COPE – COMMON OPERATIONAL PICTURE EXPLOITATION

SEVENTH FRAMEWORK PROGRAMME

GRANT AGREEMENT No 217854

Collaborative project

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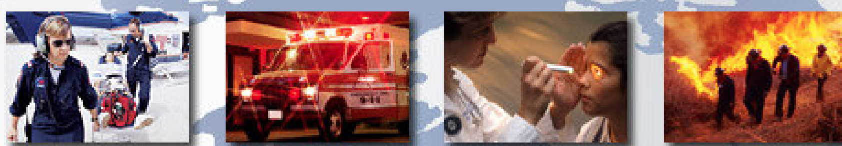

End User Requirements regarding new technology and process change

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Summary

This document provides end user requirements that have been derived following on from intensive fieldwork with emergency response agencies. The requirements are input into a more detailed technology development process.
This document is divided into three parts: An overview of the methodology for fieldwork and deriving the requirements; a discussion of the main area of concern for the COPE project and relevant actors in this area; and finally generic requirements as well as examples for more detailed requirements for selected COPE technology domains.

Contents

Abbreviations

BA	Breathing Apparatus
BA ECO	Breathing Apparatus Entry Control Officer
C2	Command and Control
CBRN	Chemical, biological, radiological and nuclear (material)
COP	Common Operational Picture
COPE	Common Operational Picture Exploitation
CS	Command Support
CTA	Cognitive Task Analysis
EMS	Emergency Medical Services
FF	Fire Fighter
FR	First Responder
FRER	First Responder Engineering Requirements
FRUR	First Responder User Requirements
FRS	Fire and Rescue Services
HazMat	Hazardous Material
HDD	Head Down Display
HF	Human Factors
HUD	Head Up Display
IC	Incident Commander
ICP	Incident Command Point
ICS	Incident Command Structure
ICT	Information and Communication Technology
OC	Operations Commander
OIC	Officer in Charge
PPE	Personal Protection Equipment
RTA	Road Traffic Accident
RTC	Road Traffic Collision (UK terminology)
SC	Sector Commander
SIPER	Sensor Integration Platform Engineering Requirements
SIPUR	Sensor Integration Platform User Requirements
SOP	Standard Operating Procedures
USAR	Urban Search and Rescue
VR	Virtual Reality
WP	Work Package

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1 Introduction

1.1 Scope and Structure of this Document

The objective of this end user requirements documents is to provide input into the technology development process of WP5. The requirements set out in Section 4 of this document have been derived following a usage-driven process that will be discussed in Section 2. They reflect the current operational situation of first responder activities and the task demands and cognitive demands faced by first responders. In that sense these requirements specify in which way and by which means solutions developed within COPE shall answer to this situation and these demands. They do not provide specific design specifications. It will be the task of WP4 in cooperation with WP5 to map technological solutions onto these requirements and to develop design specifications. Nevertheless, the requirements set out in this document are supposed to support WP5 in scoping its work.
In this document we first discuss – in Section 1.2 – who the end users in COPE are and what role they play. Then we outline a usage-driven process of requirements development; see Section 2. In Section 2.1 we describe what field activities have been undertaken to collect data that feed into the usage-driven process. Section 2.2 presents initial high level findings from the field studies. In Section 3 we discuss structures, functions and roles on the incident ground in more detail as these will have to be supported by COPE solutions. The end user requirements finally are being presented and discussed in Section 4.

1.2 The end user in COPE

“End users” of COPE products and solutions can potentially be an unlimited set of people and agencies. Apart from emergency response personnel active at the scene of an incident, further end users may include people responsible for education and training in the respective services, representatives of local, regional and national authorities responsible for emergency planning and prevention, policy makers at European level, and so on. In this sense all those who provide inputs for and use outputs from an information system or technology could be considered end users. In this definition all those who report, announce, respond and attend an emergency could be included. The scale of this would be likely to become increasingly difficult to manage. Thus, although all these people may benefit one way or other from COPE solutions, they cannot all be in our focus of attention.
Instead, we need to concentrate our attention on those people whose day to day task it is to directly respond to emergency situations. They are today’s users of tools, systems, procedures, and processes and as such are providing the expertise that we were looking for in our field studies. In this narrower sense, a ‘user’ may be considered to be a single actor or operator in an emergency response situation who uses a technology or information from a system. Examples of this kind of user are:

- The Incident Commander who is a user of information systems (including technology, people and senses to assess an environment for example);
- Command Support personnel who use the technology to log and record information for the Incident Commander thus reducing cognitive demands; these and others will be discussed in more detail in Section 3.

COPE end users are not limited to personnel of a single emergency response agency. Rather, we are looking at first responder activities as a multi-agency response activity that is constituted by cooperation and co-ordination of activities between fire services, ambulance services, and the police. Therefore we are also identifying inter-service coordination requirements and places where the COP might support coordinated understanding, decision making and action across the three first response agencies. However, as stated in Deliverable 2.1, "the primary focus is on the fire brigade units that operate on the field and the command functions that take place on site" (D2.1, p.5).

1.3 Preparatory Activities

The conceptual background to the user requirements development process has been detailed in D2.1 "Use Case Descriptions and a Human Factors Engineering Framework". The work in task 3.2 was aimed at implementing the activities described in D2.1 in order to elicit data from end users as a basis for the derivation of user requirements that then can be handed over to technology developers.

2 The User Requirements Development Process

2.1 The usage-driven development process

The requirements derivation process in COPE is decidedly a usage-driven process; see D2.1 for discussion of this term. The objective is to understand the context of the end users' day to day work, their tasks and objectives and the current ways to achieve these. This entails understanding and capturing procedures and tools used to this end. It is then the task of the human factors researcher to identify areas – procedural, social and human, technical – that need to be better supported. This has to be based not only on reviewing the current status and on observing current practices, but also requires eliciting direct input from end users on how they perceive the current situation and what kind of shortfalls they see. It is only after this process that potential solutions – new technologies, new applications, and existing technologies applied to current problems – should be presented to end users in order to examine whether or not they meet their demands. The usage-driven process in COPE is not about eliciting end user opinions and evaluations of preconceived solutions. The COPE user requirements process evaluates the demands identified through field activities with respect to their innovative potential as opposed to simply looking at taking e.g. existing and currently deployed products and enhancing their functionality.

In more detail, the COPE process for going from field studies to design requirements moves through these phases (taken from Crandall, Klein & Hoffman (2006)):

Preparation
This phase serves the objective to understand the domain. The goal was to identify the objectives pursued by – in the case of COPE – emergency response services, and fire services in particular. At a more detailed level, we aimed at understanding the tasks necessary to achieve the objective and the procedures to be followed in task execution. We established who potential users, i.e. the crucial actors, in the domain are and what interactions exist between them. For practical reasons we are focusing our attention on command roles. So far we have identified which specific problem areas need to be looked at in more detail. These areas may be categorised as problem areas either because the users perceive them as such or because researchers come to the conclusion that certain tasks or activities are under-resourced or not well designed. We have identified and continue to identify cognitively challenging situations, i.e. situations that push human decision-making and action-planning capabilities to the limit and that could be relieved if suitable technological support was in place. This also included the review of documentation, manuals, current procedures and doctrine and so forth.

Knowledge Elicitation
This phase has the objective to specify cognitive work challenges. In this phase the specific cognitive tasks linked to problem areas and challenging situations will have to be identified. To this end, operational knowledge has to be elicited from users by observing their task performance but also by direct methods such as interviews. The raw data obtained in this way need to be analysed and for COPE we decided to follow a Cognitive Task Analysis approach[1] to understand the cognitive work. Another aim of this phase is to establish team structures and related coordination tasks and means of intra-service and inter-service coordination.

Understanding the cognitive work (as opposed to the physical work) as a focus of our task analysis is a result of the fact that a common operating picture is a function of information, knowledge and experience which characterize an information domain rather than the physical domain. It was therefore deemed that CTA methods would be most appropriate to understand the nature of the COP, assessment and decision making activities, and the command and control structures within which the COP must operate.

Analysis Representation
The third phase has the objective to specify leverage points for technological and procedural improvement and innovation. The main task is to identify central issues and themes, i.e. recurring challenges or challenges of high criticality. For this the raw data have to be broken down into discrete elements that can be linked to specific cognitive requirements. Eventually, these cognitive and further user requirements have to be formulated and documented in a way that makes them accessible for design purposes.

Application Design
Here the objective is to develop design concepts in response to the identified challenges. These concepts will have to demonstrate the added value of technology solutions to support the first response activity. The focus further is to

[1] See Crandall, Klein & Hoffman (2006); see also relevant sections of D2.1 and the COPE Human Factors White Paper.

experiment on how technology and human capabilities could be combined appropriately to provide aimed emergency response functions. The design study exercises will give further insight of the requirements that should be put on the technologies, and also inform of the cognitive demands on the human operators. The design studies will focus on specified technologies and provide detailed information of their usage in contexts defined by smaller scale scenarios in test field environments. Contexts of use can be enlarged, i.e. more comprehensive scenarios developed for further steps of the design.

Evaluation
Finally, the developed solutions will have to be evaluated in order to come to a good understanding of their impact on the domain. This step and the previous one are not in the scope of COPE WP3.2.

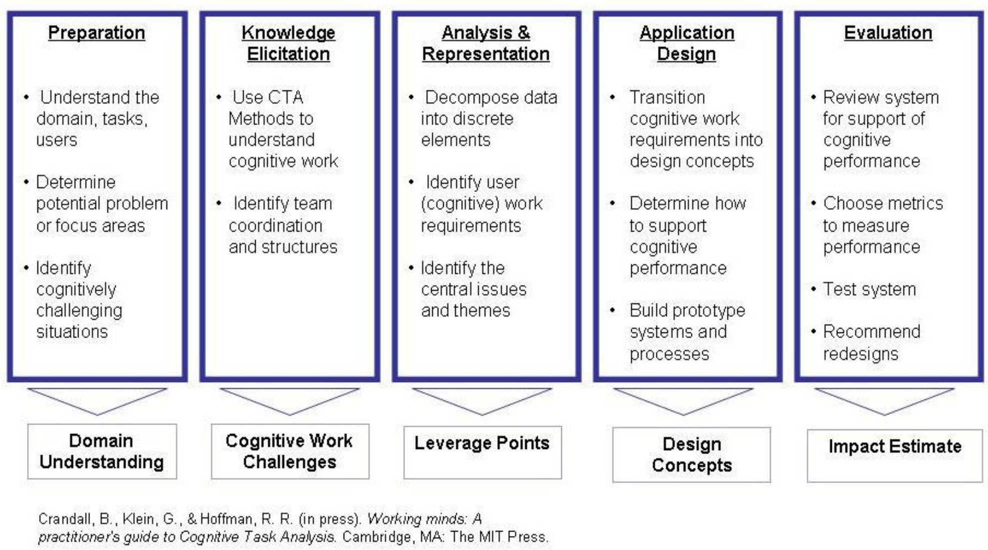

Figure 1. Summary of the usage-driven design process.

2.2 Objectives of Field Studies

This section outlines a methodology of how to distinguish between different task types and patterns of activities observed in the field studies. This methodology is partly reflected in the areas of concern described further below in this document and the requirements that have been identified. The issues discussed in this section will have a bearing on categorising the requirements and validating technology achievements. To take a very simple example, secondary tasks, as described below, are necessary activities supporting first responders' activities and are thus reflected in the "support functions" in section 3.2.1 and as such are in the scope of COPE and need to be taken into account. At the same time these tasks – and any means to better perform them – have to be designed in way that does not negatively impact on primary tasks. So at a later stage in the requirements process we may have to categorise the requirements along the lines of the methodology presented here. The categorisation is not conclusive as of yet, but may be relevant in the process of technology mapping. Thus, we would like to take this early opportunity to make the technology partners aware of this issue.

The aim of the field studies was to study first responder activity to identify requirements for technology development. The material collected allows, first, to identify first responder *primary tasks*. By primary tasks we mean actions that must be accomplished to reach the goals and sub-goals of the emergency response. The tasks have partly been described in the guidelines and procedures, and partly they have been trained and assumed to be accomplished on the basis of the skills and knowledge of the first responders. The field work shows that the primary tasks of first response activities are rather uniform in the studied countries. The definition of the requirements in this document mainly draws on our understanding of the primary tasks of first responder activity.

The material collected from the field also allows further inferences concerning requirements. The second source of requirements is what has in the human factors literature been called *secondary tasks*. By this we mean tasks that are needed to take care of the resources, tools and technologies. Hence, these tasks do not directly focus to fulfilling the first responder goals but, instead to the means to reach these ends. In this connection it appears particularly important to identify what are the constraints that the new types of technologies that largely base on Information and Communication Technology (ICT) put on the first response activity and what kind of secondary tasks arise. For example we may assume that first responders may have to control the reliability and validity of information provided by, for example, making cross checks or seeking redundant information. It is also to be analysed what is the role of information inputting, or navigating in information systems, maintaining connection via communication media, etc. The experience of implementing ICT-based systems and tools in complex activities, furthermore, shows that there is a tendency of an increase of secondary tasks. In the physically and temporally extremely constrained contexts in which the emergency response activity takes place additional tasks must be minimised.

The field studies also provide an understanding of first responders' *ways of acting*. By ways of acting we mean learned and regular *patterns* of cognitive and embodied behaviour that first responders demonstrate when accomplishing their tasks defined above. These ways of acting or patterns are important regulating instances of behaviour in an unpredictable environment, in which the achievement of goals and appropriate results requires adapting of work methods, use of tools and routines. Significant to COPE aims is that technologies provide a background and medium to how tasks are accomplished, and how the design solutions shape the ways of acting, i.e. the patterns. This is why an attempt is to be made to identify what kind of patterns of behaviour have been developed in the use of present technologies, identify their strengths and project good development in the use of the new technological possibilities. The material collected so far shows for example that first responders do not deliberately identify coordination needs but instead coordination appears to take place automatically, i.e. via learned routines or technologies. Another example is the finding that refraining from action and monitoring someone else's behaviour are coordination functions that in an essential way support fulfilling of primary tasks. The design issue is how we can make the new tools support accomplishing these functions. For example information presentation that is too focused on one person may hinder these functions.

As was indicated above, the requirements identified in this document mainly base on the understanding gained from acquaintance of the primary tasks of first response activity. The aim is, however, after a more thorough analysis of the gained field data, to identify additional requirements drawn on understanding of the secondary task demands and predictable changes in them. Finally, it is foreseen that further requirements will be identified as a result of an analysis of the ways of acting in accomplishing first response tasks. Hence an elaboration of the user requirements is foreseen in the near future. This is most likely to happen by means of design studies conducted under WP2 guidance and to be reported in D2.2 "HF based design inputs to COPE technology".

2.3 Description of Field Activities

The scope of WP3.2 was to lead the COPE development process up to the point where human factors based end user requirements can be handed over – via technology mapping activities in WP4 – to the technology partners in WP5. To this end a series of fieldwork activities has been performed that followed the concept outlined above. Specifically, the following means have been applied: a review of documentation that describes current processes and procedures, direct observations of end user operations, and interviews with end users. In paraphrase of the above mentioned process steps we tried to answer the following set of question through our field studies:

- What are the goals?
- What are the challenges?
- What are the critical judgments, assessments and decisions that COP might impact and / or improve?
- What are the critical cues that trigger action, revisions of decisions etc.?
- What are the information requirements in relation to the previous items?
- What functionalities do current tools provide?
- Beyond procedurally required decision making activities, what subtle judgments are performed by critical actors in response to changing situational parameters?
- Are there any important discriminations in terms of inputs into decision making processes that are more critical than others? What would these discriminations be based upon?
- Coordination requirements (intra-service and inter-service)
- What are the physical work activities and equipment demands and constraints that need to be taken into consideration?

2.3.1 Document Review

BAE Systems:

– Fire and Rescue Manual. Volume 2 Fire service Operations Incident Command. 3rd Edition. ISBN 978 0 11 341321 8
– A Guide to Operational Risk Assessment. Fire Service Guide Volume 3. ISBN 978 0 11 3412204
– Avon Fire and Rescue Service Training course materials
    - Incident Command for Flexi Officers
    - Incident Command for Crew Members

TCD:

- Fire Service Manual, Vol. 2: Fire Service Operations, issued by HM Fire Service Inspectorate Publications Section
- Fire Behaviour Instructors' Aide Memoire; course material issued by Dublin Fire Brigade for use in Compartment Fire Behaviour Training
- A Framework for Major Emergency Management; "A framework enabling An Garda Síochána, the Health Service Executive and Local Authorities to prepare for and make a co-ordinated response to major emergencies resulting from events such as fires, transport accidents, hazardous substance incidents and severe weather."; issued 12. September 2006
- Recommendations on Scene Safety Arrangements at Road-Based Incidents for Fire Service Personnel, issued by Chief Fire Officers' Association (Ireland), Feb. 2008
- Dublin Fire Brigade Training Centre Course Material on Incident Command Systems

VTT Finland:

- Hand book of coping with major accidents (Duodecim)
- The P3 (incident commander) handbook (Theory and Procedures)(SPEK 2007)
- A guide to rescue diving (Ministry of internal affairs SM050:00/2006)
- A full scale accident investigation report of an apartment house fire with two victims

2.3.2 Observation

BAE Systems:

- Control room
- Equipment:
  - BA use
  - IRIS (BA telemetry unit)
  - USAR gear (inc. thermal camera; snake-eye; DELSAR acoustic/seismic sensors)
  - Breathing Apparatus Entry Control Board
  - Nominal Roll Board (per appliance)
  - On-appliance map system/Airwave radios
- Aircraft fire exercises (hose and BA operations)
- Classroom command exercises (MINERVA & HYDRA)
  - Vector Command System (in Command Support Vehicle)
  - Avon FRS Command Wallet use in training exercises
- Incident Ground Command Exercises (Fire Services College, Moreton-in-Marsh)
- Review of previous technology programmes, research, and current systems on the market:
  - Helmets
  - Head mounted displays
  - Breathing Apparatus telemetry and displays
  - Use of video cameras, thermal imagery and other sensors (e.g. infra red)
  - Radios/communications systems
  - Command and control /Situation Awareness systems (map-based displays)
  - GPS – positioning and tracking systems

TCD:

– Warwickshire Fire and Rescue Services Training Centre – VR IC training system and Redkite (competence log) system
– Dublin Fire Brigade Training Centre / O'Brien Institute – participant observation in the 'hot room' / compartment fire exercise
– Dublin Fire Brigade Training Centre / O'Brien Institute – training/award/passing out day (and rehearsal) demonstrations
– Dublin Fire Brigade Training Centre / O'Brien Institute – Compartment Fire Behaviour Training, incl. demonstration of compartment fire development phases and fire fighting techniques
– Dublin Fire Brigade, Fire Station in Dublin South – BA tags; BA board; command level jackets; IC board
– Dublin Fire Brigade Training Centre / O'Brien Institute – Course on Incident Command Systems

VTT Finland:

- Visit to Emergency Services College including guidance to first responder basic and refresher education and demonstration of the training and test field
- Visit to emergency call centre simulator and instruction concerning the training content
- Observation of final tests of first responder trainees; 30 students in four practical tasks, including on-line comments of the trainer and the trainers debriefing to the students

2.3.3 Interviews

BAE Systems:

– Investigation of specific past incidents through Critical Decision Method interviews:
  1. Derelict building fire (Watch Manager was IC)
  2. Silage Barn (Crew Manager was IC)
  3. Motorway Road Traffic Collision, 3 vehicles, several casualties (Watch Manager was IC)
  4. Industrial site, unknown suspected hazardous materials (Crew Manager was IC)
  5. Flooding of major electrical facility (Flexi Officer and Incident Command Instructor was IC)
  6. Warehouse and yard, wind spread fire, electrical hazard (Watch Manager was SC then safety Officer)
  7. Motorway bridge Road Traffic Collision, 1 vehicle, 1 casualty, both carriageways involved (Watch Manager was IC)
  8. Construction site fire, unknown substances involved (Watch Manager was Safety Officer)
  9. House fire, elderly casualties (Watch Manager was SC)

– General operations interviews:

  10. Breathing apparatus equipment, telemetry and operations (Watch Manager)
  11. Typical fire appliance equipment and operations (Watch Manager)
  12. Incident command and opportunities for IT support (Flexi Officer and Incident Command Instructor)

13. Urban Search and Rescue operations (Asst Team Leader)
14. Urban Search and Rescue specialised equipment (Asst Team Leader)
15. Control Room, Airwave radio, (Watch Manager)

TCD:

- Dublin Fire Brigade Training Centre / O'Brien Institute – 2 group interviews with 2 District Officers and 4 fire fighters using RTA and Chemical/Explosion scenarios
- Dublin Fire Brigade Training Centre / O'Brien Institute – Interview with 1 Station Officer of Dublin Fire Brigade on incident command structures
- Introduction to processes and procedures of Dublin Fire Brigade Control Room / Call Centre in 2 unstructured interviews with 1 Station Officer (covering fire and ambulance calls)
- 2 Interviews with Station Officer and Sub-Officer at Fire Station in Dublin West
- Interview with Station Officer at a Fire Station in Co. Cork, on structures and processes in retained fire services
- Interview with station Officer and sub officer at a Co. Cork fire station on emergency procedures for large industrial incidents
- Workshop with nine appliance crew at a Co. Cork Fire Station, Scenario based workshop

VTT Finland

- Investigation of specific past incidents through Critical Decision Method interviews:
    - Severe falling accident during roof fire rehearsal at the ESC training field (P3, trainer, fire and ambulance)
    - Shocking incident on New Years Eve (P3 including police, fire and ambulance)
    - Forest fire in North Finland. Long duration, complex organisation (P3)
    - Fire in an industrial building. Oulu. Long duration, complex organisation (P3)
    - Fire at an old-age home. Long duration, authentic video re cording available, also further documents (P3)
    - Simulated flood due to break of a dam, P3, leadership training
- 6 further interviews in Helsinki, Kajaani, and Oulu in February 09
- Workshop on smoke diving with 6 fire fighters; material includes several real incidents experienced by the participants, and an "Everything went wrong" scenario the participants constructed jointly

2.3.4 HF workshop

WP3 human factors partners held a workshop at Trinity College Dublin on 09-10 February 2009 for a first consolidation of findings from fieldwork activities. These findings informed this deliverable.

3 Focus of Attention: Incident Command

Phases of an Incident

A call is received at a call centre or control room for the emergency services. Some information is communicated to control about the potential incident. The control room allocates resources to the incident via an automated calling system. At the fire station, a printout appears with details about the incident including the address, the type of incident and any site specific information. When the first response is on the way to the address, the senior officer (OIC (Officer In Charge)) of the response is able to generate an initial idea of what resources he will have available to him (based on an incident specific Pre-Determined Attendance) and how he will want to organize his resources to deal with the incident. This is often communicated by the OIC to the crew on his appliance and the OICs for other appliance responding. As the crews approach the incident, they may begin to get an idea of what the situation is. The peak in first responder activity appears upon arrival at the incident scene. Activity decreases to the degree the incident begins to be controlled; see HF White Paper, p.9. However, it became apparent during field work that some crucial activities, in particular related to information gathering and initial response planning happen upon alerting the initial response units and while they are en route to the incident as described above. Therefore, these phases will be taken into consideration as well.

Phases of an incident include:

1) Getting the first call (alarm)
2) Mobilizing to the incident (en route)
3) Initial dynamic risk assessment (arrival)
4) Identifying tactics and resources
5) Getting the incident under control
6) Monitoring the incident as it is dealt with and until it is over
7) Recovery/clean up
8) Investigation/Debriefing

For our purposes, we believe that technologies might best support the development of a common operating picture from mobilization through all phases of the incident, but particularly the crucial activities from receipt of the call (1) to the “stop” message (5; at which time the incident is under control, and no additional resources are required), with a focus on activities at the incident ground.

Roles & Functions

Roles and functions on the incident ground are highly structured as a reflection of how operations have evolved in the context of current technologies, tools and equipment as well as current operational doctrine and procedures. Furthermore, there is a high level of dependability between the structural units. For example, the team of two fire fighters approaching the hot zone in a building on fire is concerned with whether or not water with sufficient pressure comes through the hose, but they rely on colleagues to deal with where the water comes from. However, the Sector Commander Water will well worry about where to get water from, but does not necessarily need to know where exactly in the building it is applied at each moment of the incident.

What this example shows is that although the activities of Sector Commander Water and the Fire Fighters at the sharp end are closely linked, they normally do not have to communicate explicitly with each other. They will have been assigned their respective tasks by the Incident Commander via the command structure in place at the respective incident and then can trust that the output of tasks they depend on will actually be delivered. This is possible because – within one fire brigade – they have passed through the same training and they know of and follow the same doctrines and standard operating procedures. A further essential building block of these safe methods of work is a certain degree of autonomy that each functional unit at the incident ground is allowed. Thus, fire fighters do not have to be told how to attack each specific fire at every new incident. Based on their aforementioned knowledge they can decide on their actions as the situation requires. And more specifically, if for example their assessment of the risks involved in specific activities or the current situation differs from that of their Incident Commander, they can change tactics and e.g. withdraw from the hot zone without having to get permission first. So to some degree decision making is de-centralised, too.

It is therefore helpful to look at the requirements from the perspective of the functional role on the incident ground (e.g. Incident Commander, Operations Commander, Command Support, Sector Commanders (SC), etc.), as well as the functional areas (e.g. water sector, Breathing Apparatus sector, rescue/casualty extraction sector, casualty management sector, hazmat/decontamination sector, and so forth, which will be highly situation dependent.

This distinction already indicates that there are two ways to structure the incident ground: setting up command structures according to functional roles and sectorisation of the incident either geographically or functionally, or some combination of the two.

Sectorisation of the Incident Ground

Sectorisation is a means of accomplishing incident command and can be used at the discretion of the Incident Commander. The purpose of sectorisation is to allow the IC to delegate areas of responsibility (either geographic/spatial or functional) to other experienced personnel.

Upon arrival the incident ground may be divided into sectors in order to support spatial orientation and localisation of people, equipment and events. Sectorisation can be numerical with Sector 1 being the area where the first units arrived and other sectors being assigned clockwise around e.g. the building on fire. Sectors can also be named vertically e.g. in high rise fire, where there would be a lobby sector, a fire sector and a search sector among others. At bigger incidents there will also be functional sectors such as 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.

Sectorisation also serves another very important function that links it into the command structure on the incident ground. By dividing up the incident into sectors responsibility can be devolved to these sectors and no single person has to be actively involved with all events of the whole incident.

The general idea – at least in Dublin and in the UK – is that no single person should have to control more than five lines of communication; in other words each persons “span of control” should be limited to five. However, in rapidly evolving incident this may not always be feasible and the span of control may extend to 6-8 for a limited amount of time. The goal is to reduce the span of control by re-organisation of the resources as quickly as possible.

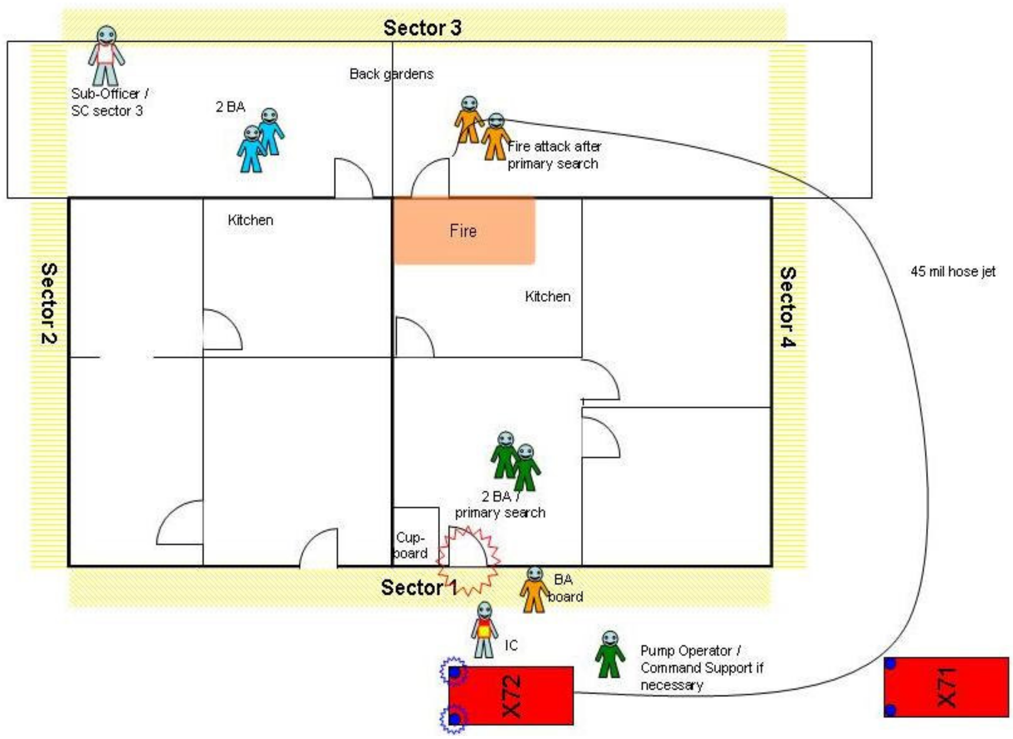

Figure 2. Example of Incident Ground Structure

3.1 Incident Commander (IC)

It should be noted that incident command is a function not a person. The role and responsibilities of incident command will fall onto different people’s shoulders as the incident changes. For example, as more appliances arrive, more senior officers may take overall incident command responsibilities. If a crew and an incident commander have been on duty, the incident command may be handed off to the oncoming senior officer. However, just because a more senior officer arrives on the scene, does not mean that he or she automatically assumes the IC function. If the senior officer assesses that the current IC is managing the situation effectively in spite of increasing resources or demands, the more senior officer may elect to take on a different role in support of the IC.

It is often the case that as a situation escalates and becomes more complex, a senior arriving officer may maintain the current IC as an operations commander in charge of the main operations, but will assume the role of IC and oversee the operations, support functions and effective utilization of available resources, recognizing that the current IC has a better understanding of the current operational approach, tactics, tactical mode and resources currently engaged in operations. The knowledge and understanding gained by the current IC is a valued commodity to be used rather than dismissed, and therefore is given a key role in the operational side of the incident.

Given the above, the Incident Commander is the person in overall charge of the incident, with legal responsibility for the outcomes. Initially, the highest ranking officer – usually a Station Officer (Ireland) / Watch Manager (UK) – arriving first at the scene will be the incident commander. Depending on how the incident evolves higher ranking officers will take over. For example, Dublin Fire Brigade distinguishes 4 Command Levels (a system not used by UK fire). At Command Level 1 – a 1 pump incident – a Station Officer or Sub-Officer can be IC. Command Level 2 is activated at 2+ pump incidents and a District Officer takes over as IC. Command Level 3 is declared at 5+ pump incidents and a Third Officer becomes IC. Command Level 4 marks the highest level of escalation of an incident. There will be 8+ pumps involved and an Assistant Chief Fire Officer or a Chief Fire Officer takes over as IC. In all cases, unless they are affecting large geographical areas or are protracted in time, the IC stays at the scene; in most cases dismounted from any vehicles and often mobile, or at least not tied to a specific vehicle. Other personnel need to be able to find the IC at all times and therefore it is expected that most of the time he will be at or near the Incident Command Point (often a Command Support Vehicle at larger incidents). In Ireland, it is important to note that role and function of the IC do not change when a higher ranking officer takes over. It is only the responsibility for all events at the incident that moves up in the hierarchy. This also important because under Irish law the Fire Service normally is in charge of any incident that requires fire services.

Some primary implication of all of this is that any technology must support the hand off of Incident Command function responsibilities efficiently, must scale up with the addition of resources, cannot be tied to a particular location or person, must allow others to always know where the Incident Commander is, and must clearly identify who the IC is.

3.1.1 Incident Commander Functions

Pre-Arrival: Preparatory Guidance

The OIC en route to the incident has received information about the address, nature of the incident, site specific information (based on the address) and generic risk assessment information (based on the type of incident). A good commander will already have some idea of what resources he has available to him and how he wants to organize and deploy them. This is communicated within an appliance by voice and between appliances by radio.

On Arrival: Dynamic Risk Assessment

The IC typically communicates goals, tasks and priorities to SCs, other individuals and teams of individuals on the incident ground.

The IC is required to perform an initial (dynamic & continuous) risk assessment upon arrival at an incident. The IC is required to declare a “tactical mode” upon completion of the initial risk assessment (and every 20 minutes thereafter).

Declaration of Tactical Mode

This tactical mode has to be communicated to all personnel involved in the incident response and to the control centre. There are three possible tactical modes – “defensive”, “offensive” and “transitional”. Defensive and offensive modes can be applied to different sectors of an incident and the whole incident itself.

Declaration of the defensive mode means that the commander (IC or SC) has assessed the risks and decided that the potential and achievable benefits do not justify the risks of committing personnel into the hazard area of the incident. Declaration of the offensive mode means that the commander (IC or SC) has assessed the risks and decided that the potential and achievable benefits justify the risks of committing personnel into the hazard area of the incident. Transitional mode should only be declared when a multi-sector incident has sectors in both modes. In the UK it is sometimes used to describe the transition from offensive mode to defensive mode when personnel are being withdrawn from the hazard area but are not yet out. However this use is being phased out.

3.2 Initial Hierarchical Task Analysis

An initial task analysis of Fire & Rescue Service goals, functions and tasks is presented here in order to provide an idea of the scope of fire and rescue service-related activities at the incident ground.

FRS incident response can be characterised by two overarching goals:

- To preserve life
- To protect property

These two goals are applied to the lives and property affected by the incident resulting in the response to the incident. They are also applied to the persons and property involved in the response to incident resulting in safe systems of work.

The response to the incident consists of an operational plan, the mobilisation of resources in order to implement that plan and action on the part of resources to implement the plan. The operational plan begins as a mobilisation of a number of resources to the scene of the incident. Implicit in this plan is the understanding that, as they arrive at the scene, the persons responsible for the resources will agree between themselves a command structure for the management of the incident response at the incident ground. This takes place formally when fire appliances arrive at the incident ground but officers in charge of appliances will begin to anticipate their roles at the incident during travel to the scene on the basis of “overheard” reports of who is arriving, has arrived, and the structure developing. The operational plan is supported by logistics and management plans if they are needed to ensure the availability of resources.

3.2.1 Hierarchical Task Analysis

1. Operations (types of operation that can be undertaken in response to the emergency)
    a. Search and rescue (has several disciplines/ specialisations which may be applied at a given incident)
        i. Interior search and rescue
        ii. Underwater search and rescue
        iii. Rope search and rescue
        iv. Urban search and rescue
        v. Vehicular extraction
        vi. Confined space rescue
    b. Control/extinguish fire
    c. control/pump out flood
    d. First aid
    e. Salvage
2. Support
    a. Protection
        i. Risk assessments
            1. assess current situation
            2. anticipate developments
            3. understand operational plan
            4. compare plan with current and anticipated situation
            5. make risk-benefit assessment
            6. plan risk mitigation measures
            7. communicate results of assessment
            8. act on results
        ii. BA Entry Control: Specific role that may be of interest, however there are already major players with technology solutions. e.g. DrägerMan Bodyguard & Merlin; Scott – IRIS
    b. Resource management
        i. Personnel management
        ii. Logging personnel at scene
        iii. Planning usage needs for crew
        iv. Scheduling usage of crews
        v. Organising welfare, resupply of crews
    c. Equipment management
        i. Logging equipment at scene
        ii. Planning needs for equipment
        iii. Scheduling usage of equipment
        iv. Organising resupply of materials, fuel, consumables
    d. Water management
        i. Appliance operation
            1. Management of pumps, inlets, outlets
            2. Amounts of media -water, foam
            3. Appliance fuel to keep pumping
        ii. Operational hoses
            1. Performance – output pressure delivered, flow rate(s)
            2. Devising routes
            3. Monitoring hose condition

        iii. Hoses from hydrants
            1. Connectivity (regional variation in hydrant types)
            2. Performance – input pressure received, flow rate
            3. Devising routes
            4. Monitoring hose condition
        iv. Hoses from passive sources
            1. Performance – suction pressure achieved, flow rate
            2. Devising routes
            3. Monitoring hose condition
    e. Liaison
3. Command (using FRS command model as basis)
    a. Gather information
    b. Set objectives
    c. Produce plan
    d. Communicate plan (give other persons tasks to do)
    e. Control actors
    f. Evaluate progress (will start the cycle beginning with step a) again)
4. others …

3.3 Other Key Roles

Differing roles have different functions and tasks, some defined by SOPs and others by the demands of the specific situation. Each has different values for different for technologies and may benefit in different ways. We have to consider the different roles and their respective information needs with respect to COP.

3.3.1 Command Support (CS)

A Command Support Officer will normally be installed to cover all lines of communication from the incident ground to the outside world. The CS will stay in touch with the Control Room, with other agencies and even e.g. media. His role is to filter information and prepare it for presentation to the IC. He is also responsible for recording all incoming information be it from the fire ground or from the outside world. To this end, a number of manual information collation media are currently in use. These are commonly called command board, command wallet, incident command wallet, etc. At a small incident the CS will be located at or near the appliance that he arrived in and the command board will be held at this appliance. Such an incident command support system needs to handle small incidents of 2 or 3 appliances or large incidents of up to 5-8 (depending on Brigade SOPs which vary within the UK) appliances before a dedicated command support vehicle turns up

3.3.2 Operations Commander (OC)

The Operations Commander is a complementary role to the CS. An OC will be installed if the number of sectors or crews deployed in sectors increases such that the IC span of control extends beyond five. The OC functions as a liaison officer between IC and Sector Commanders. Ideally, an IC would only have to deal with OC and CS at larger incidents.

3.3.3 Sector Commander (SC)

The Sector Commander controls the incident response operations, for example, search and rescue, fire suppression or extinction – in one sector. He is immediately responsible for the crew(s) in his sector. Although he has to achieve the objectives given by the IC, he is still responsible for continuously assessing the situation and implementing measures to safeguard crew safety without first confirming this with the IC. However, he has to report any decisions and actions back to the IC[2] at the earliest possible point in time.

3.3.4 Breathing Apparatus Entry Control Officer (BA ECO)

The BA ECO is responsible for monitoring the status of BA crews operating in the hazard zone. He monitors the status of the BA crews' air supply, their mobility and listens in to their communication through a dedicated radio channel. Monitoring status and localisation of BA crews the BA ECO uses tools such as the BA board or electronic systems such as IRIS. He is located next to the entry point or points into the hazard zone and also monitors and controls any movements of people in and out of the hazard zone.

3.3.5 Fire Fighter (FF)

Fire fighters are operating at the sharp end of operations. Normally their decision making is focussed on their immediate task at hand and only rarely shifts to the wider situational picture. However, they should be made aware of the tactical mode and especially any changes in tactical mode, particularly when it requires them to exit the hazard zone. BA sets are often fitted with evacuation signals that can be activated by the BAECO which signals the FFs to evacuate the hazard zone. FFs are empowered to make their own risk assessments and decide when it is time to exit the hazard area. In addition, they try to report significant changes in their activity, for example moving up or down a floor in a building, changing location from their planned search areas, anything that will help an S&R team find them more quickly if they find themselves in trouble or become unconscious.

4 Requirements

4.1 Incident Command Requirements – Needs Analysis

In this section we will outline the functions for which technology requirements have been derived, but not the requirements themselves. In the following we are giving examples of these functions. 4.1.1 to 4.1.3 focus on IC functions.

4.1.1 Global Requirements

- The IC should not be tied to a specific location by the technology, he needs to be able to be dismounted and mobile (e.g. to do a 360 reconnaissance of an incident ground)

[2] The Sector Commander has some autonomy to implement the IC's tasking, he should report any actions and decisions that differ from the IC's original tasking, objectives, priorities (intent), but actions and decisions that line up with the IC do not necessarily need to be communicated at the time.

- Needs to be usable under BA (to be confirmed)
- Technologies may be tied to functions and could therefore be attached to tabards/jackets that signify roles, e.g. IC, CS, SC, BAECO)
- Could mimic aspects of the Incident Command Board/Command Wallet concepts currently used
- Technologies shall be adaptable to escalating and de-escalating incidents
    - For example there should be automatic transfer of information to incident command systems that arrive on dedicated vehicles
- Must be flexible for unanticipated incident types (e.g. non-routine incidents, non-SOP command structures, novel solution types, novel solution requirements)
- Shall support the principle of "no more than 5 spans of control" for any one unit commander
    - However there should be no increase in difficulty of use when dealing with more lines of control (the time when one has more lines of control than optimal is the time when IT support should not become harder to use).
- Shall support decentralized command and control (i.e. allow decision authority to be pushed to the lowest level)

4.1.2 Assessment/Incident demands

- Information that feeds into the IC's assessment of the situation / incident
    - Initial description at mobilisation
    - Appearance of the incident while approaching it
    - Reports from bystanders, owners, stakeholders, other agencies on site.
    - Documentation, signs, plans, pre-planned responses, chemical hazard information.
    - Observation of the scene on arrival, visual, sounds, smells, temperature, walking around to get more complete view.
    - Thermal imaging.
    - Fire zone information from alarms.

4.1.3 Resource Requirements

- Resource information that the IC needs to be aware of.
    - Resources present at the incident. Their availability and their current commitment to ongoing or future activities. Their location at the incident. The skills of the people and the equipment present on the appliances. The remaining time for which they will be available (UK FRS always plans to have personnel working on the incident for no more than 3 hours at a time)
    - Resources on their way to the incident. As above plus estimated time of arrival and availability.
    - What extra resources are will be needed to achieve the incident response plan.
    - In addition to knowing what he has and needs the IC must make sure that requests for extra resources are composed and communicated to the control centre. Currently the actual

  transmission of the request is typically delegated to a subordinate for radio transmission over the main scheme radio network.
  - Do fire-fighters have the correct/appropriate kit to attend to the tasks required – pre-arrival and upon review as incident progresses?

4.1.4 Develop Plans / Actions / Tasks

- Setting and communicating objectives and priorities
  - Support flexible command structure
  - Support delegation of tasks and allocating resources/assets
  - Shall support voice and written/drawn commands, schemes of action and so forth
  - Support identification of objectives and IC's priorities (Commander's Intent)
  - Support identification of geographic areas/locations as well as functional areas of responsibility/sectors
  - Support a method of reporting progress towards objectives
- Sharing Incident Understanding/situation awareness
  - Nature of problem to be solved
  - Relevant conditions and factors (e.g. weather, wind, precipitation)
  - Nature of other hazards
- Sharing of risk assessment for methods of safe working
  - Nature of risks to firefighters (possibly based on Generic Risk Assessment cards)
- Supports method of reporting:
  - Task received
  - Situation and requirements understood
  - Objectives and priorities understood
  - Questions/clarification required?
  - Whether actions are feasible based on subordinate's assessment
    - Additional resources required?
  - Information recorded?

4.1.5 Additional Functional Requirements:

A) Functional Areas:

Another way of potentially representing the requirements based on functional areas at the incident ground. Below is an example of the functional areas that need to be supported (some of the material may be redundant with the material above, but is included for comprehensiveness and discussion at this point).

1) Distributed Incident Command Point (ICP)
The ICP is a place where people go to find out where things (other people, equipment, etc.) are.
The ICP is a place where people record the situation
The record of the situation is used:

- for reference during the incident
- as input to building an electronic picture of the incident when a command support unit arrives

- as an aide memoire during debriefing
- as evidence in the case of problems requiring investigation.

2) **Getting water to the incident ground:**
- Water management
- Appliance operation
- Management of pumps, inlets, outlets
- Amounts of water, foam, fuel
- Operational hoses
    - Performance – output pressure delivered, flow rate(s)
    - Devising routes
    - Monitoring hose condition
- Hoses from hydrants
    - Connectivity to hydrant (regional variation)
    - Performance – input pressure received, flow rate
    - Devising routes
    - Monitoring hose condition
- Hoses from passive sources
    - Performance – suction pressure achieved, flow rate
    - Devising routes
    - Monitoring hose condition
- Appliance Logs / Kit logs:
    - Appliance equipment on board (specification, type and volume of)
    - Appliance capabilities (water rescue kit e.g.)

3) **Casualty Management**
- Rescue
- Care
- evacuation of victims to the outer cordon/ away from scene/hot zone

4) **Incident Assessment**
- environmental information (e.g. ambient temperature, humidity, precipitation, wind)
- structural information/terrain information
- information about the threat/problem (fire (e.g. temperature, extent, how "involved" it is, etc.), flood, electric, chemical/hazmat)

5) **Risk Assessment**
- based on hazards and current situation of "persons reported" - relates mainly to the incident's intrinsic characteristics
- based on hazards and plans to expose personnel to hazards– relates to the IC's planned response to the incident

6) **Sharing SA**
- risks
- threats
- tasking/plans
- priorities and objectives (intent)

8) **Vehicle marshalling**
- cordons (inner and outer)
- traffic management schemes
- rendezvous points
- incident command point/check in areas
- parking areas
- access control measures

9) **Asset/Resource management**
- Tracking – location/estimated time of arrival/Time remaining
- planning
- marshalling

10) **Interior operations**
- BA rescue
- BA fire suppression/extinction

11) **Deciding what to do (planning/tasking**)
- knowing resources
- knowing demands
- matching resources to demands
- prioritizing based on feasible goals/objectives (saveable life/property)

12) **communicating the plan/providing tasking**

13) **evaluating progress towards goals**
- consumption of resources
- impact on incident (fire/flood water, etc)

14) **Welfare of firefighters/personnel (operations service support)**
- Standby medical support/ambulance crew for fire-fighters
- Catering
- Transportation to rest areas

15) **Fire investigation**
- scene preservation
- scene documentation/logging/recording
- evidence collection/documentation
- incident ground access logging

14) **Admin/Accounting/logging/debriefing**

B) By Role:

For Incident Commander:
- Assess Incident – priorities – people (saveable?) then property (Saveable); what are the threats/hazards?
- Assess Resources
- Develop Plan

  - command structure (sectors? By location or function?); what roles do I need? Specialist help (HazMat? CBRN? police? Ambulance?)
  - The IC shall be able to draw sectors over a map of the incident ground. Once drawn sector boundaries shall scale and zoom together with the underlying map view.
- Assess Risk
- Communicate Plan
- Evaluate progress against expectations
- Anticipate resources needs
- Anticipate incident progression

For BAECO (Function: ensure safety of BA wearers)
- Needs to know: who is wearing BA; how much time left (Time of Whistle; related to air consumption which is a function of activity/effort); who the buddy is; where they are in the building; are they still active or unconscious
- Monitoring of fire-fighter PPE. Do they still have the basic ability to see/hear properly in order to do their job and communicate effectively?
- Does the kit (mask, helmet and other PPE) still fit and function as it should at beginning and throughout incident?

Sector Commander (Internal Operations) (Function: Rescue and/or fire suppression/extinction):
- Who is in the building: are they still working/OK (from BAECO);
- where have they searched for people or fire; where are the casualties or where is the fire;
- what are the hazards in the building?
- What is the threat in the premises?
- what are the conditions inside the building (is it necessary to send other FF in? is it safe to send other FF in?)

4.1.6 Requirements concerning secondary tasks

Requirements concerning secondary tasks will become critical at the stage of technology mapping. Then it will have to be ensured that the proposed technologies do not increase the number and / or complexity of secondary tasks. Additional secondary tasks, i.e. those that arise from the design of proposed technologies, need to be justified in terms of a cost-benefit analysis. The requirements are anticipated to be falling in the following categories:
- Supporting identification of the constraints that affect the reliability and relevance of information
- Minimising information input
- Minimising equipment operations
- Usability concerning visualisation
- Using forms of information presentation that allow comprehension of connections between levels and functions of the response.

4.1.7 Fire Services and Police Coordination Requirements

For the purposes of this document we only consider incidents at which Fire and Rescue Services are overall in charge of the incident. Other agencies such as police, ambulance, and emergency medical services (EMS) play a supporting role. In order to fulfil this role efficiently they require clear information on what is requested from them and all agencies need a shared understanding of the current situation on the incident ground. Herein resides a particular challenge for COPE and its objective to provide a Common Operational Picture. Namely, it will be hard to represent when different services have the same information on the screen, but differing understanding of what the implications are, especially when the implications suggest actions different from the current plan. What is required is a process or capability to represent and resolve this friction, i.e. potential differences of opinion or assessment; whether or not different services keep their own "view" of the situation; and which other services can access these views. It might be worth considering whether or not all services can access the Incident Commander's view of the situation, so that they can see what he is thinking and therefore how what they are doing fits in with the overall plan (or not). In the case of police to fire service coordination it is to be kept in mind that the police may have a significant stake in developments on the incident ground, even if they are there mainly in a supportive role. This is the case when forensic aspects come into play be it for reasons of suspected criminal activity or in relation to future insurance claims.
In more detail the requirements in relation to FRS-police coordination and information flow can be listed as follows:

- Police officers need to know who is in charge of liaising with them and where this person can be found
- Police need to know to some degree what the plan of action in dealing with the incident is
- Police need to know what information is requested from them, e.g. information on criminal activity in a an area that may suggest that threats to rescue personnel exists that the fire service will not be aware of
- Police will have to informed of cordon requirements (inner and outer) and requirements for exclusion zones
- Police will have to be informed on the extension of the risk zones or how far threats extend
- The Incident Commander will have to inform police on evacuation requirements for residents of adjoining areas
- Police will have to make the fire service aware of their forensic requirements
- Police may be requested to get information about the local area from residents to help identify the hazards/issues
- Police officers will have to be briefed on specific threats and hazards if they have to come close to the zone of immediate danger; they will however have to keep out of the inner zone until it is declared safe when the incident is winding down.

4.1.8 Fire Service and Ambulance / Emergency Medical Services Coordination Requirements

In addition to the general remarks on interaction and coordination between Fire and Rescue Services and other agencies in section 4.1.7 above one particular challenge to coordination may arise between Fire and EMS agencies. In some countries and regions Fire and Rescue Services also provide ambulance or paramedic services. In these cases there exists a potential for conflict between FRS emergency medical services and other service providers e.g. on when casualties are being handed over and how far non-FRS service can get involved in rescue activities. In most cases rules for this are laid out in standard operating procedures or standard operating guidelines. But still the COP should support clarification of areas of responsibility and e.g. hand over procedures.
In a little more detail coordination and information requirements for FRS-EMS interaction can be summarised as below:

- EMS personnel need to know who is in charge of liaising with them and where this person can be found
- EMS personnel need to know to some degree what the plan of action in dealing with the incident is
- EMS personnel will have to know
  - How many casualties are to be expected (form police or FRS Incident Command)
  - Where they are
  - Whether there is a casualty evacuation point and where it is? (from FRS Incident Command)
  - What the expected nature of injuries is (from FRS, and/or Police)
- EMS personnel will have to determine whether and what special medical equipment or skills are required
- EMS personnel in coordination with FRS Incident Command will have to determine how many ambulances are required
- EMS personnel will have to be informed on decontamination requirements (by FRS Incident Command)
- EMS personnel will need to know whether there are casualties trapped or in need of decontamination that need prioritizing (from FRS Incident Command).

4.2 First Responder User requirements

The purpose of this section is to define the requirements of the COPE First Responder System (FRS) from the end-user requirements as presented above.

- The word **shall** in the text expresses a mandatory requirement of the Specification.
- The word **should** in the text expresses a recommendation or advice on implementing such a requirement of the Specification.
- The word **must** in the text is used for legislative or regulatory requirement (e.g. Health and Safety) with which both the Purchaser and the Supplier shall comply. It is not used to express a requirement of the Specification.

- The word **will** in the text expresses a provision or service provided by the Purchaser or an intention by the Purchaser in connection with a requirement of the Specification. The Supplier is implicitly authorised to rely on such service or intention.
- The word **may** in the text expresses a permissible practice or action. It does not express a requirement of the Specification.

Text in Italics represents comments for information only and is not used to express a requirement of the specification.

In addition, the specification of a requirement will be accompanied by a unique identification number (e.g. FRUR-1) and a statement of the method(s) that will be used to verify that the equipment provided meets the specified requirement. Each requirement will therefore appear in the following format:

Requirement Reference   Requirement Text   D3.2 End-User Req. Reference

4.2.1 End-User Requirements

The following requirements were generated from interviews with end-users by the COPE human factors partners and are relevant to the FRS.

Number	Requirement	Needs analysis Section	System Applicable To
FRUR-1	The system **shall** be mobile about the incident ground.	4.1.1	FR
FRUR-2	Elements of the system to be worn by Breathing Apparatus (BA) wearers **shall** be useable with BA.	4.1.1	FR
FRUR-3	The system **may** be have a role specific Human Machine Interface (HMI).	4.1.1	FR
FRUR-4	The system **shall** be adaptable to escalating and de-escalating incidents.	4.1.1	FR, C2
FRUR-5	The system **shall** be flexible for unanticipated incident types (e.g. non-routine incidents, non-SOP command structures, novel solution types, novel solution requirements).	4.1.1	FR, C2
FRUR-6	The system **should** support, but not be limited to, the principle of “no more than 5 spans of control” for any one unit commander.	4.1.1	FR, C2
FRUR-7	The system **shall** support decentralised command and control (i.e. allow decision authority to be pushed to the lowest level).	4.1.1	FR, C2

Number	Requirement	Needs analysis Section	System Applicable To
FRUR-8	The system **should** be able to capture thermal imagery.	4.1.2	Sensors, (possibly FR)
FRUR-9	The system **may** identify the location of resources present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	Sensors, FR, C2
FRUR-10	The system **may** identify the availability of resources present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	C2, Decision Support, FR
FRUR-11	The system **may** identify the current commitment of resources present at the incident including but not limited to the list in **Error! Reference source not found.**. *Commitment should include the task committed to and the estimated duration of the commitment.*	4.1.3	C2, Decision Support, FR
FRUR-12	The system **may** make information available to the Incident Commander (IC) about the skills of the personnel on the appliance.	4.1.3	C2, Decision Support
FRUR-13	The system **may** identify the location of personnel present at the incident including but not limited to the list in Table 2.	4.1.3	Sensors, C2, FR
FRUR-14	The system **may** identify the availability of personnel present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	C2, Decision Support, FR
FRUR-15	The system **may** identify the current commitment of personnel present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	C2, Decision Support, FR
FRUR-16	The system **may** make information available to the IC about the remaining working time for each person under his/her command.	4.1.3	C2, Decision Support
FRUR-17	The system **may** make information available to the IC about the resources on the appliance **prior to arrival** at the incident (including estimated time or arrival and availability).	4.1.3	Sensors, C2
FRUR-18	The system **shall** support a flexible command structure.	4.1.4	C2, FR

Number	Requirement	Needs analysis Section	System Applicable To
FRUR-19	The system **shall** support written/drawn tasking information.	4.1.4	C2, FR
FRUR-20	The system **shall** support geographic areas and locations.	4.1.4	C2, FR
FRUR-21	The system **shall** support functional sectors.	4.1.4	C2, FR
FRUR-22	The system **should** have access to generic risk assessments based upon incident type.	4.1.4	C2, FR
FRUR-23	The system **should** support the reporting functions listed in *Table 11*.	4.1.4	C2, FR
FRUR-24	The system **may** display hose routes.	4.1.5	Decision Support, FR
FRUR-25	The system **may** support management of water pressure at the nozzle, and display predicted hose pressure.	NA	Decision Support
FRUR-26	The system **shall** handle the reporting of potential/identified casualties.	4.1.5	C2, FR
FRUR-27	The system **shall** handle the reporting of recovered casualties.	4.1.5	C2, FR
FRUR-28	The system **shall** support the coordinated hand-over of casualties to other teams of personnel.	4.1.5	C2
FRUR-29	The system **shall** handle Situational Awareness information about risks, threats, tasking/plans and priorities/objectives.	4.1.5	C2, FR
FRUR-30	The system **shall** display the current tactical modes for the Incident Ground and relevant sectors.	NA	C2, FR
FRUR-31	The system **shall** display the IC's 'intent', specifically, information relating to objectives, priorities and any goals/constraints on actions (inc. tactical mode)	NA[3]	C2, FR
FRUR-32	The system **shall** provide an indication of the number of people reported as still missing	4.1.5	C2, FR

[3] It is important to note that the declaration of persons reported leads to a qualitative shift in stance towards how to deal with the incident. If there are no persons reported, the degree of acceptable risk to First Responders decreases an order of magnitude. There will be a specific requirement to indicate persons reported, and an indication that all persons reported have been accounted for. With respect to "stance" of the emergency responders, maybe a second level of "intensity"/risk-acceptance relates to "persons under imminent threat". This type of information has implications for the "aggressiveness" of the response and particularly the acceptance of risk.

Number	Requirement	Needs analysis Section	System Applicable To
FRUR-33	The system **should** support Breathing Apparatus (BA) operations (e.g. BA rescue and BA fire suppression/extinction etc.).	4.1.5	Not implemented in COPE
FRUR-34	The system **should** log who is wearing BA.	4.1.5	Not implemented in COPE
FRUR-35	The system **should** calculate time left to Time of Whistle based on air consumption, which is a function of activity/effort, and display it to the Breathing Apparatus Entry Control Officer (BAECO).	4.1.5	Not implemented in COPE
FRUR-36	The system **should** calculate an estimate of Time to Turn based on starting air versus estimate of consumption and display it to the BA wearer and BAECO	4.1.5	Not implemented in COPE
FRUR-37	The system **should** calculate a current Time to Turn based on actual consumption rates and distance from the exit.		Not implemented in COPE
FRUR-38	If the calculated Time to Turn is shorter than the Time to Turn initially estimated, the system **should** provide the BA wearer and BAECO with an indication of changed Time to Turn.	4.1.5	Not implemented in COPE
FRUR-39	The system **should** log the BA teams (e.g. who the buddies are).	4.1.5	FR
FRUR-40	System **should** locate BA personnel within buildings.	4.1.5	FR
FRUR-41	System **should** report whether BA personnel are active/unconscious.	4.1.5	Sensors, FR
FRUR-42	The system **should** be able to report searched areas within a specified boundary.	4.1.5	FR, C2
FRUR-43	The system **should** be able to report the locations of casualties.	4.1.5	FR, C2
FRUR-44	The system **should** be able to report the location of the threats/hazards.	4.1.5	FR, C2
FRUR-45	The system **should** be able to report the environmental conditions inside the building as listed in *Table 12*	4.1.5	FR, C2

4.2.2 End User Requirements Grouped by Function

The end-user requirements in section 4.2.1 can be grouped by function as defined below:

4.2.3 General

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-1	The system **shall** be mobile about the incident ground.	4.1.1	FR
FRUR-3	The system **may** be have a role specific Human Machine Interface (HMI).	4.1.1	FR
FRUR-6	The system **should** support, but not be limited to, the principle of "no more than 5 spans of control" for any one unit commander.	4.1.1	FR, C2
FRUR-8	The system **should** be able to capture thermal imagery.	4.1.2	Sensors, (possibly FR)
FRUR-22	The system **should** have access to generic risk assessments based upon incident type.	4.1.4	C2, FR

4.2.4 Breathing Apparatus

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-2	Elements of the system to be worn by Breathing Apparatus (BA) wearers **shall** be useable with BA.	4.1.1	FR
FRUR-33	The system **should** support Breathing Apparatus (BA) operations (e.g. BA rescue and BA fire suppression/extinction etc.).	4.1.5	Not implemented in COPE
FRUR-34	The system **should** log who is wearing BA.	4.1.5	Not implemented in COPE
FRUR-35	The system **should** calculate time left to Time of Whistle based on air consumption, which is a function of activity/effort, and display it to the Breathing Apparatus Entry Control Officer (BAECO).	4.1.5	Not implemented in COPE
FRUR-36	The system **should** calculate an estimate of Time to Turn based on starting air versus estimate of consumption and display it to the BA wearer and BAECO	4.1.5	Not implemented in COPE

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-37	The system **should** calculate a current Time to Turn based on actual consumption rates and distance from the exit.	4.1.5	Not implemented in COPE
FRUR-38	If the calculated Time to Turn is shorter than the Time to Turn initially estimated, the system **should** provide the BA wearer and BAECO with an indication of changed Time to Turn.	4.1.5	Not implemented in COPE
FRUR-39	The system **should** log the BA teams (e.g. who the buddies are).	4.1.5	FR
FRUR-40	System **should** locate BA personnel within buildings.	4.1.5	FR
FRUR-41	System **should** report whether BA personnel are active/unconscious.	4.1.5	Sensors, FR

4.2.5 Configuration

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-4	The system **shall** be adaptable to escalating and de-escalating incidents.	4.1.1	FR, C2
FRUR-5	The system **shall** be flexible for unanticipated incident types (e.g. non-routine incidents, non-SOP command structures, novel solution types, novel solution requirements).	4.1.1	FR, C2
FRUR-7	The system **shall** support decentralised command and control (i.e. allow decision authority to be pushed to the lowest level).	4.1.1	FR, C2
FRUR-18	The system **shall** support a flexible command structure.	4.1.4	C2, FR

4.2.6 Command & Tasking

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-19	The system **shall** support written/drawn tasking information.	4.1.4	C2, FR
FRUR-23	The system **should** support the reporting functions listed in Table 11.	4.1.4	C2, FR
FRUR-31	The system **shall** display the IC's 'intent', specifically, information relating to objectives, priorities and any	NA	C2, FR

Number	Requirement	Needs Analysis Section	System Applicable To
	goals/constraints on actions (inc. tactical mode)..		

4.2.7 Situational Awareness

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-9	The system **may** identify the location of resources present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	Sensors, FR, C2
FRUR-10	The system **may** identify the availability of resources present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	C2, Decision Support, FR
FRUR-11	The system **may** identify the current commitment of resources present at the incident including but not limited to the list in **Error! Reference source not found.**. *Commitment **should** include the task committed to and the estimated duration of the commitment.*	4.1.3	C2, Decision Support, FR
FRUR-20	The system **shall** support geographic areas and locations.	4.1.4	C2, FR
FRUR-21	The system **shall** support functional sectors.	4.1.4	C2, FR
FRUR-29	The system **shall** handle Situational Awareness information about risks, threats, tasking/plans and priorities/objectives.	4.1.5	C2, FR
FRUR-30	The system **shall** display the current tactical modes for the Incident Ground and relevant sectors.	NA	C2, FR
FRUR-34	System **should** locate BA personnel within buildings.	4.1.5	Not implemented in COPE
FRUR-42	The system **should** be able to report searched areas within a specified boundary.	4.1.5	FR, C2
FRUR-43	The system **should** be able to report the locations of casualties.	4.1.5	FR, C2
FRUR-44	The system **should** be able to report the location of the threats/hazards.	4.1.5	FR, C2

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-45	The system **should** be able to report the environmental conditions inside a building as listed in Table 12	4.1.5	FR, C2

4.2.8 Personnel & Resource Management

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-12	The system **may** make information available to the Incident Commander (IC) about the skills of the personnel on the appliance.	4.1.3	C2, Decision Support
FRUR-13	The system **may** identify the location of personnel present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	Sensors, C2, FR
FRUR-14	The system **may** identify the availability of personnel present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	C2, Decision Support, FR
FRUR-15	The system **may** identify the current commitment of personnel present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	C2, Decision Support, FR
FRUR-16	The system **may** make information available to the IC about the remaining working time for each person under his/her command.	4.1.3	C2, Decision Support
FRUR-17	The system **may** make information available to the IC about the resources on the appliance **prior to arrival** at the incident (including estimated time or arrival and availability).	4.1.3	Sensors, C2
FRUR-26	The system **shall** handle the reporting of potential/identified casualties.	4.1.5	C2, FR
FRUR-27	The system **shall** handle the reporting of recovered casualties.	4.1.5	C2, FR
FRUR-28	The system **shall** support the co-ordinated hand-over of casualties to other teams of personnel.	4.1.5	C2
FRUR-32	The system **shall** provide an indication of the number of people reported as still missing.	4.1.5	C2, FR

4.2.9 Water Management

Number	Requirement	Needs Analysis Section	System Applicable To
FRUR-24	The system **may** display hose routes.	4.1.5	Decision Support, FRS
FRUR-25	The system **may** support management of water pressure at the nozzle, and display predicted hose pressure.	NA	Decision Support

4.2.10 Decontamination/Hazmat Identification

There are a range of requirements with respect to hazmat operations and decontamination procedures that we have not explore yet, but will be explored at design studies at ESC, Kuopio, in May 2009 and will be reported in D2.2.

4.3 First responder Engineering requirements

This section contains engineering requirements for the First Responder System that have been generated from the end-user requirements represented in section 4.2.

- The word **shall** in the text expresses a mandatory requirement of the Specification.
- The word **should** in the text expresses a recommendation or advice on implementing such a requirement of the Specification.
- The word **must** in the text is used for legislative or regulatory requirement (e.g. Health and Safety) with which both the Purchaser and the Supplier shall comply. It is not used to express a requirement of the Specification.
- The word **will** in the text expresses a provision or service provided by the Purchaser or an intention by the Purchaser in connection with a requirement of the Specification. The Supplier is implicitly authorised to rely on such service or intention.
- The word **may** in the text expresses a permissible practice or action. It does not express a requirement of the Specification.

Text in Italics represents comments for information only and is not used to express a requirement of the specification.

In addition, the specification of a requirement will be accompanied by a unique identification number (e.g. FRER-1) and a statement of the method(s) that will be used to verify that the equipment provided meets the specified requirement. Each requirement will therefore appear in the following format:

Requirement Reference   Requirement Text   User Requirement Reference

4.3.1 Engineering Requirements

4.3.2 General

Number	Requirement	User Requirements
FRER-1	The system **shall** have mobile capability.	FRUR-1
FRER-2	The system **shall** have wireless capability.	FRUR-1
FRER-3	The system **shall** be able to be carried by one person 'hands-free'.	FRUR-1
FRER-4	The system **may** be fixed to clothing	FRUR-3
FRER-5	The system **shall** be configurable for use by a Sector Commander (SC) as well as police and medical equivalent personnel.	FRUR-3
FRER-6	The system **shall** be configurable for use by a BAECO.	FRUR-3
FRER-7	The system **shall** be configurable for use by a fire fighter wearing Breathing Apparatus (BA).	FRUR-3, FRUR-2
FRER-8	The system **shall** be configurable for use by a fire fighter[4] not wearing BA as well as police and medical equivalent personnel.	FRUR-3
FRER-9	The system **should** notify the commander when more than 5 spans of control are active.	FRUR-6
FRER-10	The system **should** be able to capture thermal imagery in video format (to be specified).	FRUR-8
FRER-11	The system **should** be able to display thermal imagery in a Head Up Display (HUD).	
FRER-12	The system **may** have the ability to stream video over ethernet.	
FRER-13	Any streamed video **shall** be in a format to be specified.	
FRER-14	The system **may** have the ability to transmit still images over ethernet.	
FRER-15	Any transmitted still images **shall** be in a format to be specified.	
FRER-16	The system **may** have the ability to display thermal imagery on a Head Down Display (HDD).	
FRER-17	The system **should** be able to access generic risk assessments.	FRUR-19
FRER-18	The system **should** be able to display generic risk assessments.	FRUR-19

[4] The term "firefighter" is used to refer to any member of the fire & rescue service

4.3.3 Breathing Apparatus

Number	Requirement	User Requirements
FRER-19	Any HUD devices to be used by BA wearers **shall** be compatible with the BA.	FRUR-2
FRER-20	The system **should** allow the BAECO to assign BA sets to personnel.	FRUR-29
FRER-21	The system **should** display the names of personnel wearing BA.	FRUR-29, FRUR-30
FRER-22	The system **should** display the “check out” time for each BA set.	FRUR-29
FRER-23	The system **should** allow the BAECO to enter the “Time of Whistle” for each BA set.	
FRER-24	The system **should** calculate the estimated “Time of Whistle” based upon current rate of air consumption versus remaining air.	FRUR-29, FRUR-31
FRER-25	The system **should** produce a warning to the BAECO if the estimated “Time of Whistle” for any BA set falls below the entered “Time of Whistle”.	FRUR-29, FRUR-31
FRER-26	The system **should** display the “Time of Whistle” to the BAECO for all BA sets being used.	FRUR-29, FRUR-31
FRER-27	The system **should** produce a warning to the BAECO x minutes before the “Time of Whistle” of any BA set.	FRUR-29, FRUR-31
FRER-28	The system **should** produce a warning to the fire fighter wearing the BA set x minutes before their “Time of Whistle”.	FRUR-29, FRUR-31
FRER-29	The system **should** produce a warning to the BAECO when any BA set has reached its “Time of Whistle”.	FRUR-29, FRUR-31
FRER-30	The system **should** produce a warning to the fire fighter wearing the BA set when the “Time of Whistle” has been reached.	FRUR-29, FRUR-31
FRER-31	The system **should** display the time remaining to “Time of Whistle” to the BAECO for all BA sets being used.	FRUR-29, FRUR-31
FRER-32	The system **should** display the time remaining to “Time of Whistle” to the fire fighter wearing the BA set.	FRUR-29, FRUR-31
FRER-33	The system **should** calculate the estimated “Time Turn” which: “Time of Whistle” – estimated time to building exit.	FRUR-29, FRUR-32
FRER-34	The system **should** display the “Time to Turn” to the fire fighter wearing BA.	FRUR-29, FRUR-32
FRER-35	The system **should** display the remaining time to “Time to Turn” to the fire fighter wearing BA.	FRUR-29, FRUR-32

Number	Requirement	User Requirements
FRER-36	The system **should** display a warning to the fire fighter wearing BA x minutes before the “Time to Turn”.	FRUR-29, FRUR-32
FRER-37	The system **should** display a warning to the fire fighter wearing BA when the “Time to Turn” has been reached.	FRUR-29, FRUR-32
FRER-38	The system **should** allow the BAECO to assign each fire fighter wearing a BA set into a sub team.	FRUR-29, FRUR-33
FRER-39	The system **should** display to the BAECO which fire fighters wearing BA are in which sub teams.	FRUR-29, FRUR-33
FRER-40	The system **should** display to the BAECO the locations of fire fighters wearing BA.	FRUR-29, FRUR-34
FRER-41	The system **should** produce a warning to the BAECO if a fire fighter wearing BA has been inactive for 30 seconds.	FRUR-29, FRUR-35
FRER-42	The system **should** allow the BAECO to “check in” BA sets.	FRUR-29, FRUR-30
FRER-43	The system **should** allow the BAECO to remove BA sets from personnel.	FRUR-29, FRUR-30

4.3.4 Configuration

Number	Requirement	User Requirements
FRER-44	The system **shall** allow the addition of personnel.	FRUR-4, FRUR-5
FRER-45	The system **shall** allow the removal of personnel.	FRUR-4, FRUR-5
FRER-46	The system **shall** allow its role to be re-configured.	FRUR-4, FRUR-5, FRUR-15
FRER-47	The system **shall** allow its immediate commander to be changed. *e.g. The immediate commander may be changed from being the Incident Commander (IC) to a Sector Commander (SC)*	FRUR-4, FRUR-5, FRUR-7, FRUR-15

4.3.5 Command & Tasking (C2 Application: filtered for First Responder Applications)

Number	Requirement	User Requirements
FRER-	The system **shall** display task allocations.	FRUR-16

Number	Requirement	User Requirements
48		
FRER-49	The system **shall** display task progress.	FRUR-16
FRER-50	The system **shall** display task inter-dependencies.	FRUR-16
FRER-51	The system **shall** display task priorities.	FRUR-16
FRER-52	The system **shall** display task objectives.	FRUR-16
FRER-53	The system **should** allow the user to send the responses to task requests listed in *Table 11*:	FRUR-20
FRER-54	The system **shall** display the tactical mode (overall and by sector) (FRER 67 & 68)	FRUR-28

4.3.6 Situational Awareness (C2 Application: filtered for First Responder Applications)

Number	Requirement	User Requirements
FRER-55	The system **may** display the location of resources at the incident ground including but not limited to the list in **Error! Reference source not found.**.	FRUR-9
FRER-56	The system **may** display the current availability of resources at the incident ground including but not limited to the list in **Error! Reference source not found.**	FRUR-10
FRER-57	The system **may** display the current commitment of resources at the incident ground including but not limited to the list in **Error! Reference source not found.**	FRUR-11
FRER-58	The system **shall** host a digital moving map of the local area.	FRUR-17
FRER-59	The system **should** host a digital moving map of building interiors.	FRUR-17
FRER-60	The system **shall** support the display of geographical areas of interest.	FRUR-17, FRUR-36, FRUR-38
FRER-61	The system **shall** support the display of geographical points of interest.	FRUR-17, FRUR-34, FRUR-37, FRUR-38
FRER-62	The system **should** be able to display the location of the personnel at the incident ground listed in *Table 14*.	FRUR-17, FRUR-23, FRUR-24,

Number	Requirement	User Requirements
		FRUR-25, FRUR-34, FRUR-37
FRER-63	The system **should** be able to display the areas of interest on the incident ground listed in *Table 13*.	FRUR-17, FRUR-36, FRUR-38
FRER-64	The system **should** be able to display which personnel are in a particular building.	FRUR-17, FRUR-34
FRER-66	The system **should** be able to report the environmental conditions inside a building listed in *Table 12*.	FRUR-17, FRUR-41
FRER-67	The system **shall** display the current tactical mode for the Incident Ground.	FRUR-27
FRER-68	If the system has been assigned to a sector then it **shall** display the current tactical mode for that sector.	FRUR-27

4.3.7 Personnel & Resource Management

Number	Requirement	User Requirements
FRER-69	The system **may** make available to the Incident Commander the skills & qualifications of any personnel assigned to the system.	FRUR-12
FRER-70	The system **may** make available to the Incident Commander a list of any resources assigned to the system.	FRUR-12, FRUR-14
FRER-71	The system **may** allow the assignment of resources to the system.	FRUR-14
FRER-72	The system **may** allow the removal of resources from the system.	FRUR-14
FRER-73	The system **may** provide the facility to change the status of a resource to any of the values listed in *Table 10*.	FRUR-14
FRER-74	The system **may** display the remaining work time for personnel assigned to the system.	FRUR-13
FRER-75	The system **may** make the remaining work time for personnel assigned to the system available to the Welfare Officer.	FRUR-13
FRER-76	The system **shall** provide the facility to input the location of identified casualties.	FRUR-23
FRER-77	The system **shall** send output the location and information about identified casualties to the C2 system.	FRUR-23
FRER-	The system **shall** provide the facility to change a	FRUR-24

Number	Requirement	User Requirements
78	known casualty's status to 'Recovered'.	
	The system **shall** provide the facility to change the casualty's status to 'Handed over'. *Handed over to medical team or other team that will transport the casualty to the designated medical area.*	FRUR-25
FRER-79	The system **shall** send casualty status changes to the C2 system.	FRUR-24, FRUR-25

4.3.8 Water Management

Number	Requirement	User Requirements
FRER-80	The system **may** be able to display hose routes.	FRUR-21
FRER-81	The system **may** display predicted hose pressure.	FRER-22

4.4 SIP End-User Requirements

The following requirements were generated from interviews with end-users by the COPE human factors partners and are relevant to the FRS.

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-1	The system **shall** be mobile about the incident ground.	4.1.1	Sensors FR
SIPUR-2	The system **shall** support the observation of the scene on arrival by deployable sensors.	4.1.2	Sensors
SIPUR-3	The system **should** be able to capture thermal imagery.	4.1.2	Sensors, (possibly FR)
SIPUR-4	The system **may** identify the location of resources present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	Sensors, FR, C2
SIPUR-5	The system **may** make information available to the Incident Commander (IC) about the skills of the personnel on the appliance.	4.1.3	C2, Decision Support, Sensors

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-6	The system **may** identify the location of personnel present at the incident including but not limited to the list in Table 2.	4.1.3	Sensors, C2, FR
SIPUR-7	The system **may** make information available to the IC about the resources on the appliance **prior to arrival** at the incident (including estimated time or arrival and availability).	4.1.3	Sensors, C2
SIPUR-8	The system **shall** make available the information related to the relevant conditions and factors (e.g. weather, wind, precipitation)	4.1.4	Sensors
SIPUR-9	The system **shall** make available the information related to the nature of other hazards	4.1.4	Sensors
SIPUR-10	System **should** locate BA personnel within buildings.	4.1.5	Sensors, FR
SIPUR-11	System **should** report whether BA personnel are active/unconscious.	4.1.5	Sensors, FR
SIPUR-12	The system **shall** make available the information related to the environmental information (e.g. ambient temperature, humidity, precipitation, wind)	4.1.5	Sensors
SIPUR-13	The system **should** make available the information about the threat/problem (fire (e.g. temps, extent, how "involved" it is, etc.), flood, electric, chem/hazmat)	4.1.5	Sensors
SIPUR-14	The system **shall** make available the information related to the : access control measures (for vehicle marshalling)	4.1.5	Sensors
SIPUR-15	The system **should** offer the support for **fi**re investigation: scene preservation, scene documentation/logging/recording, evidence collection/documentation, incident ground access logging	4.1.5	Sensors, FR, C2
SIPUR-16	The system **shall** be easy to transport and easy deployable		Sensors, FR, C2
SIPUR-17	The system **should** require low space to be stored or transported		Sensors, FR, C2

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-18	The system **should** resist against transportation and handling stress & impacts		Sensors, FR
SIPUR-19	The system **should** resist in tough weather and other environmental conditions		Sensors, FR
SIPUR-20	The system **shall** be operational into the temperature range from... to ...		Sensors, FR
SIPUR-21	The system **should** be easy to handle by FR in protection suits/ gloves		Sensors, FR
SIPUR-22	The system **should** be easy to understand		All
SIPUR-23	The system **should** be easy to setup/ install		All
SIPUR-24	The system **should** be self adjusting; no calibration on the incident ground		Sensors, FRS
SIPUR-25	The system **may** implement adaptive adjustment (e.g. of sensitivity, thresholds etc.)		Sensors, FR
SIPUR-26	The system **should** be self-positioning (GPS)		Sensors, FR
SIPUR-27	The system **will** be in sufficient numbers (quantity) available in order to support relevant test scenarios		Sensors, FR
SIPUR-28	The system **will** seek low cost solution, Re-usability or throwaway mass products (would heavily impact the deployment strategy)	---gen	All
SIPUR-29	The system **should** allow fast deployment		All
SIPUR-30	The system **should** support easy deployment in adverse / dangerous conditions		Sensors, FR
SIPUR-31	The system **may** support air-drop deployment in contaminated areas		Sensors
SIPUR-32	The system **should** support easy redeployment without re-adjustment		Sensors, FR
SIPUR-33	The system **may** support dynamic/ adaptive deployment – e.g. with ground robotics and/ or airborne platforms/ mini-helicopters		Sensors
SIPUR-34	The system **should** support remotely controllable deployment/ redeployment		Sensors, FR

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-35	The system **should** support automated search for critical environment (e.g. concentration of poisonous gas; propagation direction)		Sensors, Decision Support, FR
SIPUR-36	The system **should** support automated building of patterns, adaptive to the environment		Sensors, FR
SIPUR-37	The system **should** be vehicle - mountable		Sensors
SIPUR-38	The system **should** support automated hook-up to the network		Sensors, Comm
SIPUR-39	The system **should** use standard communication protocols		Sensors, Comm
SIPUR-40	The system **should** be adaptive to different communications networks		Sensors, Comm
SIPUR-41	The system **should** support a self-configuring network		Sensors, Comm
SIPUR-42	The system **should** offer information easy to integrate into the COP and easy to interpret/ use by decision support tools		Sensors
SIPUR-43	The system **should** support remotely controllable modes of operation, calibration, sensitivity etc.		Sensors, FR
SIPUR-44	The system **should** support display of sensor deployment and status of operation in the COP		Sensors, C2
SIPUR-45	The system **may** offer/support a tool for fast planning and re-planning of sensor deployment		Sensors, C2, Decision Support

4.4.1 SIP End User Requirements Grouped by Function

The end-user requirements as outlined above can be grouped by function as defined below:

4.4.2 General

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-1	The system **shall** be mobile about the incident ground.	4.1.1	Sensors, FR

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-3	The system **should** be able to capture thermal imagery.	4.1.2	Sensors, (possibly FR)
SIPUR-15	The system **should** be able to support the fire investigation: scene preservation, scene documentation/logging/recording, evidence collection/documentation, incident ground access logging	4.1.5	Sensors, FR, C2
SIPUR-18	The system **should** resist against transportation and handling stress & impacts		Sensors, FR
SIPUR-19	The system **should** resist in tough weather and other environmental conditions		Sensors, FR
SIPUR-20	The system **shall** be operational into the temperature range from... to ...		Sensors, FR
SIPUR-21	The system **should** be easy to handle by FR in protection suits/ gloves		Sensors, FR
SIPUR-22	The system **should** be easy to understand		All
SIPUR-23	The system **should** be easy to setup/ install		All
SIPUR-24	The system **should** be self adjusting; no calibration on the incident ground		Sensors, FR
SIPUR-25	The system **may** implement adaptive adjustment (e.g. of sensitivity, thresholds etc.)		Sensors, FR
SIPUR-27	The system **will** be in sufficient numbers (quantity) available in order to support relevant test scenarios		Sensors, FR
SIPUR-28	The system **will** seek low cost solution, Re-usability or throwaway mass products (would heavily impact the deployment strategy)		All
SIPUR-38	The system **should** support automated hook-up to the network		Sensors, Comm
SIPUR-39	The system **should** use standard communication protocols		Sensors, Comm
SIPUR-40	The system **should** be adaptive to different communications networks		Sensors, Comm
SIPUR-41	The system **should** support a self-configuring network		Sensors, Comm

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-42	The system **should** offer information easy to integrate into the COP and easy to interpret/ use by decision support tools		Sensors
SIPUR-43	The system **should** support remotely controllable modes of operation, calibration, sensitivity etc.		Sensors, FR
SIPUR-44	The system **should** support display of sensor deployment and status of operation in the COP		Sensors, C2

4.4.3 Breathing Apparatus

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-10	System **should** locate BA personnel within buildings.	4.1.5	Sensors, FR
SIPUR-11	System **should** report whether BA personnel are active/unconscious.	4.1.5	Sensors, FR

4.4.4 Situational Awareness

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-2	The system **shall** support the observation of the scene on arrival, visual, sounds, smells, temperature, walking around to get more complete view.	4.1.2	Sensors
SIPUR-8	The system **shall** make available the information related to the relevant conditions and factors (e.g. weather, wind, precipitation)	4.1.4	Sensors
SIPUR-9	The system **shall** make available the information related to the nature of other hazards	4.1.4	Sensors
SIPUR-12	The system **shall** make available the information related to the environmental information (e.g. ambient temperature, humidity, precipitation, wind)	4.1.5	Sensors

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-13	The system **should** make available the information about the threat/problem (fire (e.g. temps, extent, how "involved" it is, etc.), flood, electric, chem/hazmat)	4.1.5	Sensors

4.4.5 Personnel & Resource Management

Number	Requirement	D3.2 End-User Requirements Section	System Applicable To
SIPUR-4	The system **may** identify the location of resources present at the incident including but not limited to the list in **Error! Reference source not found.**.	4.1.3	Sensors, FR, C2
SIPUR-5	The system **may** make information available to the Incident Commander (IC) about the skills of the personnel on the appliance.	4.1.3	C2, Decision Support, Sensors
SIPUR-6	The system **may** identify the location of personnel present at the incident including but not limited to the list in Table 2.	4.1.3	Sensors, C2, FR
SIPUR-7	The system **may** make information available to the IC about the resources on the appliance **prior to arrival** at the incident (including estimated time or arrival and availability).	4.1.3	Sensors, C2
SIPUR-14	The system **shall** make available the information related to the : access control measures (for vehicle marshalling)	4.1.5	Sensors

4.4.6 System deployment

Number	Requirement	System Applicable To
SIPUR-16	The system **shall** be easy to transport and easy deployable	Sensors, FR, C2
SIPUR-17	The system **should** require low space to be stored or transported	Sensors, FR, C2
SIPUR-29	The system **should** allow fast deployment	All

Number	Requirement	System Applicable To
SIPUR-30	The system **should** support easy deployment in adverse / dangerous conditions	Sensors, FR
SIPUR-31	The system **may** support air-drop deployment in contaminated areas	Sensors
SIPUR-32	The system **should** support easy redeployment without re-adjustment	Sensors, FR
SIPUR-33	The system **may** support dynamic/ adaptive deployment – e.g. with ground robotics and/ or airborne platforms/ mini-helicopters	Sensors
SIPUR-34	The system **should** support remotely controllable deployment/ redeployment	Sensors, FR
SIPUR-35	The system **should** support automated search for critical environment (e.g. concentration of poisonous gas; propagation direction)	Sensors, Decision Support, FR
SIPUR-36	The system **should** support automated building of patterns, adaptive to the environment	Sensors, FR
SIPUR-37	The system **should** be vehicle - mountable	Sensors
SIPUR-26	The system **should** be self-positioning (GPS)	Sensors, FR
SIPUR-45	The system **may** offer/support a tool for fast planning and re-planning of sensor deployment	Sensors, C2, Decision Support

4.5 SIP Engineering Requirements

4.5.1 General

Number	Requirement	User Requirements
SIPER-1	The system **shall** have mobile capability.	SIPUR-1
SIPER-2	The system **shall** have capability to interface with communication and FR modules.	SIPUR-1, SIPUR-28, SIPUR-38, SIPUR-39, SIPUR-40, SIPUR-41, SIPUR-42, SIPUR-43, SIPUR-44
SIPER-3	The system **shall** be able to be carried by one person ‘hands-free’.	SIPUR-1

Number	Requirement	User Requirements
SIPER-4	The system **may** be fixed to clothing	SIPUR-1
SIPER-5	The system **shall** be configurable for use by a fire fighter[5] , wearing or not wearing BA, as well as police and medical equivalent personnel.	SIPUR-1
SIPER-6	The system **shall** have battery power autonomy of x hours (tens of minutes?).	
SIPER-7	The system **shall** be able to charge the battery from both auto vehicle 12V DC plug and the civilian power grid.	SIPUR-1, SIPUR-7,
SIPER-8	The system **shall** be able to capture thermal imagery and make the information available on x format.	SIPUR-3
SIPER-9	The thermal imagery system **should** be considered a subsystem of the SIP system.	SIPUR-1, SIPUR-3,
SIPER-10	The thermal imagery system **may** be powered from a separate battery pack than the SIP system.	SIPUR-1
SIPER-11	The thermal subsystem **shall** have battery power autonomy of x hours (tens of minutes?).	SIPUR-3
SIPER-12	The system **shall** be able to locally log the sensors raw data in order to support the post-incident investigation.	SIPUR-15
SIPER-13	The system **should** report the battery status	SIPUR-43
SIPER-14	The system **should** report equipment tamper	SIPUR-43
SIPER-15	The system **should** be totally protected against dust, protected against low pressure jets from all directions (Limited ingress permitted) and mechanical protection against impact of 0.5 joule (e.g. 250g weight falling from 20cm height) – **IP 653**	SIPUR-18 SIPUR-19
SIPER-16	The system **shall** be operational into the temperature range from **- 15ºC** to **+50ºC**	SIPUR-20
SIPER-17	The system **should** be easy to handle by FR in protection suits/ gloves	SIPUR-21
SIPER-18	The system **should** be easy to setup/install and understand	SIPUR-22 SIPUR-23
SIPER-19	The system **should** operate with no calibration on the incident ground	SIPUR-24
SIPER-20	The system **may** implement adaptive adjustment (e.g. of sensitivity, thresholds etc.)	SIPUR-25

[5] The term “firefighter” is used to refer to any member of the fire & rescue service

4.5.2 Breathing Apparatus

Number	Requirement	User Requirements
SIPER-21	The system **should** locate the BA personnel within buildings.	SIPUR-10, SIPUR-4
SIPER-22	System **should** report whether BA personnel are not moving for more than TBD seconds.	SIPUR-11

4.5.3 Situational Awareness

Number	Requirement	User Requirements
SIPER-23	The system **shall** be easily deployable.	SIPUR-2, SIPUR-10
SIPER-24	The system **shall** report the wind direction and speed.	SIPUR-8, SIPUR-12
SIPER-25	The system **shall** report the ambient temperature and humidity.	SIPUR-8, SIPUR-12
SIPER-26	The system **may** report the precipitation data.	SIPUR-8, SIPUR-12
SIPER-27	The system **shall** report the CBN hazards.	SIPUR-9, SIPUR-13
SIPER-28	The system **should** detect the presence of the poisonous[6] gases.	SIPUR-13

4.5.4 Personnel & Resource Management

Number	Requirement	User Requirements
SIPER-29	The system **shall** report the outdoor position of the personnel present at the incident, as specified into Table 1.	SIPUR-4
SIPER-30	The system **should** report the indoor position of the personnel present at the incident, as specified into Table 1.	SIPUR-4, SIPUR-10
SIPER-31	The system **shall** report the outdoor position of the vehicles present at the incident.	SIPUR-4
SIPER-32	The system **may** identify the outdoor position of the equipment and the apparatus present at the incident, as specified in Table 2.	SIPUR-4
SIPER-33	The system **may** report an identification code of the personnel present on the appliance.	SIPUR-5
SIPER-34	The system **may** report an identification code of the resources present on the appliance.	SIPUR-6

[6] Poisonous gases to be detected are: $CH4$, $NH3$, $CO2$, $NO2$

Number	Requirement	User Requirements
SIPER-35	The system **may** make available the appliance speed and outdoor position.	SIPUR-7
SIPER-36	The system **may** issue an alert if there is a breach in the protected perimeter.	SIPUR-14

4.5.5 System Deployment

Number	Requirement	User Requirements
SIPER-37	The system **shall** be compact, easy to be transported, deployed and operated	SIPUR-16, SIPUR-17, SIPUR-31, SIPUR-33, SIPUR-35, SIPUR-36
SIPER-38	The system **should** allow permit fast (re)deployment even into adverse / dangerous area.	SIPUR-29 SIPUR-30, SIPUR-32, SIPUR-34
SIPER-39	The system **may** support deployment from airborne platforms, for deployment into contaminated areas	SIPUR-31
SIPER-40	The system **should** be vehicle - mountable	SIPUR-37
SIPER-41	The system **should** be self-positioning (GPS)	SIPUR-26

5 Conclusion

The finalisation of this document marks the end of the COPE fieldwork and its first phase of end user interaction. At the same time it marks the beginning of COPE technology development and of a design process jointly undertaken by human factors experts and solution providers.
The problem areas and requirements identified in the previous section will be taken as the basis of the technology mapping work in the COPE work package 4. In this work package working groups have been established around the main COPE technology topics. Each working group is jointly led by a human factors expert and by a technology expert. The objective is to work in detail on problem areas and requirements identified in this document and to propose relevant technological solutions. In this sense the work reported in this deliverable continues in a focussed way.

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6 Appendix

Name	Description
Appliances	Emergency service vehicles – will need to differentiate between: Pumps Turntable ladders Hydraulic platform (?) Rescue vehicle (4WD; specialist cutting equipment) USAR vehicles Command vehicles Police vehicles Ambulance Hazmat Detection Vehicles Decontamination vehicles
Cutting Equipment	
Breathing Apparatus	
First Aid equipment	(including specialist first aid kit: defibrillators; trauma kits;
Cordon/barrier equipment	Anything used to create a barrier/cordon, that will help define the inner/outer cordon lines on the incident ground
Decontamination tents/shelters/areas	
USAR gear	
High volume pumps/flood protection	
Specialist Equipment	We need to clarify what might be on an appliance that is "special", i.e. not expected, e.g. - Specialist cutting equipment - Specialist medical equipment (defibrillators, trauma kits) - Specialist USAR equipment (ropes, life sensors, construction gear) - high volume pumps

Table 8. Resources to be tracked.

Name	Description
Incident Commander	
Sector Commanders	
Fire Fighters	
Command Support Officer	
Safety Officer	
BAECO	
Operations Commanders	

Table 9. Personnel to be tracked.

Name	Description
In Transit	
Available	
Committed	

Table 10a. Personnel & Resource Status Values.

Name	Description
Task received	Acknowledge receipt of tasking
Situation and requirements understood	Some equivalent of "read back situation and tasking information" to confirm understanding
Objectives and requirements understood	Some equivalent of "read back objectives and commander's intent/priorities" to confirm understanding
Questions / clarification required	Support questioning/seeking clarification
Whether actions are feasible based on subordinate's assessment	Support feedback to IC from decentralized decision making and subordinate dynamic risk assessment
Additional resources required?	Support requests for additional resources
Task progress	Support the reporting of task progress (probably not in terms of "% complete", but maybe distinctions like: "in progress" "task complete" "estimated time to complete is X minutes" "estimated time to complete is "one more BA team to search" (20 mins??) – meaningful/easy to report and capture "progress reporting"

Table 11. Tasking Information.

Name	Description
Rapid temperature change	Signal rate of change over X degrees per second (?)
Absolute threshold temperature	Signal temps over some threshold value that should prohibit entry
Visibility	May be the height of a heat ceiling; probably specified in terms of posture required to move through the building (e.g. upright; stoop; hands and knees; crawl) or, In terms of "feet" of visibility (clear; impaired; severely impaired; can't see hand in front of face)
Poisonous gases	This will not impact BA wearers; maybe another important distinction is "hazmat requiring decontamination procedures" - not sure if we can have sensors for all of them; but maybe the most commonly occurring?
Subjective temperature assessment	May be the height of a heat ceiling; probably specified in terms of posture required to move through the building (e.g. upright; stoop; hands and knees; crawl)
Rapid temperature change	Signal rate of change over X degrees per second
Absolute threshold temperature	Signal temps over some threshold value that should prohibit entry

Table 12. Supported Building Environmental Conditions.

Name	Description
Interior searched areas	
Interior areas to search	
Exterior searched areas	
Exterior areas to search	
Fire areas	
Poisonous cloud areas	
Hazard areas Inner Cordon Outer cordon Incident Command Post Access Points Access Lanes Traffic marshalling area Rest and Recuperation area (where's the tea?) Decontamination areas/zones First aid points Casualty collection points for ambulance/evacuation to hospital Media area Volunteer areas	

Table 13. Areas of Interest.

Name	Description
Fire fighters (BA)	
Fire fighters (No BA)	
SCs	
IC	
Casualties	

Table 14. Personnel to Display on Digital Maps.