Analysis of a Real Case Study : the WORKPAD Project

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General Information

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Topics

- Requirements Engineering
- Interviews and Scenarios
- Task Analysis
- Mock-Ups
- User Interfaces
- Evaluation Techniques

Requirements Classification

- **User requirements**
  - ⇨ What will the user be able to do with the final system?
- **System requirements**
  - ⇨ Which functionalities must be implemented by the engineers?
    (in order to satisfy the user requirements)

How to Collect User Requirements in a real project

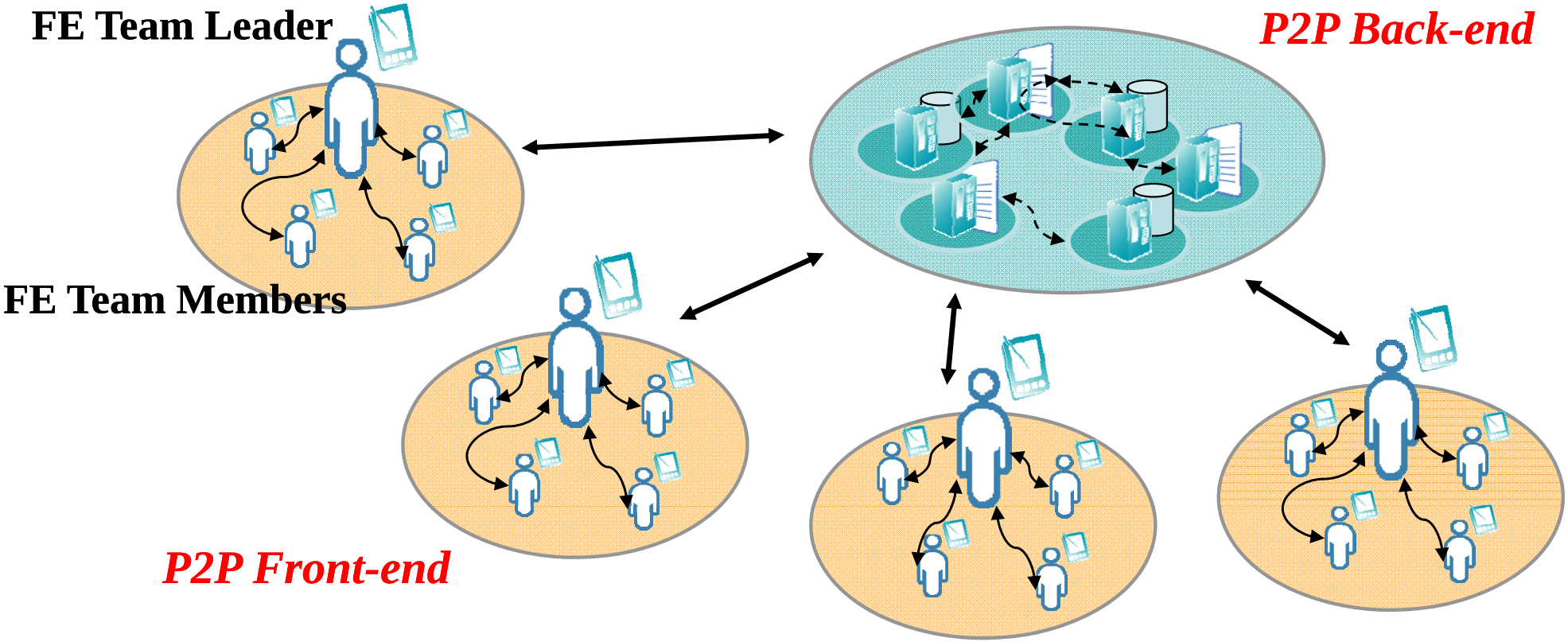
- Before starting learn about your product and users involved
- Define methods, protocols and prepare all the activities
- Perform the activities
- Analyse the data

Before Starting

- **Learn about your product and users involved**
- **The WORKPAD Project (1 Sept.2006-31 August.2009)**
  - **High-Level Architecture**
  - **Context**
  - **Users involved**
    - Main User = Protezione Civile Calabria

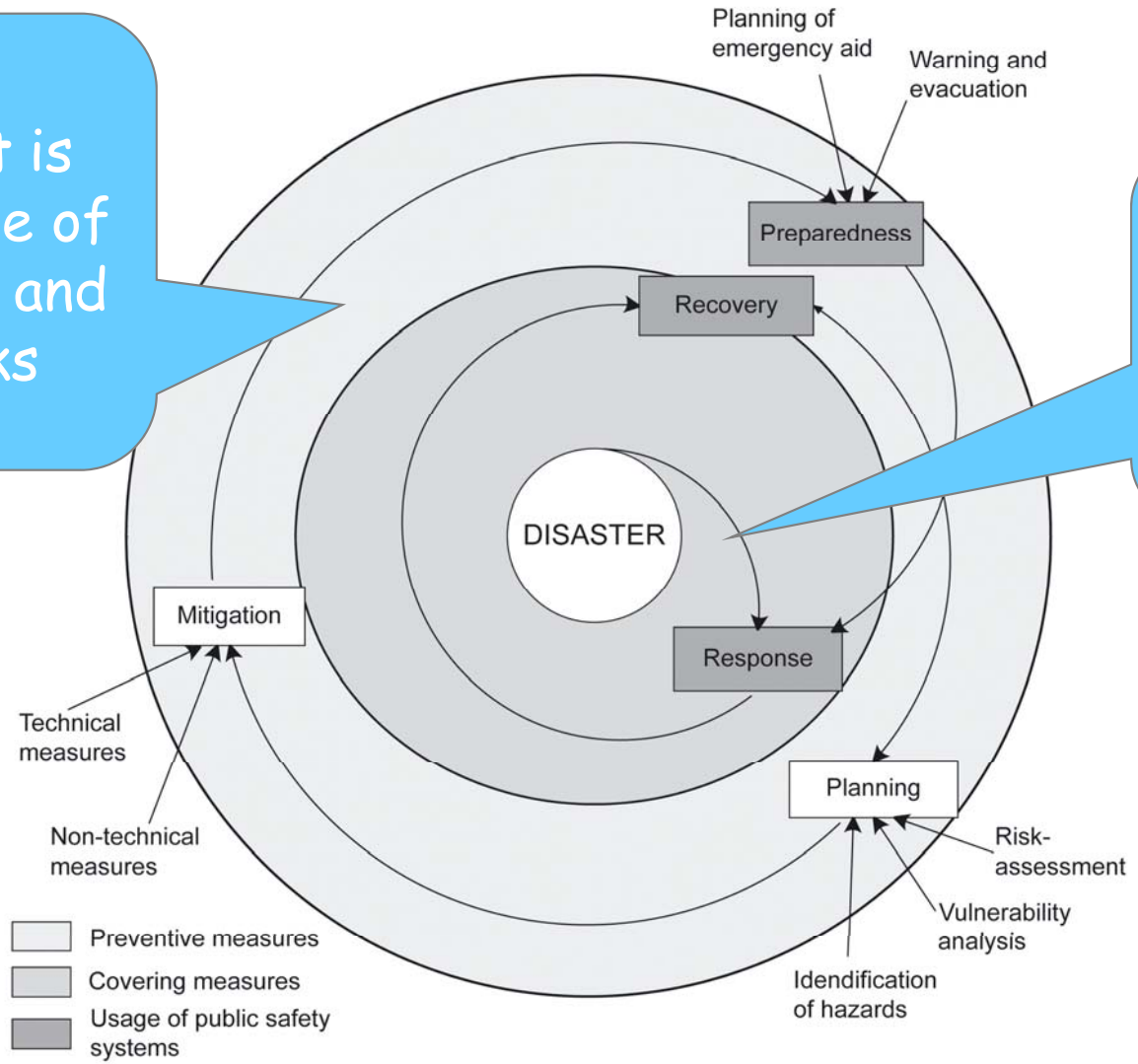
High-level Architecture of the WORKPAD Project

- An adaptive peer-to-peer service-oriented software infrastructure for supporting collaborative work of human operators in emergency/disaster scenarios.



Dealing with Emergencies

Emergency management is the discipline of dealing with and avoiding risks



The project addresses **response** and **short-term recovery**

Types of calamitous events

- The Italian laws identify 3 levels of emergencies, with different responsibilities:
  - Micro-Emergencies
  - Middle-Emergencies
  - Macro-Emergencies

Micro-Emergencies

- Mayors coordinate Micro-Emergencies involving their own territory by using **COCs** (Centri Operativi Comunali).

Middle and Macro-Emergencies

- Middle-emergencies involve provinces or regions and are coordinated by Prefect(s).
- Macro-emergencies (at national level) are handled by National Homeland Security
  - ⇨ They are out of the scope of the WORKPAD project.

CCS (1)

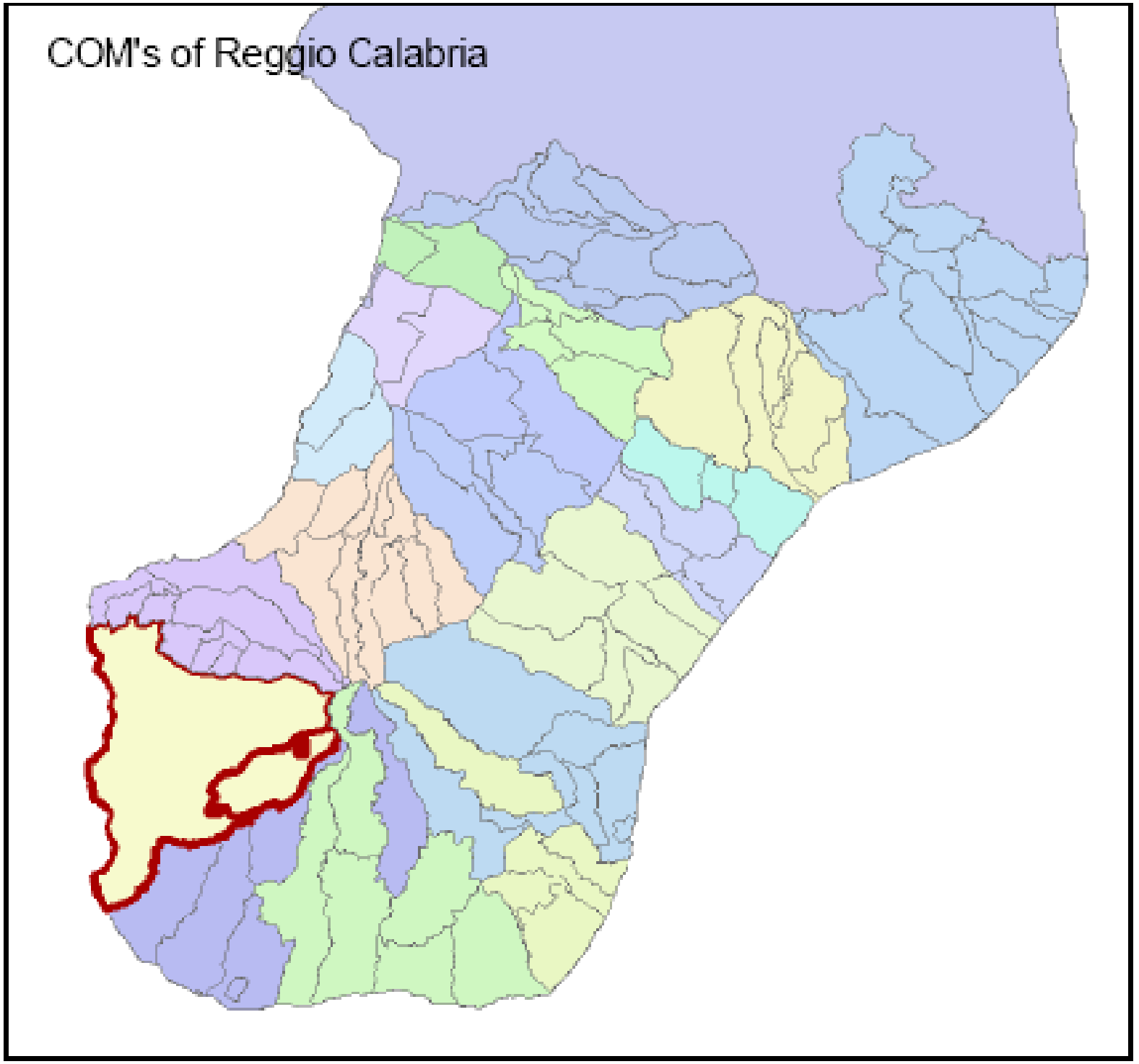
- Middle emergencies are handled by the CCS (Centro Coordinamento Soccorsi)
- CCS is leaded by a Prefect
  - Prefect authorizes and coordinates actions suggested by organizations on the field.
- It is composed by a fixed number of functionaries of the most important emergency organizations: Police, Fire Brigade, Red Cross…
  - In specific situations, further organizations can be involved around "the CCS table"
    - For example A.N.A.S. (the organization that manage roads) is involved in emergency concerning nationals roads.

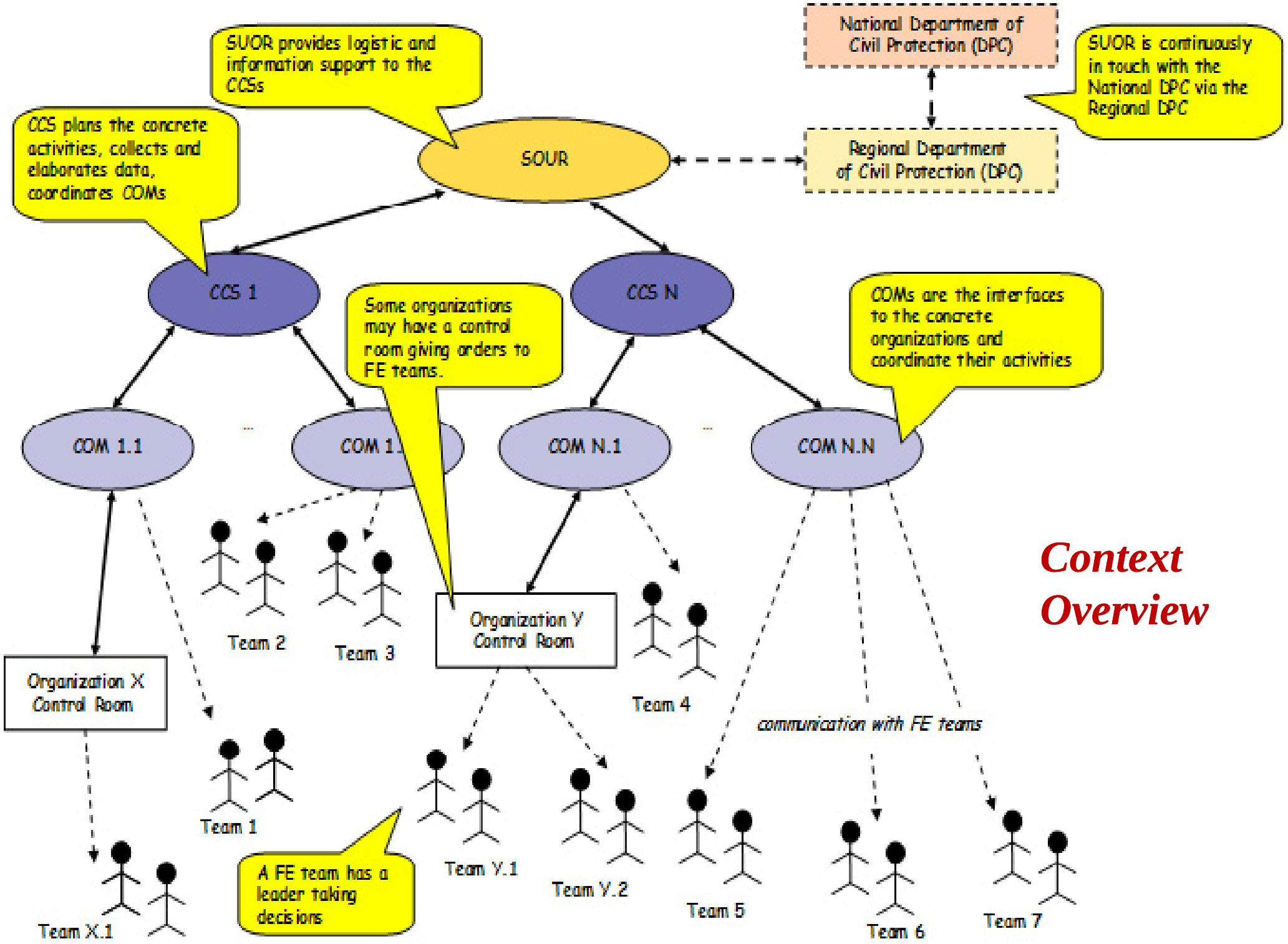
CCS (2)

- Tasks of the CCS:
  - Collection and elaboration of data and information about the evolution of the situation.
  - Coordination of the activities performed in the COMs (Centri Operativi Misti).

COM

- COM is an operative decentralized structure that depends by decisions taken within the CCS.
- COM is intended to react quickly to local demands and to guarantee the needed coordination.
  - ⇨ The province of Reggio Calabria has 19 COMs.


COM's of Reggio Calabria

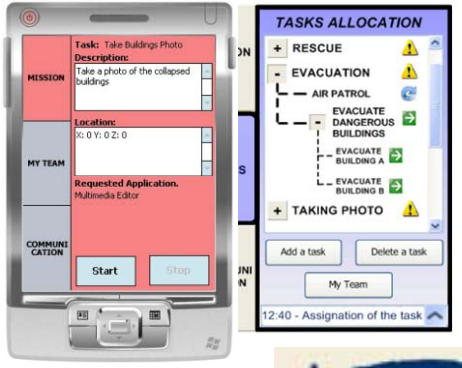

National Department of Civil Protection (DPC)
SUOR is continuously in touch with the National DPC via the Regional DPC
SUOR provides logistic and information support to the CCSs
CCS plans the concrete activities, collects and elaborates data, coordinates COMs
SOUR
Regional Department of Civil Protection (DPC)
CCS 1
CCS N
Some organizations may have a control room giving orders to FE teams.
COMs are the interfaces to the concrete organizations and coordinate their activities
COM 1.1
COM 1.
COM N.1
COM N.N
Team 2
Team 3
Organization Y Control Room
Team 4
Organization X Control Room
communication with FE teams
Team 1
A FE team has a leader taking decisions
Team Y.1
Team Y.2
Team 5
Team 6
Team 7
Team X.1
Context Overview

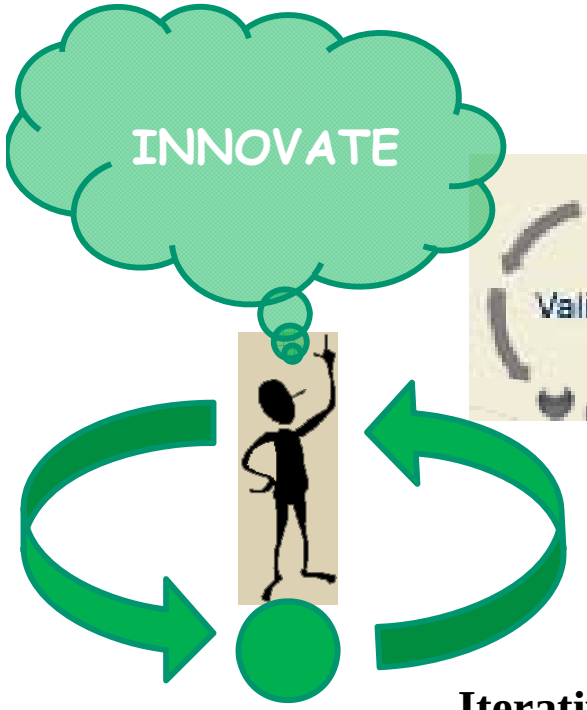
How to Collect User Requirements in a real project

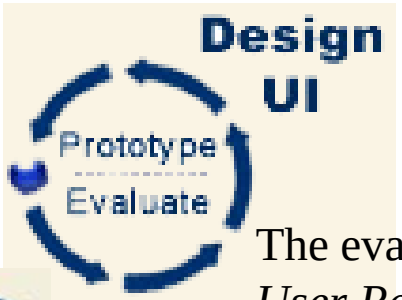
- Before starting learn about your product and users involved
- Define methods, protocols and prepare all the activities
- Perform the activities
- Analyse the data

Incremental design of the components of the system, with a step-by-step realization of :

Mock-Ups
Working Prototypes





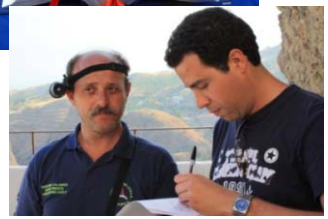


The evaluation of *User Requirements* allows to understand how the final user should interact with the system :

Scenarios Analysis
Task Analysis
Use Case Analysis

USER CENTERED DESIGN

Iterative evaluation and **refinement** of the prototyipes



A twofold approach :

Top-Down = used to get information regarding the related works
Bottom-Up = used to get requirements from the practical work carried in the field.

Two-fold Requirements Elicitation Approach

- **Top down**
  - Regulations, laws, initiatives and projects on a European basis
- **Bottom up**
  - Case study: EM of Civil Protection
  - Experience of users and system engineers

Top-Down Approach

- Analysis of Emergency Management in other European countries
  - Austria, Czech Republic, Spain
- Analysis of EU regulations concerning Emergency Management
  - MIC, CECIS, Training Program
- Analysis of related European Projects
  - Amira, Oasis, Pompei …

Bottom-Up Approach

- Deployed HCI techniques
  - User group categorisation
  - Semi-structured interviews
  - Focus groups
  - Scenario development
  - Storyboards
  - Hierarchical task analysis
  - Usability tests
    - Mock-ups and real prototypes

Interviews

- Interviewing is a technique that involves structured or unstructured discussion between requirement engineers and potential users of the application or system.

- Structured interviews can be conducted if the requirements engineer already has a fairly good knowledge about the user's requirements.

WORKPAD Interviews

- Semi-structured interviews using pre-defined set of questions.
- Open-end discussion with the potential user.
- Definition of an **Interview Form** combined with **Interview Guidelines**.
- Interview guidelines provided instructions for the moderator.

Interview Guidelines - Example

- *The moderator is the leader of the interview and guides the potential user through the personal interview by asking questions that are specified in this document. The answers are recorded by one more person who also takes part to the interview. The interview is videotaped and tape-recorded by a third (technical) person, so that all statements are backed up.*

- *The moderator gives a short summary about the WORKPAD project to the users. The WORKPAD project aims at building and developing an innovative software infrastructure (software, models, services, etc.) for supporting collaborative work of human operators in emergency/disaster scenarios....*

Interview Form - Example

Date:	
Name of the interviewed person:	
Organisation:	
Position in the organisation	
Moderator:	
Present Persons:	

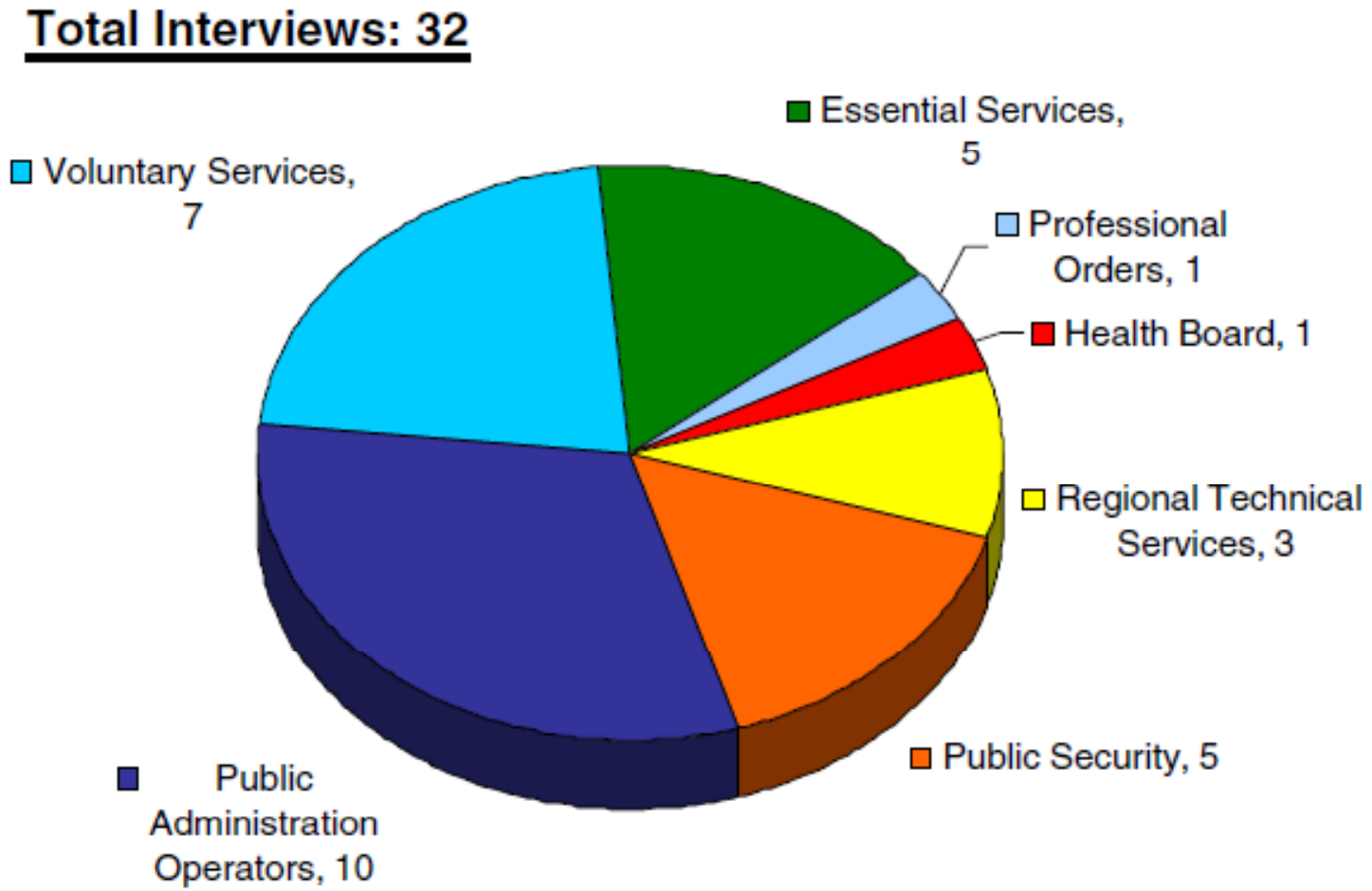
Execution of Interviews

- Calabria, November 22-24, 2006
- 32 interviews
- 3 experts involved
- Users involved
  - Public Security
  - Public Administation Operators
  - Voluntary Service
  - Essential Services
  - Professional Orders
  - Health Board
  - Regional Technical Services

Execution of Interviews

- **Results:** a collection of (unstructured) information useful to :
  1. Collect user requirements.
  2. Understand how Civil Protection works.
  3. Get information about existing software infrastructures.

Interviews


Total Interviews: 32
Essential Services, 5
Professional Orders, 1
Health Board, 1
Regional Technical Services, 3
Public Security, 5
Public Administration Operators, 10
Voluntary Services, 7

List of questions

- 1) User Group Definition
  - Question 1: What are your main responsibilities within this organisation ?
  - Question 2: In what kind of emergencies is your organisation involved ?
  - Question 3: What is your role during an emergency ? In which phase of an emergency are you involved ?
  - Question 4: Do you know the statistical frequency according to which an emergency happens in your territory ?

List of questions

- At this point (it depends by the user), the interview is divided in two trunks: the first one concerns front-end users, whilst the second one focuses on back-end users.
- The main purpose is to is to investigate which steps a user performs when preparing him\herself to face the emergency.

List of questions

- 2A) Front-End Users (*Shortly after the emergency has happened*)
  - **Question 5a:** Which steps do you perform shortly after the emergency has happened ?
  - **Question 6a:** What kind of information (related to the emergency) do you get from the control centre ?
  - **Question 7a:** How long is the front-end team actively involved in this phase of the emergency (average) ?
  - **Question 8a:** What kind of information do you exchange with other members of the team during the transport to the place where the emergency has happened ?

List of questions

- 2A) Front-End Users (*During the emergency*)
  - **Question 9a:** Describe the composition of the team and the various roles of the team members allocated to them during the emergency.
  - **Question 10a:** What kind of technical devices do you currently use in emergencies ?
  - **Question 11a:** How do you communicate with the other team members and the back-end centre?
    - Does your team use a separate communication channel ?

List of questions

- 2A) Front-End Users (*During the emergency*)
  - **Question 12a:** What kind of technology do you currently use in/after emergency situations ?
  - **Question 13a:** What kind of information (and in which form) do you exchange with the team leader ?
  - **Question 14a:** Do you co-operate with members of other organizations ? (for example police, etc.) ?
    - Do you exchange information and/or data ?
    - Do you share a common technology ?

List of questions

- 2B) Back-End Users (*Shortly after the emergency has happened*)
  - **Question 5b:** Which steps do you perform shortly after the emergency has happened ?
  - **Question 6b:** How much time are the back-end team actively involved in this phase of the emergency (average) ?
  - **Question 7b:** What kind of information do you send to front-end operators, who have to prepare them to face the emergency ?
  - **Question 8b:** In what way do you obtain such information and in which format ?

List of questions

- 2B) Back-End Users (*During the emergency*)
  - **Question 9b:** What kind of technical devices do you use for the communication with the front-end operators ?
  - **Question 10b:** What kind of communication technology do you use ?
    - Does your team use a separate communication channel ?
  - **Question 11b:** Does the communication take place with a particular team member(s) or can you communicate arbitrarily with everybody (how strict are the hierarchical and the communication structures defined within your organisation) ?

List of questions

- 2B) Back-End Users (*During the emergency*)
  - **Question 12b: What kind of information do you send to the front-end users ?**
  - **Question 13b: What kind of information do you receive from the front-end users ?**
  - **Question 14b: Do you share technology and data with other organizations ?**
    - Which kind of data / technology ?
    - In which way does this exchange of information take place ?

List of questions

- 3) Last questions are the same for every kind of user
  - **Question 16: Do you currently use Geographic Information Systems (GIS) ?**
    - If yes, which software and data do you use ?
  - **Question 17: Do you think that the devices and technologies used to face the emergency are conform to the purpose for which they are used ?**
  - **Question 18: What do you think would be a big improvement concerning the technology part ?**
    - What kind of improvement would you propose ?

How to Collect User Requirements in a real project

- Before starting learn about your product and users involved
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Public Security Organizations

- Public Security organizations are in first line in the emergency management
  - Usually they are in charge to collect warning signals sent by citizens.
  - They immediately reach the place stricken to analyze the situation.
- Each public security organization perform its own specific tasks
  - Policemen and Carabineers guarantee the maintenance of people security.
  - The urban police deals with traffic.
  - Fire Brigade coordinates actions on the field suggesting to Prefecture what actions should be done.
- Each Public Security organization provides a control room which communicate both with the CCS and COMs and with operators on the field.

Public Administration

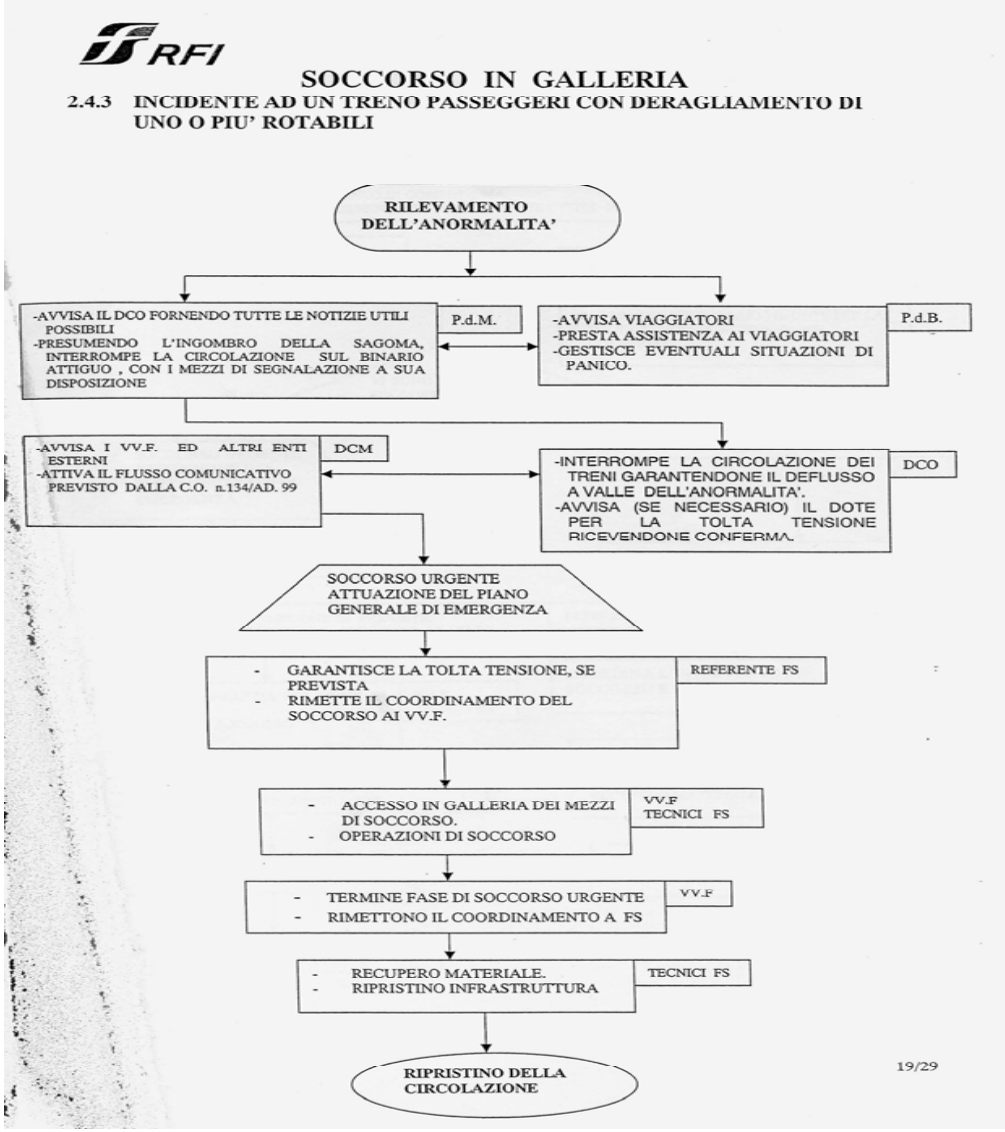
- Each COM differs from any other…
  - Some COMs are fully equipped with local network, laptop computers and internet…
  - Some others do not even have internet access: they may communicate and get information only by phone.

Essential Services (1)

- They have specialistic competences in specific sectors (for example, A.N.A.S. for road management)
- Each essential service organization takes part in an emergency whenever its skills are requested.
- They communicate through mobile phones.

Essential Services (2)

- Some organizations (i.e. R.F.I. – Italian Railway Networks) have got precise action plans for emergencies.
  - For example this figure depicts the workflow to deal with emergencies happened inside tunnels.



Voluntary Service

- The Voluntary organizations cooperate with Civil Protection in the first aid response.
  - ⇨ Their rule is fundamental: they can support people and institutional territorial forces.
- Some organizations are characterized by high specializations: dog units, free divers, radio amateurs, etc…
- They communicate mainly using transceivers and mobile phones.

Health Board

- It takes part to all emergencies where public health is involved
  - ⇨ Often Public Health and volunteers overlap in interventions.
- The communication always happens through phones.

Professional Orders

- Professional orders are composed by qualified persons (Geologists, Architects, Engineers, Druggists etc.)
- Usually, they aren't directly involved by Prefecture in the majority of emergencies
  - ⇨ Each freelancer act by himself without coordination when he/she realizes he/she can be useful.

Other notes

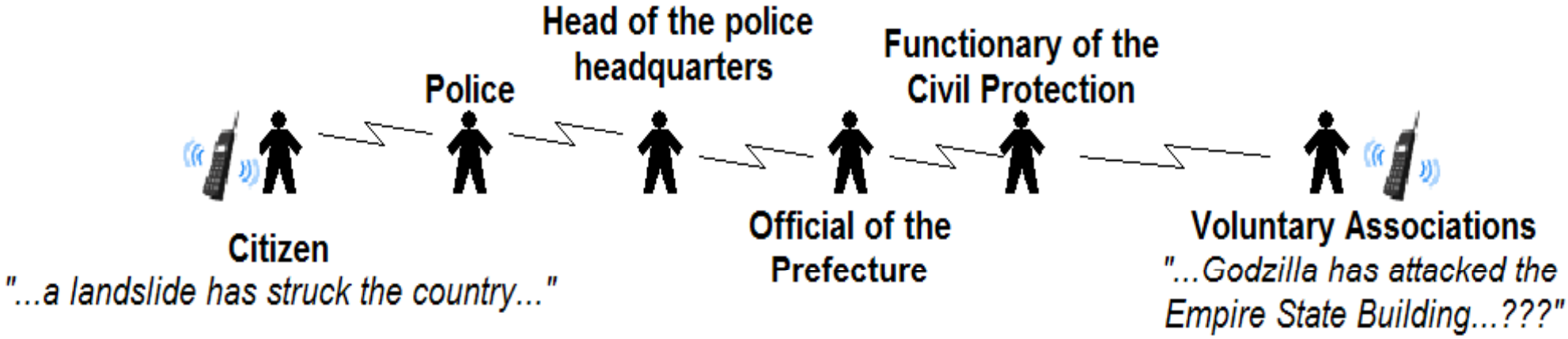
- At Back-end
  - Usually, control rooms have an informative system where data collected about emergency are stored.
  - This information is not directly shared among organizations.
- At Front-end
  - Currently, inside a team the communication takes place by transceivers and mobile phones.

Focus Groups

- Six/ten individuals are brought together to discuss their experiences or opinions around topics introduced by a moderator.
- It is used for having a quick understanding of user's perception about a topic.
- Very useful
  - ⇨ to individuate with precision problems and possible solutions that are still not clear.
  - ⇨ to build user scenarios and to perform task analysis.

How is activated each organization?

- The activation of the organizations involved happens with a 'chain of phone calls'...
- ...often a 'chain of phone calls' can distort the information...



How to obtain information and data?

- When an emergency happens, currently the only way to exchange information is through mobile phones.
- This happens because the collected data are considered as "strictly reserved"...

The WORKPAD solution for the back-end side

- WORKPAD Project proposes to "build" a grid of systems where each operator can get or set relevant information to the situation faced…
- …this information will be potentially spread over the network…
- …so, this could guarantee a consistent gain of time in the managment of the emergency…

How do communicate the members of a team? (1)

- On the front-end side, users have underlined some problems…
  - The radio communication often dead…so operators are forced to use mobile phones…
  - …unfortunately in a lot of zones the mobile phones don't have field…
- So, a big improvement about the communication would be very useful…

How do communicate the members of a team? (2)

- Moreover, there is a great difficulty to communicate with members of other organizations…
- …this happens because each team use a dedicated frequency to talk to every other.
  - Currently it doesn't exist a way for putting in communication two Teams Leaders (except through mobile phone, if the phone number is known).

How do communicate the members of a team? (3)

- It is important to note that the communication MUST BE dedicated for all the team belonging to the same organization (this is a USER REQUEST)
- Some organizations (as the State Forest Corp) are looking for a tool that not only allows to communicate, but also have visual information…exactly a PDA

The WORKPAD solution for the front-end side

- The WORKPAD project proposes to equip each team member with handheld devices (PDAs), that enable to execute some operations…
- …moreover, Team Leader's device could be connected using a satellite channel…the team's members could constitute an ad-hoc network…in this way all the limits concerning the "dead" of the radio communication would be overcome …
- …the Team Leader's device could be connected with the back-end peer, in order to obtain the information to face the emergency…
- …the Team Leader's device coordinates the other team member's devices by providing appropriate information (for example, cartography)

A first definition of User Requirements

ID	A unique identifier, composed of a classifier and a sequential number (eg "G-2"): G … General requirement C … Communication requirement B … Back-End requirement F … Front-End requirement
Title	A short title of the requirement giving an overview.
Description (optional)	A more detailed description of the requirement.
Classification	A classification according to: G … General requirement C … Communication requirement B … Back-End requirement F … Front-End requirement
Significance	Depicts the importance of the requirement for an emergency management system in general: Must … This requirement *must* be provided. Shall … This requirement *shall* be provided. Should … This requirement *should* be provided.
Priority	Indicates the priority in terms of an implementation of this requirement within the WORKPAD project: 1 … Mandatory 2 … Desirable 3 … Optional
Relevancy	The requirement is relevant for either scenario 1 or 2 (implying also the storyboards), and the showcase (true/false) (eg "1/false", 'X' would denote 'relevant for both")
Source	The requirement was acquired through: U … User analysis (such as Interviews, user workshops, HTAs) I … Investigations of related work and/or EU regulations
Dependency (optional)	Indicates a relation between requirements.
Evaluation	The evaluation of this requirement is done via: Ver … Verification: testing (such as software, performance etc.) or review Val … Validation: user/field test, user feedback

Example of User Requirements

ID	**B-4**
Title	The BE must integrate various data sources and provide them through a well-known interface.
Description	To alleviate information access and to address interoperability, well-known interfaces – ideally based on standards – must be provided at the WORKPAD BE. By this, the BE abstracts from logical and physical data models and implementations of data providers such that they are not visible to knowledge consumers.
Classification	**B**
Significance	Must
Priority	1
Relevancy	X/true
Source	I
Dependency	**G-3, G-12**
Evaluation	Ver

Example of User Requirements

ID	**F-10**
Title	FE application must include some basic GIS functionality.
Description	It must be possible to deliver geographic data to the FE entities and to present it accordingly.
Classification	**F**
Significance	Must
Priority	1
Relevancy	X/true
Source	**U**
Dependency	G-3, B-14
Evaluation	**Val**

Bottom-Up Approach

- Deployed HCI techniques
  - User group categorisation
  - Structured interviews
  - Focus groups
  - Scenario development
  - Storyboards
  - Hierarchical task analysis
  - Usability tests
    - Mock-ups and real prototypes

Refinement of User Requirements

- User Requirements need to be improved more and more...
- ...alone, the interview techniques are unable to go in depth about users tasks and requirements

SOLUTION???

→ **Scenario-based Requirements Analysis Method (SCRAM)**

- A scenario is a description that envisions a person's interaction with a system.
- A scenario can be plain text/narrative. However, it can be augmented by sketches and pictures. The sketches and pictures are called *storyboards*.
- Note that detail can help make the events in the scenario seem more real.

User Scenarios

- Scenarios can help to identify characteristics of the user that may impact the design and the tasks that the system needs to support.
- Scenarios force us to think about the design in detail and notice potential problems before they happen; we can therefore verify whether the design would make sense to the user and whether the proposed implementation architectures would work.
- Moreover, scenarios can be used to:
  - *Communicate with others* (e.g. designers, clients, users)
  - *Validate other models*
    - A detailed scenario can be 'played' against other models e.g. task and dialog models.
  - *Express dynamics*
    - Mere screenshots and pictures primarily give a sense of the appearance of the system. A scenario can give a sense of the behavior of the system.
- Note that scenarios can be used and reused throughout the design process

User Scenarios in WORKPAD

- Structured (formal) scenarios: written, textual descriptions and structured in a scenario description form
  - ⇨ Two main scenarios : Earthquake and Flood

Their aim is to serve as the basis for:

- A better definition of users and user groups
- Task Analysis, Use Cases and UML modelling
- Showcase : validation and test

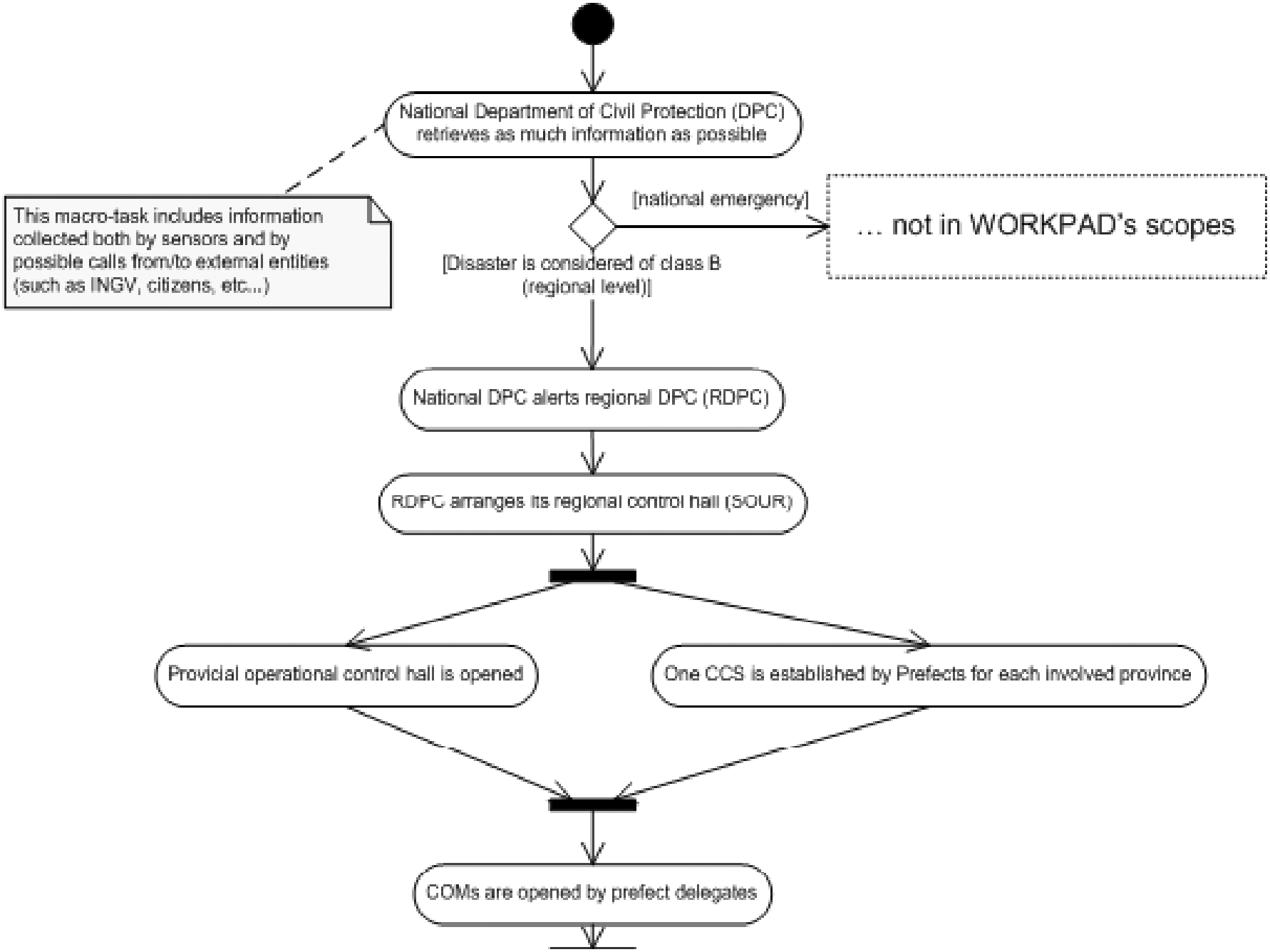
Scenarios have been organized as follow :

- ⇨ giving a brief introduction to the scope;
- ⇨ containing scenario title, relevant emergency phase, main goal, duration, actors, initial state, final state, and dependencies;
- ⇨ designing UML activity diagrams depicting the sequence of involved high-level activities.

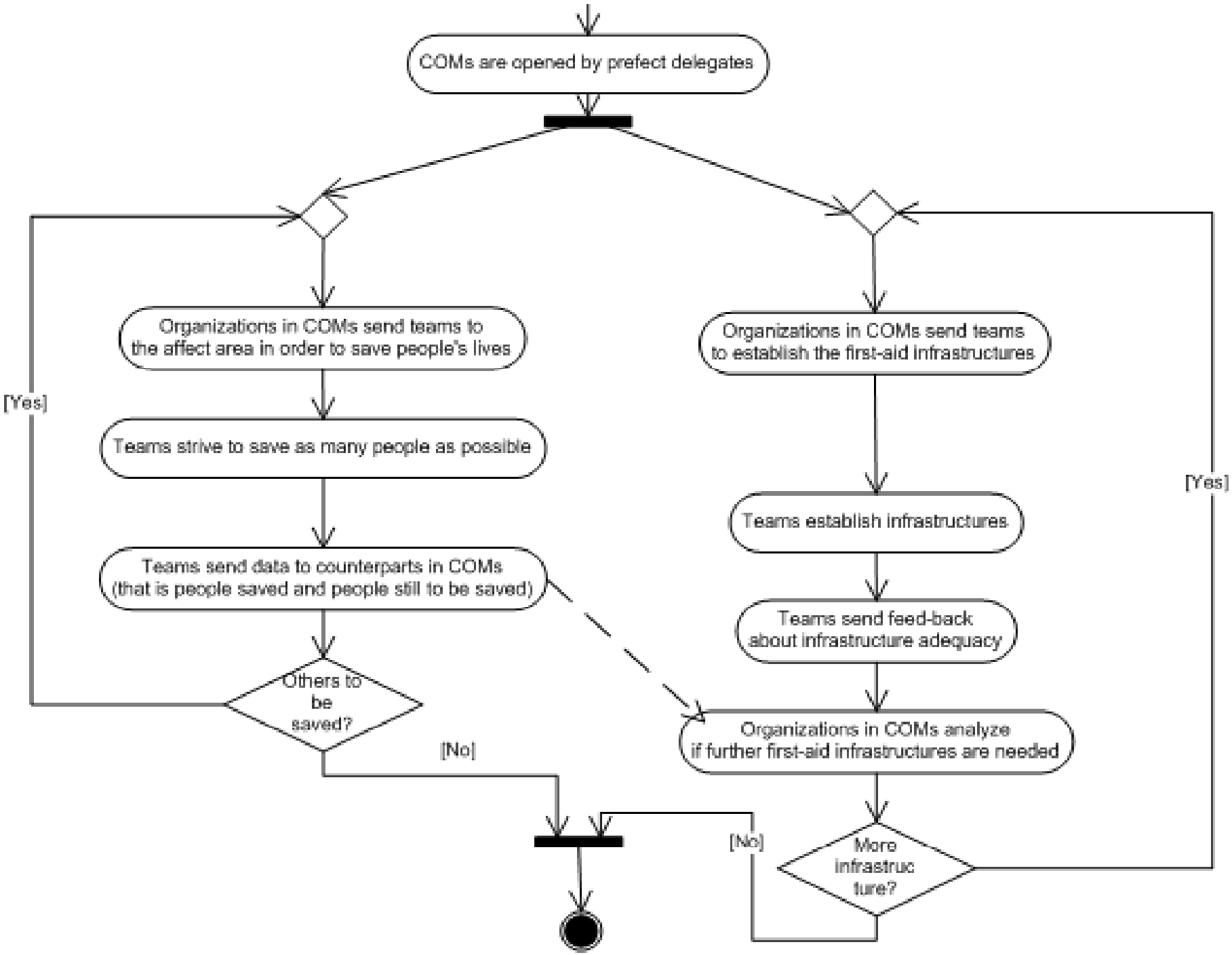
Earthquake Scenario

Scenario	Earthquake
Phase	Response Phase
Main goal	First aid to population
Duration	2-3 days
Actors	National and regional Civil Protection Departments, Police (State Police, Carabinieri, etc.), Hygenic Public Health department, Voluntary Services, Transportation & Infrastructure (e.g., Railway) Providers, Fire Brigades, State Forest Corp
Initial State	Emergency incident → notification about seismic activities
Final State	Teams are present in the field and received appropriate commands
Dependencies	Predecessor to second phase (Short-term Recovery Phase)
Task overview	See Figure : Macro Description of the Response phase process

Earthquake Scenario



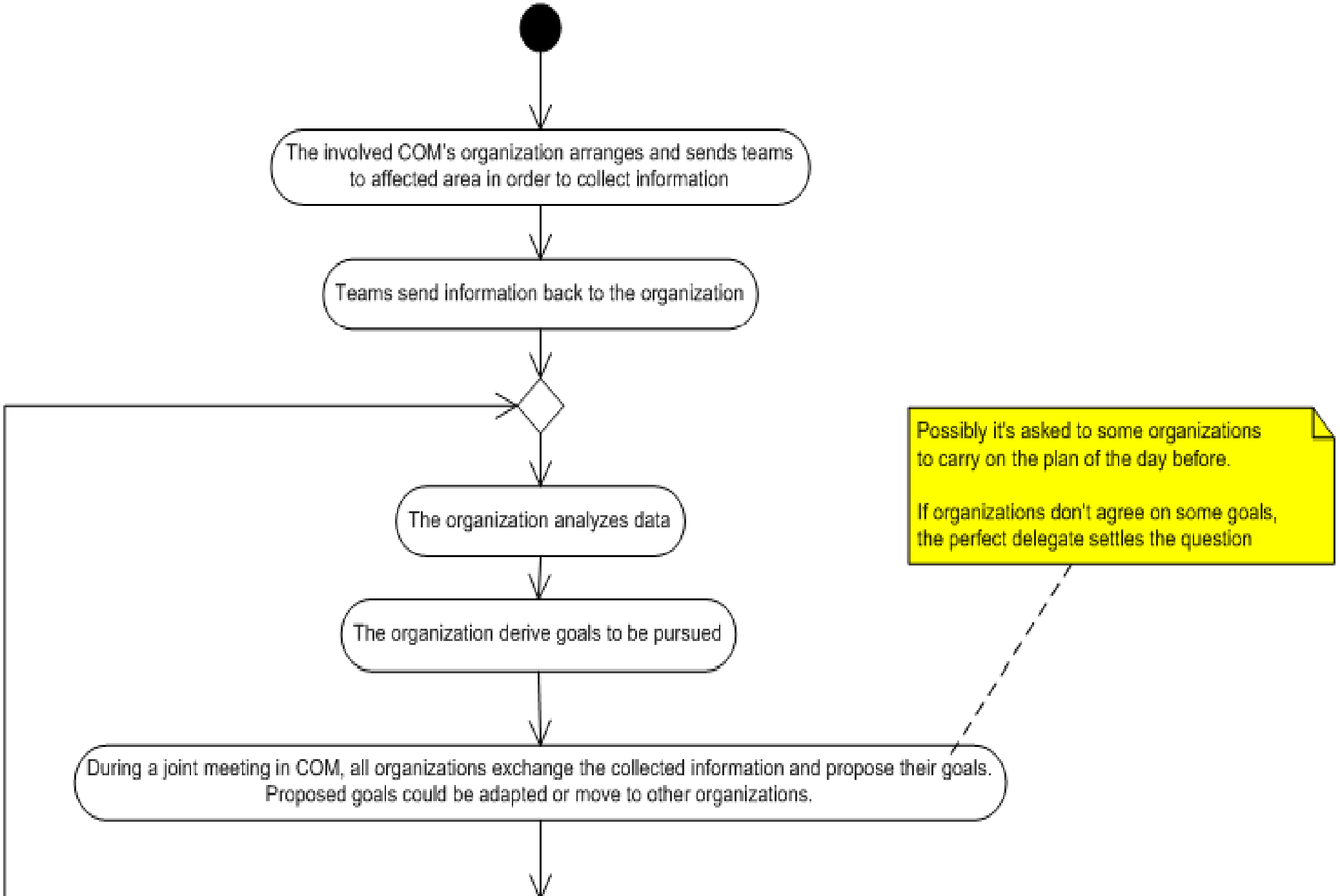
Earthquake Scenario



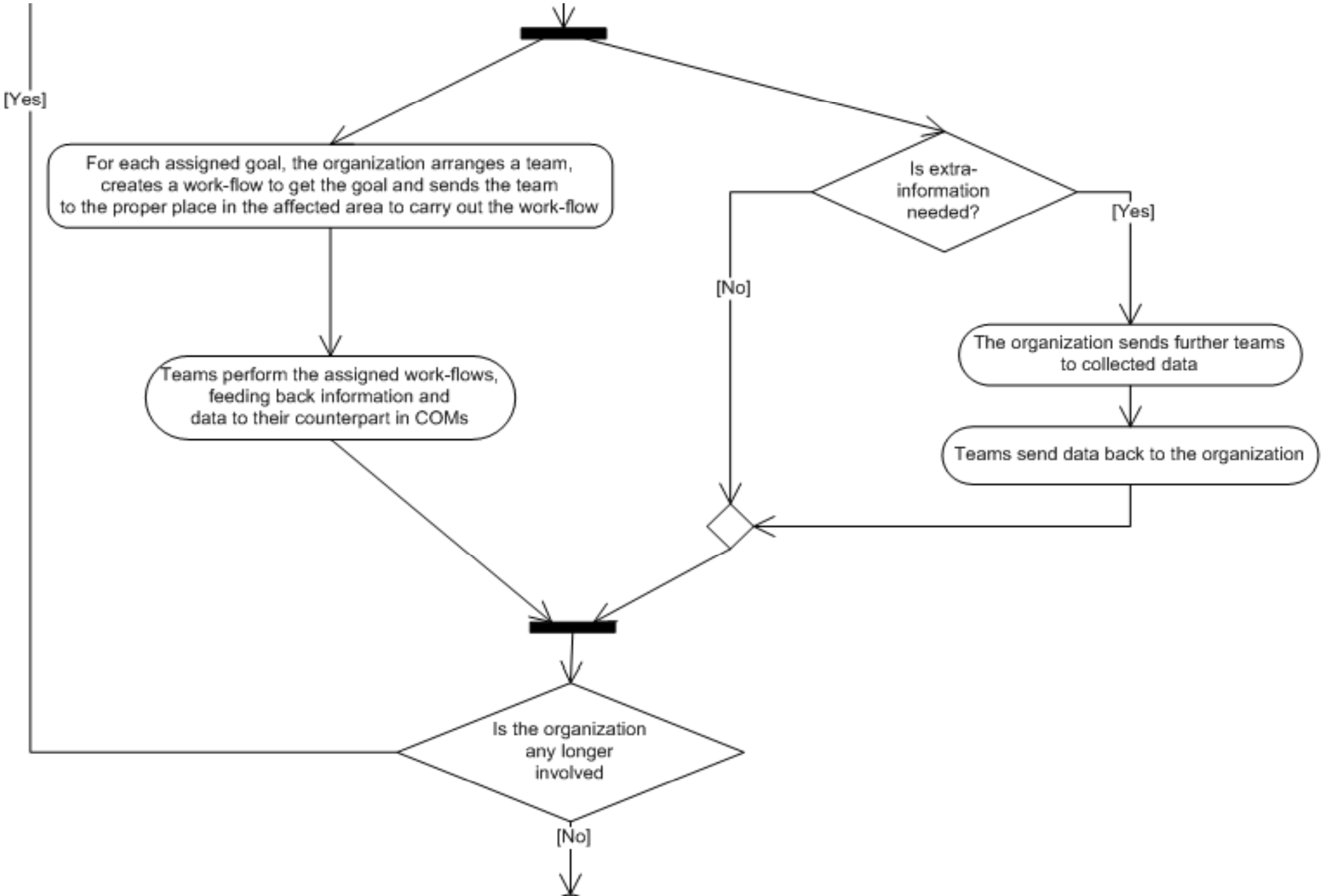
Flood Scenario

Scenario	Flood
Phase	Short-term Recovery Phase
Main goal	Recovery of the affected area, restoring infrastructure/essential service
Duration	14 days
Actors	DPC (national and regional), Fire Brigades, Army, Police (State Police and Carabinieri), Hygienic Public Health department, Voluntary Services, Transportation & Infrastructure Providers, State Forest Corp
Initial State	Initial assistance is provided, situation is stabilised → living conditions can not yet be sufficiently provided
Final State	Basic living conditions can be provided up to a certain degree → CCS are closed
Dependencies	Ancestor to response phase and predecessor to further long-term recovery phases
Task overview	See Figure : Macro description of the Short-Term Recovery phase process

Flood Scenario



Flood Scenario



Storyboards and HTA for the Earthquake Scenario

- Some storyboards have been derived from earthquake scenario
- Each storyboard is analyzed through HTA, that describes the low-level tasks performed by the actor involved to reach the goal proposed.
- In order to understand better the analysis carried out, we propose a summary of the earthquake scenario used for obtain storyboards:

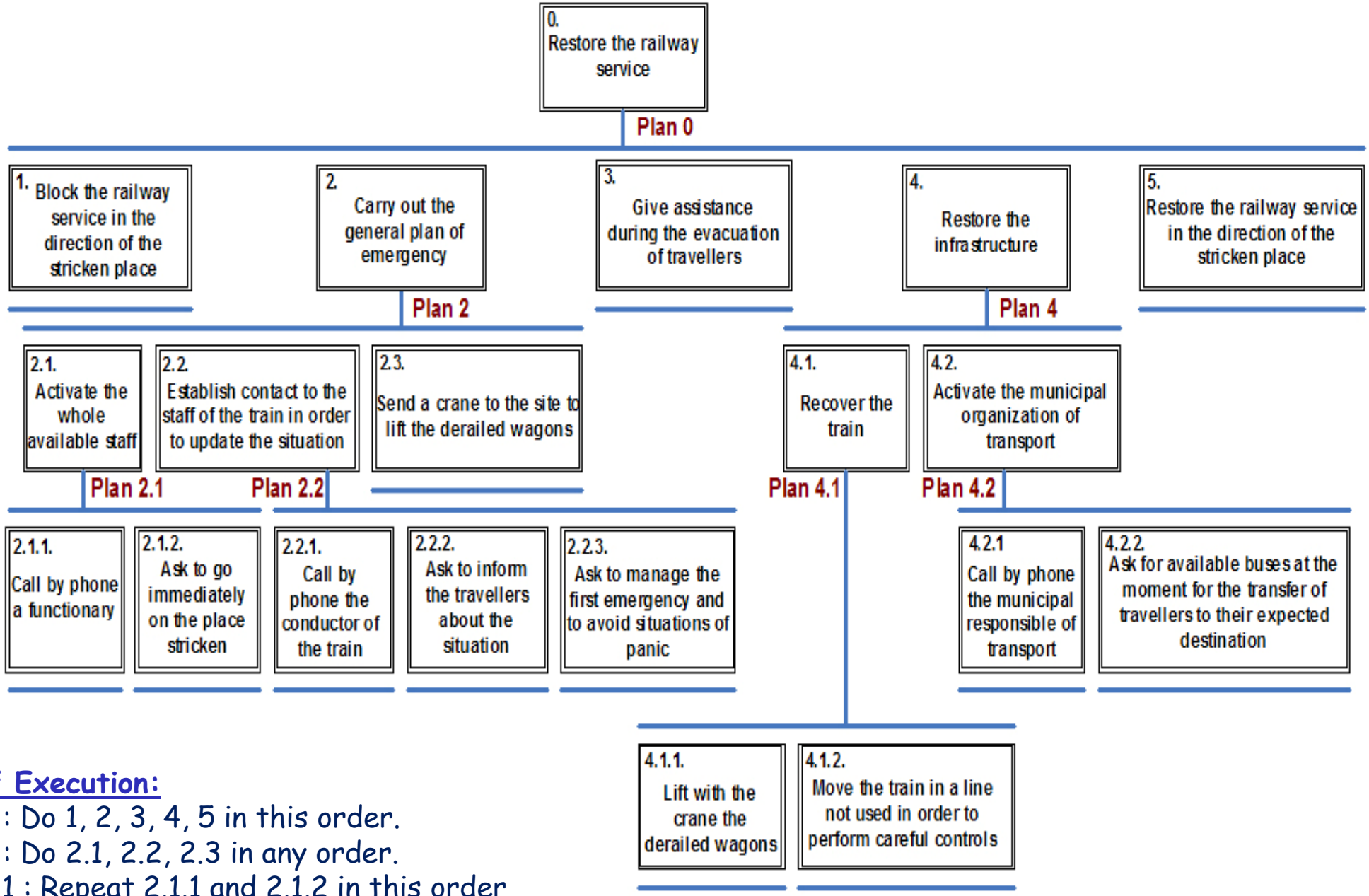
  "At 10:30 A.M. a violent earthquake of 6 degree on the Richter scale hit the south of Italy, with severe damages in a Calabrian town of 34.000 inhabitants. Furthermore, it is reported that the earthquake has provoked damages to things and people in many other Calabrian cities"

Storyboard "Restore Railway Service"

- Actor : Ferrovie dello Stato (State Railways)
- Phase : Response and Short-Term Recovery Phase
- Initial State : The COM which was opened in the catastrophe zone alerts the State Railways of the city. This heavy downpour has provoked an interruption of the electricity in some areas of the city and therefore created problems to the railway practicability. A short-circuit caused fire on a passengers train standing in a gallery.
- Relevant Conditions : Fire Brigade, Police and Red Cross have already been alerted to intervene and lead the operations of first help at the operational area. Volunteers of Civil Protection also join them.
- Final State : The railway service can again be activated.

Storyboard "Restore Railway Service"

- Main Goal : Restore the railway service
- Duration : 2-3 hours
- Dependencies :
  - Fire Brigade: firemen move with functionaries of State Railways into the gallery. Their task is to extinguish the fire and to evacuate all people out of the train.
  - Voluntary Associations: the people who have been evacuated are transported out of the gallery by volunteers who afterwards give them assistance.
  - Police: policemen secure the area in order to guarantee maintenance of the public security.
  - Red Cross: Red Cross operators move with functionaries of State Railways into the gallery in order to conduct the operations of first help. The ambulances stay outside the gallery.



Plan of Execution:

- Plan 0 : Do 1, 2, 3, 4, 5 in this order.
- Plan 2 : Do 2.1, 2.2, 2.3 in any order.
- Plan 2.1 : Repeat 2.1.1 and 2.1.2 in this order

while all available functionaries haven't been alerted to go on the place stricken.

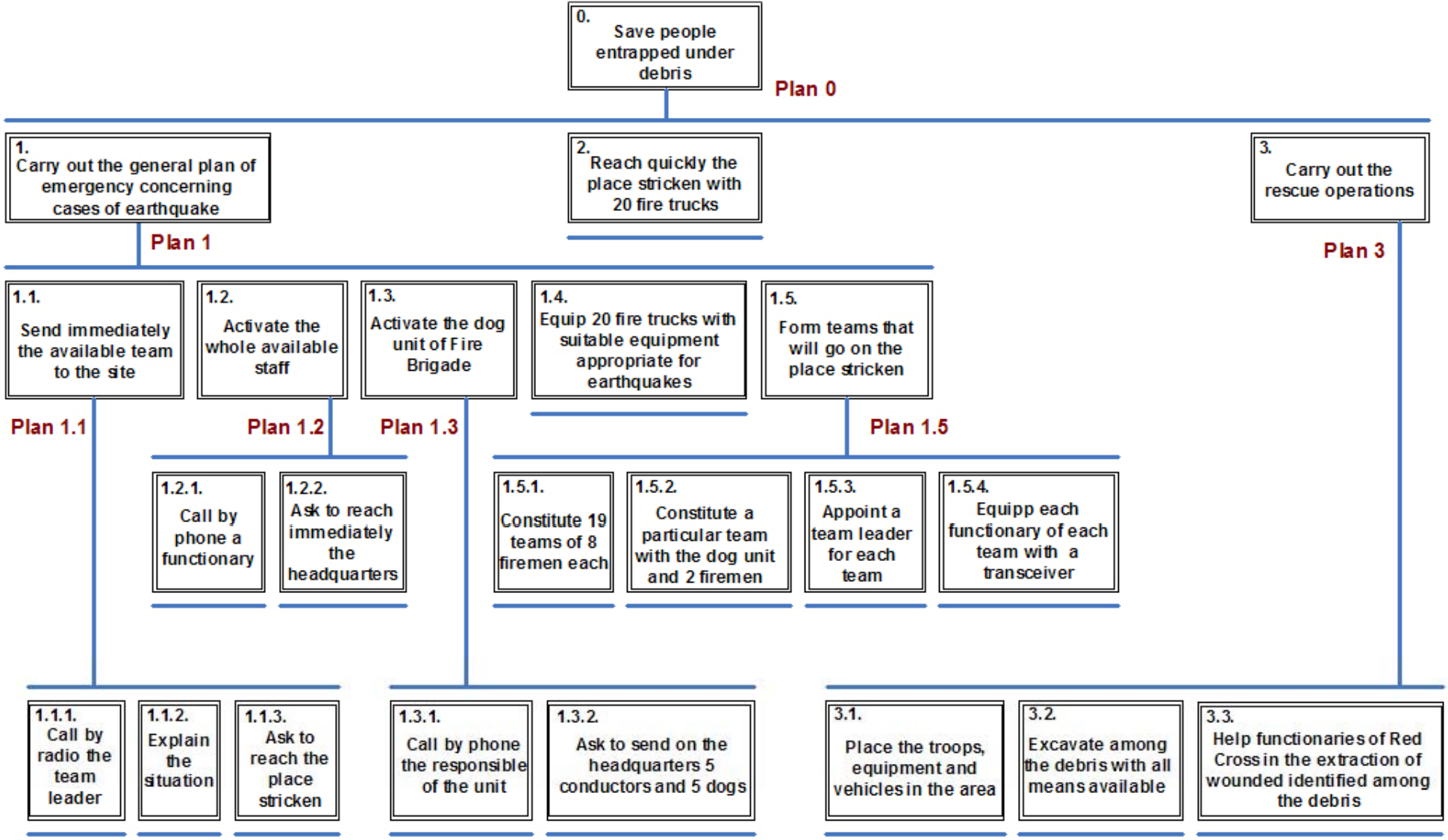
- Plan 2.2 : Do 2.2.1; then do 2.2.2 and 2.2.3 in any order
- Plan 3 : Do 3.1 and 3.2 in any order. Then do 3.3 and 3.4 in this order.
- Plan 4 : Do 4.1, 4.2 in this order. Then, if 4.2 has been successful, do 4.3; else do 4.4.
- Plan 4.1 : Do 4.1.1, 4.1.2 in this order.
- Plan 4.4 : Do 4.4.1, 4.4.2 in this order.

Storyboard "Evacuation of People"

- Actor : Vigili del Fuoco (Fire Brigade)
- Phase : Response Phase
- Initial State : The Fire Brigade headquarter of the zone is alerted by the Regional Civil Protection Department. In a building of 6 floors, 7 kilometers out of the city centre, water has partially flooded the ground floor (not inhabited). 40 people are captured - women, elderly and children. The number of the wounded people is not yet known.
- Relevant Conditions : Two ambulances move to the operational area. Some functionaries of Civil Protection are already at the place to manage the situation. Two police teams have already closed off the area in order to avoid safety problems.

Storyboard "Evacuation of People"

- Final State : The building must be evacuated in the shortest possible time in order to rescue all inhabitants.
- Main Goal : Rescue all people captured in the building
- Duration : 4-5 hours
- Dependencies :
  - Civil Protection: At first functionaries of Civil Protection make a census of inhabitants. After the arrival of the Fire Brigade at the operational area, their order is to give assistance to the already evacuated people.
  - Police: The policemen have a focus on maintenance of public security and on avoidance of rape.
  - Red Cross: Functionaries of Red Cross intervene when there are wounded people who have to be helped.



Plan of Execution :

- Plan 0: Do 1, 2 in this order. When the fire trucks arrive on the place stricken, do 3.
- Plan 1: Do 1.1, 1.2, 1.3 in the same time. Then do 1.4.
- Plan 1.1: Repeat 1.1.1, 1.1.2 in this order while all available functionaries haven't been alerted to reach the headquarters.
- Plan 1.2: Do 1.2.1, 1.2.2 in this order.
- Plan 1.4: Do 1.4.1, 1.4.2 in any order. Then do 1.4.3, 1.4.4 in any order.
- Plan 3: Do 3.1, 3.2, 3.3 in this order.
- Plan 3.2: Do 3.2.1, 3.2.2, 3.2.3 in this order

Storyboards and HTA for the Flood Scenario

- Some storyboards have been derived from flood scenario
- Each storyboard is analyzed through HTA, that describes the low-level tasks performed by the actor involved to reach the goal proposed.
- In order to understand better the analysis carried out, we propose a summary of the earthquake scenario used for obtain storyboards:

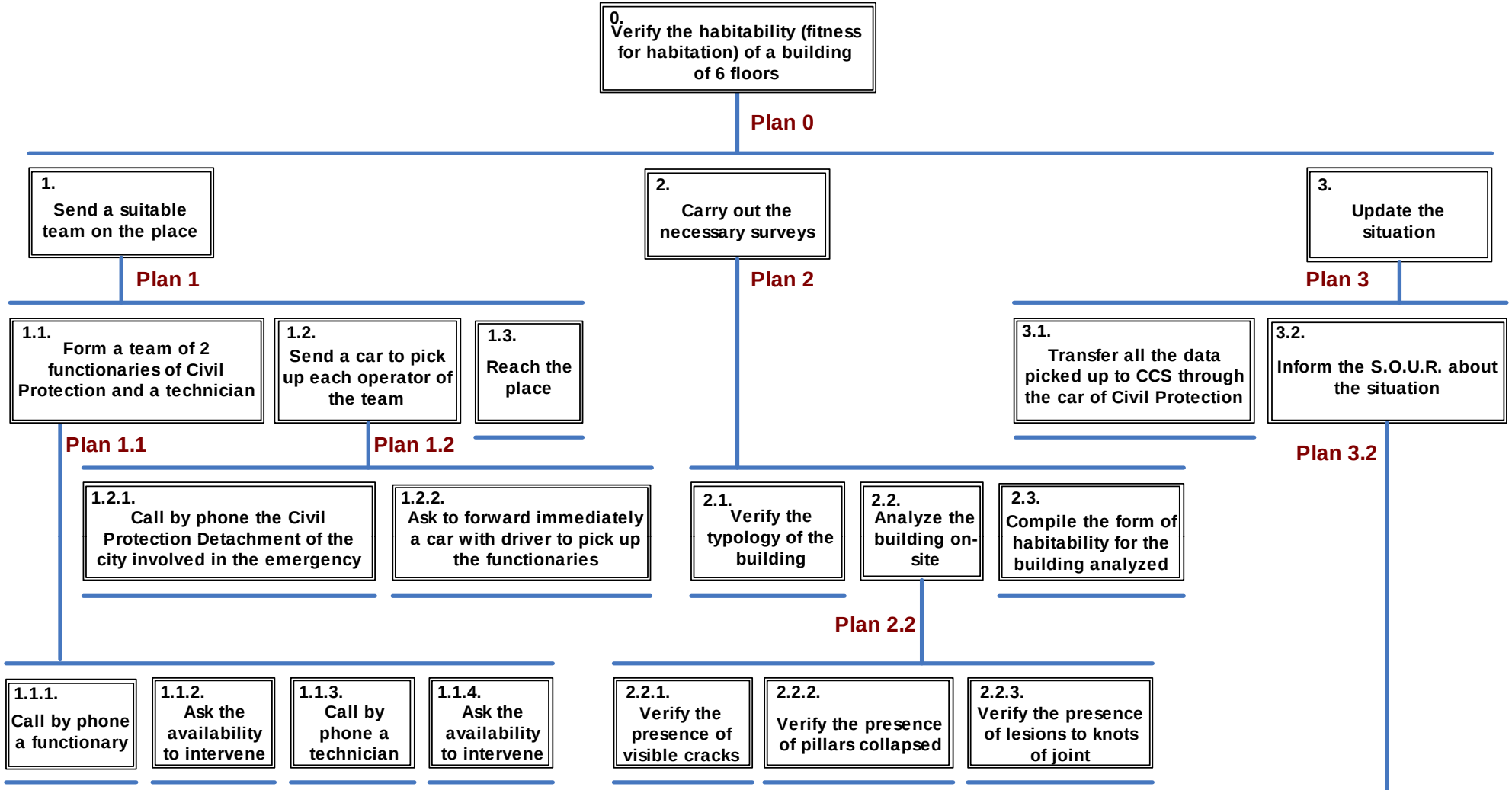
  "During the night a violent and unexpected downpour hit a Calabrian town of 34.000 inhabitants. The town is flooded, which makes the lifesaving operations difficult."

Storyboard "Verifying the habitability"

- Actor : Civil Protection
- Phase : Response Phase
- Initial State : S.O.U.R. is alerted by the CCS activated in prefecture. According to some notifications of citizens, the violent downpour that hit the city in the night has provoked the collapse of some pillars in a building of 6 floors situated in the city centre. It is necessary to go to the place to verify the habitability (fitness for habitation) of the building.
- Relevant Conditions : Since the great distance of the S.O.U.R. from the city affected by the emergency, it would be desirable to involve the Civil Protection Detachment of the city.

Storyboard "Verifying the habitability"

- Final State : The habitability of the building must be verified in the briefest possible time and the CCS must be informed about the results of the verification.
- Main Goal : Verify the habitability of a building
- Duration : 2-3 hours
- Dependencies :
  - Civil Protection: It acts directly in the city involved in the emergency. It is coordinated by S.O.U.R.



Plan of Execution :

•Plan 0 : Do 1. When the Civil Protection staff arrives on the place stricken do 2, 3 in this order.
•Plan 1 : Do 1.1, 1.2, 1.3 in this order.
•Plan 1.1 : Repeat 1.1.1, 1.1.2 in this order while at least 2 functionaries haven't been alerted to intervene. Then repeat 1.1.3, 1.1.4 in this order while at least a technician hasn't been alerted to intervene.
•Plan 2 : Do 2.1, 2.2, 2.3 in this order for the villa in which the collapse has happened. Then repeat these tasks while all the buildings in the immediate proximities have not been verified.
•Plan 2.2 : Do 2.2.1, 2.2.2, 2.2.3 in any order.
•Plan 3 : Do 3.1, 3.2 in any order.
•Plan 3.2 : Do 3.2.1, 3.2.2 in this order.

From Task Analysis to Use Cases

- The design of :
  - scenarios (the macro level)
  - storyboards (the medium level)
  - task analysis (the micro level)

  allows to define very detailed User Requirements and Use Cases.

- In WORKPAD User Requirements have been categorized according to forms categories:
  - general, communication, Back-End and Front-End.

A Summary of final User Requirements listing

General (G)

- G-3 The user must be able to access spatial as well as non-spatial information through one platform.
- G-11 The user must be able to exploit the WORKPAD system in all kinds of disasters (natural, technical and man-made).
- G-12 The user must be able to access relevant data-sources of different organizations involved in the emergency management process through WORKPAD.
- G-17 The user must be supported in her relevant work-flows in emergency situations by appropriate and adaptive process management techniques within WORKPAD.
- G-29 Usability issues shall be taken into account.
- G-31 The user shall be able to get (quasi) real-time and comprehensive information about the current status of the situation.
- G-37 The user shall be supported in her coordination activities by geographic data.

A Summary of final User Requirements listing

Communication (C)

- C-1 By using WORKPAD, the user must be able to be connected between different organizations involved in an emergency.
- C-4 The user's communication must be guaranteed via fault-tolerant network services.
- C-6 The user must not notice dynamic joins or leaves of network nodes; instead the network must be able to (re-)configure itself.

Back-End (B)

- B-4 The user must be able to access various data sources integrated in the BE through a well-known interface.
- B-11 Users must be able to get notifications about (generic) information updates at the inter-organizational level related to subscriptions.
- B-14 The user must be able to query geographic data from the BE.

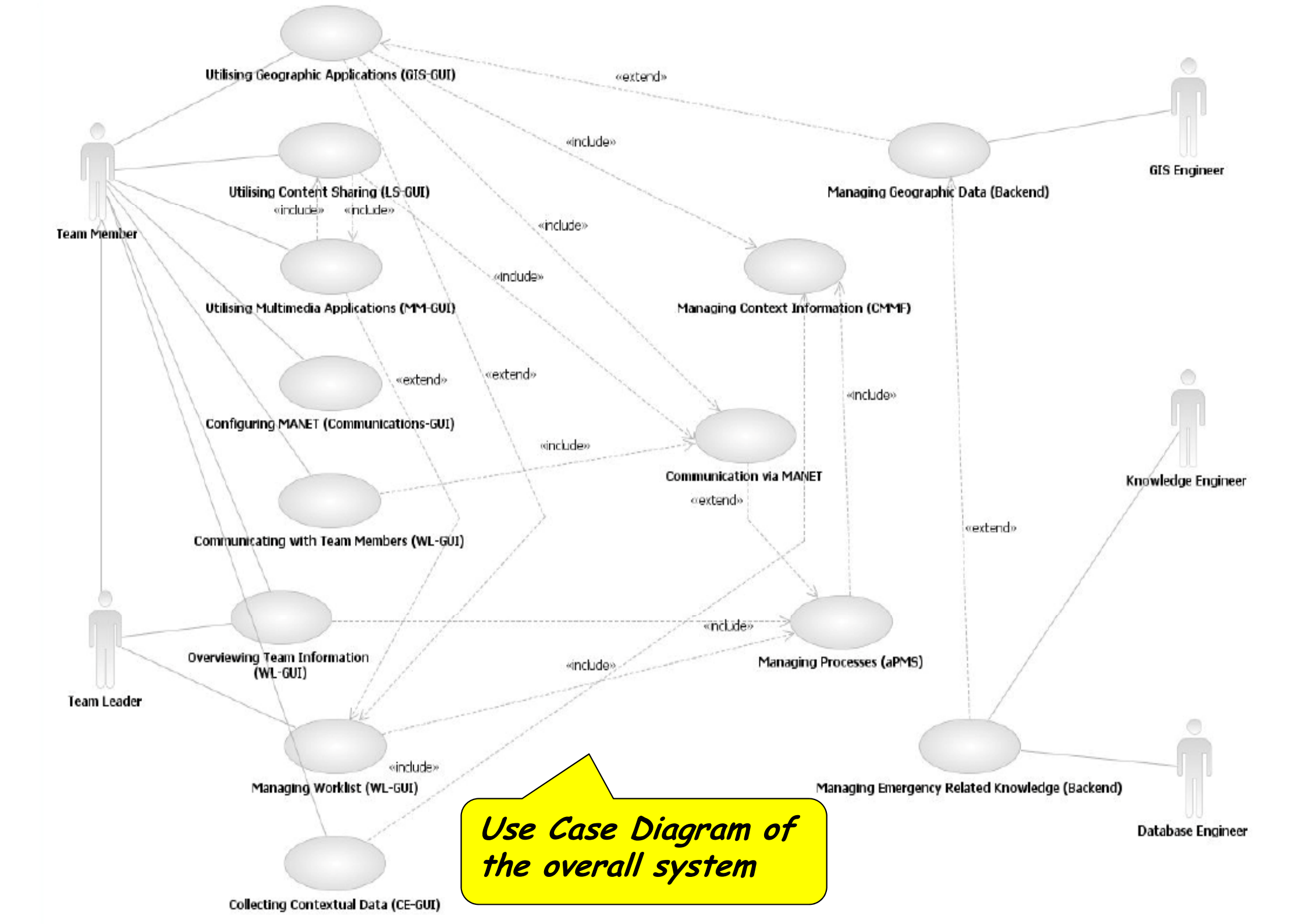
A Summary of final User Requirements listing

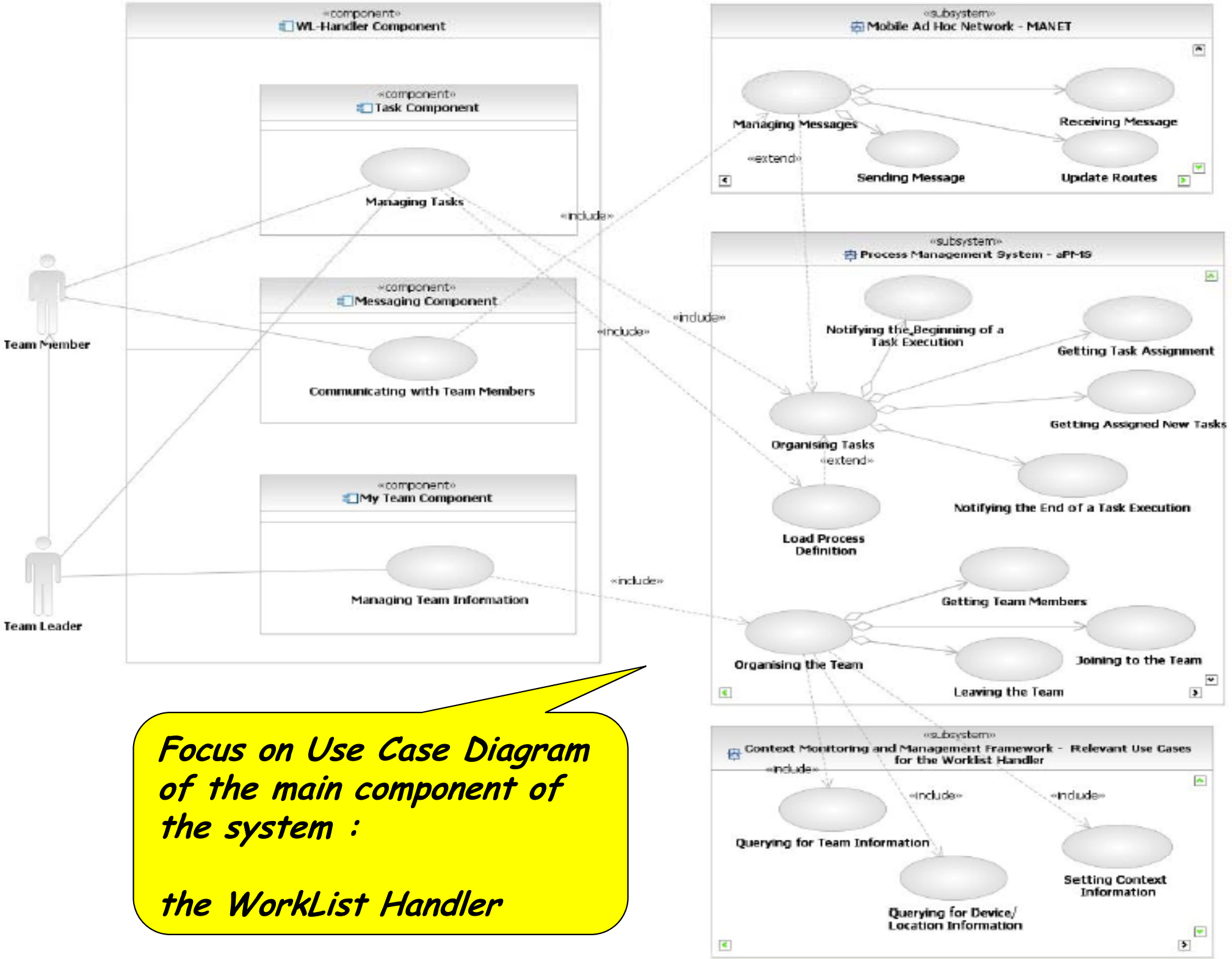
Front-End (F)

- F-1 The users in FE teams must be able to electronically communicate with the BE and request data.
- F-2 The users in FE teams must be able to deliver information to the BE.
- F-7 The user must be supported by notification mechanisms.
- F-9 Information must be presented to the user in an appropriate, user-friendly (i.e. usable) way.
- F-20 The users of FE teams should be supported by the WORKPAD system in collaboration, data exchange, and the exploitation of distributed services and information when operating in the field.
- F-21 The user must be able to communicate with other team members via text\audio messages.
- F-24 The user must be provided with current positions of objects (e.g., vehicles,buildings) or persons (other team members) of interest.
- F-25 The user must be able to create, modify, or annotate points of interests on a digital map.

User Requirements serves as input for the use cases…

…and System Requirements are the outputs.

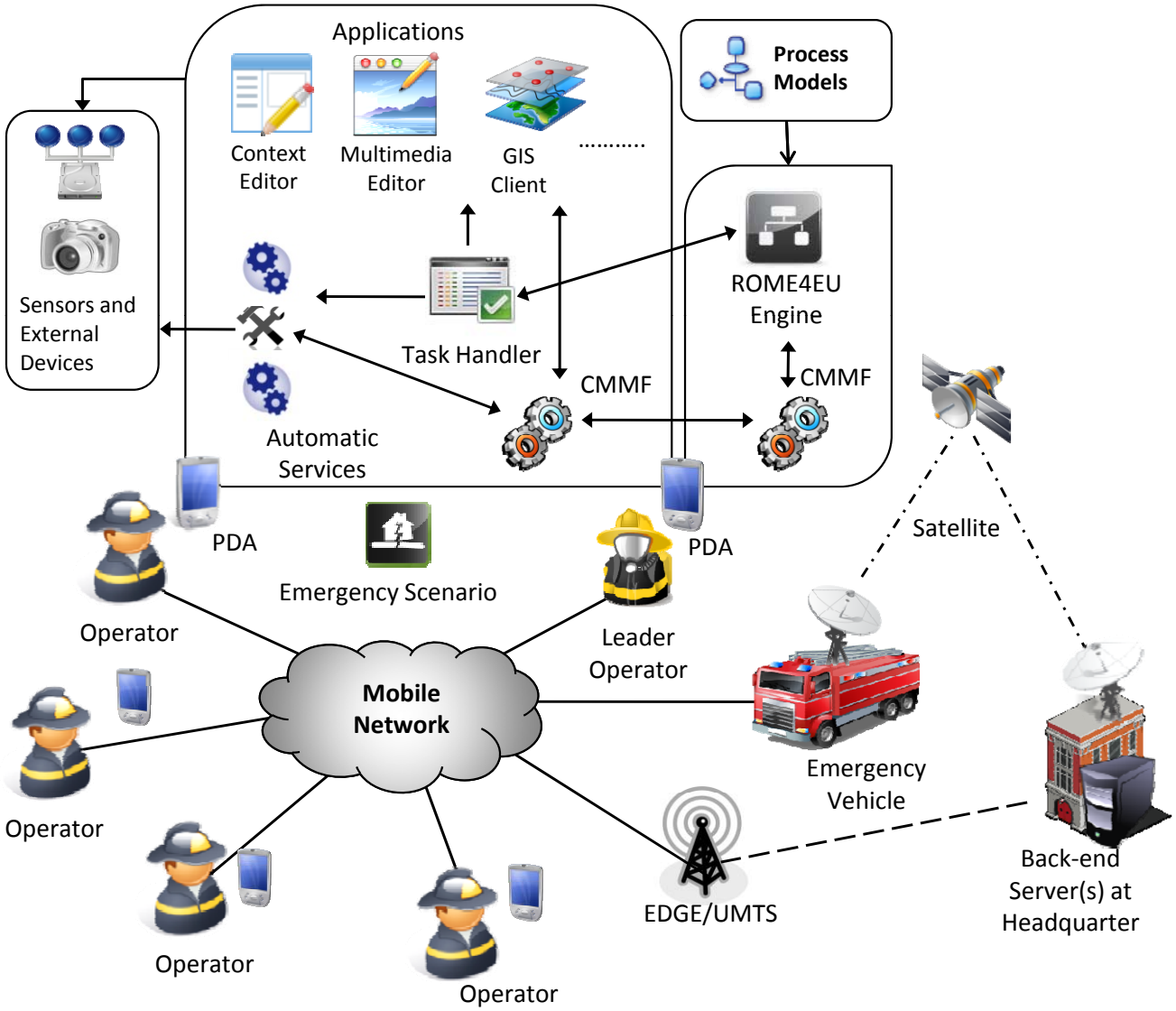

Utilising Geographic Applications (GIS-GUI)
«extend»
GIS Engineer
Utilising Content Sharing (LS-GUI)
«include»
Managing Geographic Data (Backend)
Team Member
«include»
«include»
«include»
Utilising Multimedia Applications (MM-GUI)
Managing Context Information (CMMF)
«extend»
«extend»
«include»
Configuring MANET (Communications-GUI)
Knowledge Engineer
«include»
Communication via MANET
«extend»
Communicating with Team Members (WL-GUI)
«extend»
Overviewing Team Information (WL-GUI)
«include»
«include»
Managing Processes (aPMS)
Team Leader
«include»
Managing Worklist (WL-GUI)
Managing Emergency Related Knowledge (Backend)
Database Engineer
Collecting Contextual Data (CE-GUI)
Use Case Diagram of the overall system


«component»
WL-Handler Component
«component»
Task Component
Managing Tasks
«component»
Messaging Component
Communicating with Team Members
«component»
My Team Component
Managing Team Information
Team Member
Team Leader
«include»
«include»
«include»
«include»
«subsystem»
Mobile Ad Hoc Network - MANET
Managing Messages
Receiving Message
«extend»
Sending Message
Update Routes
«subsystem»
Process Management System - aPMS
Notifying the Beginning of a Task Execution
Getting Task Assignment
Getting Assigned New Tasks
Organising Tasks
«extend»
Notifying the End of a Task Execution
Load Process Definition
Getting Team Members
Organising the Team
Joining to the Team
Leaving the Team
«subsystem»
Context Monitoring and Management Framework - Relevant Use Cases for the Worklist Handler
«include»
«include»
«include»
Querying for Team Information
Setting Context Information
Querying for Device/ Location Information
Focus on Use Case Diagram of the main component of the system :
the WorkList Handler

An Example of System Requirement

ID	UC-WLH-2
Use Case Name	Communicating with Team Members
Brief Description	Interact with each other by an audio or textual communication.
Actors	Team Member, Team Leader
Preconditions	Communication devices
Final State(s)	Sended audio or textual messages.
Main Flow	1. The actor receives an incoming message. 2. The system displays it. 3. The system broadcasts new message to all team members and also to the team leader. 4. The system displays overview of the received messages.
Alternatives	None.
Related System Requirements	WH-F-2
Related User Requirements	G-28, F-21, F-22
Included Use Cases	UC-Abstract-MANET-1
Extended Use Cases	None.
Frequency of Execution	Very often.
Created by	Andrea Marrella
Date created	13/12/2008
Last Updated By	Andrea Marrella
Date Last Updated	22/02/2008

The Final Architecture



Mock-Up of the Worklist Handler

Three categories easily accessible through the use of tabs on the left side of the screen

Every macro-category is characterized by a different color, so that the user gets easier to memorize and locate the context where s/he is

Low probability to push the wrong button

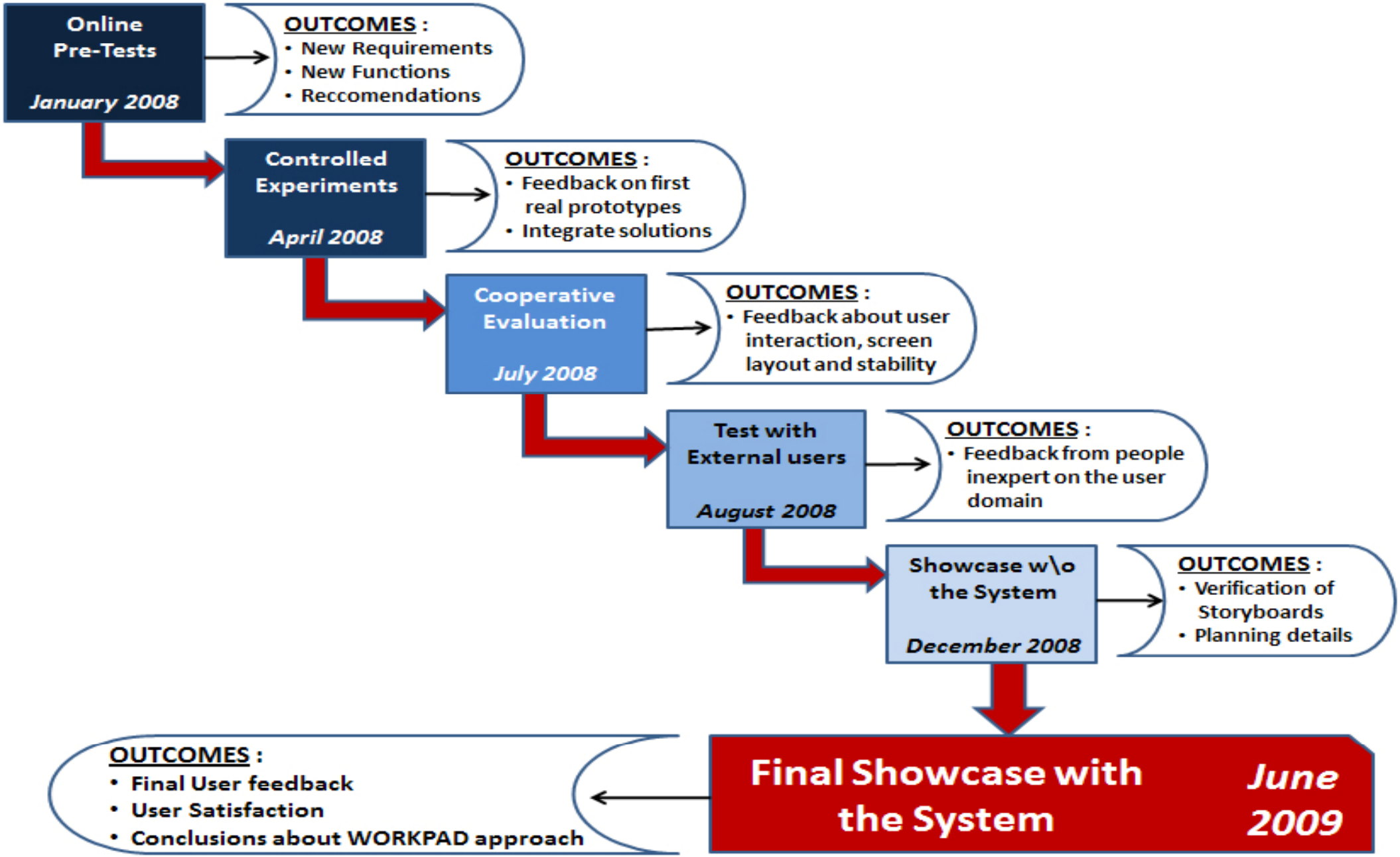
Tasks organized on the screen in a hierarchical way

Each category contains only the essential information

Overview

- User Test Methodology
  - Online Pre-Tests
  - Controlled Experiments
  - Cooperative Evaluation
  - Test with External Users
- The WORKPAD Showcases
  - Without and with WORKPAD

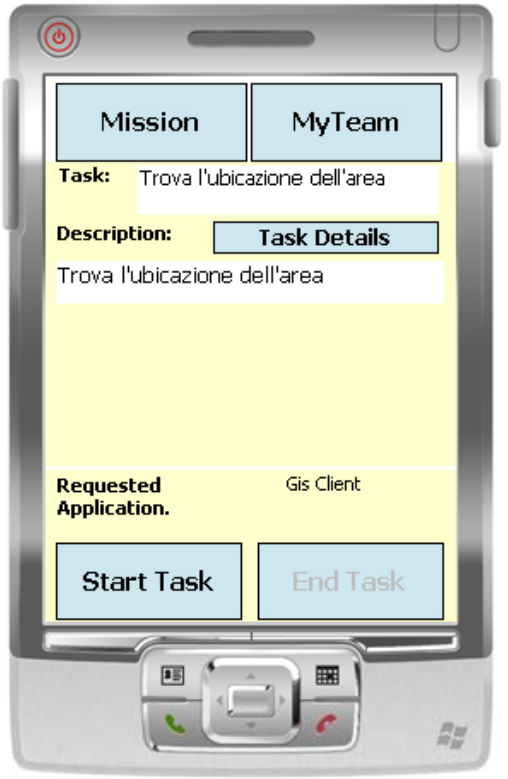
User Test Methodology



Gradual improvement of the User Interface

Controlled Experiments

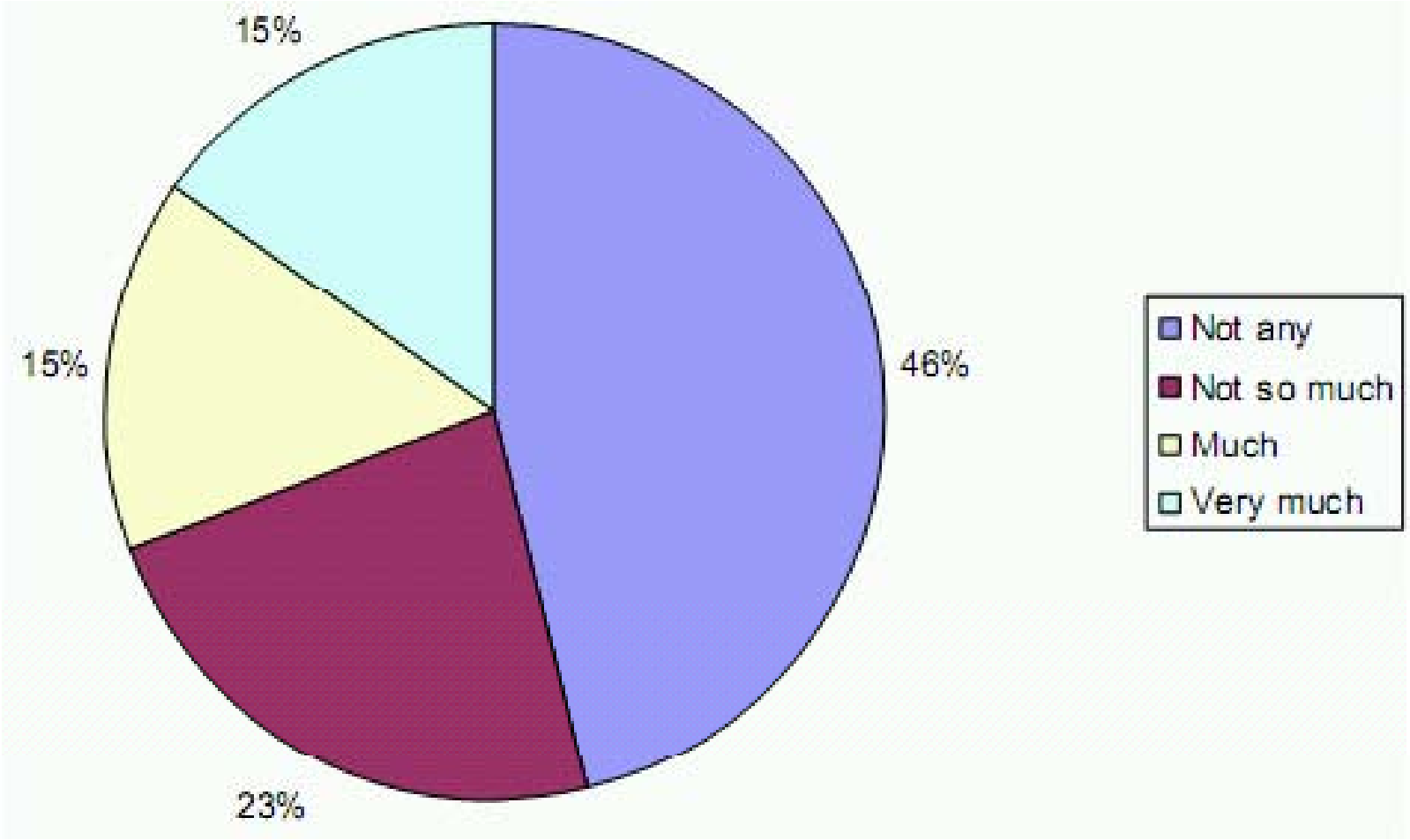
Cooperative Evaluation



On-line pre-tests

- Mock-ups (Web and Powerpoint) available and ready to be tested with potential users
  - The main goal is to gain a first insight into the level of usability and understandability.
  - Important to get feedback from the users, if the requirements were understood correctly and are adequately met by the system features.
- Questionnaire (Web) : questions about task management, map overview, connection establishment, multimedia and context editor, file sharing
- 13 users (8 male and 6 female) from Calabria region, 3 of age 46-60 and 10 of age 31-45, with different experience with PDA's participated in the test

Example Results: Experiences with PDA's



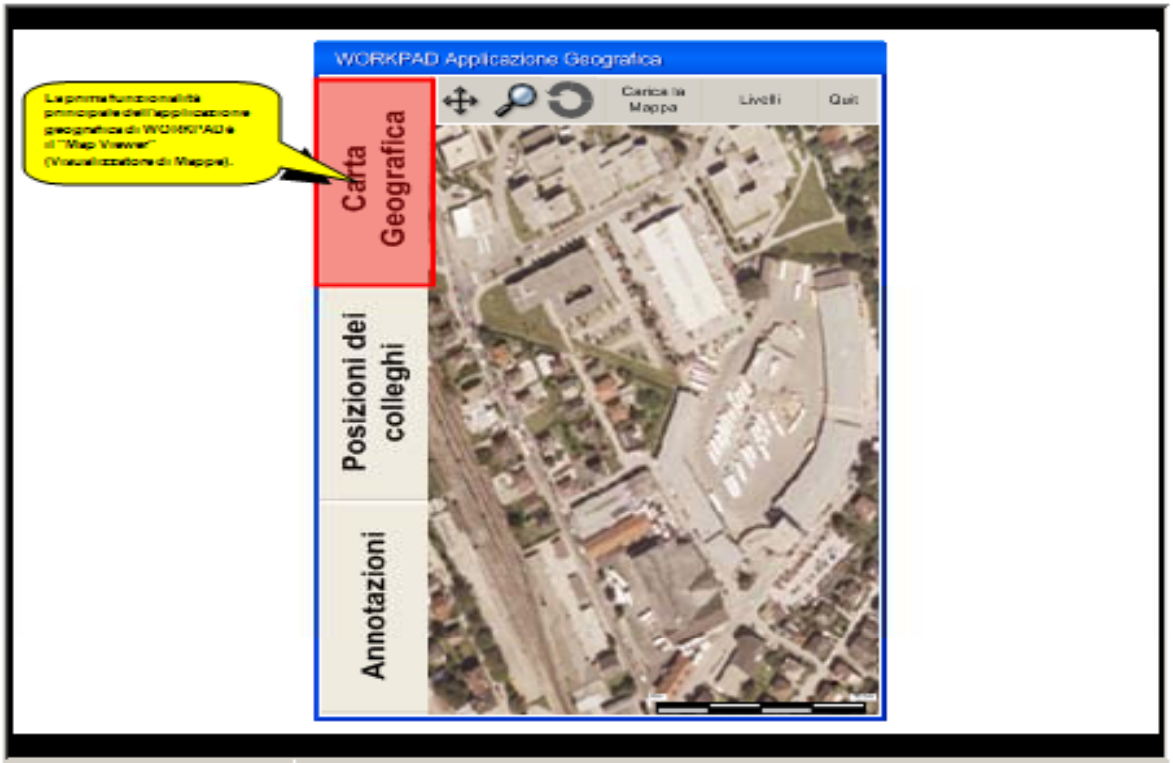
MAP OVERVIEW

Imagine you work for the fire brigades and are currently at the emergency area where your task is to first of all rescue people out of the debris. A young women needs your help! You are not able to help her on your own and therefore want to know where the other team members currently are. With the help of the map overview you can locate them in the area and call them for help.

The **map overview** provides:

- geographic information of the affected area
- position information about team members that are present in the emergency area
- map interaction functionalities
- functionalities for transferring geographic information to other team members

Please go carefully through the following graphics and descriptions of the map overview and answer the questions then!
Start the presentation with a mouse click at the link "presentation" (see: down to the right)



If the presentation does not work well, please use the following link:

http://www.salzburgresearch.at/~rstein/srfg/mockup.ppt

11. Would a digital map be helpful for your daily work?

For your information:
If your answer is "no", you will move automatically to the next section of the questionnaire!

- ○ yes
- ○ No

12. Is the map view interface understandable and intuitive for you?

- ○ Yes
- ○ No
- ○ If no, please mention why:

13. How attractive is the map screen design for you?

Very attractive	attractive	less attractive	Not attractive
○	○	○	○

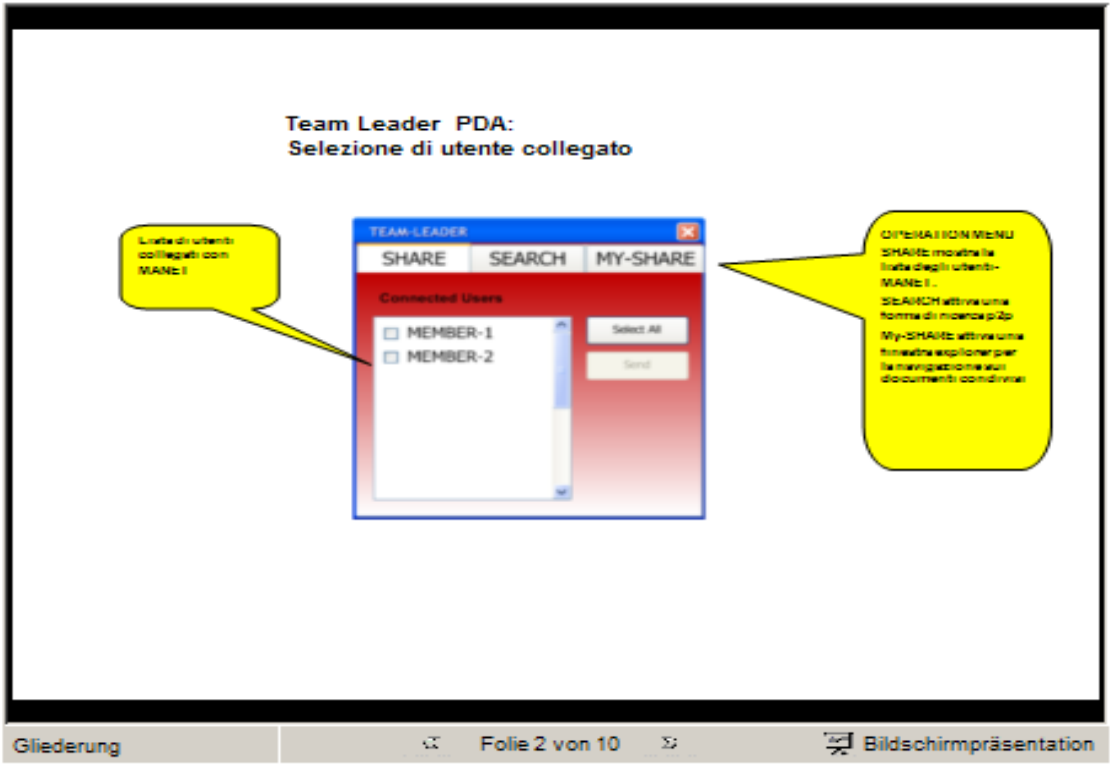
14. Do you consider the "Team Member's Position" functionality as useful?

○ very useful ○ Useful ○ Not so useful ○ useless

FILE SHARE

Think of a situation out in the emergency area where you want to share actual damage documentation of a bridge with your team partner over your handheld device. The **file share** component makes this possible! You can send files from one device to another device.

Please go carefully through the file share presentation and then answer the questions!
Start the presentation with a mouse click at the link "presentation" (see: down to the right)!



If the presentation does not work well, please use the following link:

http://www.salzburgresearch.at/~rstein/tor/mockup.ppt

33. Did you understand the presentation about the file share component?

- ○ Yes
- ○ No

Controlled Experiments

- Lab environments under controlled conditions.
- Bilateral meeting with end users.
- Direct feedback gained by the technical team of WORKPAD.
- It is very useful to analyze carefully the systems currently used by end users.
- E.g., end users showed us the current-day GIS systems they use, thus giving us useful hints into the most valuable data they are interested in having access.

- These tests are intended to observe users when use the system and to discover open issues and areas of improvement.
- Special focus was given to the communication and the integration of the different components: users should feel the impression to work with a single system rather than with different components.

Controlled Experiments

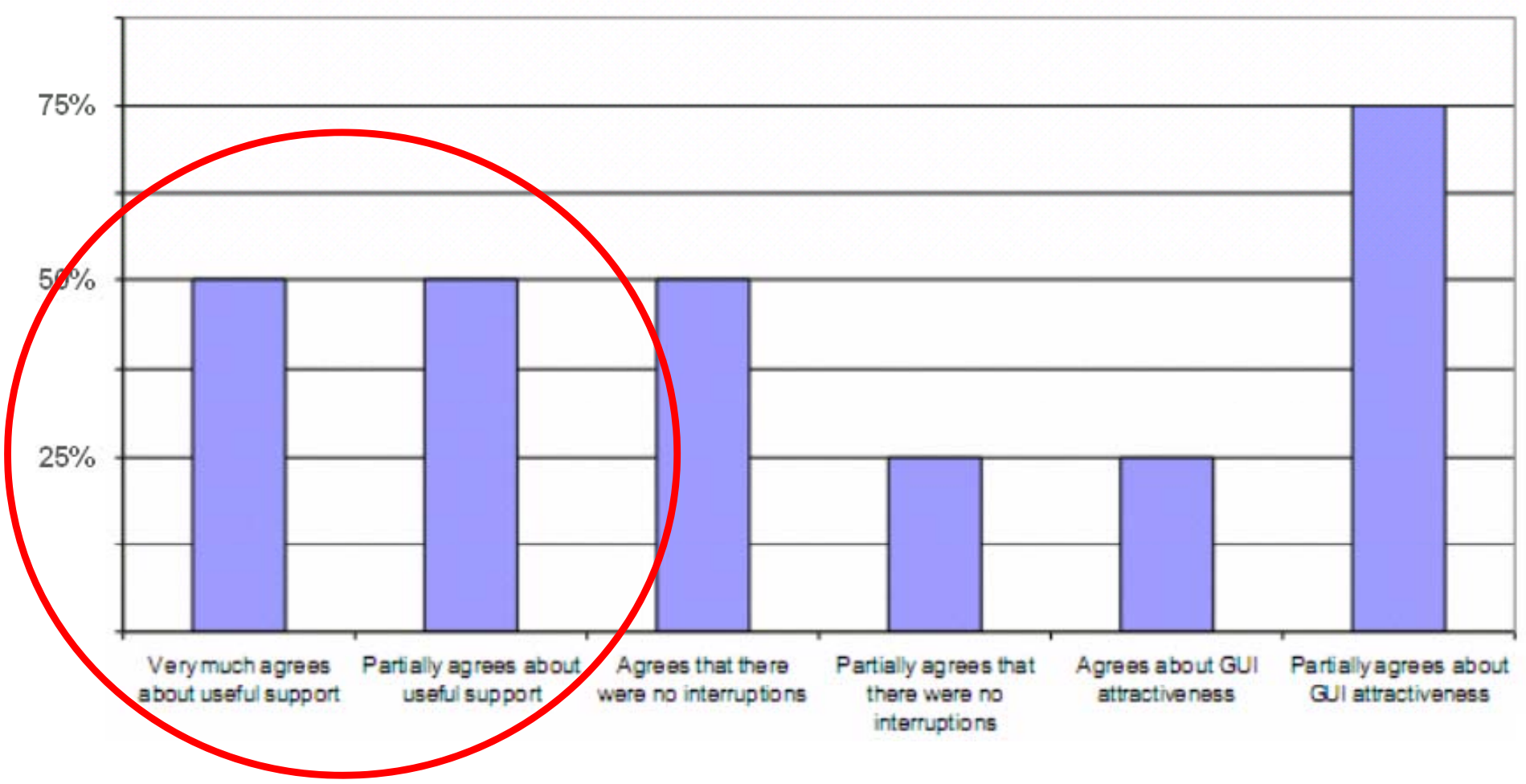
- After this phase, we were able to envision several improvements:
  - It is very important that the user interface of the WORKPAD system is easily understandable and easily usable: the emergency operators are in critical conditions (stress, sometimes dangerous, ...) while facing an emergency.
  - The different components needs to be fully integrated so that they look like one system, rather than different systems.
  - Concerning the Task-list Handler the users mentioned that it will be very helpful and save them time in case of an emergency.

Cooperative Evaluation

- First real user tests with prototypes on mobile devices in the real-world context.
  - Thus ensuring a "usable" interface
- These tests are an useful and necessary step towards the final showcase.

Cooperative Evaluation

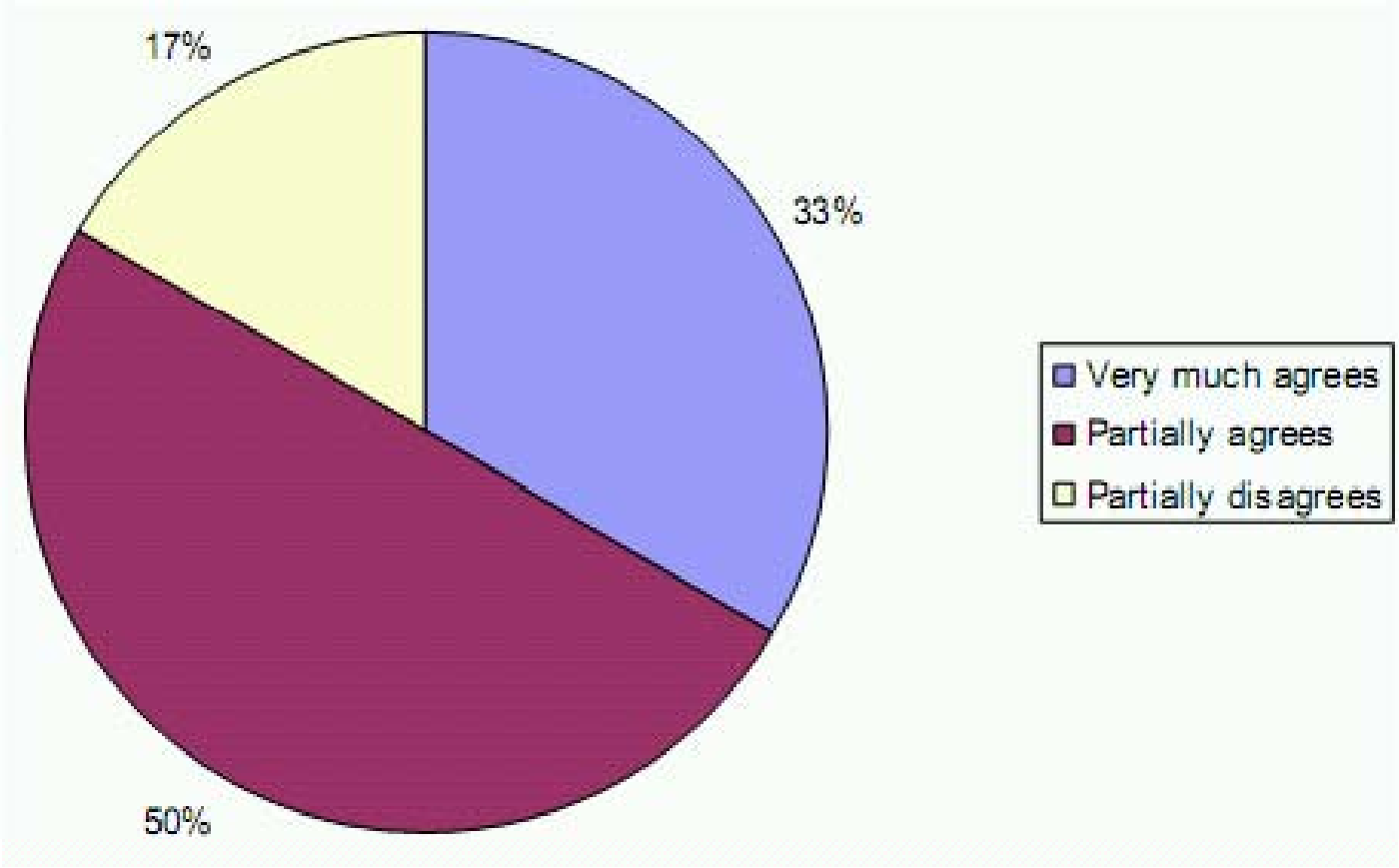
- Then users were asked to interact with the system in order to complete a specific task.
- Evaluators guided the users through the test and continuously interacted with them in order to gather information on user satisfaction.
- These tests were recorded by cameras in order to analyze the level of the usability of the system off-line and look for recurrent usage patterns that possibly could be speeded up.


75%
50%
25%
Very much agrees about useful support
Partially agrees about useful support
Agrees that there were no interruptions
Partially agrees that there were no interruptions
Agrees about GUI attractiveness
Partially agrees about GUI attractiveness

Test with External Users

- External users are those who are inexpert of emergency management but showing comparable technological skills.
- Executed by each technical partner
  - ⇨ 4-6 users per Project partner

Example Result



The WORKPAD Showcases

Pentidattilo, Calabria, Italy

First Showcase without WORKPAD

- Intention of the WORKPAD team:
  - A better understanding of real world activities.
  - Verifying if storyboards are feasible and realistic.
  - Become familiar with the showcase site Pentidattilo.

Where is Pentidattilo?

Some Impressions…

Some Impressions…

Interviews

- After the execution of the storyboards we interviewed three people involved to get feedback for the final (small) improvements before the showcase with the WORKPAD system.
- We interviewed the following people:
  - 1 volunteer of civil protection
  - 1 member of the dog unit
  - 1 person supporting the dog unit

End-user comments after the interviews

- Currently the different emergency organisations mostly use radio communication in order to talk with their colleagues.
- Appreciation to have a GIS system on PDAs so as to be able to move around and be informed about the current situation on the display at a quick glance.
- Nowadays, they receive additional information (e.g., about weather) by voice communication, but it would be helpful to have this information constantly updated

Second Showcase *with* WORKPAD

- Goal:
  - ⇨ Show and evaluate the prototypical implementation of the reference architecture proposed in the project WORKPAD
- Taken place in Mid of June 2009
- One week of showcase
- Six end-user organisations
- Four storyboards

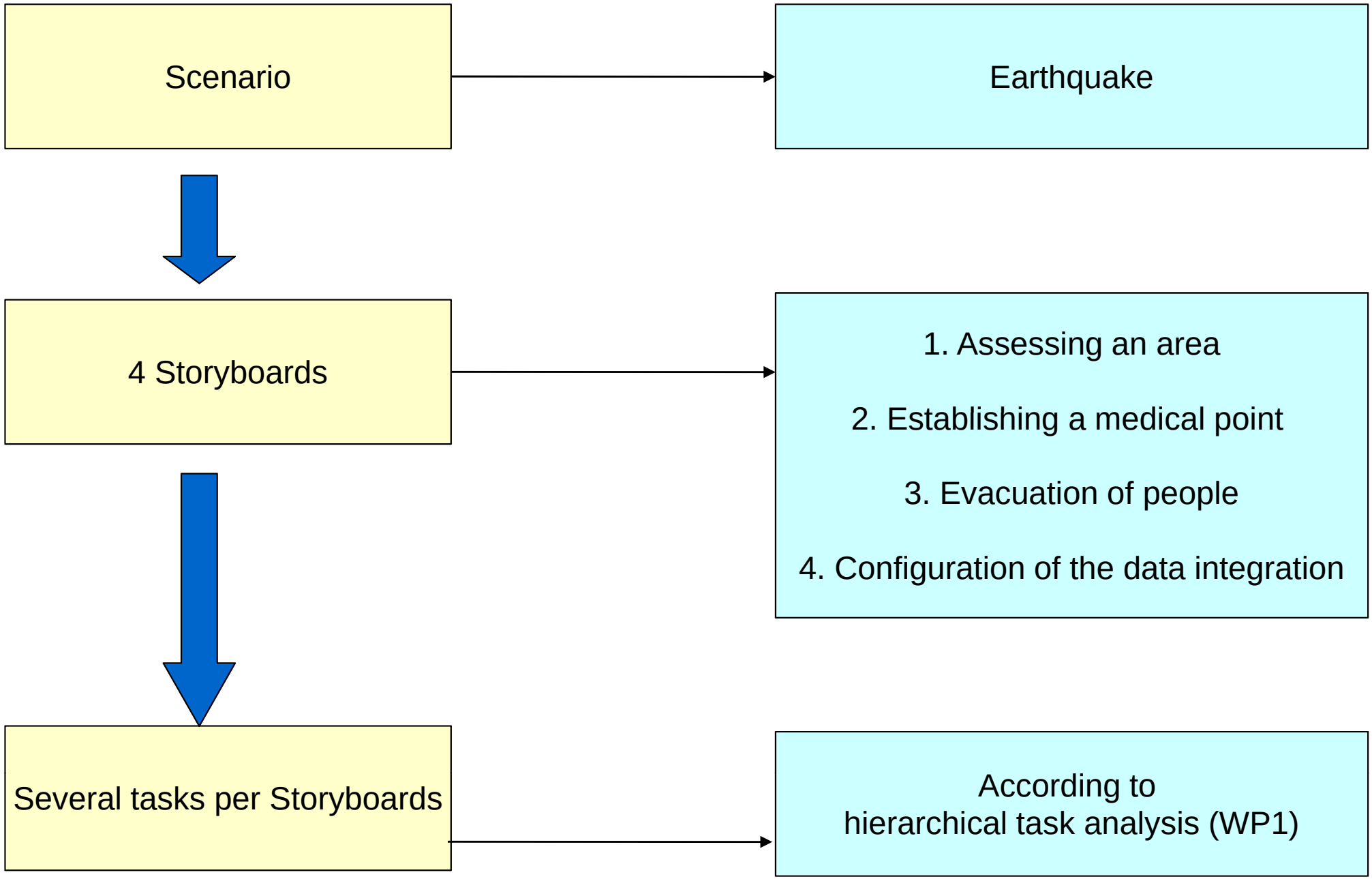
The Showcase Week

- Day 1:
  - Arrival and first test runs
- Day 2:
  - On-site tests in Pentidattilo
- Day 3:
  - User training
- Day 4:
  - Execution of SB1, 2, 4, and 3
- Day 5:
  - Dissemination event and showcase reflection meeting

User Organisations

- Carpo Nazionale dei Vigili del Fuoco (VVF)
  - The Fire Brigade Provincial Headquarters
- Corpo Nazionale Soccorso Alpino e Speleologico (CNSAS)
  - Alpine Aid and Speleologic National Body
- Servizio di Urgenza ed Emergenza Medica (SUEM)
  - Service of Urgency and Medical Emergency
- Croce Rossa Italiana (CRI)
  - Italian Red Cross
- Europa Unita (EU)
  - Voluntary organisation
- Confraternita Misericordia (CM)
  - Voluntary organisation

Second Showcase *with* WORKPAD



The 4 Storyboards

SB1: Assessing an area

SB2: Establishing a medical point

SB3: Evacuation of people

SB4: Configuration of the data integration

Components Invoked per User

- Example Storyboard 1

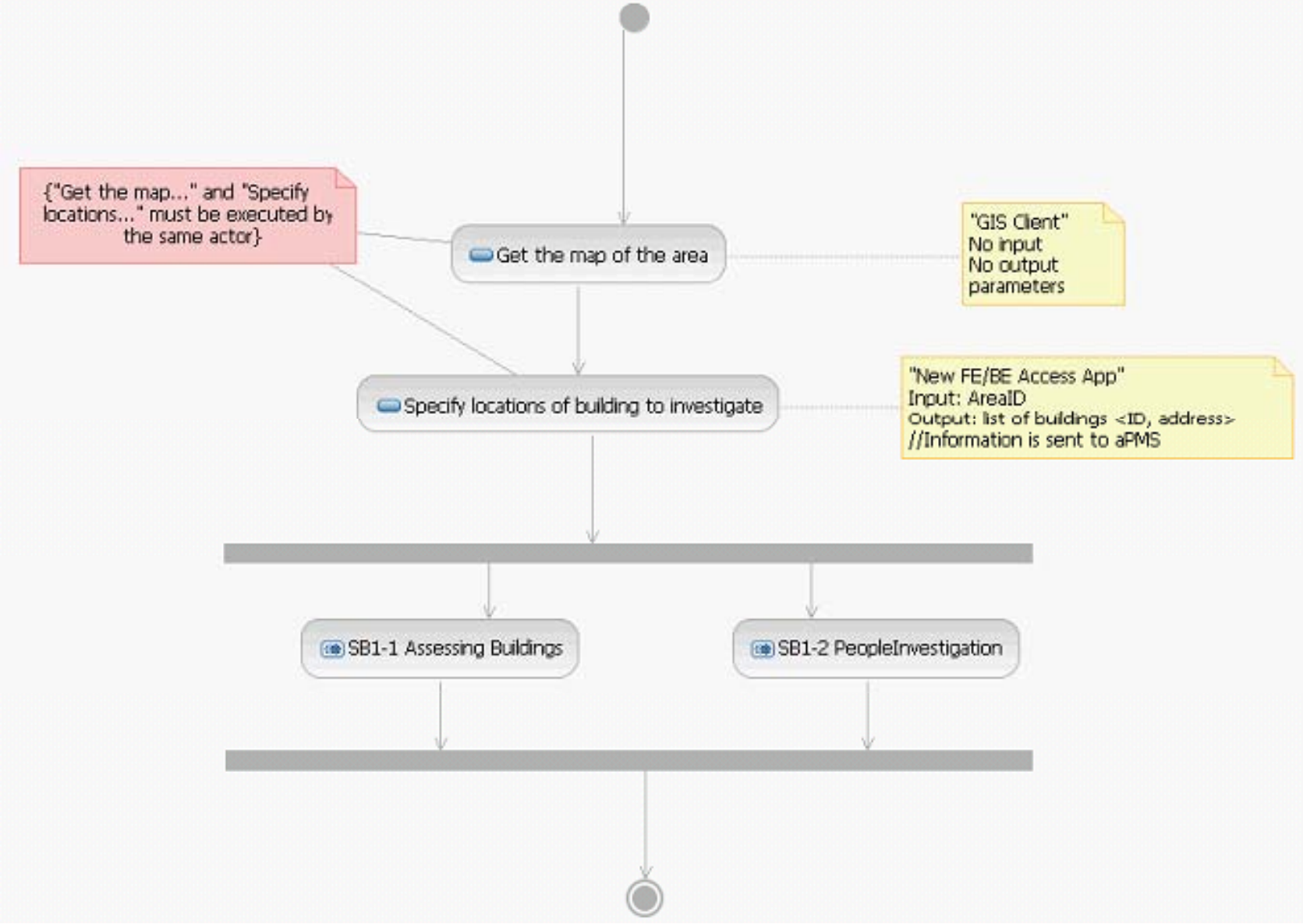
	Process Management	Task-list Handler	Context Monitoring	Context Editor	Multimedia Editor	GIS Client	Lightweight Storage	BE Access
Member 1 /Leader	X	X				X		X
Member 2	X	X	X	X	X		X	X
Member 3	X	X	X	X	X		X	X
Member 4	X	X	X	X	X		X	X
Member 5	X	X	X	X				X
Member 6	X	X						X
Member 7	X	X						X
Member 8	X	X						X

Components per User

	Process Management	Task-list Handler	Context Monitoring	Context Editor	Multimedia Editor	GIS Client	Lightweight Storage	BE Access
Member 1 /Leader	X	X				X		X
Member								
Member								
Member								
Member								
Member								
Member								
Member								

	Process Management	Task-list Handler	Context Monitoring	Context Editor	Multimedia Editor	GIS Client	Lightweight Storage	BE Access
Member 1 /Leader	X	X				X		X
Member 2	X	X				X		X
Member 3	X	X				X		X
Member 4	X	X				X		X
Member 5	X	X				X		X

SB1:
On-Site Documentation



Documentation

- Task execution forms
- Interview questionnaires
- Video recording, Action Cam

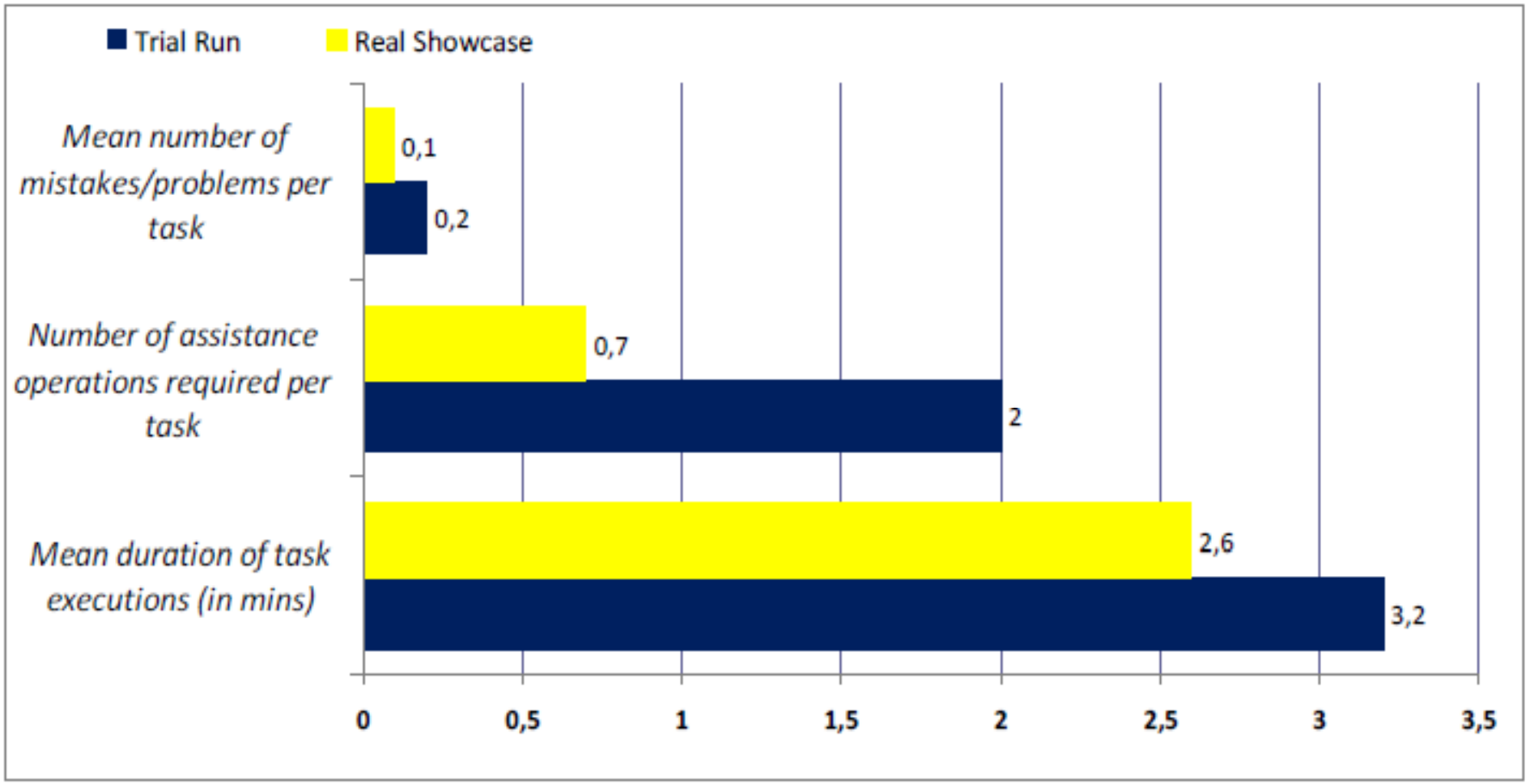
MOVIE of the SHOWCASE

http://www.youtube.com/watch?v=idou2NkhPTg

Selected Analysis Results

- Metrics
  - ⇨ Time span, number of required assists, correct task outcome, number of errors
- Evaluation is based on task execution forms and interviews
- Trial and "real" execution
  - ⇨ For interesting conclusions: all mean values dropped meaning that users accustomed quickly

Example Results

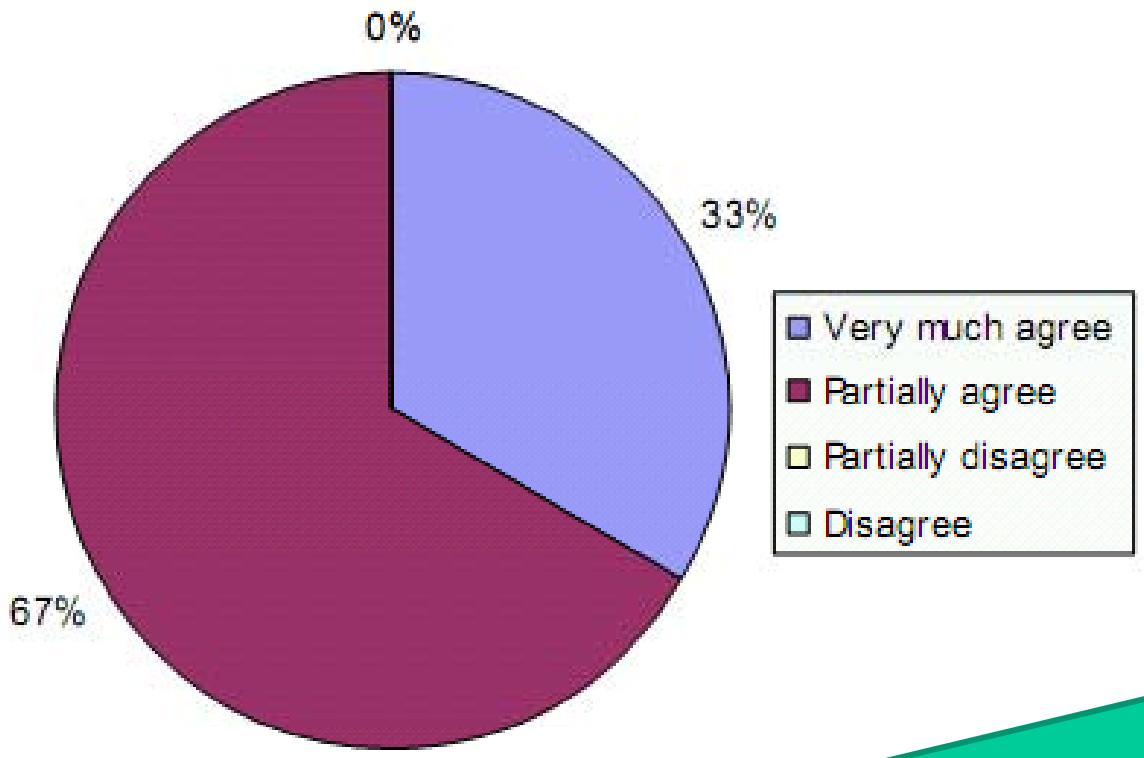


Interviewees

After each storyboard execution, 12 users were interviewed to get information on user satisfaction and to collect proposals for further improvement of WORKPAD.

	First Name	Last Name	Organistion name	Role in the organisation	Tasks in the organisation	Age	gender	Interviewer name
1			Soccorso Alpino	2nd chief in the station Aspromonte	preparing in peace time, instructor, trainer, all rescue tasks	42	M	Matteo
2			Regione Calabria - Unita Operativa Protezione Civile	worker in the department	Management and coordination of associations of volunteers	52	M	Angela
3			Le Pantere Verdi	Volunteer	logistic support in emergency situations, natural hazards, breakdown service	18	M	Matteo
4			Le Pantere Verdi	Volunteer	logistic support in emergency situations, breakdown service	21	F	Angela
5			Soccorso Alpino	Volunteer	Find and rescue lost people in the mountain	24	M	Renate, Angela
6			Civil Protection Calabria	Technical administration	Technician, Administrator	45	M	Allessandro
7			Civil Protection Calabria	Volunteer	Coordinator	25	M	Michele
8			PCRC	Technician		56	M	Massimo
9			Le Pantere Verdi	Administration	Treasurer, Administration, coordination of the logisitics group	43	F	Daniele
10			Soccorso Alpino	Volunteer		35	M	Michele
11			Soccorso Alpino	generic worker	technical assistant of the CNSAS	39	M	Allessandro
12			Le Pantere Verdi	President, coordinator of the organisation at national level	coordination of emergency teams	28	M	Allessandro

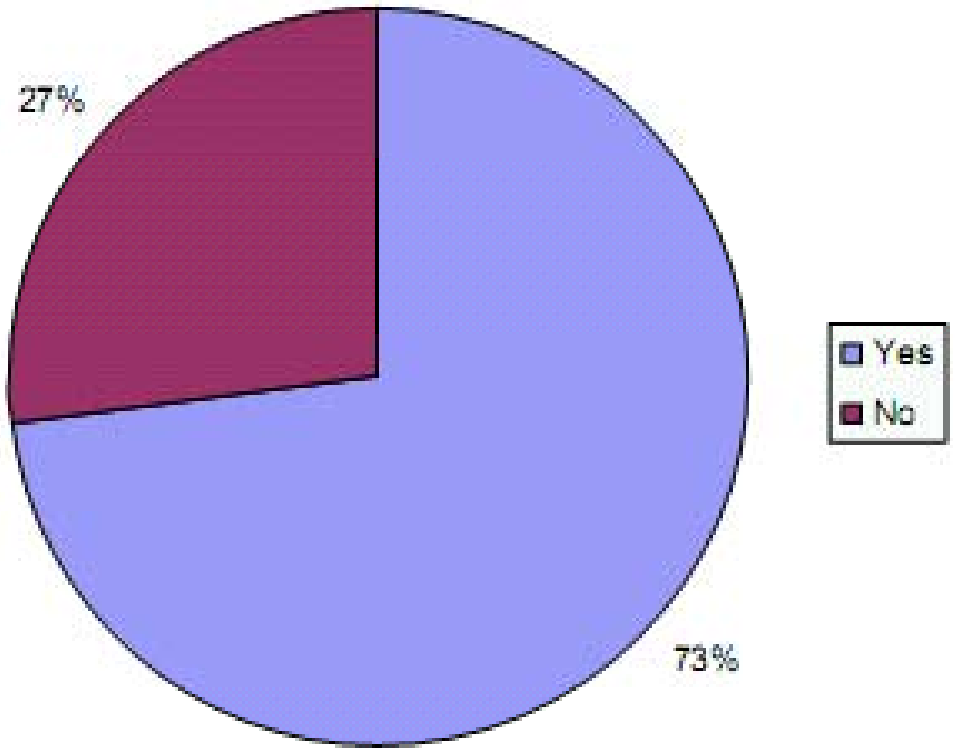
Example Results



Some users had problems with visibility on the screen in the blazing sun

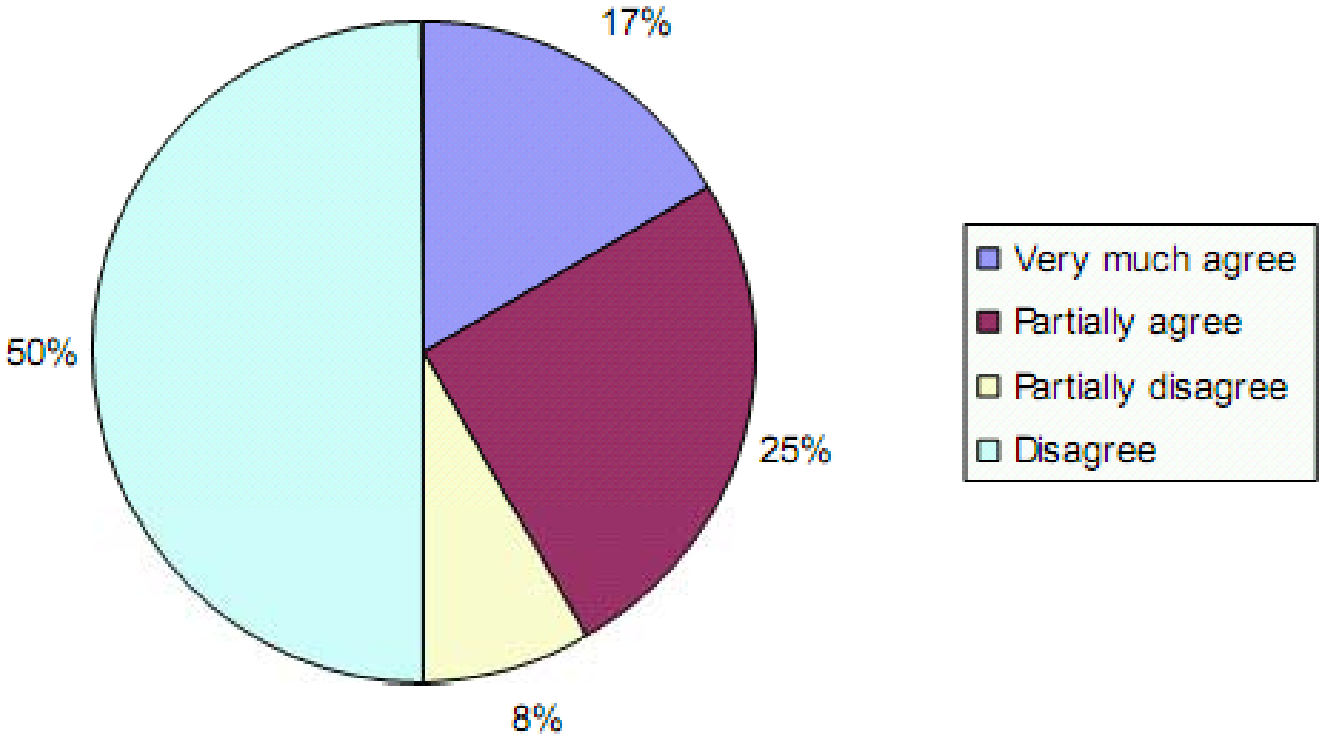
WORKPAD is easy and intuitive to use.

Example Results



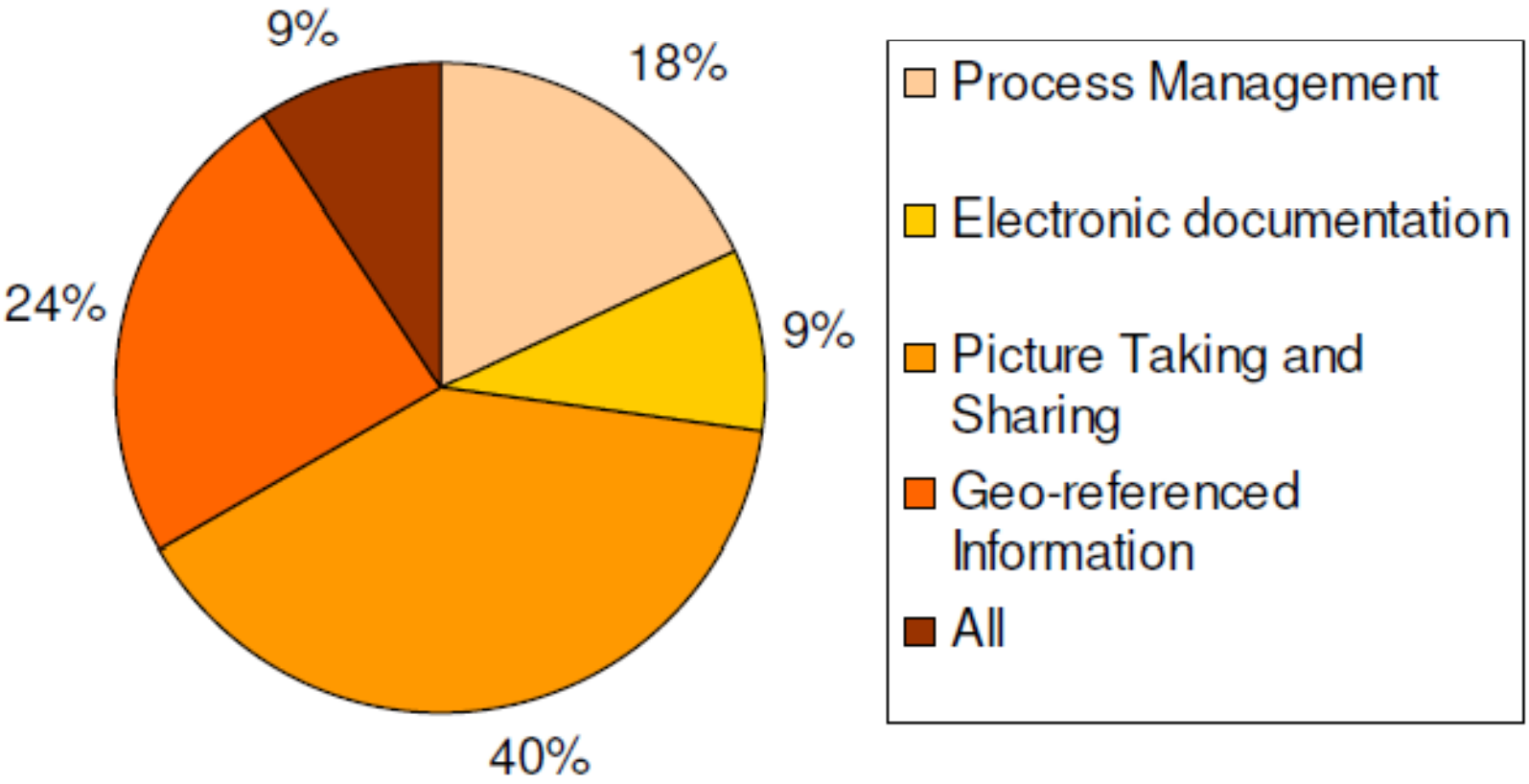
Does the WORKPAD system improve emergency management?

Example Results



It is difficult for me to navigate in WORKPAD.

Example Results



Which aspects do you consider as very useful?

Lesson Learned

Advantages and **Disadvantages** to use User Centered Design Techniques in a real project

Advantages	Disadvantages
Products are more efficient, effective, and safe	It is more costly
Assists in managing users' expectations and levels of satisfaction with the product	It takes more time
Users develop a sense of ownership for the product	May require the involvement of additional design team members (i. e. ethnographers, usability experts) and wide range of stakeholders
Products require less redesign and integrate into the environment more quickly	May be difficult to translate some types of data into design
The collaborative process generated more creative design solutions to problems.	The product may be too specific for more general use, thus not readily transferable to other clients; thus more costly

Lessons Learned / 1

- Active and continuous involvement of Protezione Civile both as institution and as individuals
  - Users have always been at the heart of the development through several iterations of the user requirement analysis
  - Users have been always confronting with the intermediate development milestones (ranging from initial paper mockups and intermediate demonstrators to the final prototype)
- Being users always at the center, the final results have been extremely satisfactory, and the system has fully met the user requirements from every perspective

Lessons Learned / 2

- The Human-Machine Approach to the analysis user requirements have been very useful for the end users themselves
- During the initial phases of user-requirement collection, we learned that civil-protection operators did not have clearly in mind the actual procedures and activities that they followed to face against emergencies.
  - That is also typical in many other domains.
- They have been forced to analyze carefully the current-day procedure and, hence, could find any pitfalls.
- Systemizing the procedures followed to manage emergencies guarantee a more systematic emergency management
  - Overall improvement of the response time that is not only motivated by the mere use of the system.