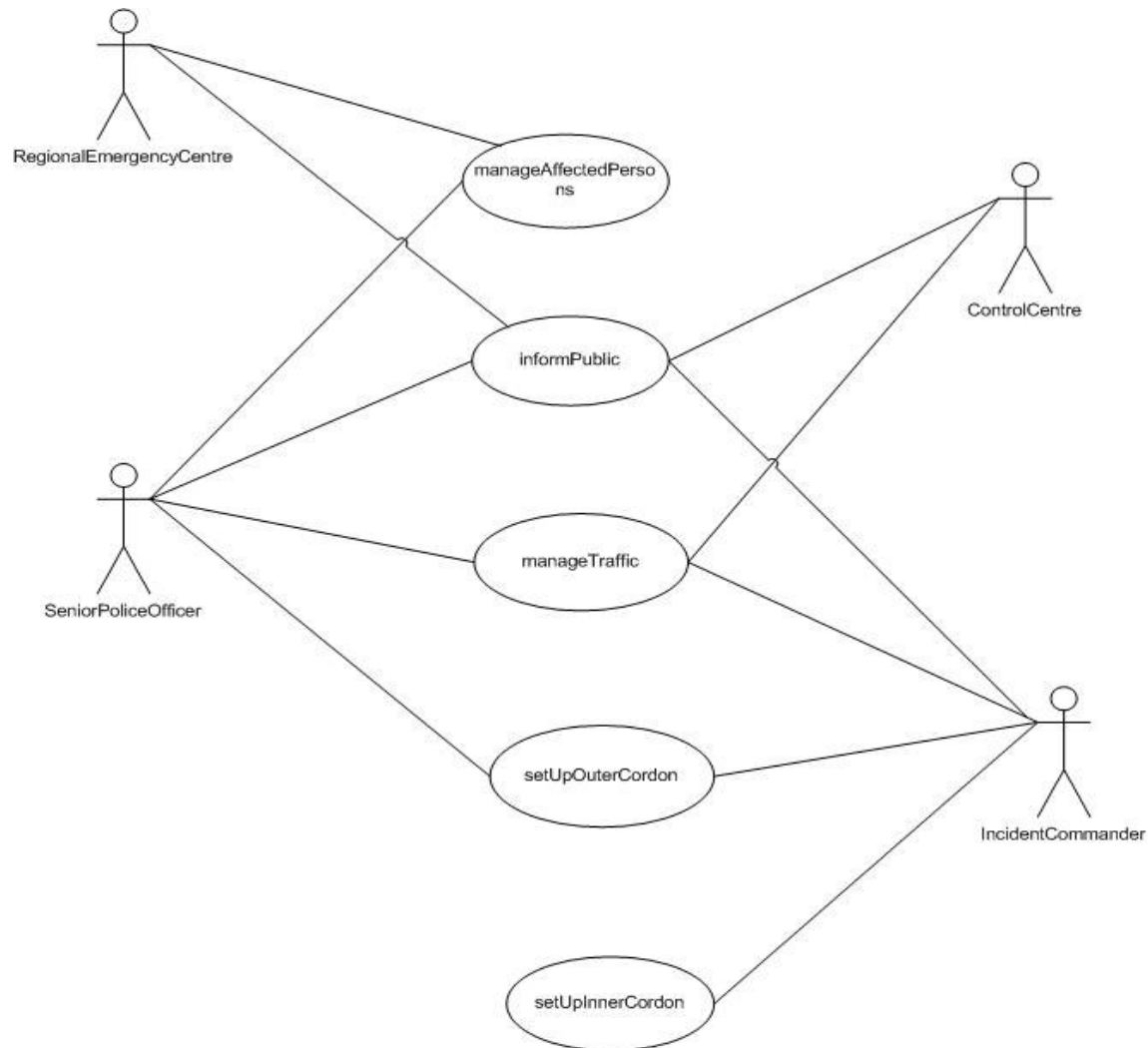
Figure 10. Use cases for FRS – police coordination.

From an FRS point of view the main tasks for police will be traffic management, security, cordoning and dealing with the public and media. However, police is not supposed to be close to the inner cordon, i.e. near the hot zone in a fire incident and vice versa the fire services may not be involved at all in e.g. evacuation orders which may require involvement of higher levels of emergency management.

2.3.9 FRS activities: Fire Attack Use Cases

Figure 11. Fire attack use cases.

The fire attack use cases show that sector command is not directly involved in the activities in the hot zone, but plays a role in decision making that has impact on frontline activities. The diagram further shows that basically two types of tools are being used in this domain: Tools for monitoring resource deployment and status, e.g. the BA tag or BA board, and tools used to attack the fire, represented as the "equipment" actor above, because the specific equipment used will vary according

to the type of fire and the environment among other factors. The diagram also indicates that in the current situation there is no online monitoring of equipment use and deployment. This is becomes evident by the fact that currently equipment can be borrowed from appliances across fire stations. Missing equipment then will be redistributed after the event.

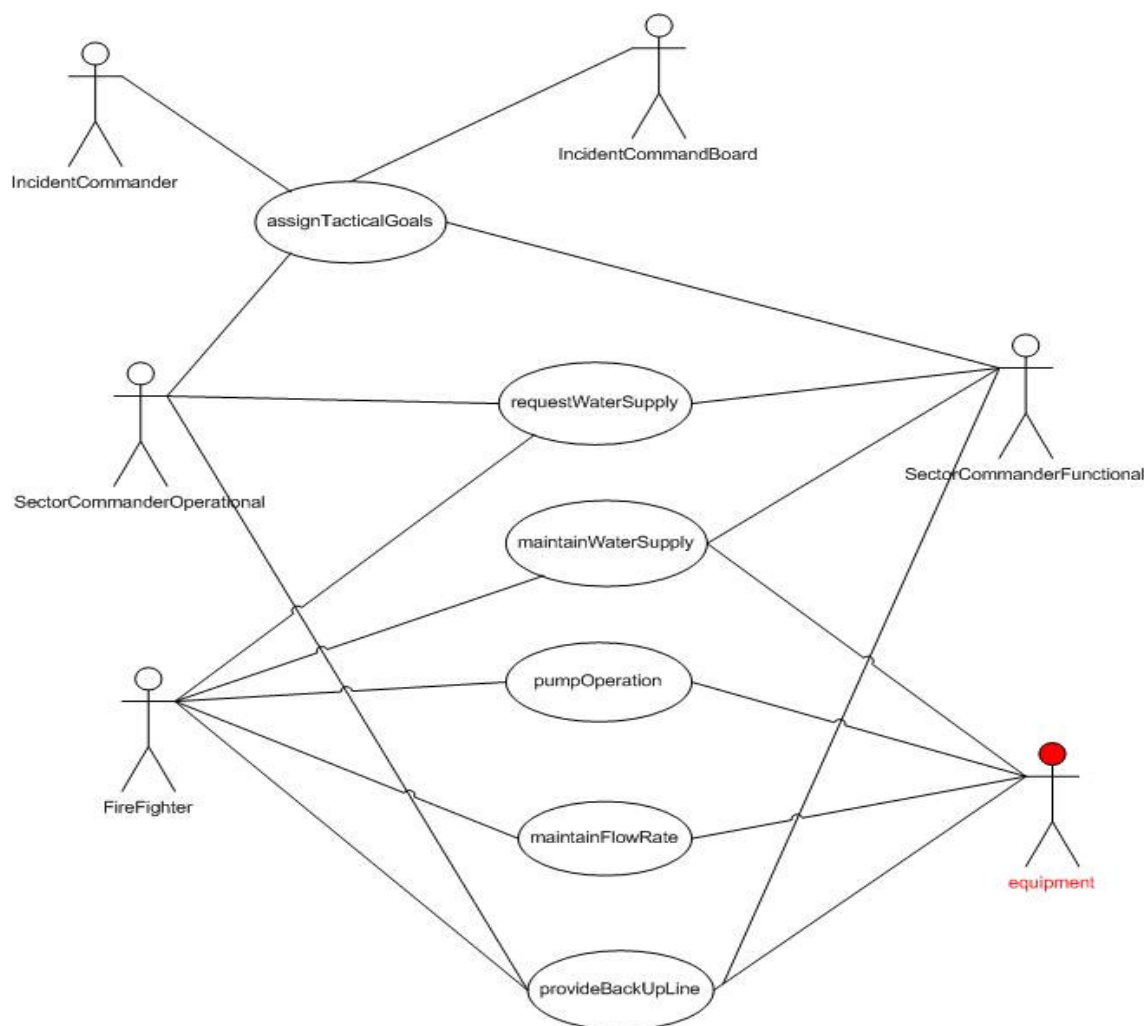## 2.3.10 FRS activities: Water management use cases

Figure 12. Water management use cases.

The water management use cases indicate that this is an area of coordination across sectors, but between a limited set of actors. It is however noteworthy that not every actor has to know exactly how any other actor goes about his/her specific task. For this reason, for example, there is a "maintainWaterSuppply" use case and a "maintainFlowRate" use case. Firefighters have a vital interest in being supplied with a sufficient amount of water. So they have a stake in this use case, but they don't need to know about the source of the water. On the other hand the sector commander "water" has to make sure that there is no interruption in water supply for maintaining the flow rate, and by this token performing tasks in the operational sector, is not in his/her remit. This is what frontline firefighters and firefighter deployed as pump operators have to deal with using the appropriate equipment. Additionally, coordination between sector command at operational and functional level and incident command is crucial here, because different

tactical goals require specific usage of water. For example, when pushing back the fire ands creating a stable environment for search and rescue, smaller amounts of water may have to be used to avoid developing too much steam and thus conditions of high temperatures and low visibility. On the other hand, when the operations are in defensive mode and water is applied to cool structures on fire as well as adjacent exposures then much more water maybe required. Therefore decisions at IC level have immediate impact on operations related to water management.

2.3.11 FRS activities: Search and rescue use cases
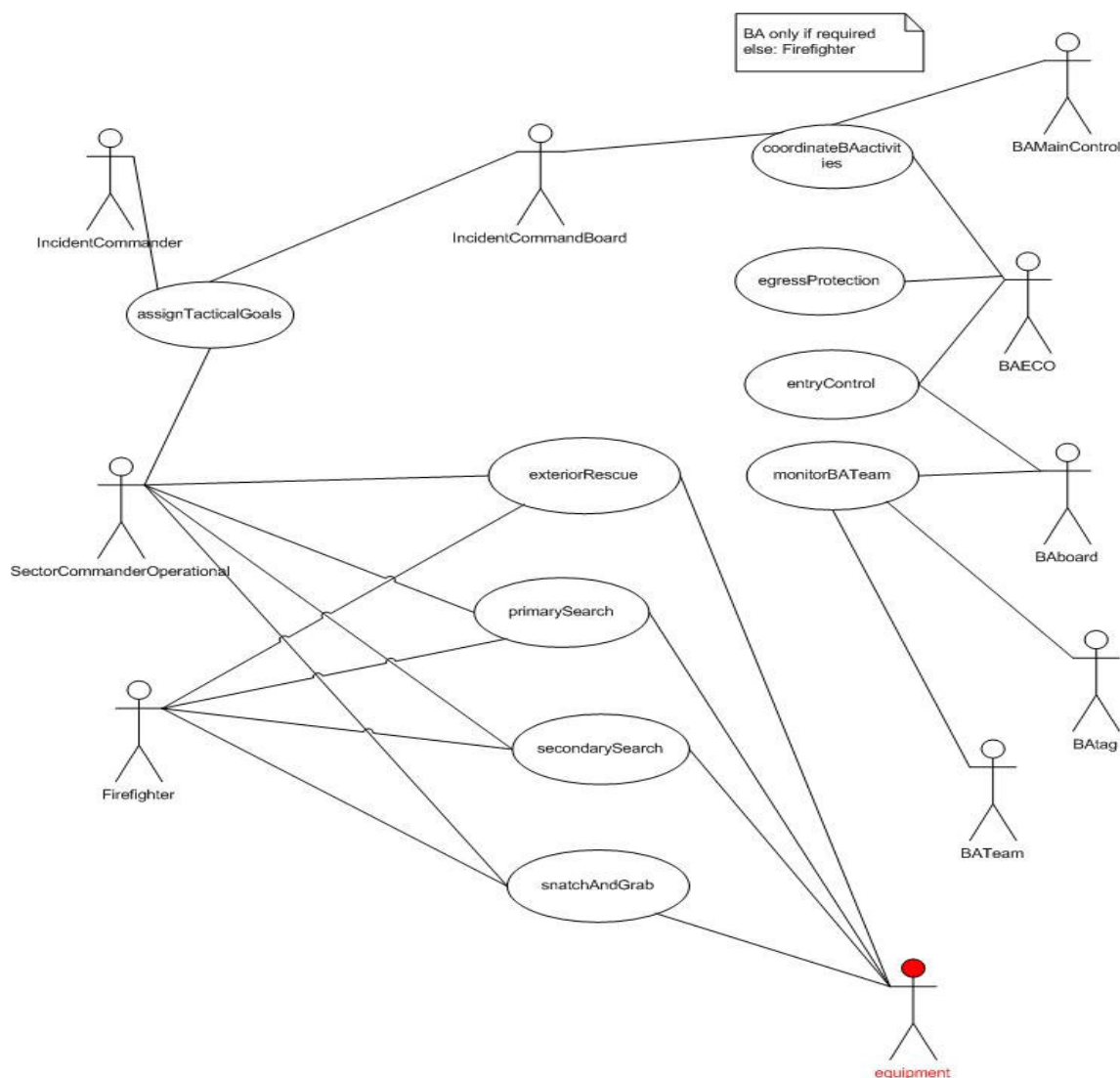
Figure 13. Search and Rescue use cases.

The search and rescue use cases are similar to the fire attack use cases in some respects. There are resource monitoring and coordination functions that happen alongside the operational tasks and in some cases they enable or safeguard them e.g. by providing egress protection for search and rescue crews – who in most cases would be BA wearers and as such be involved in the BA side of the use cases in figure 13. Beyond this , this diagram illustrates that the incident commander sets the overall frame for the operations that then has to be translated

into tasks by sector commanders. These tasks, here the diverse search and rescue tasks, then have to be executed by firefighters on the frontline. What this also shows is that that the incident commander has to rely on information transferred up the command line as a basis for his/her decision making and risk assessment. Additionally, it becomes clear that some scope for decision making is delegated to the sector command level as it is here that real-time, first hand knowledge is available.

2.3.12   FRS activities: Hand over use cases

Figure 14. Hand over use cases.
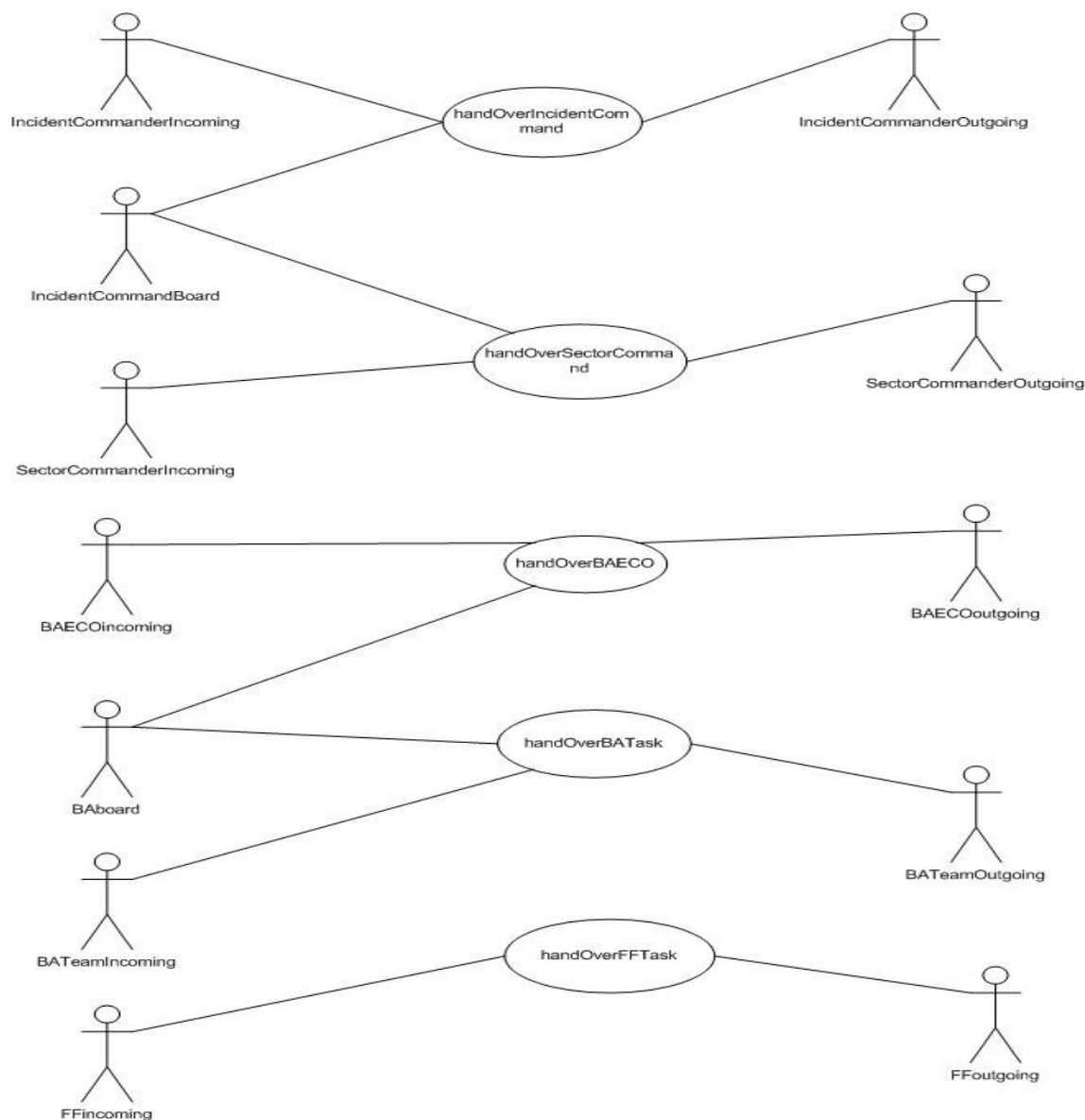
The use cases in figure 14 above indicate that at certain stages of the incident lifetime hand over between incoming and outgoing crew members have to take place. These activities are formalised to some degree with some variance at the different levels. The BA board and the incident command board play a crucial role in documenting crew deployment and status features of the incident.

2.4 Modes of operation for the reference system

The Incident Command System essentially consists of people-orientated / people-run processes. One of its main objectives is to support decision-making at different levels and communicating these decisions to the appropriate addressees. The underlying information transfer occurs along pre-defined channels, but not necessarily in a pre-defined or standardised manner. Much of it is remote, but synchronous person-to-person communication via basic ICT technology (radio). A major problem of this system is that it can easily break down, because of technology failure, but also because of environmental and human factors. Receiving and processing information in a highly dynamic and often noisy and potentially dangerous environment is no simple task. However, removing this task to a safer and more stable environment, e.g. an incident command vehicle, may cut off first hand information sources. Further, providing information from the frontline is subject to an unstructured filtering process, because constraints imposed e.g. by equipment or exhaustion may lead to incomplete information transfer.

2.5 User classes and other involved personnel

This section describes who the actors are which are affected by the current incident command system. This includes every person who contributes to the information flow in the current system. Users of products and solutions that will be part of the COPE systems and their way of system usage will be identified during the COPE development process and will be included in the internal iteration of this document as outlined in section 1 above. The main body of this section comprises of class diagrams that are based on the use cases of section 2.3.

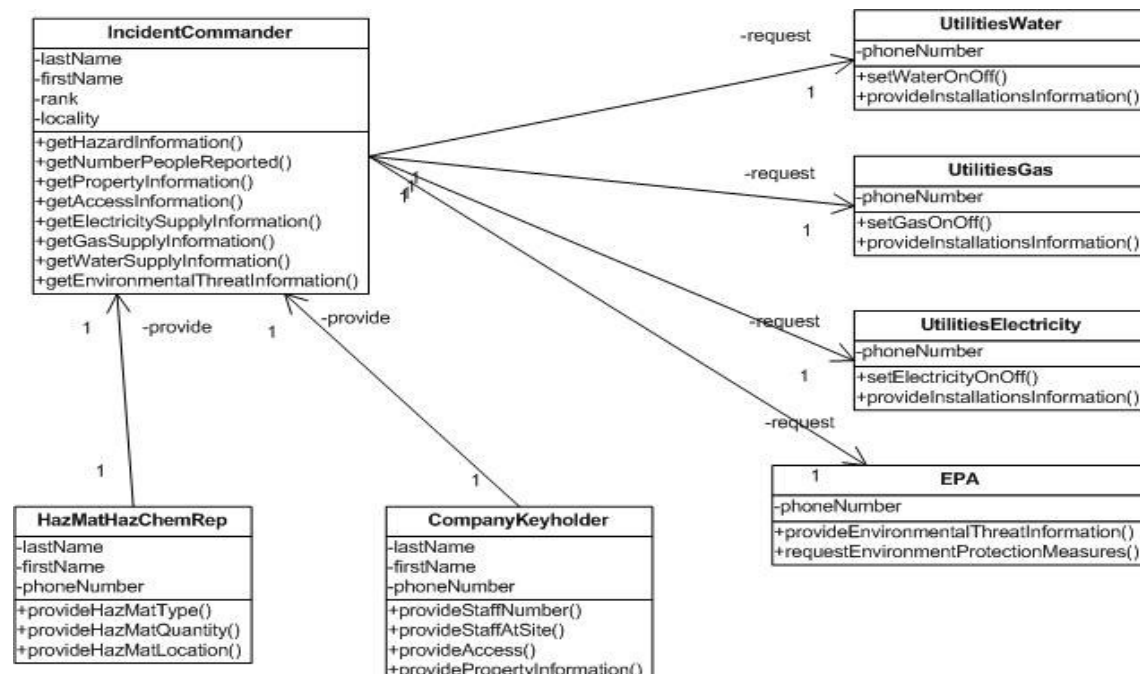### 2.5.1 Incident Command Class Diagrams: Size Up

Figure 15. Incident Command Classes: Size Up.

The diagram in figure 15 describes at a high level what relationships exist between classes of actors in the emergency response system when being involved in the size up use case. Each class is characterised by a name, e.g. incident commander; a list of attributes, i.e. distinguishing features, in the second compartment and a list of operations, i.e. actions performed by instances of the class. Attributes and operations determine information items that will be processed in the system and they may give indications of what technology can do to support operations. What actually needs support by new systems and technologies and how this support should be given or implemented has been described to some degree in the user requirements document D3.2 and will be specified further in the technology mapping process.

2.5.2 Incident Command Class Diagrams: Incident Ground Management

Figure 16. Incident Ground Management Class Diagram.
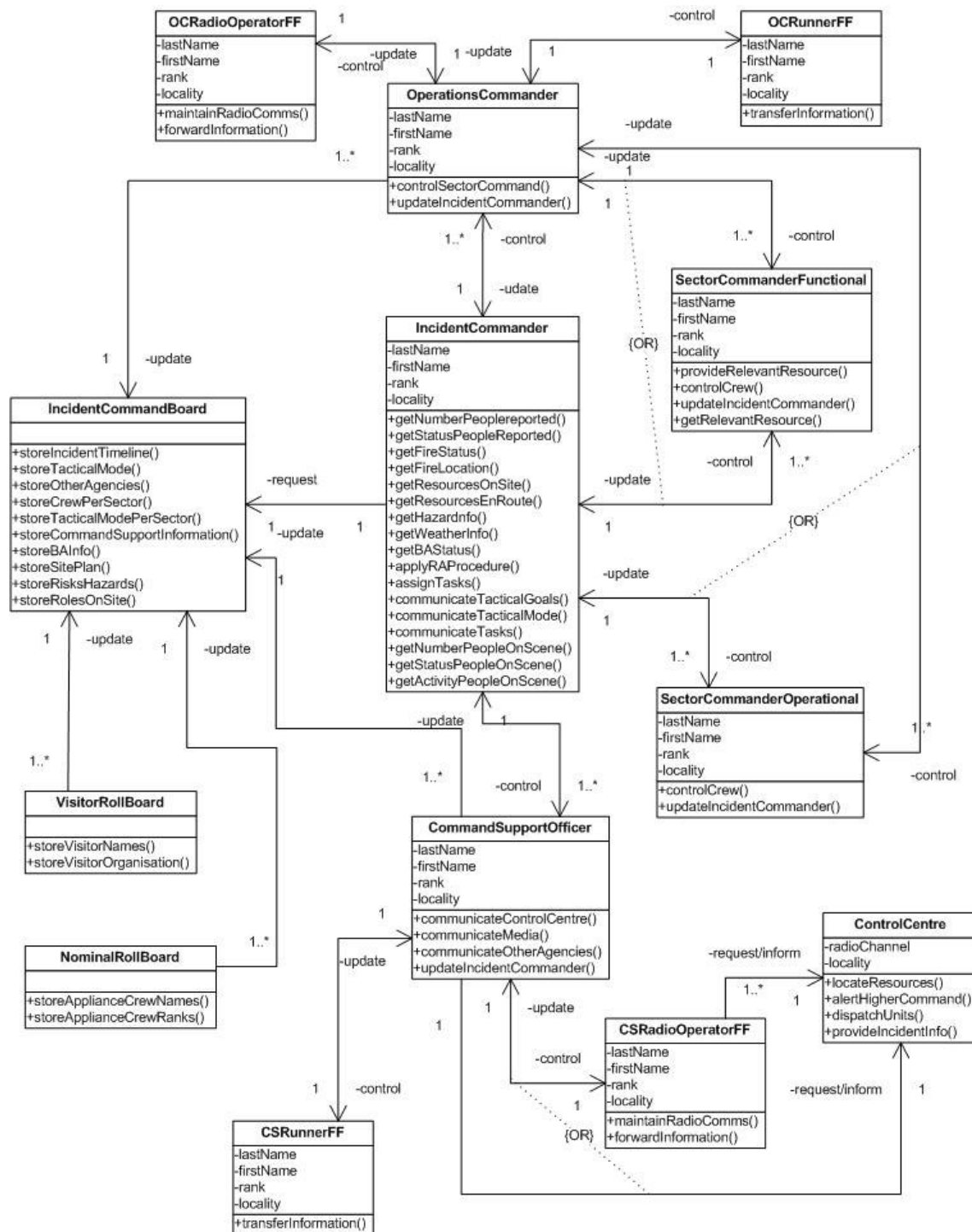
The diagram in figure 16 captures all classes involved in the incident command use cases and their basic relationships. Obviously, not all operations will be activated in each use case, but since this is a static view of the system they can be represented in one overarching diagram rather than very similar diagrams for each use case. The "or" relation between some of the links indicates that depending on the set up of the incident command system in each individual incident only one of the links exists at any point in time.

2.5.3 Incident Command Class Diagrams: Coordination with non-FRS agencies
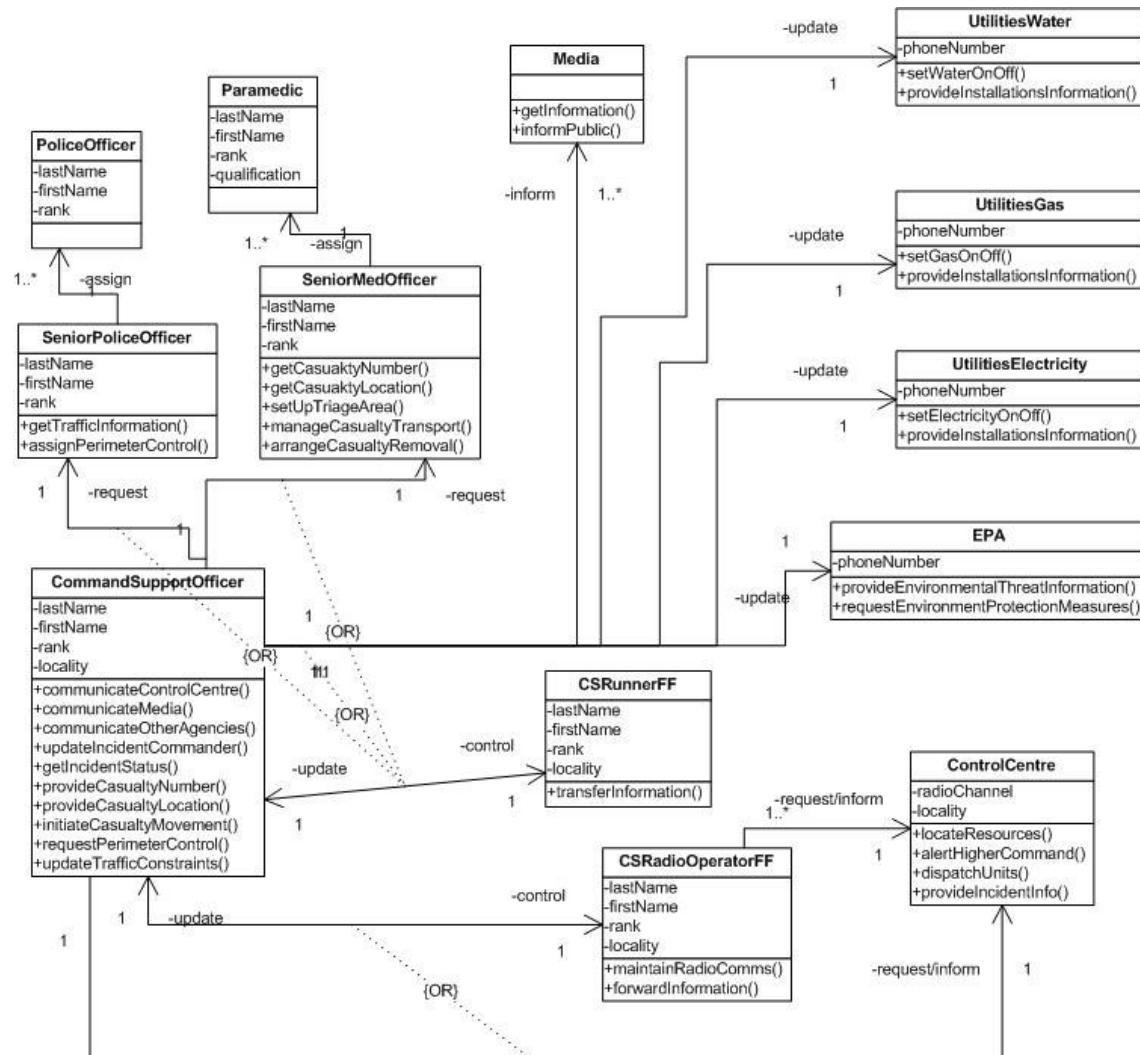

Figure 17. Coordination with other agencies: Class diagram.

The diagram in figure 17 follows the same logic as the previous one. It captures classes of actors and their relationships in a generic way – this time regarding the FRS and other agencies coordination activities.

2.5.4 Interactions among user classes

This section describes – by means of two exemplary case – how the different actors interact with each other and in what sequence. However, any sequence indicated here can vary according to the circumstances of a specific real life incident. The picture provided here is generic and focuses on interaction and exchange more than on the exact chronological sequence of units of exchanges. In addition to the exchanges and their main topics, this section provides information on what communication tools and channels are used in certain cases and what information items are associated with some exchanges. Thus, this section also gives some indication on the basic information flow on the incident ground, too. Further diagrams of this type will be produced during technology development for those use cases that will be associated with specific COPE solutions. These diagrams will be documented in internal reports.
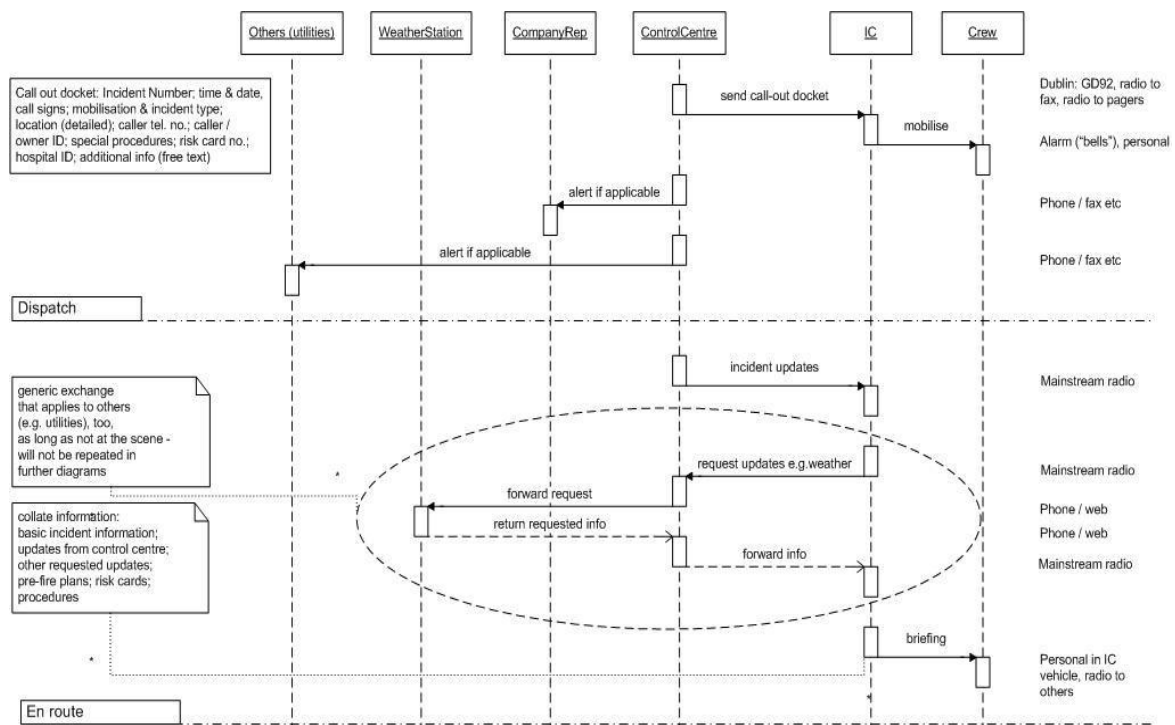

Figure 18. Incident Size-Up: Sequence diagram[4].

The initial phases of response to an incident reflect some of the main tasks of the incident commander throughout the incident lifetime. Basically, the incident commander has to gather as much information as possible about the incident and formulate the appropriate response tactic on the basis of this information. For the initial stages of incident response this activity is called "size-up". During size-up the IC has to establish an initial picture of the situation and deploy the immediately available resources as efficient as possible. S/he also has to get a first

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[4] The notation of sequence diagrams is to be read as follows: The top line indicates all actors potentially involved in this sequence of interaction. The dotted lines below each actors represent their lifelines. Whenever a box is shown on a lifeline, this indicates that the actor becomes active; usually in response to a call sent from another actor. Dotted arrows indicate that this message is a response to a call. In addition to standard UML notation, text boxes give further detail on information items (left hand side of the diagram) and communication tools used (right hand side of the diagram).

understanding of the amount of additional resources required and whether or not the command level has to be changed.

As figure 18 indicates an incident response begins – for the crews at a particular station – with mobilisation on the basis of the call out docket. At the same time the control centre may alert additional non-FRS actors to the incident. The incident commander engages in size-up as soon as possible and normally uses the time en route to the incident to gather additional information – with the help of the control centre – and to brief his crews on the initial steps s/he plans to take.

Figure 19. Incident Size-Up upon arrival: Sequence diagram.
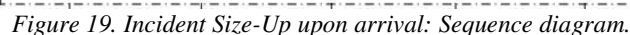
The various exchanges displayed in figure 19 may not all happen at the initial stage of an actual incident, because they can quickly become time consuming and time is very short at this stage of response. Most of what is described in figure 19 takes place within the first two to five minutes after arrival. This clearly indicates that we have to assume very rapid decision making at this stage and considerable variation to the picture above. For example, some of the command that will be made via radio at later stages may be shouted at this stage, because the actors are still close together. Similarly, entries on the IC board may be held back until there is time to actually set it up and to write down the required information items. Against this background, figure 19 describes an idealised picture and at the same time a picture of the activities undertaken as the incident develops. These activities and exchange provide crucial input to the ongoing risk assessment and subsequent potential modification of tactics by the incident commander. In essence, the information exchange above capture the IC's task of gathering all relevant information on the so-called fire ground factors (see Brunacini 1985,

pp.47). These factors concern the building on fire, the type of the fire itself, occupancy or workforce present or expected to be present at a site or building, potential threats and life hazards to occupants and fire crews, the geographical arrangements, available resources, appropriate actions, and any special circumstances.

3 Justification for and nature of changes

3.1 Justification of changes

This part of the document has become redundant for reporting purposes as the deliverable D3.2 "End User Requirements" has already been delivered. Remaining topics for this section of a CONOPS document include: a description of desired changes, priorities among changes, and changes considered but not included. These topics are being addressed at the time of writing in working groups set up under the auspices of WP4. Each of the working groups is dedicated to a specific field of technology and is co-led by a human factors and a technology expert. Results of this work will be reported in WP4 deliverables. Any issues that can not be reported in those deliverable swill be taken into account for the internal iteration of this document in so far as they are required to understand the nature of the proposed COPE systems.

4 Concepts for the proposed system

As indicated in section 1, this document deals with the current system only and as such provides necessary input to the COPE development process. However, as the development progresses it is intended to complete this section to ensure that the development and its compliance with the usage-driven design process is documented in an appropriate manner. The material collected in this document may also prove to be a good starting point for publications of WP3 results and interaction between WP3 and other work packages. It can also be of interest to the end user community and relevant industry.
Topics to be addressed here may include:
- Background, objectives, and scope of the proposed system
- Operational policies and constraints
- Description of the proposed system
- Modes of operation
- User classes and other involved personnel
- Support environment.

5 Operational scenarios

Operational scenarios are being developed in WP4 with input from WP3. There are also demonstration and evaluation scenarios under development in WP6. Therefore there is no need to include them in this document.

6 Summary of impacts

Impact Analysis is initially being performed in WP4 with input from WP3 and will finally be part of the evaluation and assessment activities of COPE. Therefore there is no scope for them being discussed in this document.

7 Analysis of the proposed system

The analyses of the reference system and the impact of the COPE solutions on this system as well as an assessment of the proposed COPE system will be performed on the basis of the KSM (Knowledge Space Model) methodology. This methodology has been developed by Trinity College Dublin within the EU-FP6 projects TATEM (Techniques and Technologies for new Aircraft Maintenance Concepts) and HILAS (Human Integration into the Lifecycle of Aviation Systems).

The Knowledge Space Model (KSM) captures knowledge about how operational systems actually work in practice and it provides a framework for analysing operational processes. The KSM can be described in three ways:

- The KSM as a model
  It comprises a model of the operational process, which incorporates knowledge about how a system actually works. Building on the functional logic of the analyses within the social process analysis modules of the KSM it also allows constructing potential future models of the process, e.g. as a result of new support technologies brought into operation.
- The KSM as a methodology
  It is a methodology for analysing the impact of new technologies or operational concepts on the operational process, but also for identifying and mitigating against the potential impact of threats and risks within the process. In doing so it focuses on the human/social structure of that operational process.
- The KSM as a process
  It is a process for facilitating the transformation of knowledge about that operational system, held by the stakeholders (across the lifecycle), into a common understanding of the operational implications of new concepts and the envisaged changes. It is this knowledge transformation process, using the KSM methodology, which supports the analysis and assessment of a model of future operations.

This deliverable represents an essential achievement towards the first step of analysis and assessment within the KSM framework. The system description in the various UML models provided in this document not only represents the reference model for the COPE technology development but also for the analytical steps indicated above.

These analyses lead into task 3.3 and will be reported in the associated deliverable. This will inform WP6 and will be addressed within in the framework of the evaluation activities of that work package.