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**Satellite Earth Stations and Systems (SES);
Reference scenario for the deployment of
emergency communications;
Part 2: Mass casualty incident in public transportation**

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Contents

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Satellite Earth Stations and Systems (SES).

The present document is part 2 of a multi-part deliverable covering the reference scenario for the deployment of emergency communications, as identified below:

Part 1: "Earthquake";

Part 2: "Mass casualty incident in public transportation".

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**may not**", "**need**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

Major emergencies or disasters may result in a need for additional resources in local telecommunications networks, especially if they are damaged or overloaded, in order to maintain or enhance the ability of emergency services to respond and coordinate their activities effectively. Satellites can play a role in replacing or supplementing terrestrial telecommunications links in these scenarios. For example satellite systems can provide:

- broadband and secure communication facilities anywhere/anytime in locations where no other facilities are available
- temporary replacement of broken/saturated infrastructures by means of backhauling
- fast deployment of temporary communication networks during emergencies/disasters

Hence a basis for requirements for such links needs to be established, and it is intended that the scenarios defined here may be used for this purpose at a later stage.

The present document also is a response to EC mandate M/496 [i.13], specifically dossier 9 "Disaster Management" part 2: "Emergency Telecommunication Services" which aims to support standardization for the optimal needs of the emergency responders.

The use of satellite communication in disasters is described in ETSI TR 102 641 [i.3].

In the present document, clause 4 defines the scenario, what actions need to be taken by which actors (who will have communications needs) and what their tasks are. This definition constitutes a basis for clause 5, which defines the nature of information exchanges needed. Clause 6 defines the detailed parameters relating to positions and movements of scenario actors, which are intended to form a basis for modelling of the scenario response topology. These parameters are generic enough to be applicable or adapted to similar but different scenarios, and may eventually be used to model the requirements for actors' communication exchanges, and associated capacities.

1 Scope

The present document defines a reference scenario for a mass-transportation accident (MTA) in a rural environment. The scenario includes definition of the responders involved and their gross communication needs without specifying the network technologies involved. Finally the topology modelling of the responders involved is defined, in terms of their disposition in the incident area, their time evolution and their movements (if any).

The scenario is not generic in the sense of representing all emergencies of this type, but is intended to be a "typical" example, and thus a reference in order to allow evaluation and dimensioning of required overall emergency telecommunications.

The regulations and operating procedures for emergency responses vary between countries; for example the organization responsible for the overall emergency management can be the police, the fire or rescue organization, a dedicated organization for this purpose (e.g. civil protection), or others.

The response services defined for these scenarios are limited to safety-related services (i.e. not security such as law enforcement).

Casualties and personnel not active in the rescue operations (e.g. the press) have been excluded, as their communications needs are not covered by the emergency communication systems considered here, but their needs are considered in ETSI TR 102 410 [i.2].

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the reference document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 102 181: "Emergency Communications (EMTEL); Requirements for communication between authorities/organizations during emergencies".

[i.2] ETSI TR 102 410: "Emergency Communications (EMTEL); Basis of requirements for communications between individuals and between individuals and authorities whilst emergencies are in progress".

[i.3] ETSI TR 102 641: "Satellite Earth Stations and Systems (SES); Overview of present satellite emergency communications resources".

[i.4] Recommendation ITU-T G.114. Series G: Transmission Systems and Media, Digital Systems and Networks. International telephone connections and circuits - General recommendations on the transmission quality for an entire international telephone connection. One-way transmission time.

[i.5] United Nations Disaster Assessment and Coordination UNDAC Field Handbook.

[i.6] European Union Handbook on Assistance Intervention in the Frame of Community Mechanism for the Cooperation of Civil Protection.

[i.7] Cabinet Office. UK Civil Protection Lexicon.

[i.8] Hamdi Monia, Franck Laurent and Lagrange Xavier: "Topology modelling and network partitioning: an application to forest firefighting". Radio science bulletin, 2013, pp. 8-20.

[i.9] Franck Laurent, Hamdi Monia and Giraldo Rodriguez Carlos: "Topology modelling of emergency communication networks: caveats and pitfalls". The International Emergency Management Society Workshop 2011, The International Management Society, 22-23 June 2011, Nîmes, France, 2011.

[i.10] Aschenbruck Nils, Gerhards-Padilla Elmar and Martini Peter: "Modelling mobility in disaster area scenarios". Performance Evaluation, 2009, vol. 66, n 12, pp. 773-790.

[i.11] Schwamborn Matthias, Aschenbruck Nils and Martini Peter: "A realistic trace-based mobility model for first responder scenarios". Proceedings of the 13th ACM international conference on Modeling, analysis, and simulation of wireless and mobile systems, Bodrum, Turkey, October 17-21, 2010.

[i.12] ETSI TR 102 643: "Human Factors (HF); Quality of Experience (QoE) requirements for real-time communication services".

[i.13] EC mandate M/496: "M/496 Mandate addressed to CEN, CENELEC and ETSI to develop standardisation regarding spaceindustry (phase 3 of the process)".

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

accident: unplanned, unexpected, unintended and undesirable happening which results in or has the potential for injury, harm, ill-health or damage [i.7]

casualty: individual in the incident area and requiring evacuation including those who are:

(i) non-injured, but affected,

(ii) injured and treated on site,

(iii) injured and needing treatment off-site (medevac), and

(iv) deceased.

Common Operating Picture (COP): single display of information collected from and shared by more than one agency or organization that contributes to a common understanding of a situation and its associated hazards and risks along with the position of resources and other overlays of information that support individual and collective decision making [i.7]

control centre: operations centre from which the management and co-ordination of the response by each emergency service to an emergency are carried out [i.7]

disaster: emergency (usually but not exclusively of natural causes) causing, or threatening to cause, widespread and serious disruption to community life through death, injury, and/or damage to property and/or the environment [i.7]

emergency: an event or situation which threatens serious damage to human welfare, environment, or security (based on [i.7])

Emergency Control Centre (ECC): facilities used by emergency organizations to handle rescue actions in answer to an emergency call ETSI TS 102 181 [i.1]

emergency service: service, recognized as such by the member state, that provides immediate and rapid assistance in situations where there is a direct risk to life or limb, individual or public health or safety, to private or public property, or the environment but not necessarily limited to these situations ETSI TS 102 181 [i.1]

emergency team (ET): the smallest group of actors (i.e. one or more) considered to be acting together.

Field Emergency Control Centre (FECC): facilities used by emergency service organizations to manage, command, coordinate, and control rescue works and logistics in the incident area

Geographical Information System (GIS): computer based system that supports the capture, management, analysis and modelling of geographically referenced data [i.7]

hazard area: area with obvious or supposed threats to physical/psychological health, properties, and/or environment

holding area: generic term for an area to which resources and personnel not immediately required at the scene or being held for further use, can be directed to standby [i.7]

incident: event or situation that requires a response from the emergency services or other responders [i.7]

incident area: area where the incident occurred, and/or the area which needs communication coverage to manage the response implemented ETSI TS 102 181 [i.1]

incident commander: the nominated officer with overall responsibility for management, command, coordination, and control of rescue and relief works in the incident area

Local Emergency Management Authority (LEMA): local organization within the public services fully or partly responsible for emergency preparedness and handling of incidents (based on ETSI TS 102 181 [i.1])

Mass Casualty Incident (MCI): incident (or series of incidents) causing casualties on a scale that is beyond the normal resources of the emergency services [i.7]

Non-Governmental Organization (NGO): organization that is neither run or controlled by a government nor a profit-oriented business

Personal Protective Equipment (PPE): protective clothing, helmets, goggles or other garment designed to protect the wearer's body from injury [i.7]

Public Safety Answering Point (PSAP): physical location where emergency calls are received under the responsibility of a public authority ETSI TS 102 181 [i.1]

Respiratory Protective Equipment (RPE): designed to protect workers from dusts, fumes, vapours or gases [i.9]

site incident officer: representative from the affected organization, when an incident occurs within the perimeter of an industrial or commercial establishment, public venue, airport or harbour, to liaise with the emergency management structures [i.7]

triage: assessment of casualties and allocation of priorities by the medical or ambulance staff (based on [i.7])

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

CCP	Casualty Collection Point
CFECC	Coordinating Field Emergency Control Centre
COP	Common Operating Picture
DCP	Deceased Collection Point
EC	European Commission
ECC	Emergency Control Centre
EMTEL	EMergency TELecommunications
ET	Emergency Team
ETSI	European Telecommunications Standards Institute
FECC	Field Emergency Control Centre

GIS	Geographical Information System
IC	Incident Commander
IPR	Intellectual Property Right
ISO	International Standardization Organization
ITU	International Telecommunication Union
ITU-R	International Telecommunication Union Radiocommunications Sector
ITU-T	International Telecommunication Union Telecommunications Sector
LEMA	Local Emergency Management Authority
MCI	Mass Casualty Incident
Medevac	Medical Evacuation
MIC	Medical Incident Commander
MTA	Mass Transportation Accident
NGO	Non-Governmental Organization
PMR	Private Mobile Radio
PPE	Personal Protective Equipment
PSAP	Public Safety Answering Point
SatEC	Satellite Emergency Communications Working Group
SECC	SubService Emergency Control Centre
SES	Satellite Earth Station and Systems
SQ	Scenario Quantity
STF	Specialist Task Force
TC	Technical Committee
TCC	Temporary Care Centre
TR	Technical Report
TS	Technical Specification

4 Disaster scenario

4.1 General

This clause firstly defines a mass transportation accident (MTA) scenario. Subsequently the response actions by emergency services to this scenario are defined in terms of the services involved, actors, roles, and organizational structures.

The main characteristics of an MTA in a rural environment are:

- Many casualties in the incident area.
- Accident is concentrated on a small geographical area.
- Access limitations (e.g. narrow roads or dirt tracks only).
- Limited available emergency services resources.
- Limited nearby hospital treatment capacities and/or treatment specialities.
- Sparse communication network coverage/capacities, both for private mobile radio (PMR) and commercial wireless services.

4.2 Scenario definition

The disaster scenario is a train crash due to a collision with a road vehicle at a level crossing located in a sparsely populated countryside environment. Some coaches of the passenger train overturn resulting in 170 casualties. The overhead line is not damaged.

120 casualties are not injured, 30 are slightly injured, 15 are seriously injured, 5 are dead, and 10 casualties are trapped. The accident happens in the evening of a cold winter day.

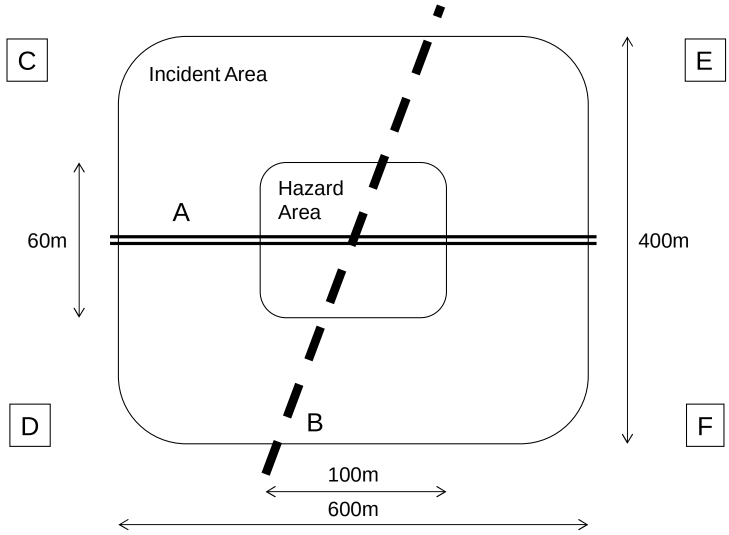

Figure 4.1: Geographical layout of the incident area

Figure 4.1 depicts the geographical layout of the MTA with zones and support areas:

The incident area has a dimension of 400 m by 600 m.

1) The hazard area includes the derailed/overturned coaches and the destroyed road vehicle and has a dimension of 100 m by 60 m.

2) "A" denotes the rail track.

3) "B" denotes the road with the level crossing.

4) "C" is the nearest ambulance station (25 km distance to hazard area).

5) "D" is the nearest fire station (15 km distance to hazard area).

6) "E" is the nearest shelter (15 km distance to hazard area).

7) "F" is the nearest hospital (25 km distance to hazard area).

The rear part of the train blocks the level crossing so that road traffic cannot pass any more. There is neither light nor heating in the coaches. Additionally, smoke emerges from one of the coaches.

Main consequence of the MTA is a mass casualty incident (MCI) requiring efficient casualty treatment and transport logistics.

4.3 Tasks and activities

This clause defines the response entities (i.e. actors) and their roles within the incident area in handling the accident. The main entities are emergency services and relevant authorities and/or NGOs supporting the emergency services. Depending on local/national organization of services and division of tasks/responsibilities, the entities involved, their responsibilities, and their individual areas of work may differ between countries.

In addition to their primary roles, actors may participate in other tasks. The roles will differ between countries, but a typical distribution of roles is given below:

1) Emergency management: setting up of management structures for all involved emergency services, coordination of emergency services, and reporting to the emergency control centre (ECC) and to the local emergency management authority (LEMA) [i.5], [i.6], leading the coordinating field emergency control centre (CFECC).

2) Fire-fighting: securing the hazard area, fighting fires.

3) Rescue: securing the hazard area, rescuing casualties.

4) Maintenance of public order: documentation, investigations.

5) Provisions: supplies, shelters, transport.

6) Casualty logistics: triage, registration, and treatment of the injured, organizing and conducting medical evacuation out of the incident area, organizing and conducting evacuation of non-injured casualties out of the incident area.

The actions during the emergency response in the incident area of this particular scenario are further defined in the following clauses.

4.4 Accident response actions

4.4.1 General

The actions of the actors (defined in clause 4.3) in the incident area of this particular scenario are further defined below including overall duration for each action.

Figure 4.2 shows the general organizational hierarchy of the teams of actors (responders) involved.

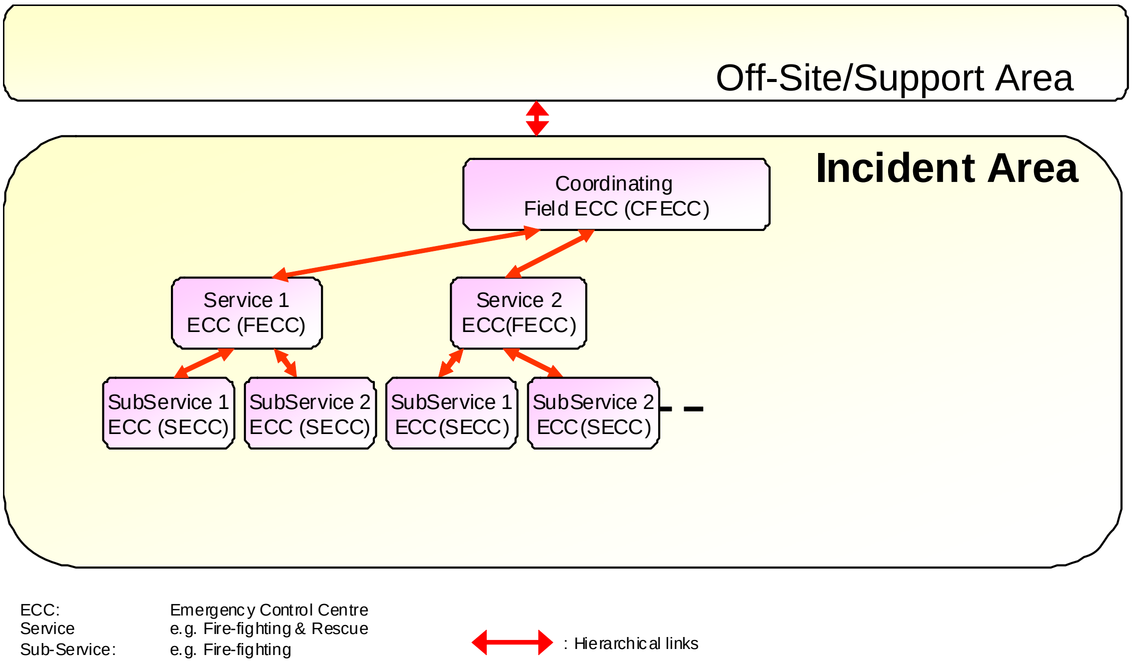

Figure 4.2: Responder organizational hierarchy

4.4.2 Emergency management

Deployed emergency services set up their own management structure in terms of service field emergency control centres (FECCs) and SubService emergency control centres (SECCs), as shown in figure 4.2. The actions in table 4.1 are sorted according to their ideal occurrence. In fact, nearly all actions of all involved actors are conducted nearly simultaneously so that there is no distinct order.

Table 4.1: Emergency management

Involved actors	Actions	Start point	Intermediate point	End point	Duration
All involved emergency services	Transport of emergency management personnel and equipment (e.g. command vehicle) to the incident area	First alerting	Arrival	Arrival	Minutes
Incident commander (IC)	Establishing emergency management structures	Arrival	CFECC in place	End of emergency response works	Hours
Fire service	Establishing emergency management structures	Arrival	All FECCs/SECCs in place	End of emergency response works	Hours
Rescue service	Establishing emergency management structures	Arrival	All FECCs/SECCs in place	End of emergency response works	Hours
Health service	Establishing emergency management structures	Arrival	All FECCs/SECCs in place	End of emergency response works	Hours
Relevant authority/non-governmental organizations (NGO)	Establishing emergency management structures	Arrival	All FECCs/SECCs in place	End of emergency response works	Hours
Site incident officers	E.g. railway operator and roads department representatives; Consulting to emergency services	Arrival	-	End of emergency response works	Hours/days

4.4.3 Risk management and damage mitigation

Risk management is a key response activity which is in the MTA scenario mainly related to the hazard area. The deployed emergency services have to identify risks, assess risks, and plan risk mitigation measures. Tables 4.2 and 4.3 describe main activities of fire-fighting and rescue emergency services.

Table 4.2: Fire-fighting

Involved actors	Actions	Start point	Intermediate point	End point	Duration
Fire service	Transport of emergency teams (ET) and fire-fighting equipment to the incident/hazard area	First alerting	Arrival	Arrival	Minutes
Fire service	Risk identification/assessment; Set-up of exclusion zone (i.e. inner cordon); Immediate life-saving measures; Handing over of casualties to health service at CCPs; Fire-fighting, securing the hazard area; Reporting to CFECC	Arrival	All fires out, hazard area secured	End of emergency response works	Hours
Site incident officers	Support to fire-fighting (e.g. grounding of overhead line)	Arrival	Reporting to fire-fighting	End of emergency response works	Hours

Table 4.3: Rescue

Involved actors	Actions	Start point	Intermediate point	End point	Duration
Rescue service	Transport of emergency teams (ET) and rescue equipment to the incident/hazard area	First alerting	Arrival	Arrival	Minutes
Rescue service	Risk identification/assessment; Localization of casualties in hazard area; Rescue/evacuation of casualties out of hazard area (e.g. medical evacuation with stretchers, vehicle extrication) Immediate life-saving measures; Handing over of casualties to health service at CCPs; Reporting to CFECC	Arrival	All casualties localized	End of rescue works (all casualties rescued/evacuated from hazard area)	Hours
Site incident officers	Support to rescue (e.g. consulting, grounding of overhead line)	Arrival	Reporting to rescue	End of emergency response works	Hours

Damage mitigation is not only restricted to physical damages in the hazard area. It includes security aspects and provisions supply.

Table 4.4: Maintenance of public order

Involved actors	Actions	Start point	Intermediate point	End point	Duration
Police	Public order; Documentation; Investigation;	Arrival	-	End of investigations	Hours/days

Table 4.5: Provisions

Involved actors	Actions	Start point	Intermediate point	End point	Duration
LEMA	Shelter provision; Support to organization of evacuation; General support to deployed emergency services	Assessment	All non-injured casualties at temporary shelter	All non-injured casualties outside incident area	Hours

4.4.4 Casualty logistics

The activities related to casualty management are depicted in figure 4.3. Injured casualties are either transported directly to hospitals ("immediate medical evacuation - medevac") or taken to the temporary care centre (TCC). Depending on their health status and depending on available resources these casualties are either handed over to a temporary shelter or transported to hospitals.

Non-injured casualties are directly guided to a temporary shelter and then evacuated to shelters outside the incident area.

For the scope of the present document, logistics related to deceased casualties are not considered.

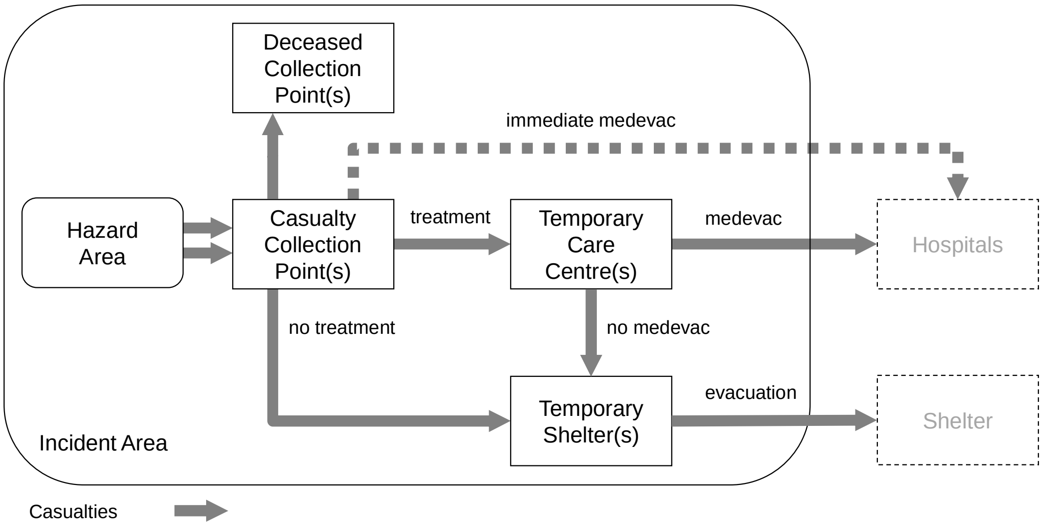

Figure 4.3: Casualty flow chart

Tables 4.6 and 4.7 describe the actors and actions related to casualty logistics both for injured and non-injured casualties.

Table 4.6: Treatment and medical evacuation

Involved actors	Actions	Start point	Intermediate point	End point	Duration
Health service, NGO	Transport of emergency teams (ET) and medical equipment to the incident area	First alerting	Arrival	Arrival	Minutes
Health service CCP	Immediate life-saving measures; Take-over of casualties at CCP(s); Search for individuals outside hazard area; Assessment of all casualties (triage) and registration; Initial treatment and stabilization, preparation for medical evacuation; Documentation of findings and reporting	Discovery of casualties	All casualties assessed and registered	No casualties at CCPs any more	Hours
Health service TCC	Assessment of casualties (triage) and registration; Initial treatment and stabilization, preparation for medical evacuation	TCC available	Most urgent casualties on their way to hospitals	No casualties at TCC any more	Hours
Health service medevac	Medical evacuation of casualties according to priority. Note: destination hospital has to be chosen according to treatment capacity and type of injury.	Overview of all casualties' priorities available	Most urgent casualties on their way to hospitals	No casualties at TCC any more	Hours

Table 4.7: Temporary shelter and evacuation

Involved actors	Actions	Start point	Intermediate point	End point	Duration
Relevant authority/NGO	Transport of emergency teams (ET), transport vehicles, and shelter equipment to the incident area	First alerting	Arrival	Arrival	Minutes
Relevant authority/NGO temporary shelter	Provision of temporary shelter, psycho-social care	Arrival	Temporary shelter available	No non-injured casualties at temporary shelter any more	Hours
Relevant authority/NGO evacuation	Evacuation of casualties	Arrival	No casualties at temporary shelter any more	All non-injured casualties at shelter or on their way home	Hours

5 Information exchanges

5.1 General

The response organizations involved in the MTA will include those who are active in the incident area and others who remain outside of this area (i.e. in the off-site/support area).

Information exchanges arising from the scenario between organizations solely within off-site areas are out of scope as they are assumed to be satisfied with existing infrastructure, whilst those in the incident area may need additional emergency communications infrastructure.

Hence this clause firstly defines the information exchanges involving the actors (response entities) defined in clauses 4.3 and 4.4 within and to/from the incident area.

The overall requirements are compatible with ETSI TS 102 181 [i.1], but this clause defines their specific application to this scenario.

This clause then describes the characteristics of the information exchanges, based on the actors and actions. Information exchanges include both physical communications and telecoms services.

Figure 5.1 depicts the organizational hierarchy and its associated lines of communication in a scenario of this type. In addition, there is a need for communication between these structures and off-site organizations which is shown as "horizontal" exchanges.

The off-site area comprises:

- Public safety answering points (PSAPs) / emergency control centres (ECCs) for individual (or integrated) emergency services A, B, C (e.g. fire-fighting and rescue, health service, police) plus assisting PSAPs/ECCs for support in case of major incidents.
- LEMA represents the local government level and carries out general management and coordination of all response activities.
- (Inter-)national resources incl. NGOs provide support to the deployed emergency services.

Within the incident area involved emergency services are organized in a hierarchical management structure:

- The CFECC is staffed with a coordinating incident commander or a coordinating task force.
- In most cases for each emergency service 1, 2, 3 there is a dedicated ECC (FECC).
- Dedicated tasks/responsibilities of emergency services can be managed from SECCs which report to the upper layer FECC.
- Deployed emergency teams (ETs) may be grouped as divisions.

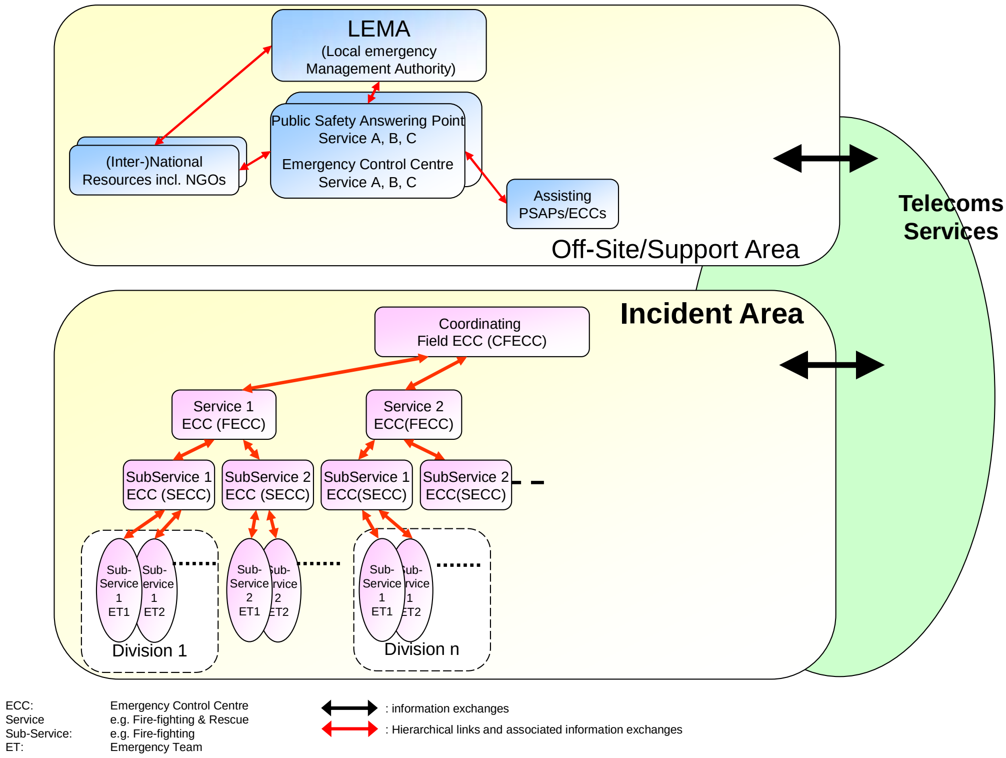

Figure 5.1: Responder organizational hierarchy and related information flows

NOTE: Information exchanges solely within off-site areas and arising from the scenario are out of scope as they are assumed to be satisfied with existing infrastructure.

5.2 Communication needs between emergency management hierarchies

The hierarchical structure of emergency services requires information exchanges between the management levels as task descriptions from higher to lower levels and status reports in the opposite direction. All involved decision makers on all hierarchy levels continuously iterate management and decision cycles, which are depicted in figure 5.2. The main elements of a management cycle are:

- Obtain task from higher level.
- Observe and/or investigate situation, obtain report from lower level.
- Evaluate situation/resources, plan and decide.
- Act and/or instruct lower level.
- Check and adjust if necessary.
- Report status to higher level.

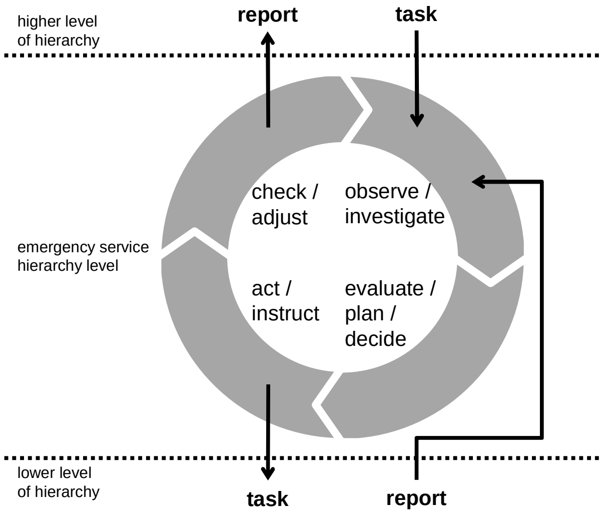

Figure 5.2: Generic management cycle for area of responsibility

A key prerequisite for appropriate decision making is timely acquisition of relevant reports and distributed information via different communication channels and assembling a common operating picture (COP), which again has to be processed, distributed, and appropriately presented to involved decision makers and stakeholders.

The management cycle frequencies and associated information exchanges in terms of task descriptions and status reports depend on:

- Risks to different assets: threat to human life or physical condition vs. threat to animals vs. threat to environment and properties.
- The level of hierarchy and the sort of task. The closer emergency teams are deployed to the incident/hazard area, the faster the current situation has to be re-assessed.

Conversely, requirements on performance and reliability of information exchange means are partly driven by the frequency of the decision cycle.

5.3 Communication needs by action

5.3.1 Emergency management

Generic (qualitative) emergency management communication needs of the involved emergency services are listed in the following tables. Quantitative parameters will be described in clause 5.4.

Table 5.1: Emergency management within incident area

Source to destination(s)	Type of information	Main communications service	Main requirements
Emergency teams to SECC	Status reports, availability, constraints, demand notification, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC to emergency teams	Tasks, allocated resources	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECCs to SECCs	Task coordination, availability, constraints, demand, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECCs to SECCs	Common operating picture	Data	High Data integrity, medium data timeliness (minutes), medium to low throughput
SECC to FECC/CFECC	Status report, demand, availability, constraints, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC to FECC/CFECC	Common operating picture	Data	High Data integrity, medium data timeliness (minutes), medium to low throughput
FECC/CFECC to SECC	Tasks, decisions, deployment area, resources to be used, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
FECC/CFECC to SECC	Common operating picture	Data	High data integrity, good data timeliness, medium to low throughput

Table 5.2: Emergency management between incident area and off-site area

Source to destination(s)	Type of information	Main communications service	Main requirements
ECC to emergency teams (before CFECC/FECC/SECC have been established)	Dispatching	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
ECC to emergency teams (before CFECC/FECC/SECC have been established)	Dispatching (computer aided dispatch)	Data	High data integrity, good data timeliness (i.e. seconds), low throughput
Emergency teams to ECC (before CFECC/FECC/SECC have been established)	Status report, request for resources	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency teams to ECC (before CFECC/FECC/SECC have been established)	Common operating picture	Data	Data integrity, data timeliness (seconds), low throughput
ECC to CFECC/FECCs	Tasks, allocated/available resources, constraints	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
ECC to CFECC/FECCs	Common operating picture; Background information (e.g. construction plans, maps/geographical information system (GIS), manuals, guidelines, information on relevant infrastructure etc.)	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput
CFECC/FECCs to ECC	Status reports, availability, constraints, demand notification, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
CFECC/FECCs to ECC	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput

5.3.2 Risk management and damage mitigation

5.3.2.1 Fire-fighting

Figure 5.3 depicts the information exchanges for the fire-fighting tasks in the described MTA.

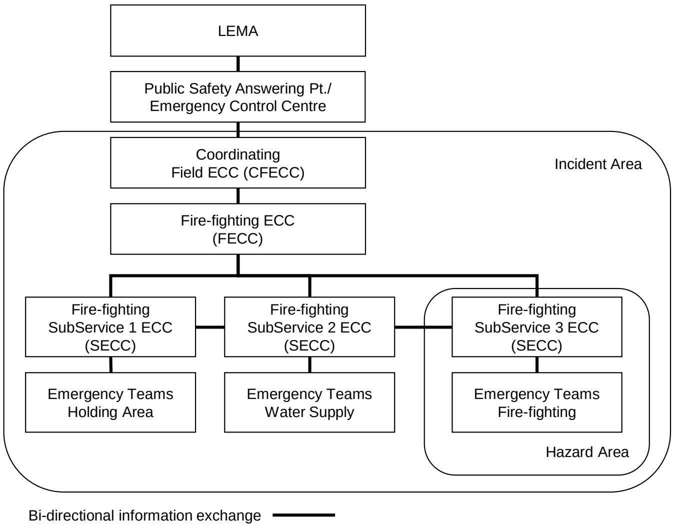

Figure 5.3: Fire-fighting information exchanges

The main information exchanges are as follows:

- Deployed teams issue continuously updated status reports and demand notification towards the higher management levels.
- In the opposite direction, higher management levels inform lower levels about tasks, risks, and available resources.
- SECCs exchange information about task coordination, availability, constraints, demand, and potential risks.

The holding area serves as buffer for arriving fire-fighting and water supply resources.

Table 5.3 describes information exchanges for fire-fighting activities in more details. A differentiation between the three SECCs introduced in figure 5.3 is not necessary since both information types and main communications services will be nearly the same.

Table 5.3: Information exchanges fire-fighting

Source to destination(s)	Type of information	Main communications service	Main requirements
SECC to emergency team officers	Tasks, decisions, deployment area, resources to be used, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC to emergency team officers	Common operating picture	Data	High data integrity, data timeliness (i.e. seconds), medium to low throughput
SECC to SECC	Task coordination, resource coordination	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC to SECC	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput
Emergency team officers to SECC	Status report, availability, constraints, demand, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency team officers to SECC	Common operating picture	Data	High data integrity, data timeliness (i.e. seconds), medium to low throughput
Emergency teams to emergency team officers	Status report, demand, availability, constraints, monitoring of personal protective equipment (PPE) parameters	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency teams to emergency team officers	Monitoring of PPE parameters	Data	High data integrity, good data timeliness (i.e. seconds), low throughput
Emergency team officer to emergency team	Tasks, decisions, deployment area, resources to be used, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay

5.3.2.2 Rescue

Figure 5.4 depicts the information exchanges for the rescue tasks in the described MTA.

The main information exchanges are as follows:

- Deployed teams issue continuously updated status reports and demand notification towards the higher management levels.
- In the opposite direction, higher management levels inform lower levels about tasks, risks, and available resources.
- SECCs exchange information about task coordination, availability, constraints, demand, and potential risks.

The holding area serves as buffer for arriving rescue resources.

Again, a differentiation between the two SECCs is not necessary since both types of information and main communications services will be nearly the same.

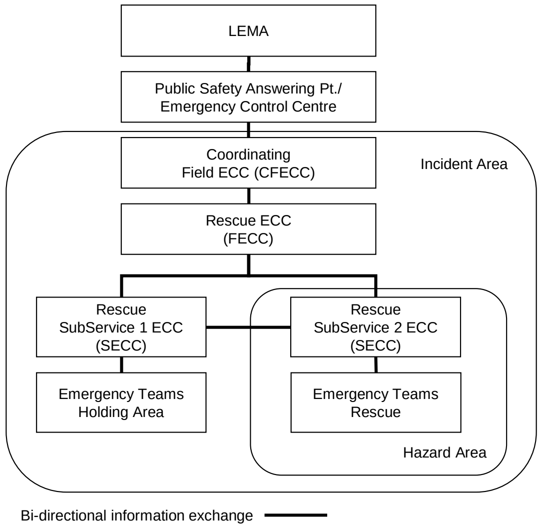

Figure 5.4: Rescue information exchanges

Table 5.4: Information exchanges rescue

Source to destination(s)	Type of information	Main communications service	Main requirements
SECC to emergency team officers	Tasks, decisions, deployment area, tasks, resources to be used, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC to emergency team officers	Common operating picture	Data	High data integrity, data timeliness (i.e. seconds), medium to low throughput
SECC to SECC	Task coordination, resource coordination	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC to SECC	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput
Emergency team officers to SECC	Status report, availability, constraints, demand, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency team officers to SECC	Common operating picture	Data	High data integrity, data timeliness (i.e. seconds), medium to low throughput
Emergency teams to emergency team officers	Status report, demand, availability, constraints, monitoring of PPE parameters	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency teams to emergency team officers	Monitoring of PPE parameters	Data	High data integrity, good data timeliness (i.e. seconds), low throughput
Emergency team officer to emergency team	Decisions, deployment area, tasks, resources to be used, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay

5.3.2.3 Maintenance of public order

The envisaged MTA scenario does not involve dedicated on-site police control centres (FECC/SECC). There are direct information exchanges between police teams and the off-site ECC.

Table 5.5: Information exchanges maintenance of public order

Source to destination(s)	Type of information	Main communications service	Main requirements
ECC to police teams	Dispatching	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
ECC to police teams	Dispatching (computer aided dispatch)	Data	High data integrity, good data timeliness (i.e. seconds), low throughput
Police teams to ECC	Status reports, requests	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Police teams to ECC	Status reports (e.g. location data/pictures, etc.)	Data	High data integrity, good data timeliness (i.e. seconds), low throughput

5.3.2.4 Provisions

Information exchanges between LEMA and shelters outside the incident area are out of scope of the present document. The LEMA provides general support to the deployed emergency services both directly via the CFECC and indirectly via the ECC.

5.3.3 Casualty logistics

5.3.3.1 Overview

Information exchanges related to treatment and medical evacuation of casualties (see figure 4.3) are depicted in figure 5.5. The holding area serves as buffer for arriving transport and medical evacuation vehicles and emergency teams.

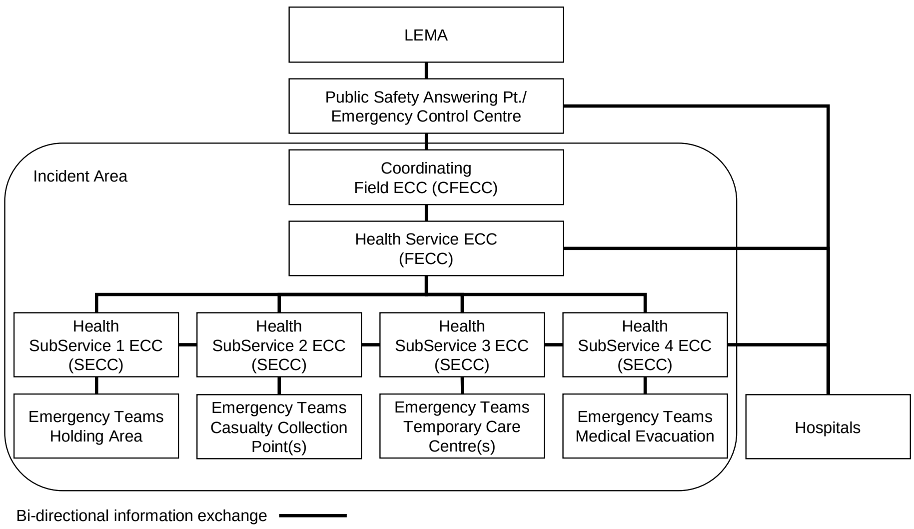

Figure 5.5: Health service information exchanges

5.3.3.2 Treatment and medical evacuation

The main objective of MCI logistics in the incident area and of medical evacuation logistics is keeping track of all casualties. Rough knowledge of all casualties' current locations is desirable, but detailed movement patterns are not required. An overview of remaining casualties in vicinity of the CCP(s), patients entering/leaving each TCC, and patients on their way to or arriving at receiving hospitals is the basis for all emergency management decisions.

Figure 5.6 depicts the (idealized) MCI process chain from the casualty data perspective. Casualty data is not static which means that all relevant status changes have to be communicated to all SubService ECCs. E.g. if one casualty's triage category changes after the initial assessment, then all decisions regarding treatment and medical evacuation priority of all other casualties will have to be re-evaluated. Likewise, there might be an updated diagnosis affecting medical evacuation priority and the choice of the receiving hospital.

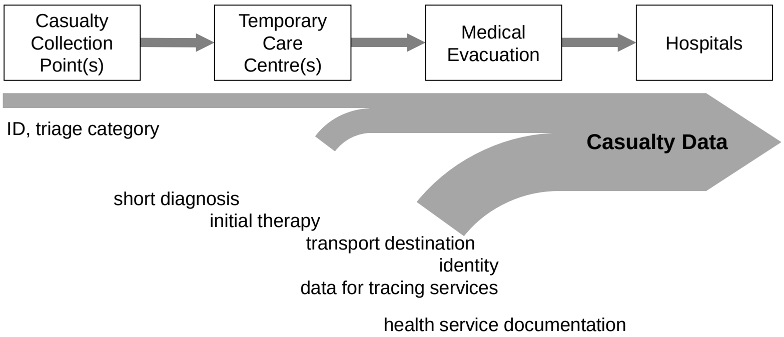

Figure 5.6: Casualty data along medical evacuation

Current approaches for MCI management are mainly based on paper tags which are attached to all casualties during the registration process. These tags have a unique ID and are marked with the casualty priority and a short diagnosis as result of a brief medical examination which is typically a standardized triage algorithm checking main vital parameters. Additionally, supplementary information like date, time, or position information can be filled in, too. Triage teams maintain paper lists in which they document their findings. After finishing the triage and registration tasks these lists are forwarded to the appropriate SECC. Likewise, casualty logistics at the TCC and in the medical evacuation division is organized with similar paper lists supported by voice-based radio systems.

A major improvement of this approach is to gather and exchange all data related to casualty logistics electronically. This requires synchronization of data between all involved teams and management levels, both on-site and off-site.

Table 5.6: Information exchange for casualty logistics and treatment data

Source to destination(s)	Type of information	Main communications service	Main requirements
Emergency teams CCP, TCC, medevac, holding area; SECCs CCP, TCC, medevac, holding area; FECC health service; CFECC; ECC; hospitals; police/LEMA	Casualty logistic data	Data	Automatic data synchronization, data integrity, data timeliness (minutes), low throughput, capable of handling network interruptions
TCC (or other suitable location) to/from hospital or telemedicine centre	Telemedicine application data	Data	Short setup time, constant high quality and integrity, high throughput

Similar to the fire-fighting and rescue information exchanges, the information exchanges for health service management have two main directions:

- Deployed teams issue continuously updated status reports and demand notification towards the higher incident management level.
- In the opposite direction, higher management levels inform lower levels about tasks, risks, and available resources.

For clarity reasons the information exchanges for the MCI management are shown in two separate tables 5.7 and 5.8.

Table 5.7: Information exchange between deployed emergency teams and assigned SECCs

from / to	CCP emergency teams	SECC CCP	TCC emergency teams	SECC TCC	Medevac emergency teams/ holding area	SECC medevac
CCP emergency teams	Task coordination, availability, constraints, demand, risks	Tasks, decisions, deployment area available resources, risks	-	-	-	-
SECC CCP	Status report, demand, availability, number of casualties, triage categories, short diagnosis, date/time, casualty IDs	-	-	Status report, casualty IDs within/ entering/ leaving TCC	-	-
TCC emergency teams	-	-	Task coordination, availability, constraints, demand, risks	Tasks, decisions, deployment area, available resources, risks	-	-
SECC TCC	-	Status report, number of casualties, triage categories, short diagnosis, date/time, casualty IDs	Status report, triage categories, short diagnosis, date/time, casualty IDs within/ entering/ leaving TCC	-	-	Status report, availability, constraints, risks
Medevac emergency teams/ holding area	-	-	-	-	Task coordination, availability, constraints, demand, risks	Triage categories, short diagnosis, date/time, casualty IDs, receiving hospital
SECC medevac	-	Status report, number of casualties, triage categories, short diagnosis, date/time, casualty IDs	-	Status report, demand, triage categories, short diagnosis, date/time, casualty IDs within/ entering/ leaving TCC, receiving hospital	Status report, availability, constraints, risks	-

NOTE 1: Key task of all SECCs is to keep track of all casualties along the medevac process chain.
NOTE 2: Unique casualty IDs are required for casualty tracing. The team/role issuing a report with casualty IDs to other entities implicitly reports the positions of these casualties (e.g. entering the TCC, arriving at the receiving hospital etc.)
NOTE 3: The first arriving team and depending on the size of the incident the subsequent teams are supposed to start with triage and registration of all casualties. In most cases these teams are paramedics and emergency physicians working in the regular health service.
NOTE 4: A short diagnosis can be e.g. traumatic brain injury or burn. This information is required to determine a suitable receiving hospital. Several triage algorithms specify additional data fields (e.g. child/adult and gender).
NOTE 5: The SECCs/FECC assign tasks to deployed emergency teams according to availability and demand. For example, after concluding triage and registration, these teams will preferably take care of prioritized casualties (including immediate medical evacuation).
NOTE 6: Depending on the actual legal situation there can be different roles in charge of assigning patients to transport vehicles to receiving hospitals. Examples are a medical incident commander (MIC) or a chief emergency physician working at the CCP/TCC, or a transport coordinator working in the medical evacuation SECC.
NOTE 7: Medical evacuation decisions require a comprehensive situation overview including the overall number of casualties, triage categories, short diagnosis, available transport means, transport times to receiving hospitals, hospital specialities, and hospital treatment capacities.
NOTE 8: There are considerations to support staff working at the TCC with remote medical specialists by means of telemedicine applications. This requires dedicated communication links between the TCC (or vehicles with suitable equipment) and hospitals or telemedicine centres.

Table 5.8: Information exchanges between SECCs, FECCs, and off-site/support area

from / to	SECC CCP	SECC TCC	SECC medevac	FECC	CFECC	ECC	Hospitals
SECC CCP	-	-	-	Tasks, decisions, deployment area, available resources, risks	-	-	-
SECC TCC	Status report, number of casualties, triage categories, short diagnosis, date/time, casualty IDs	-	Availability, constraints	Tasks, decisions, deployment area, available resources, risks	-	Hospital treatment capacities	Hospital treatment capacities
SECC medevac	-	Casualty IDs, short diagnosis, receiving hospital	-	Tasks, decisions, deployment area, available resources, risks	-	Task (re-)assignment	-
FECC	Status report, demand, availability, number of casualties, triage categories, short diagnosis, date/time, casualty IDs	Status report, demand, availability, number of casualties, triage categories, short diagnosis, date/time, casualty IDs, receiving hospital	Availability, constraints	Task coordination	Tasks, decisions, deployment area, available resources, risks	Available resources, constraints, risks	Hospital treatment capacities
CFECC	-	-	-	Status report, demand, availability, constraints, risks	-	Available resources, constraints, risks	-
ECC	-	-	Casualty IDs, short diagnosis, receiving hospital	Status report, demand, availability, constraints, risks	Status report, demand, availability, constraints, risks	-	Hospital treatment capacities
Hospitals	-	(optional: direct notification)	(optional: pre-notification)	-	-	Pre-notification, demand, casualty IDs, short diagnosis	-

5.3.3.3 Temporary shelter and evacuation

Information exchanges related to evacuation coordination are listed in table 5.9.

Table 5.9: Information exchanges temporary shelter and evacuation

Source to destination(s)	Type of information	Main communications service	Main requirements
SECC relevant authority/NGO temporary shelter to emergency teams	Tasks, decisions, deployment area, resources to be used	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC relevant authority/NGO temporary shelter to emergency teams	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput
Emergency teams temporary shelter to SECC	Status report, availability, constraints, demand, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency teams temporary shelter to SECC	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput
SECC relevant authority/NGO evacuation to emergency teams	Tasks, decisions (e.g. transport plans), deployment area, tasks, resources to be used	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
SECC relevant authority/NGO evacuation to emergency teams	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput
Emergency teams evacuation to SECC	Status report, availability, constraints, demand, risks	Voice (group call)	Good speech intelligibility/quality, short call setup time, little end-to-end delay
Emergency teams evacuation to SECC	Common operating picture	Data	High data integrity, data timeliness (i.e. minutes), medium to low throughput

5.4 Characteristics of emergency communication services

5.4.1 General

This clause describes main characteristics of emergency communications services. As described above a major share of the information exchanges requires real-time communication. A detailed discussion of related quality of service and quality of experience requirements is available in ETSI TR 102 643 [i.12].

5.4.2 Speech services

5.4.2.1 Main requirements

Speech services are currently the most instinctive and most used communication services in emergencies, and this is likely to remain the case for years to come. For speech services several universal requirements exist, characterized by:

Speech intelligibility and quality: that received speech is capable of being understood reliably and some cases high speech quality is desirable.

Call setup-time: short call set-up times enable rapid communication of relevant information.

End to end delay: regardless of the type of application, Recommendation ITU-T G.114 [i.4] is not to exceed 400 ms.

Examples of speech services are point-to-point calls, push-to-talk services, and group calls.

5.4.2.2 PMR group call channels

The number of required voice channels depends on the number of involved emergency service disciplines and the management structure:

- 1 group call channel jointly used by ECC, CFECC, and all FECCs;
- 1 group call channel jointly used by each emergency service's FECC and all assigned SECCs;
- 1 group call channel jointly used by each SECC and all assigned emergency team officers;
- optional: 1 group call channel used by each emergency team.

EXAMPLE: 7 involved emergency service incident commanders manage 3 divisions each, and 3 teams per division. The total (maximal) number of required voice channels for group calls sums up to 1+7+7×3+7×3×3=92.

5.4.3 Paging (short message) services

Paging services are used by a variety of authorities in order to contact their personnel, and paging services are available from a variety of networks and technologies. The network needs to be able to identify the requested authorized emergency agent(s), and then deploy the appropriate technology to contact them. This requirement may encompass different communication network technologies, services and applications such as paging, presence, texting, etc.

5.4.4 Status monitoring and location services

Status monitoring includes a wide variety of parameters, e.g. breathing air tank levels, accountability monitoring, distress buttons and vital signs monitoring. Location services provide real-time information regarding the position of personnel or vehicles to an emergency team leader. This information may also include status information regarding the person or vehicle. Location reporting services may be one-way with no acknowledgement, necessitating a robust communication mechanism. Position information may be considered sensitive in some emergencies and may require security mechanisms to protect the data.

5.4.5 Data services

Data services are used to provide a large number of applications which can have widely differing requirements in terms of capacity, timeliness and robustness of the data service. Ideally, the communication networks should support the required data throughput and minimize end to end delay, especially for applications such as real time video. Noting the extreme circumstances which may be in force during an emergency, it may be desirable for networks to degrade gracefully when user requirements exceed the agreed levels of service.

There are a variety of data applications such as e-mail, imaging, geographical information system (GIS), location services, video, data base access, and personnel monitoring. The data applications can be characterized by:

Throughput: data volume in a given time.

Timeliness: importance of the information arriving within an agreed timeframe.

Preservation of data integrity: how (reliable) free from bit errors the information transmission needs to be.

Data service requirements are driven by the applications used by emergency service disciplines. Typical use cases for the envisaged MTA response are:

- Point-to-point data transfer (e.g. ECC sends background information to CFECC).
- Multi-point-to-point data transfer (e.g. PPE data from team members is sent to team officer, aggregation of registration and triage data).
- (Multi-)point-to-multi-point data transfer (e.g. synchronization of common operating picture or casualties data between ECC/CFECC/FECC/SECCs).
- Unidirectional point-to-point streaming (e.g. data generated by sensors).
- Bidirectional point-to-point streaming (e.g. video conferences, real-time telemedicine applications).
- Multi-point-to-multi-point streaming (e.g. audio/video conference calls).

6 Topology model

6.1 General

Topology modelling is generally used to represent a network's layout and dynamics mathematically in terms of the topology of the network nodes, represented here by the scenario actors. Algorithms may be chosen to depict properties such as the location and motion of the nodes, and whether nodes switch on/off during the lifetime of the network.

This clause defines a set of model parameters which may be used as a basis for topology simulation of emergency teams or "actors" in the defined scenario.

The topology model parameters define primarily how actors are deployed and move in the Incident Area. This specification is based on topology modelling concepts in [i.8] and [i.9]. The mobility models described in [i.10] and [i.11] serve as a reference for the movements of the actors.

NOTE 1: Casualties are part of the model, even though they are not "actors". They indicate the geographical location where the response teams are acting. For the modelling, they are classified according to the following types:

1= requiring treatment and medevac

2= requiring minor treatment and evacuation

3= requiring no treatment but evacuation

4= deceased

NOTE 2: Because this scenario involves numerous response actions, actors (see clause 4.3) are modelled as teams rather than individuals.

6.2 Model graphics

Figure 4.1 in clause 4.2 shows the physical layout of the incident area.

Figure 6.1 shows a snapshot of the incident area at the highest point of activity, complying with the requirements defined in clause 6.3 regarding the positions in the incident area and the mobility of the actors.

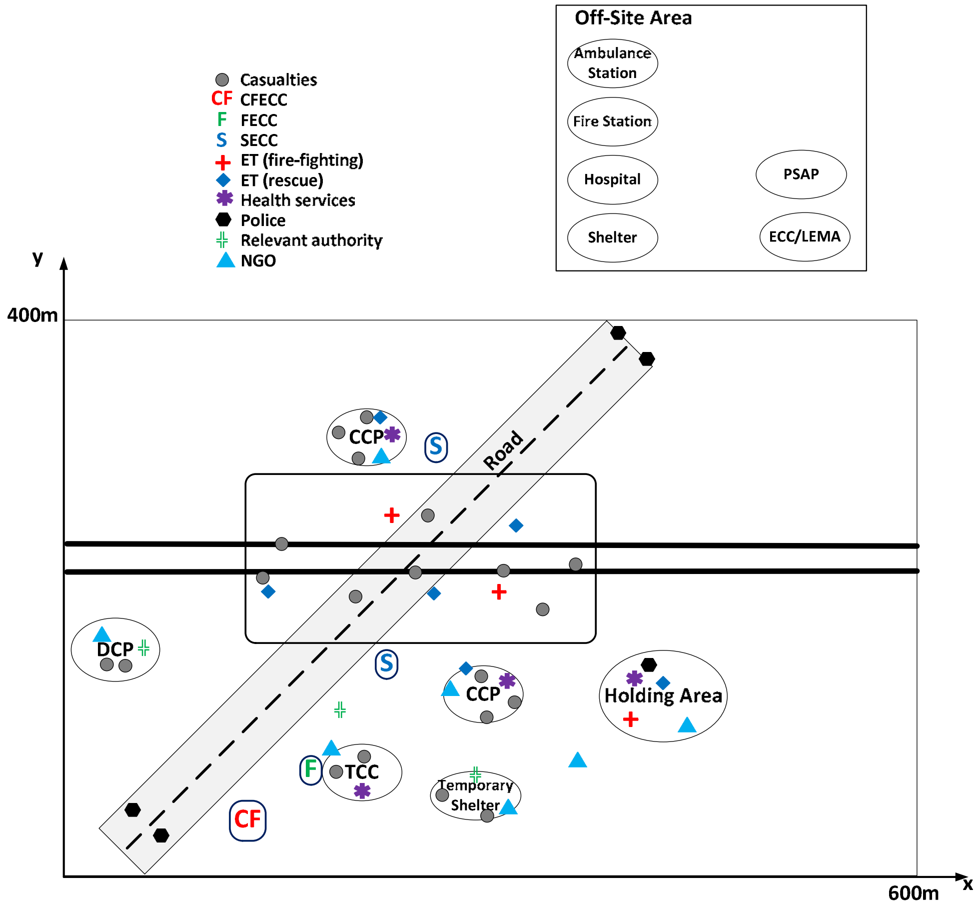

Figure 6.1: Snapshot of the MTA (mid-term)

6.3 Model specification

6.3.1 Scenario quantities

This clause specifies the topology of the actors and physical locations involved, together with their properties and parameters.

An implementation of the reference topology of this type of event shall conform to the following model, made of a set of tables and illustrations. It is specified here in a top down approach, focussing first on the scenario quantities, which are expressed as mean values and define the size of the event. Table 6.1 specifies the scenario quantities and the modelling geometry associated with the event. Clause 6.3.2 defines the on-site and off-site locations with both time-variant and time-invariant parameters. Finally, clause 6.3.3 defines requirements on position and mobility of on-site actors.

Table 6.1: Scenario quantities

Parameter	Value
Size of incident area	400 m x 600 m
Modelling geometry (distances etc.)	(see figure 4.1)
Total number of casualties	170
Casualties in need of treatment and medical evacuation	45
Casualties in need of on-site treatment and (nonmedical) evacuation	20
Casualties in need of (nonmedical) evacuation	100
Casualties deceased	5
Number of fire-fighting teams (including NGOs)	5
Number of rescue teams (including NGOs)	10
Number of health services teams (including NGOs)	25
Number of medical evacuation transport vehicles	20
Number of NGO teams	5
Number of NGO evacuation transport vehicles	4
Number of police teams	1
Number of CFECC	1
Number of FECCs (fire service, rescue service, health service)	3
Number of SECCs (3 fire service, 2 rescue service, 4 health service)	9

6.3.2 Locations

6.3.2.1 On-site

Table 6.2: On-site locations

Location	Requirements on position	Time-variant parameters	Time-invariant parameters
Hazard area	Inside incident area. For simplicity, a stationary hazard area is considered only.	n/a	Centre coordinates, size
Casualty Collection Point(s) (CCP)	Outside hazard area, inside incident area.	Number, centre coordinates.	Size
Temporary Care Centre(s) (TCC)	Outside hazard area, inside incident area. May be merged with CCP. Location typically between CCP and exit road.	Number, capacity	Centre coordinates, size
Temporary Shelter(s)	Outside hazard area, inside incident area.	Number, capacity	Centre coordinates, size
Holding area(s)	Outside hazard area, inside incident area.	Number, capacity	Centre coordinates
Fire	Inside hazard area	Number	Centre coordinates, size

6.3.2.2 Off-site

Table 6.3: Off-site locations

Location	Notes	Time-variant parameters	Time-invariant parameters
Ambulance station(s)	Nearest station: 25 km distance	Journey time to incident area (CCP, TCC, holding area)	Capacity (number of teams / ambulances available)
Fire station(s)	Nearest station: 15 km distance	Journey time to incident area (hazard area, holding area(s))	Capacity (number of teams / fire engines available)
Hospital(s)	Nearest hospital: 25 km distance	Journey time from/to incident area (CCP, TCC, holding area), capacity	Number
Shelter(s)	Nearest shelter: 15 km distance	Journey time from/to incident area (interim shelter, holding area), capacity	Number
LEMA/ECC	For communication only	n/a	n/a

6.3.3 On-site actors

On-site actors and their properties are listed in table 6.4. The notation for the topology properties are as follows:

/P: Position

/M: Mobility

/B: Start condition

/MT: Mid-term step

/E: Stop condition

Table 6.4: On-site actors

Actor	Requirements on position and mobility	Requirements on behaviour and presence on site (start / mid-term, stop)	Other parameters - Additional description- Number (size of the group)
Casualties	/P: In hazard area initially. /M: Mobility from hazard area only with an ET. Then mobility out of incident area only with a (medical) evacuation team.	/B: In hazard area /MT: Arrival of first rescue team /E: When transported to hospital or shelter	**Do not take part in the response actions** - Number - Rescue time
Site management (CFECC)	/P: In incident area /M: Static	/B: 1st alert to PSAP /MT: Set-up completed /E: End of accident handling	Size of the group
Service Management (FECC)	/P: In incident area (CCP and TCC) /M: Static	/B: Arrival on site /MT: Set-up completed /E: Supported action completed	Number of teams
SubService Management (SECC)	/P: In incident area (close to hazard area) /M: Static	/B: Arrival on site /MT: Set-up completed /E: Supported action completed	Number of teams
ET fire-fighting	/P: In hazard area /M: Moving in vicinity of fires	/B: Arrival on site /I: Reporting from fire-fighting actions /E: All fires out	Number of teams, size of the group (may be transferred to other tasks after completing fire actions)
ET rescue	/P: In hazard area /M: Moving in a grid pattern in hazard area /M: Moving between hazard area and CCP	/B: Arrival on site /MT: Reporting from rescue actions /E: All individuals rescued from hazard area	Number of teams, size of the group (may be transferred to other tasks after completing fire actions)
ET triage at CCP (division of health services)	/P: In incident area: CCP /M: Static	/B: Arrival on site /MT: Reception of 1st casualty from ET rescue /E: All casualties assessed and registered	Number of groups / teams, Size of groups
ET treatment at TCC (division of health services)	/P: In incident area /M: Between CCP and TCC	/B: Arrival on site /MT: Reception of 1st casualty from CCP /E: All casualties treated and evacuated	Number of groups / teams, Size of groups
ET medical evacuation (division of health services)	/P: Inside and outside incident area /M: Between TCC and hospital	/B: Arrival on site /MT: 1st casualty transport to hospital /E: Medevac completed	Number of medevac vehicles Transport capacity per vehicle Type of vehicle (land-based vs. air-borne)
Temporary shelter personnel (relevant authority/NGO)	/P: In incident area /M: Between CCP and temporary shelter	/B: Arrival on site /MT: 1st casualty arrives at temporary shelter /E: All casualties evacuated	Number of groups / teams, Size of groups

Actor	Requirements on position and mobility	Requirements on behaviour and presence on site (start / mid-term, stop)	Other parameters - Additional description- Number (size of the group)
Evacuation personnel (relevant authority/NGO)	/P: Inside and outside incident area /M: between TCC and off-site shelter	/B: Arrival on site /MT: 1st group of casualties ready to be evacuated /E: All casualties evacuated	Number of transport vehicles Transport capacity per vehicle
Police	/P: In incident area /M: Mobility independent of victims	/B: Arrival on site /E: End of accident handling	
Site incident officers	/P: In incident area, close to hazard area /M: Static	/B: Arrival on site /MT: Assessment completed /E: End of accident handling	Number of groups, size of groups

Annex A contains a more detailed description of each actor, together with the mathematical parameters and pseudo-code required to implement the model.

Annex A (informative): Modelling specification of objects, parameters and behaviour

A.1 Modelling assumptions

In order to model the complex disaster scenarios several assumptions and simplifications have to be made. Especially details that concern the response of the emergency teams are simplified in order to limit the complexity.

Several remarks on the modelling specification:

1) Details on scenario quantities (SQ) and locations can be found in clause 6 "Topology model".

2) The CCPs are assumed to be static even though in reality CCPs might appear/be cleared/move over time.

3) The emergency services are split into divisions consisting of emergency teams that fulfil specific tasks even though in a real life scenario the same teams might be able to fulfil different tasks. The latter can be modelled by transforming an ET that fulfilled its task into another ET.

4) The casualties are of static type, even though in reality casualties' conditions might change over time, the types are:

    a. Type 1: requiring treatment and medevac

    b. Type 2: requiring treatment and evacuation

    c. Type 3: requiring no treatment but evacuation

    d. Type 4: deceased

5) The rescue and treatment of casualties is in random order, not prioritized as it would be in reality to provide quick help to the ones who need it the most urgent.

6) A fire that is not taken care of will not grow bigger as it would in reality.

7) Everything that leaves the incident area can be considered at an off-site location. Distances between off-site and on-site as well as between off-site and off-site locations only reflected in time variables.

8) For all parameters default values and ranges are provided that can also depend on the scenario. For other scenario settings they should be adjusted accordingly.

9) The emergency teams for temporary shelter, provisions and evacuation are staffed by personnel from the relevant authority and NGOs, even though in some countries they will be staffed by health services personnel or military forces.

A.2 Modelling action/time parameters

The topology model describes the movement of the different response actors inside the incident area and off-site.

To model actions that do not imply any movement, waiting timers are used. Table A.1 describes the different actions / timers introduced in the modelling of the scenarios. When such an action occurs, the value is calculated using a Gaussian process (also called normal distribution) with mean and standard deviation values as defined in table A.1. It is re-evaluated when the next iteration of a task starts.

Table A.1: Actions/timers for modelling the scenario

Action/timer	Description	Typical mean value	Typical standard deviation
Toff	Time that is needed to reach one of the off-site locations in the vicinity of the incident area access. For simplification of the model, the same timer is used for both hospitals and off-site shelters	μToff = 20 min	σToff = 5 min
ToffRemote	Time that is needed to reach one of the remote off-site locations from the incident area access. For simplification of the model, the same timer is used for both remote hospitals and remote off-site shelters	μToffRemote = 60 min	σToffRemote = 20 min
Thold	Time that is needed between one of the neighbour off-site locations (fire station, ambulance station, other service station, hospital, shelter) and the holding area	μThold = 20 min	σThold = 5 min
TholdRemote	Time that is needed between one of the remote off-site locations (remote: fire station, ambulance station, hospital, shelter) and the holding area	μTholdRemote = 55 min	σTholdRemote = 20 min
Tresp	Time that is needed after the alerting until the team arrives at the incident area	See table A.2	See table A.2
Tdispatch	Time that is needed to be dispatched from the holding area	μTdispatch = 15 min	σTdispatch = 5 min
Tfire	Time that is needed to extinguish the fire	μTfire = 30 min	σTfire = 15 min
Trescue	Time that is needed to rescue a trapped casualty	μTrescue = 15 min	σTrescue = 5 min
Ttriage	Time that is needed for triage of a casualty as well as immediate first aid	μTtriage = 2 min	σTtriage = 1 min
Ttreat	Time that is needed for health treatment of a casualty at the TCC	μTtreat = 15 min	σTtreat = 5 min
Thandover	Time that is needed for handing over a casualty	μThandover = 1min	σThandover = 0,5 min
Treport	Time that is needed for reporting after a task has finished	μTreport = 1min	σTreport = 0,5 min

The modelling of the response time requires however further refinements according to the related actors, as described in table A.2.

Table A.2: Response times for involved actors

Actor	Typical mean value	Typical standard deviation
Emergency management structures (CFECC, FECC, SECC),	μTresp = 20 min	σTresp = 5 min
Fire-fighting: sum of two Gaussian processes representing the different waves of arrivals, i.e. early stage and local region	μTresp = 20 min	σTresp = 5 min
Rescue: sum of two Gaussian processes representing the different waves of arrivals, i.e. early stage and local region	μTresp = 20 min	σTresp = 5 min
Health service (triage, treatment, medevac): sum of two Gaussian processes representing the different waves of arrivals, i.e. early stage and local region	μTresp = 20 min	σTresp = 5 min
Police	μTresp = 15 min	σTresp = 5 min
Relevant authority/NGO	μTresp = 20 min	σTresp = 5 min

A.3 Pseudo-code describing the model behaviour

A.3.1 Pseudo-code describing the initialization of the simulation including placement of locations

NOTE: Values of timers used in the pseudo-code descriptions are given in clause A.4.

1) Instantiate incident area according to size in scenario quantities (SQ).

2) Instantiate location of the hazard area according to SQ.

3) According to SQ place fire inside the hazard area.

4) According to SQ place casualties inside the hazard/incident area(s). Uniform distribution in train direction and Gaussian distribution orthogonal to train direction with mean at the train centre axis and standard deviation of about 0,5 widths of the hazard area (that means that about 95 % of casualties end up inside the hazard area).

5) Place CCP(s).

6) Place (one or multiple) TCC(s) close to the hazard area(s).

7) Place (one or multiple) temporary shelter(s) close to the hazard area.

8) Place holding area.

9) Place DCP.

A.3.2 Pseudo code describing the mobility and sequential actions of the respective actors

Casualties

1) Casualties are instantiated and positioned in step 4 of initialization, (mainly inside the hazard area).

2) Cooperate with emergency teams (passive role).

CFECC

1) When receiving alert, wait CFECC.responseTime, enter the incident area.

2) Take position in incident area (outside hazard area).

Further behaviour is not modelled. Usually the FECC is a central communication source and sink with SECCs, FECCs and all other emergency teams as well as individual experts (e.g. site incident officers) as partners.

FECC

1) When receiving alert, wait FECC.responseTime, enter the incident area.

2) Take position in incident area (outside hazard area).

Further behaviour is not modelled. Usually the FECC is a central communication source and sink with SECCs, CFECC and possibly individual teams as partners.

SECC

1) When receiving alert, wait SECC.responseTime, enter the incident area.

2) Take position in incident area (outside hazard area).

Further behaviour is not modelled. Usually the SECC is a central communication source and sink with FECC and possibly individual teams as partners.

Fire-fighting

1) When receiving alert, wait Firefighting.responseTime, enter the incident area.

2) If SECC/FECC/CFECC is not in place, go to point 4, else move to holding area.

3) Wait Firefighting.dispatchingTime until dispatched.

4) Enter hazard area (position defined by a random mathematical statistical formula, close to fire).

5) Wait Firefighting.fireTime until fire is extinguished (represents the fire-fighting action).

6) Move to holding area.

7) Wait Firefighting.reportingTime until report finished.

8) Transform into another type of actor (e.g. Rescuing).

Rescuing

1) When receiving alert, wait Rescuing.responseTime, enter the incident area.

2) If SECC/FECC/CFECC is not in place, go to point 4, else move to holding area.

3) Wait Rescuing.dispatchingTime until dispatched.

4) Enter hazard area and move to casualty (random choice).

5) Wait Rescuing.rescuingTime until a casualty is ready to be transported (representing the search and rescue time).

6) Bring casualty to closest CCP.

7) Wait Rescuing.handoverTime + Rescuing.reportingTime until report finished (same time parameter as for Firefighting, defined as a random function).

8) If still casualties in hazard area, go back to point 4, else move to holding area and transform into another type of actor.

Triage

1) When receiving alert, wait Triaging.responseTime, enter the incident area.

2) If SECC/FECC/CFECC is not in place, go to point 4, else move to holding area.

3) Wait Triaging.dispatchingTime until dispatched.

4) Move to selected CCP (i.e. with the smallest number of teams; if multiple ones with smallest number of teams, choose randomly between them).

5) If casualty is available, wait Triaging.triageTime until casualty has passed triage (= waiting time representing the triage and basic treatment, defined as random function).

6) Move casualty according to its type and wait Triaging.handoverTime
if casualty.type=1 or 2, bring casualty to closest TCC
if casualty.type=3, bring casualty to closest TS with TS.numberCasualties<TS.capacity
if casualty.type=4, bring casualty to DCP.

7) Return to CCP.

8) Wait Triaging.reportingTime until report finished, go to 5.

9) When no more casualties available, move to holding area and transform into another type of actor.

Treatment

1) When receiving alert, wait Treatment.responseTime, enter the incident area.

2) If SECC/FECC/CFECC is not in place, go to point 4, else move to holding area.

3) Wait Treatment.dispatchingTime until dispatched.

4) Move to selected TCC (i.e. with the smallest number of teams; if multiple ones with smallest number of teams, choose randomly between them).

5) If casualty is available, wait Treatment.treatmentTime (representing the treatment and documentation).

6) Move casualty according to its type and wait Treatment.handoverTime
if casualty.type=1, request medevac at holding area, wait for pick-up by medevac
if casualty.type=2, bring casualty to closest TS with TS.numberCasualties<TS.capacity, return to TCC

7) Wait Treatment.reportingTime until report finished, go back to point 5.

Medevac

1) When receiving alert, wait Medevac.responseTime, enter the incident area.
2) Move to holding area.
3) Wait until request for medevac from a TCC is available, then go to 4.
4) Move to TCC to pick up a casualty.
5) Wait Medevac.handoverTime.
6) Bring casualty to hospital (off-site).
7) If Hospitals.numberCasualties<Hospitals.capacity
   Wait Medevac.medevacTime until back from hospital
   Else
   Wait Medevac.medevacTimeRemote until back from hospital
   (accounting for the driving time of return trip according to TCC's time to hospital + handover time at hospital).
8) Wait Medevac.reportingTime until report finished, go back to point 2.

TempShelter

1) When receiving alert, wait TempShelter.responseTime, enter the incident area.
2) If SECC/FECC/CFECC is not in place, go to point 4, else move to holding area.
3) Wait TempShelter.dispatchingTime until dispatched.
4) Move to selected TS (i.e. with the smallest number of teams; if multiple ones with smallest number of teams, choose randomly between them).
5) Wait until sufficient number of casualties for transport is reached (TS.numberCasualties > Evacuation.capacity.
6) Request Evacuation at holding area.
7) When Evacuation arrived, wait (TempShelter.handoverTime x number of casualties evacuated) until task is finished.
8) Wait TempShelter.reportingTime until report finished.
9) Go back to point 5.

Evacuation

1) When receiving alert, wait Evacuation.responseTime, enter the incident area.
2) Move to holding area.
3) Wait until request for Evacuation from a TS is available, then go to 4.
4) Move to TS to pick up casualties.
5) Wait Evacuation.handoverTime x number of casualties evacuated.
6) Bring casualties to shelter (off-site).
7) If Shelters.numberCasualties<Shelters.capacity
   Wait Evacuation.evacuationTime until back from shelter
   Else
   Wait Evacuation.evacuationTimeRemote until back from shelter
   (accounting for the driving time of return trip according to TS's time to shelter + handover time at shelter).
8) Wait Evacuation.reportingTime until report finished.

9) Go back to point 2.

NOTE: The evacuation is not necessarily carried out by emergency relief personnel, this is just an assumption. Also it is safe to assume that most if not all of the evacuation teams will consist of teams that originate from "relevant authority/NGO", see below.

Police

1) When receiving alert, wait Police.responseTime, enter the incident area.

2) If SECC/FECC/CFECC is not in place, go to point 4, else move to holding area.

3) Wait Police.dispatchingTime until dispatched.

4) Move around randomly in the incident area (outside of hazard area).

Relevant authority/NGO

As different countries have different structures for disaster relief, it is impossible to model the relevant authorities as well as the NGOs in a correct manner, however it is safe to assume that the teams will support the other emergency teams. The NGOs that support the emergency teams are already included in their respective values in the SQ. The rest of the NGO teams is assumed to take care of the temporary shelters and evacuations. It is advised to model the relevant authority/NGO teams by splitting them up and treat them as emergency teams or to let them move in the incident area in an arbitrary way to account for unspecified support they provide.

A.3.3 Pseudo code describing the end of the incident and "ramp down"

For every actor an "end of mission" has been defined in clause 6.

After the end of mission of an actor has been reached (e.g. no fires in hazard area for fire-fighting) the teams can go on and help other teams (e.g. fire-fighting becomes rescuing and helps the other teams, etc.).

Details of this behaviour are left open as a degree of freedom for the implementation.

Generally, the scenario simulation can be considered finished when all casualties have been transported off-site as the main focus is on the immediate disaster relief. Optionally the "end of mission" for every single actor can be considered and thus the simulation end can be prolonged.

A.4 Objects and their parameters

Table A.3: Locations on-site

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
HazardArea	**Hazard Area**	**Number defined by SQ**
x_Pos	Centre position in X direction	Incident area, defined by SQ
y_Pos	Centre position in Y direction	Incident area, defined by SQ
shape	Approximate shape of the hazard area	Rectangular or circular, defined by SQ
radius	Radius of the hazard area (circular shape)	Initialization parameter, defined by SQ
length	Length of the hazard area (rectangular shape)	Initialization parameter, defined by SQ
width	Width of the hazard area (rectangular shape)	Initialization parameter, defined by SQ
rotation	Rotation of the hazard area in degrees (rectangular shape)	0-360, defined by SQ
numberCasualties	Number of casualties (all four types)	decreasing from initial value to 0, defined by SQ

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
CCP	**Casualty Collection Point**	**At least one per hazard area**
x_Pos	Centre position in X direction	Incident area not in but close to hazard area, defined by SQ
y_Pos	Centre position in Y direction	Incident area not in but close to hazard area, defined by SQ
numberCasualties	Number of casualties currently at the CCP	Varying along the scenario initial and final values = 0, in between, value <= capacity
TCC	**Temporary Care Centre**	**At least one per hazard area**
x_Pos	Centre position in X direction	Incident area not hazard area, defined by SQ
y_Pos	Centre position in Y direction	Incident area not hazard area, defined by SQ
numberCasualties	Number of casualties being treated or waiting for treatment in the TCC	Varying along the scenario initial and final values = 0, in between, value <= capacity
capacity	Maximum number of casualties that can be accepted in the TCC at the same time	4-50, default 8
TS	**Temporary Shelter**	**At least one per incident area**
x_Pos	Centre position in X direction	Incident area not hazard area, defined by SQ
y_Pos	Centre position in Y direction	Incident area not hazard area, defined by SQ
numberCasualties	Number of casualties (type 2 and 3) in the TS	Varying along the scenario initial and final values = 0, in between, value <= capacity
capacity	Maximum number of casualties (type 2 and 3) that can be accepted in the TS at the same time	e.g. 100
HoldingArea	**Holding Area**	**One per scenario**
x_Pos	Centre position in X direction	Incident area not hazard area, defined by SQ
y_Pos	Centre position in Y direction	Incident area not hazard area, defined by SQ
DCP	**Deceased Collection Point**	One per scenario
x_Pos	Centre position in X direction	Incident area not hazard area, defined by SQ
y_Pos	Centre position in Y direction	Incident area not hazard area, defined by SQ
numberDeceased	Number of deceased, that have been brought to the DCP	Varying along the scenario initial value = 0 final value (total of all DCPs) = number of casualties deceased
Fire	**Fire**	**Number defined by SQ**
x_Pos	Centre position in X direction	Hazard area, defined by SQ
y_Pos	Centre position in Y direction	Hazard area, defined by SQ

Table A.4: Locations off-site

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
AmbulanceStation	**Ambulance station**	**No specific number modelled**
	No special parameters, here for completeness, relevant for communications (not modelled)	
FireStation	**Fire station**	**No specific number modelled**
	No special parameters, here for completeness, relevant for communications (not modelled)	
LocalHospitals	**Hospitals that are situated close to the incident site**	**No specific number modelled**
numberCasualties	Number of casualties at the hospital	Changes during disaster response
capacity	Maximum capacity of the local hospitals for casualties	40
RemoteHospitals	**Hospitals that are situated further away from the incident site**	**No specific number modelled**
numberCasualties	Number of casualties at the hospital	Changes during disaster response
LocalShelter	**Shelters that are situated close to the incident site**	**no specific number modelled**
numberCasualties	Number of casualties at the shelter	Changes during disaster response
capacity	Maximum capacity of the local shelters for casualties	100
RemoteShelters	**Shelter that are situated further away from the incident site**	**No specific number modelled**
numberCasualties	Number of casualties at the shelter	Changes during disaster response
LEMA	**LEMA/ECC**	**No specific number modelled**
	No special parameters, here for completeness, relevant for communications (not modelled)	

Table A.5: Actors

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
casualties	**Casualties**	**Number defined by SQ**
x_Pos	Position in X direction	Hazard area and incident area, defined by SQ
y_Pos	Position in Y direction	Hazard area and incident area, defined by SQ
type	1= requiring treatment and medevac 2= requiring treatment and evacuation 3= requiring no treatment but evacuation 4= deceased	Numbers provided according to SQ
CFECC	**Site Management CFECC**	**Number defined by SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the CFECC establishment	Result of the Gaussian process
FECC	**Service Management**	**Number defined by SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the FECC establishment	Result of the Gaussian process
SECC	**SubService Management**	**Number defined by SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the SECC establishment	Result of the Gaussian process
Firefighting	**ET fire-fighting**	**Number obtained from SQ**
x_Pos	Position in X direction	Incident area
y_Pos	Position in Y direction	Incident area
responseTime	Instantiation of Tresp for the ET fire-fighting arrival	Result of the sum of two Gaussian processes (see table A.2)
dispatchingTime	Instantiation of Tdispatch for the ET fire-fighting arrival	Result of the Gaussian process
fireTime	Instantiation of Tfire for the ET fire-fighting at the target fire	Result of the Gaussian process
reportingTime	Instantiation of Treport for the ET fire-fighting	Result of the Gaussian process
speed	Movement speed	4 km/h

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
Rescuing	**ET rescue**	**Number obtained from SQ**
x_Pos	Position in X direction	Incident area
y_Pos	Position in Y direction	Incident area
responseTime	Instantiation of Tresp for the ET rescue arrival	Result of the sum of two Gaussian processes (see table A.2)
dispatchingTime	Instantiation of Tdispatch for the ET rescue	Result of the Gaussian process
rescuingTime	Instantiation of Trescue for the ET rescue and one target casualty	Result of the Gaussian process
handoverTime	Instantiation of Thandover for the ET rescue and one target casualty	Result of the Gaussian process
reportingTime	Instantiation of Treport for the ET rescue and one target casualty	Result of the Gaussian process
speedCasualty	Movement speed with casualty	E.g. 3 km/h
speed	Movement speed without casualty	E.g. 5 km/h
Triaging	**ET taking care of triage**	**Number obtained from SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the ET triage arrival	Result of the sum of two Gaussian processes (see table A.2)
dispatchingTime	Instantiation of Tdispatch for the ET triage	Result of the Gaussian process
triageTime	Instantiation of Ttriage for the ET triage and one target casualty	Result of the Gaussian process
handoverTime	Instantiation of Thandover for the ET triage and one target casualty	Result of the Gaussian process
reportingTime	Instantiation of Treport for the ET triage and one target casualty	Result of the Gaussian process
speedCasualty	Movement speed with casualty	E.g. 3 km/h
speed	Movement speed without casualty	E.g. 5 km/h
Treatment	**ET taking care of treatment**	**Number obtained from SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
meanResponseTime	Mean of the Gaussian process that specifies the time that is needed after the alerting until the unit arrives at the incident area	
responseTime	Instantiation of Tresp for the ET treatment arrival	Result of the sum of two Gaussian processes (see table A.2)
dispatchingTime	Instantiation of Tdispatch for the ET treatment	Result of the Gaussian process
treatmentTime	Instantiation of Ttreat for the ET treatment and one target casualty	Result of the Gaussian process
handoverTime	Instantiation of Thandover for the ET treatment and one target casualty	Result of the Gaussian process
reportingTime	Instantiation of Treport for the ET treatment and one target casualty	Result of the Gaussian process
speedCasualty	Movement speed with casualty	E.g. 3km/h
speed	Movement speed without casualty	E.g. 5km/h
Medevac	**ET medical evacuation / Medical evacuation transport vehicles**	**Number obtained from SQ (medevac vehicles)**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the ET medevac arrival	Result of the sum of two Gaussian processes (see table A.2)
handoverTime	Instantiation of Thandover for the ET medevac and one target casualty	Result of the Gaussian process
medevacTime	Sum of: instantiation of Toff for the ET medevac and one target casualty + instantiation of Thandover for the ET medevac at the hospital + instantiation of Thold for the ET medevac to return to holding area	Sum of the results of the Gaussian process
medevacTimeRemote	Sum of: instantiation of ToffRemote for the ET medevac and one target casualty + instantiation of Thandover for the ET medevac at the hospital + instantiation of TholdRemote for the ET medevac to return to holding area	Sum of the results of the Gaussian process
reportingTime	Instantiation of Treport for the ET medevac	Result of the Gaussian process
speed	Movement speed	E.g. 60 km/h
TempShelter	**Personnel operating the temporary shelter**	**Number obtained from SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the ET temporary shelter arrival	Result of the Gaussian process
dispatchingTime	Instantiation of Tdispatch for the ET temporary shelter	Result of the Gaussian process
handoverTime	Instantiation of Thandover for the ET temporary shelter and one target casualty	Result of the Gaussian process
reportingTime	Instantiation of Treport for the ET temporary shelter	Result of the Gaussian process
speed	Movement speed	E.g. 4 km/h
Evacuation	**Vehicles including personnel taking care of evacuation**	**Number obtained from SQ (evacuation vehicles)**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the evacuation vehicles arrival	Result of the Gaussian process
handoverTime	Instantiation of Thandover for the evacuation of one target casualty	Result of the Gaussian process
evacuationTime	Sum of: instantiation of Toff for the evacuation of one group of target casualties + instantiation of Thandover (x number of casualties) for the evacuation at the shelter + instantiation of Thold for the evacuation vehicle to return to holding area	Sum of the results of the Gaussian process

Object Name/ Parameter Name	Description	Default Value/ Range/ Dependencies
evacuationTimeRemote	Sum of: Instantiation of ToffRemote for the evacuation of one group of target casualties + instantiation of Thandover (x number of casualties) for the evacuation at the shelter + instantiation of TholdRemote for the evacuation vehicle to return to holding area	Sum of the results of the Gaussian process
reportingTime	Instantiation of Treport for the evacuation personnel after evacuating one group of casualties	Result of the Gaussian process
speed	Movement speed	E.g. 30 km/h
capacity	Number of casualties that can be transported	8 - 50, default: 30
Police	**Police**	**Number obtained from SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the police arrival	Result of the Gaussian process
dispatchingTime	Instantiation of Tdispatch for the police	Result of the Gaussian process
speed	Movement speed	E.g. 4 km/h
RelevantAuthorityNGO	**Relevant authorities/NGOs**	**Number defined by SQ**
x_Pos	Position in X direction	Incident area not hazard area
y_Pos	Position in Y direction	Incident area not hazard area
responseTime	Instantiation of Tresp for the relevant authority personnel / NGO team arrival	Result of the Gaussian process
dispatchingTime	Instantiation of Tdispatch for the relevant authority personnel / NGO team	Result of the Gaussian process
reportingTime	Instantiation of Treport for the relevant authority personnel / NGO team	Result of the Gaussian process

Annex B (informative): Bibliography

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