Project Final Report

Health Early Warning System

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1 Introduction

Recent history has shown a worldwide increase of emerging threats to human life, particularly in the health sector. Some examples are the rapid spread of new viruses such as the ones responsible for SARS, Ebola, Avian Flu and also bacterial pathologies in post-disaster settings such as tsunamis, floods and earthquakes. The early identification and mapping of cases and the prompt implementation of containment and relief actions are essential to achieve wide-ranging health benefits.

The HEWS system intends to be an Integrated Management Platform devised to support Epidemiologic Surveillance, Public Health Monitoring, Crisis Management and Civil Protection Programmes.

HEWS constitutes a support tool that can enable individuals, communities and governments to act in a swift and appropriate manner in order to reduce the loss of livelihoods, and the personal, environmental and socio-economic negative effects of an infectious disease outbreak, a natural hazard or a man-made disaster.

In fact, the occurrence of several unusual and extreme events has shown that there is the need for improved communication systems between the involved institutions. The use of satellite communications is important and effective whenever usual communication lines experience breakdown, saturation or simply are not available because of geographical location or absence of infrastructure.

The current capabilities of satellite communications represent an excellent opportunity to integrate information and existing knowledge that can be made available anywhere in the world in real time. It is possible to upload new data and information from multiple sources, ranging from field laboratories to automatic weather stations, into a central management unit without enormous efforts or costs. HEWS is a system able to integrate information using satellite communications, and therefore drastically contribute to minimize the negative consequences of crisis situations.

HEWS is a project co-financed by ESA in the frame of the Health and Telemedicine via Satellite Program.

2 Project Summary

2.1 Objectives

The objectives of the project are:

- Demonstrate the added value of satellite communications in situations in which there are threats to Public Health;
- Develop a system for early detection and alert of threats to Public Health;
- Develop an intelligent system to support the control of epidemics and other threats to Public Health;
- Engage the Health actors in the definition and validation of the system, in order to guarantee its full operational suitability and sustainability;
- Demonstrate the possibility of performing the function of a support instrument for the reinforcement of the populations' protection through the obtainment of added value in the domains of risk reduction and management activities and in the actions comprising alert dissemination, preparedness and crisis response.
- Demonstrate the potentiality of functioning as a support tool to the epidemiologic surveillance systems through the capacity of improving the automatic processes of statistical treatment.

The HEWS system, as a support tool, will allow for the possibility of enhancing the performance of its users through:

- A wider real-time perspective of the events and their management;
- The integration of all the knowledge on any specific disease or threat in the databases;
- The access to information, even in remote areas;
- The access to communications, even when land communications are disrupted.
- An optimised logistic support that decreases the need of carrying extensive and heavy equipment into the intervention sites;
- An enhanced capacity to prevent and minimize the negative effects of the catastrophes in social, economic and environmental terms.

HEWS was devised as a system that will enable the access to information related with threat situations to Public Health. An outstanding factor is the use of satellite communications, which is considered a more reliable means of communication in cases of extreme conditions and unusual situations. Hence, a prompt and more effective response can be initiated to mitigate the consequences of tragic events.

2.2 Participants

Consortium members came from different backgrounds and joined efforts in order to successfully fulfil the aim of the project. Project activities mainly took place in Portugal, with the broad cooperation of Portuguese institutions.

The consortium was led by **INSA** (the Portuguese National Health Institute). The other consortium partners are two companies, **TEKEVER** and **Ridgeback**, which bring vital technical expertise into the project.
INSA, acting as project coordinator, is in charge of all the scientific aspects of the project.

TEKEVER lead the WPs that dealt with technical aspects such as IT, SW and communication technologies, including Satcom.

Ridgeback was responsible for QA issues, translation and validation of users' needs into functional specifications of the system. It also supported **INSA** and **TEKEVER** on those issues where both types of approaches (scientific and technical) are needed.

The consortium partners maintained a direct collaboration with the General-Directorate of Health (**DGS**), particularly in the aspects related with the epidemiological surveillance.
Also involved and cooperating for the fulfilment of the Project objectives are the National Authority for Civil Protection (**ANPC**), the National Institute of Medical Emergency (**INEM**), the Criminal Police (**PJ**) and the Public Security Police (**PSP**), that contributed with the operational perspective of a prompt field intervention. The Institute of Meteorology (**IM**) supplied technical support in the meteorological and atmospheric domains.

Instituto Nacional de Saúde Dr. Ricardo Jorge (INSA)

INSA acts as the State laboratory in the Health sector, the national reference laboratory and the national health observatory. Among INSA's tasks are the epidemiological investigation and the collaboration with the DGS in the execution of epidemiological surveillance activities regarding communicable and non-communicable diseases.
The organizational unit that coordinated the project was ONSA (the Portuguese National Health Observatory) that during the project execution was renamed as Department of Epidemiology (of the National Health Institute Dr. Ricardo Jorge), which develops activities in the areas of epidemiological records, databases, biostatistics, epidemiology, clinical epidemiology and investigation in health services.
The organizational unit that coordinated the development of the two scenarios of the project is the newly-named Department of Infectious Diseases which develops activities in the areas of bacteriology, immunology, parasitology, virology, as well as studies of vectors and infectious diseases.

TEKEVER

TEKEVER is an information technology SME created in January, 2001 and based in Lisbon, Portugal, with establishments in Silicon Valley (USA), Beijing (China) and São Paulo (Brazil).

TEKEVER guides itself through three main axes:

- Global organization, creating highly innovative software products using cutting-edge technologies

- Comprehensive technical knowledge and industry experience in embedded software, telecommunications and aerospace systems, working with world-class organizations and research centres to develop new “Best-Of-Breed” technologies for emerging markets
- Providing Multi-Channel Business Process Execution Solutions for sharing essential data across all channels. These solutions enable extension to the best processes across entire organizations for improved service and communication efficiency

Ridgeback

Ridgeback s.a.s. (Torino, Italy) is a SME established in 1996 by two Senior Associates (Dr. Paolo Barattini and Dr. Maria Teresa Gallo), that has expertise in project management (IT, ESA, International Humanitarian Cooperation), quality assurance and control, statistics for industrial production processes control, capacity building and training, medical/physiological technical knowledge, data analysis and mathematical modelling for the Biomedical Sciences and ISO standards implementation. Ridgeback relies on a network of associates to provide client-tailored knowledge and solutions in different industrial and scientific areas.

General-Directorate of Health

The mission of the General-Directorate of Health (DGS) is to regulate, orientate and coordinate the activities concerning the promotion and protection of health, the prevention and control of disease and the definition of the technical conditions for providing appropriate healthcare. It is also responsible for coordinating and assuring the epidemiological surveillance in the area of Public Health at the national level and in the framework of the appropriate international organization, as well as managing the alert and response systems.

In the fulfilment of its duties, the DGS runs the system of Public Health emergencies and coordinates the activity of all the services of the Ministry of Health that intervene in this area. To ensure the identification, management and monitoring of Public Health emergency situations, there was a need to create the Public Health Emergency Unit (UESP) that is in charge of the swift mobilization of the resources and means required to deal with emergency situations. Therefore, DGS was a primary partner of the consortium.

National Authority for Civil Protection

The mission of the National Authority for Civil Protection (ANPC) is to plan, coordinate and execute the civil protection policy, namely in the prevention and reaction to serious accidents and catastrophes, in providing protection and relief to populations and in the supervision of the Firemen activities.

In the domain of risk forecast and management, the ANPC is in charge of the organization of a national system of alert and warning.

The Portuguese Firemen are constituted by professionals and volunteers, organized at municipal level. They are coordinated at district and national level by the corresponding Civil Protection services.

National Institute of Medical Emergency
The mission of the National Institute of Medical Emergency (INEM) is to define, organize, coordinate, report and assess the activities and the functioning of a Medical Emergency Integrated System (SIEM) in order to ensure that those involved in accidents or victims of sudden illness receive prompt and appropriate healthcare.
INEM also ensures the elaboration of the emergency/catastrophe plans in collaboration with the regional health administrations and with the ANPC, in the corresponding legal framework.

Criminal Police
The Criminal Police (PJ) is hierarchically organized under the Minister of Justice.
Its mission is to develop and promote actions of prevention and investigation in its area of competence and to support the judicial authorities in their investigations.

Public Security Police
The Public Security Police (PSP) is a security force whose mission is to guarantee the country's internal security, the citizen's rights and to safeguard the democratic principles, as stated in the Constitution.
The maintenance of public order and the protection of people and property, as well as the prevention of criminality in cooperation with the other forces and security services, are also among its core functions.

Institute of Meteorology
The Institute of Meteorology (IM) is the institution responsible for carrying out the national policies in the domains of Meteorology, Climatology and Geophysics. As the organisation responsible for assuring the meteorological and seismic surveillance, it also performs climate and seismology studies and delivers weather forecasts.

Angolan Ministry of Health
For the African Scenario demonstration, taking place in Angola, it was necessary to contact the Angolan Ministry of Health, that became an essential partner on the field enabling the HEWS project team to contact with local Health professionals.

2.3 Demonstration Scenarios

Two demonstration scenarios were conducted, accordingly to Project specifications. The first scenario to take place was the African one, portraying the occurrence of a Haemorrhagic fever epidemic in Angola.
An European scenario was later conducted, exemplifying the response given to a bioterrorist attack in Lisbon.

2.3.1 African Scenario

The expected virulence of a possible epidemics of Haemorrhagic fever caused by Marburg virus demands for prompt alert and intervention actions in order for the implementation of the most suitable mitigation measures, as exemplified by the latest epidemic that took place in Angola in 2004-2005.

The probability of the occurrence of a cholera epidemic is particularly high, given the poor hygienic and sanitarian conditions, therefore creating a potential environment for the epidemics evolution, as was seen last year in Angola.
The current HWS for both diseases is barely inexistent, and could therefore greatly be improved in order to allow a better handling of cases and lesser negative impacts.

The bases of the system are the Health professionals, who transmit their information to the Provincial Health Directorates or to the Ministry of Health when detecting anomalies. Whenever necessary, the Angolan Ministry of Health will request the cooperation of the WHO (World Health Organization) and other international organizations.

The confirmation of the situation is sought from reference laboratories abroad that will also assist and monitor the epidemics evolution. Other external partners, such as the United States CDC (Centre for Control of Diseases), other foreign Governments, the IFRC (International Federation of the Red Cross and Red Crescent Societies) and other NGOs (non-Governmental Organizations), may also be contacted.

Given this situation on the field and the communication problems felt on the continent, it was evident that a system like HEWS could be of great benefit in developing Early Warning and therefore enabling a prompt and adequate response to threats.

2.3.2 European Scenario

The demonstration scenario selected for HEWS testing on an European setting was the occurrence of a bioterrorist attack in Portugal, more particularly in downtown Lisbon.
Given the relevance of this issue, the information and alert system concerning the possibility of a bioterrorist attack in Portugal is very sensitive, as the situation is deeply connected to national security. Operations are conducted by the PJ (Criminal Police), in cooperation with other governmental forces, regarding the identification and investigation of terrorist activities that pose a threat to national security.

Therefore, at the current state of affairs, the HEWS system would start to provide critical support after collecting information regarding a possible emergency situation, whether by public disclosure, either by evident proof of the occurrence, *i.e.* infected patients in hospitals. It is nevertheless possible to foresee a wider use in the future, if the HEWS application becomes feasible and is broadly adopted by the key actors of HWS.

It would then be possible for HEWS to acquire a broad capability of integrating multiple monitoring public health parameters, and therefore having the capability to act before such an event occurs. This will only be possible if requirements, from police forces acting in this domain, are fully integrated into HEWS, given the sensitivity of this issue.

The first sign of alert will therefore probably originate in an individual, calling the 112 because of a health situation or directly contacting the Police on the basis of a suspicion. This line is connected to an Emergency Central, with access to the INEM (National Institute of Medical Emergency), the ANPC (National Authority for Civil Protection) and the Police forces (PSP and GNR).

The current state of cooperation between the different entities that would be involved in the response to such a scenario raised the interest on this scenario and also the demands faced by the HEWS consortium.

2.4 Results: the End-User Perspective

Overall, the institutions (health, civil protection and police authorities) involved in the HEWS system development considered this an important project. It was always acknowledged as an important tool, which could generate added value in the health area if properly framed. The system's operational demonstration was always envisaged as the common goal and vast resources were affected to it by all parties.

In Portugal, the system development brought to all institutions an unusual awareness of the importance of working together. It was clearly visible, from the beginning, that all that was defined in the regulations and plans did not always work in reality, requiring additional cooperation from the remaining institutions/partners and re-adaptation of each one to its real role on the situation.

In Angola, local authorities gave the project an outstanding help. The harsh conditions endured showed that a system such as HEWS can contribute to improve the population's health in a very clear way. In fact, HEWS could be useful in several ways such as gathering health information, improving and promoting health, optimizing health resources providing structural support. While infra-structures are not fully operational or available, HEWS could centrally gather information, for instance with a back-up at INSA - Lisbon, in a full cooperation protocol with the Angolan Ministry of Health and its Public Health Institute as well as in Angolan institutions properly equipped.

As the conditions of local communication networks improve, a better distribution of databases can be made at local levels. HEWS terminals could be distributed locally and used as telemedicine support to remote areas where physicians are not available.

The HEWS prototype showed to be highly intuitive and usable at the desktop/laptop level within institutions. But in the field of operations, when things are happening, the devices used – those that are commonly available to the public – were referred by users as non-practical as in the case of normal PDA's that presented difficulties concerning the introduction of data while wearing gloves and problems regarding the visibility of the on-screen information.

It became clear to the end-users that a different paradigm is necessary to introduce structured information in the HEWS forms and to manage them. The general opinion was that some wear-ware (wearable hardware/software) integrated with voice recognition and transcription should be developed to allow a quick and easy collection of structured information in the field of operations. Otherwise, many challenges arise.

3 Project Report

3.1 Work Package 1 – Definition of Users and Requirements

3.1.1 Developed Activities

During Work Package 1, an epidemiological risk assessment in African and European contexts was designed and conducted, in order to help the identify the major epidemiological threats on these two contexts.
A literary review and a collection of information on existing early warning systems was also performed, so as to allow the project team to have a broad view of the state of affairs on this issues.
Several end-users were joined to the project, in order to permit the creation of a discussion group, essential for the scenario demonstrations envisaged.
A theoretical model for the Health Early Warning System was also designed, and data and information flows of the existing Early warning systems were described, so as better to help the future Functional and System Design.

3.1.2 Deliverables

ESA/HEWS/DLV/TN1.1/D3.0 – TN1.1: Epidemiological Risk Assessment

The aim of Work Package 1.1 (WP1.1) was to identify and classify the major current and future health threats for human populations through an assessment of the major epidemiological risks to which they are exposed. This Technical Note 1.1 describes the results of the activities developed in the WP1.1 of the HEWS project. Although Europe is the main region of interest for HEWS, it was considered relevant to extend the subject of WP 1.1 to Africa. In fact, satellite technologies can play an important role in Africa. Therefore, this technical note also includes results for African settings.

Introduction

The nature and intensity of most health threats and the probability of their occurrence vary widely according to characteristics of the populations. Populations in developed countries like Europe certainly have a higher probability of being threatened by man-made disasters, nuclear accidents or terrorist actions, than populations in developing countries. On the other hand, communicable diseases like cholera or malaria are much more frequent there than in Europe.
For the purposes of HEWS, it seemed adequate to prepare two different prioritised lists of health threats to be applied to populations living both in developed and in developing countries.

Methods

The methods and procedures to select the most severe diseases and events included the preparation of a "long list" of epidemic or acute events, using very broad selection criteria. The list included 6 communicable diseases, 5 natural events, 6 man-made intentional (terrorist) situations and 3 man-made non-intentional events (Table TN1.1-1).

Table TN1.1-1 – Major Diseases and Events eligible to be addressed by HEWS project and overall possibility of their occurrence, according to the type of social-geographic setting (Long List)

	Possibility of occurrence	
	Europe	**Africa**
1. Communicable diseases		
Cholera	1	8
Legionellosis	8	1
Yellow fever	1	4
Viral haemorraghic fevers (Ebola, Marburg)	1	4
Pandemic influenza	3	3
Malaria	1	8
2. Natural events		
Heatwaves	7	3
Earthquakes	5	2
Floods	7	10
Tsunami	1	1
Forest fires	7	8
3. Man-made events		
3.1 Intentional / Terrorism		
Bio		
Anthrax	1	1
Botulism	1	1
Smallpox	1	1
Chemical		
Nerve agents	2	1

Then, a set of criteria was prepared to classify the severity of each disease or event in both the European and the African settings. It included 12 criteria aggregated in three main categories, including "Size of effects", "Capability to forecast the event" and "Capability of the event to disrupt terrestrial communications". A weight was set for each 12 criteria (Table TN1.1-2).

Table TN1.1-2 - Level 1(L1), level 2 (L2) and level 3 (L3) criteria used to classify diseases and events according to their severity, and corresponding weights*

	Weights for L1 and L2 criteria	Weights used*
A. SIZE OF EFFECTS (L1)	0.85	
A.1- IN HUMANS (L2)	0.50	
A.1.1 Nb persons potentially affected (L3)		**0.20**
A.1.2 Long term disabilities(L3)		**0.05**
A.1.3 Nb of potencial deaths(L3)		**0.25**
A.2 - IN HEALTH CARE USE (L2)	0.05	**0.05**
A.3 - ENVIRONMENTAL IMPACTS (L2)	0.06	
A.3.1- air (L3)		**0.02**
A.3.2 –Water (L3)		**0.02**
A.3.3. Soil (L3)		**0.02**
A.4 - SOCIOECONOMICAL IMPACTS (L2)	0.24	
A.4.1 Destruction of equipment and facilities (L3)		**0.10**
A.4.2 Absenteeism to work (L3)		**0.09**
A.4.3 – Capability to create panic (L3)		**0.05**
B. CAPABILITY TO FORECAST THE EVENT (L1)	0.05	**0.05**
C. CAPABILITY OF THE EVENT TO DISRUPT TERRESTRIAL COMMUNICATIONS (L1)	0.10	**0.10**
TOTAL		**1.00**

Additionally, a specific severity value was assigned to each disease and event in the “long list” from an intensity scale previously prepared. A weighted intermediate severity score (isscore) was then calculated. Subsequently, a “possibility of occurrence” (poocc) value obtained from a corresponding scale was attributed to each of diseases and events, both for the European and the African settings (TN1.1-1). A final severity score (fscore) was then calculated for all diseases and events in the “long list”.

Results of the Assessment

The 20 disease and events included in the “long list” were ranked according to the final severity score, separately for the European and the African settings (Table TN1.1-3 and Table TN1.1-4).

* Only weights in the right - end column were used: it includes all L3 criteria and the last two L2 criteria. The weights of the others L1 and L2 criteria are only aggregate weights from the respective L3 criteria

Table TN1.1-3 - Intermediate severity score, possibility of occurrence and final severity score of the 20 diseases and events included in the "Long list", ranked by the values of the final score – Europe

Rank	Disease / Event	Intermediate severity score[1] (isscore)	Possibility of occurrence[2] (poocc)	Final severity score[3] (fscore)
1	Floods	4,22	7	5,89
2	Earthquakes	6,73	5	5,69
3	Heat waves	3,19	7	5,48
4	Legionellosis	1,36	8	5,34
5	Forest fires	1,61	7	4,84
6	Physical terrorism	2,28	6	4,51
7	Nuclear terrorism	8,70	1	4,08
8	Accident in nuclear plants	8,55	1	4,02
9	Pandemic influenza	5,05	3	3,82
10	Tsunami	6,31	1	3,12
11	Chemical accidents	2,29	3	2,72
12	Collapse of dams	4,47	1	2,39
13	Chemical terrorism	2,03	2	2,01
14	Smallpox (bio-terrorism)	2,03	1	1,41
15	Anthrax (bio-terrorism)	1,89	1	1,36
16	Botulism (bio-terrorism)	1,74	1	1,30
17	Haemorraghic fevers	1,24	1	1,10
18	Yellow fever	1,14	1	1,06
19	Cholera	1,11	1	1,04
20	Malaria	0,79	1	0,92

For Europe, floods, earthquakes and heat waves were in the first three highest positions. Floods, cholera and malaria ranked first, second and third in the African scenario.

Table TN1.1-4 - Intermediate severity score, possibility of occurrence and final severity score of the 20 diseases and events included in the "Long list", ranked by the values of the final score – Africa

Rank	Disease / Event	Intermediate severity score[1] (isscore)	Possibility of occurrence[2] (poocc)	Final severity score[3] (fscore)
1	Floods	4,92	10	7,97
2	Malaria	3,96	8	6,38
3	Cholera	3,18	8	6,07
4	Forest fires	1,58	8	5,43
5	Nuclear terrorism	8,70	1	4,08
6	Accidents in nuclear plants	8,55	1	4,02
7	Earthquakes	6,98	2	3,99
8	Pandemic influenza	4,60	3	3,64
9	Yellow fever	2,38	4	3,35
10	Tsunami	6,31	1	3,12
11	Haemorraghic fevers	1,34	4	2,94
12	Physical terrorism	2,43	3	2,77
13	Heat waves	2,30	3	2,72
14	Collapse of dams	4,92	1	2,57
15	Chemical accidents	2,49	1	1,60
16	Smallpox (bio-terrorism)	1,88	1	1,35
17	Chemical terrorism	1,88	1	1,35
18	Anthrax (bio-terrorism)	1,79	1	1,32
19	Botulism (bio-terrorism)	1,64	1	1,26
20	Legionellosis	1,06	1	1,02

Having been completed the selection of the five most severe diseases and events, a description of their more relevant characteristics was prepared in order to contribute for the choice of those to be submitted to demonstration.

Conclusions

Current and future severe epidemic or acute health threats for human populations are spread worldwide.
A common list of diseases and events, including communicable diseases, natural disasters and man-made events, caused intentionally (terrorism) or non-intentionally (accidents), was classified according to their severity in European and in African populations.
The most severe health threats in Europe were all natural events (floods, earthquakes and heat waves). As in Europe, in Africa, floods were also found to be the most severe but, in this case, cholera and malaria occupy the second and third positions.
According to these results, any of the 5 diseases or events indicated above can be selected as first candidates for scenarios in later Work Packages of HEWS.
Nevertheless, other diseases and events ranking lower than those must not be immediately excluded. In fact, a number of them reached high final severity scores in the European or African classifications and could be considered appropriate for the future demonstration scenarios.

ESA/HEWS/DLV/TN1.2/D4.0 – TN1.2: State-of-the-Art on Early Warning

Introduction

The Technical Note 1.2 contains the results of the activities performed to assess the current Health Warning Services and Systems at European Level, both National and International. In the assessment, Systems related to mass gatherings were included, since they represent an application setting similar to those of an Emergency setting, in which most of the knick-knack of the Epidemiologist has been in some way employed including Syndromic Surveillance, GIS applications and Risk Maps.

Methods

A bibliographical research was done and a literature review performed. Only the most recent and relevant papers were considered for the scope of the present document. Papers older than 2000 present HWS that are outdated with regard to the use of IT as well as epidemiological techniques and concepts.
A detailed assessment was performed on a selected number of Health Warning Service and Systems that are representative of the different typologies present in Europe at National and International level, in order to have detailed information that highlights the peculiarities of each HWS, as well as the differences between them.
INSA experts provide additional information stemming from their direct experience and Portuguese National Services.

Results

From our literature review and direct assessment of several HWS (that comprise both Health Monitoring and Surveillance systems), implemented at national, European and world wide levels a major fact is clear, that the existing HWS are very diverse.

The HWS are diverse in their nature, regularity, time-span, data collected, data input, actors involved and actual output production.

Overall, our proposed general scheme for HWS seemed to fit all reviewed and assessed systems. In fact, all evaluated systems are characterized by their scope, type, event or indicator driven, certain regularity and at least one type of data; and have a generic Input-Analysis-Output Structure.

It is clear that this Input-Analysis-Output (IAO) is a very broad Structure.

INPUT – has very diverse natures among the several HWS.

Generally, HWS seem to co-exist with both electronic and paper inputs, both generally requiring some human intervention. One cannot make a generic rule to the number of data sources, and variables required for a HWS input. Normally the number of data sources and data variables required really depends on the nature/scope of the service, but is usually a much reduced number, usually between 1 to 3 variables. Clinical data are obviously sources in most of them.

There seems to be some space and opportunity to process improvement in the data input procedure of several HWS.

Some systems have software solutions to retrieve data from national data bases (e.g. Enter-Net in UK).

ANALYSIS – System core – characterisation is also very diverse among the several HWS.

In our approach we elected three main features for survey; the existence of data analysis, the existence of an underlying model and existence of software solutions.

In a general way all HWS deal with data analysis. Again, this is very dependent of the nature/scope of the service, with some systems having data analysis within minutes to systems that only have annual reports.

This basically relates to having a setting of monitoring system or a surveillance system. The monitoring situation only requires the systematic recollection of information without a necessary knowledge of what will define a case, event or outbreak situation definition. On the other hand, the surveillance systems imply a previous knowledge of risk defined in some way (e.g. a threshold) and a somewhat available intervention. This explains why some HWS have underlying models and some don't.

Results are clear in pointing that some systems will always depend on human or even experts' intervention to define relevant case, event or outbreak situations from data. This conveys the notion that HWS are dynamic in their nature, and they will generically have the need to update according to the available scientific knowledge for their scope.

Several HWS that have underlying models or threshold have usually some specific software solutions. Interview results gave the overall notion that these software

solutions are often “home” solutions. Rarely or never was a professional software solution referred.
Some commercial software use was sometimes mentioned but relating to data handling (e.g. MS Excel and Access) and statistical data analysis (e.g. SPSS). Though this often relates to identification of case, events or outbreak situation, it wasn’t clear if this could automatically be done. Our perception is that such automatisation is only possible when existent knowledge allows automatic case, event or outbreak identification. Nevertheless it was clear that in the ANALYSIS sub-structure of HWS a great space for process improvement exists.

OUTPUT – output results from HWS may not be as diverse as in other systems’ sub-structures but they showed some complexities.
In fact there are systems that produce reports or alerts with a high frequency and there are systems that only produce a report per year. Most systems tend to increase their output frequency when a case, event or outbreak situation is identified.
Some systems generate confidential reports that are disseminated only to key-actors (individuals or institutions) from which indirect outputs both public and confidential result subsequently. Often the surveillance responsible institution does not have the power or capability to issue the necessary health warning, and therefore privileged channels for information exist.
Also Output results depend clearly on HWS nature/scope. Some systems may only generate scientific literature output with appreciable time delay, especially when no timely case, event or outbreak is identified or really existed. Though this may seem awkward, this is part of HWS’ evolutionary path.

HWS’ other aspects
All HWS’ showed to be concerned with patients/individuals data protection. All systems implement some kind of encryption. In some cases encryption can be improved. So this must be a consensual subject while constructing a general HWS solution.
Some systems refer having a zero notification. It seems to emerge as a natural feature for some HWS nature/scope. One can identify situations of zero case reporting, when it is a system concerned with compulsory notifications, and identify zero reporting when a non additional risk for some threat is predicted.
In what concerns quality policy, the HWS actually have their implementation are rare. Only laboratories and laboratory results seem to be fully involved in quality procedures. This does not means that HWS are necessarily out of control. By their dynamic nature they are generally always evolving and updating, granting improvement of results. Nevertheless the pursuit of a quality for HWS makes sense and must be sought.
Most HWS report the existence of minor problems that broadly report to situations of timeliness of data collection; global coordination between national versus international levels of collaboration, and between technical versus intervening services; and problems with specific software solutions.

Conclusions

The assessment performed shows that many commonalities exist among the several HWS, basically they all can be thought as having the same structure. But HWS are very different from each other. It is the system's nature/scope that pre-defines the individual characteristics of each HWS. The nature/scope of the system leads to different requisites that consequently need different types of analysis and later produce different outputs and diverse output disseminations.

Overall, it is secure to say that a generic IT solution is possible. This solution must be flexible enough to bridge all existent systems and to improve their communication skills, and ultimately work better and generate health and life gains. Obviously such solution must rely on somewhat heavy parameterisation that must be thoroughly put together.

There are already some national HWS that use and are upgrading to an effective use of IT to improve detection capabilities and timeliness including news approaches in health threats like biochemical terrorism and imported cases of infectious disease within Europe and from other countries, this is a clear evidence that these systems can be systematically improved and to a great extent automated. There will always be some human intervention necessity and the generic solution to be implemented must be prepared for it. HWS ARE DYNAMIC, HWS are always improving this is a feature that cannot be neglected within the objectives of the HEWS Project.

In fact, the construct of a generic HWS management tool with the skill to use the cheapest communication channels available can grant a continuous update of integrated systems and contribute to their overall improvement. The construction of a HWS management platform can, and will certainly, help in improvements in several aspects: Redefinition of poorly defined processes either at the Input, Analysis or Output levels; improvement of different levels of communication (national level versus international level, or others); quality enforcement.

ANNEX – Best Practices Analysis

Processes

The processes presently involved in a HWS are data collection, data upload, data analysis and validation, sending validated data to higher level to produce information (statistics), decision about Response, output data flow for Response (including tracking of patients, contacts and population/persons/patients at risk, information to GP and other Health personnel).

Data Collection

The best practice of data collection should include, apart the clinical and laboratory data, also the possibility of exploiting and updating risk maps (so that they can be exploited for Response), access to other databases containing relevant information to the risk evaluation (as well as for Response) and data mining.
The main sources of information and the main uploader of information are GP, Emergency Departments and Hospitals.
The emergency concept of Syndromic Surveillance has evidenced the need to include other data sources like drugs sales and telephone help lines. Any kind of data

collection can be effective only when it is timely. So far, only the exploitation of IT technologies allows the use of additional sources of data in a proficient way.

Data Upload

Data upload is a great limitation of present HWS, since it requires dedicated time from Health personnel, especially for notifiable diseases for which special forms and invoice procedures are needed. Best practice is the automatised search of the information in available data sources.
Very important for the case of epidemics or other threat, is the possibility of uploading partial patient data, so to have an early picture of the ongoing process while waiting for laboratory confirmation or other clinical analysis data that will support the final diagnoses and identification of the *noxa*.

Data Analysis

Data analysis is, in some cases, automatised. This is the best practice in order to have timely information output

Data Validation

This step cannot be fully automatised but should anyway be supported by the adequate format of the output of the analysis phase, and should be capable of exploiting IT in order to collect additional information if needed.

Sending Validated Data to Higher Hierarchical Level

Validated data are usually sent through the HWS at the higher level of the system in order to be used to produce statistics and other information about the Health related events. This information is to be exploited for response as well as the output of the system.

Output Information Flow

The current output process of the HWS consists mainly of some basic statistics and tables. The best practice is related to timeliness of the system and graphical presentation.

Technology

Information technology has shown to be critical in supporting HWS in the following steps:
Input: supporting the user in the gathering and introduction of relevant data in the system, either at fixed locations or remote ones via mobile terminals and interfaces;
Storage: managing central and distributed huge database systems;
Analysis: providing advanced tools for automatic and semi-automatic analysis of data, as well as user-friendly interfaces for data visualization;
Transfer: allowing communication of information between distributed systems in real-time or near-real-time, and providing integration mechanisms between different systems;
Output: offering distinct means for disseminating information to restricted users and/or the general public.

Although a lot of good practices exist, it is difficult to find a system that follows them all. Different priorities guide the development of such systems to the support of some specific tasks and steps of the process, paying less attention to others. Also, one must not forget the different periods at which the systems were developed and the different levels of knowledge and expertise of the involved entities (both users and IT experts).

It is a key point that new IT systems must be able to communicate with legacy ones, and integration becomes a challenge. This is more true when one of the goals is to guarantee that developed systems do not become outdated, or at least that the decaying period is long. In Early Warning Systems, where the goal is to detect outbreaks, one must expect that the system may be activated for the first time long after it was deployed.

Also, demands tend to rise on special events, like mass gatherings. For example, during the 2006 Olympic Winter Games in Turin, the 21 general practitioners (covering a population of 28 080, which is 2% of the 1.4 million people living in the area affected by the Olympic Games) provided data to SeREMI (the regional health authorities) on a daily, rather than weekly, basis. It is important to assure that the developed systems are scalable to such extent, without the need for any kind of additional intervention (such as deployment of further hardware, or intervention of IT experts), and this is a specificity of Health Early Warning Systems as they are precisely developed to cope with unexpected major health events.

The availability of cheap hardware and base software (operating systems, word and spreadsheet processors) is to be exploited, and applications requiring additional software licenses and expensive back-end systems should be avoided. (This was an explicit requirement for SurvNet@RKI, for instance, where economic factors were important).

Actually, to meet budget constraints, open-source tools (such as Python programming language, PostgreSQL or MySQL database systems, and many others) can be a good choice, as they have proven to be useful in Health Warning Systems, like for instance in some key parts of the software systems supporting health surveillance at the Rugby World Cup Australia 2003. The problematic of using open-source tools in opposition to commercial ones has been long debated in the software community, and the issues do not relate specifically to Health Warning Systems. Open source software has the advantage of being free and open. Although one may question the security and safety of using open source software, in reality this is seldom a problem, and open source packages can be as secure and safe as commercial ones when they have significant appreciation from the development and user community. The main drawback is that the amount of support from open-source software developers is typically much less than what is obtained from commercial developers, and tends to decay and disappear through time. Unless, of course, if it is transformed into a commercial package, by starting to require a license fee, which is also very common with open source software.

Solutions may be based on custom-made systems or COTS (Commercial Off-The-Shelf) systems. Presently, there is no software system supporting whole Health Warning or Early Warning systems which is solely based on COTS, however there are already some commercial packages which perform specific task in standard way. This is the case of EDIS (from HAS Solutions Pty Ltd) which is installed in the majority of Emergency Departments in New South Wales, Australia. COTS use reflects the

existence of standard ways of performing operations; they usually are more bug-free and they show maturity in the domain they are applied on. Nevertheless, the core of HWS software has always been custom-made as the requirements for such solutions are very strict and the overall problem is very complex, without a proof that it can be dealt in a standard way.
Also regarding custom-made solutions and the priorities to application of the budget in the development of software for a specific HWS, another aspect to consider is the availability of applied techniques. Some techniques, even if complex, are wide-spread and therefore their use is cheap and secure/safe. This is the case of web technologies and secure communication via internet, which is currently able of guaranteeing both correct data delivery and protection of confidential data.
The next level regards specific solutions developed under the scope of specific activities. These show maturity in their specific task and although not general purpose and wide-spread, they can be used with the same degree of confidence. However, they cost much more and their use must be justified and proven to be worthy and cost-effective. This is the case of GIS technology, which has shown to be of great value for HWS, mainly in data analysis and dissemination (see for instance the health inspection program for the Athens 2004 Olympic Games). In the same way, satellite communication has shown to be valuable (for instance, for the 2SEFAG project) in cases where communication through normal means is not possible. Satellite communication cost-effectiveness for Health Early Warning Systems is actually one of the issues we shall prove in our HEWS project.
Finally, some technologies lie still on the domain of innovation. Nevertheless, such technologies as Artificial Intelligence for automatic text categorisation (see the Rugby World Cup Australia 2003) have proven that the investment in innovation is not waste of money, and can become cost-effective as well.

Input/Output

Software supporting Health Warning Systems show maturity in the use of multiple channels for I/O. Some of the National HWS are already in electronic format and web-based for data input and output. Many allow use of telephone, fax, e-mail, SMS or a web-site as needed.
Internet communication is an asset but communication downtime is still a reality in such heterogeneously distributed systems, especially when we talk about remote locations such as African in-land locations. Therefore, it is a necessity that systems are able to work off-line, making the web channel alone insufficient. Dedicated client applications are therefore necessary. For instance, in SmiNet-2, Java clients are used together with Web on-line reporting clients, for data input/output.
Although one should enforce the use of real-time input/output channels and data integration, it is noteworthy and actually necessary the providence of other legacy channels such as outdated software/hardware systems (when they are already installed and working in some locations) and regular user interfaces to introduce data coming from paper or voice, and to print results in paper as a mean of output. For instance, in SIMI-Italy, some of the data still arrived to the system on diskette via regular mail, from regional reference centres.
The output and dissemination channels up to the moment (besides paper and voice communication) have been mostly web-based publishing of static results (for instance,

SurvNet@RKI) and dynamic interactive reports are seldom available. This is therefore one area for possible improvement.

Storage

There is not much to say regarding data storage technology. Perhaps this is one of the most pacific applications of information technology in HWS. Mature and simple, the mechanisms to store and manage huge database systems are easily deployable and a lot of expertise exists throughout the world.
In fact, the technological ability to stock up so much data can become deceiving in the sense that one is led to believe that one can manage all the data that is stored. In reality, this is no true, and some systems would actually benefit from a reduction of data amount and complexity (for instance, this is recommended for future upgrades of SurvNet@RKI). More data is useless if we are unable to determine whether that data contains information which demands our attention.

Transfer and integration

Transfer is meant here as the automatic communication of information between isolated systems, and can bee seen as a substitute for output on one side and input on the other. Also, it means that if we are communicating information between two different systems, than we are actually implementing some level of integration between them.
Integration is a necessity in Health Warning Systems, given the broadness of different SW systems and SW editions used by different facilities. For instance, in SMI-NET the developed system was able to cope with multiple sources of data such as automatic transfer of data from the laboratories systems, manual input via web-based interface, and simple voice communication followed by manual input labour.
Two particular best practices are worth noting regarding integration and data communication: the use of a VPN (virtual private network) for data sharing within distributed systems, and the use of standard formats for data communication such as HL7 message format (for instance in the Rugby World Cup example described earlier in this document).
Internet is the preferred (and many times the only possible) mean for automatic communication (FTP, web services, etc.), although as stated before, there is the need for off-line functionality to cope with eventual downtime. Automatic communication by such means can reduce communication of information from several days to Near Real Time.

Analysis

Advanced tools for automatic and semi-automatic analysis of data are included in a different branch of IT in support of Health Warning Systems (different from data input, output, storage and transfer). These are often specific tools that apply to specific problems, embrace powerful techniques and are product of long time development and gained expertise.
The “best practice” in this sense is the investment on specific tools to support analysis tasks, and some technologies have already proven to produce valuable results:
User-friendly interfaces for interactive data visualization help the user understand data and its implications;

AI techniques, such as naïve Bayes for text categorization, substitute actual mechanical work which is believed to be possible only by humans;
Data mining algorithms explore huge amounts of data, detecting both patterns and outcast records, in a way otherwise impossible for humans to do;
Automated word search in emergency/clinical medical reports (for example to find international health disease classification codes and so far to count possible cases), again provide access to information otherwise impossible to obtain in feasible time;
GIS (Geographic Information Systems) databases and applications (such as EpiInfo 2002, ArcView 3.2, etc.) not only add geographical knowledge in support of analysis tasks but also nurture further applications otherwise not possible. For instance, the health inspection program for the Athens 2004 Olympic Games incorporated mobile resource management – routes and travel times for inspection units were anticipated using GIS-based technology. In general, colour maps displaying categorised information have also proven to be a very useful output, especially in the support of management decisions.
Data integration and display of multiple source data is also a key asset in some of the applications surveyed. ISIS (from Holland) combines information both from 33 notifiable diseases and pathogen-surveillance. In the Athens 2004 Olympic Games there was the ability to link the health inspection results to information regarding the surveillance of human cases of Legionnaire's disease. Combining such multiplicity of sources raises power of analysis and the value of its outputs, and IT provides the necessary tools for simple and rapid production and use of such outputs.

ESA/HEWS/DLV/TN1.3/D5.0 – TN1.3: User Communities

The objective of this work was to identify and establish relations with the providers and users of both epidemiological information and health warning services, and to understand how they relate themselves when acting within the scope of HWS alert.

Introduction

In the previous work done in the HEWS project, a list of Health threats to the European and African population was presented in TN1.1. And in the following technical note, TN1.2, a generic model for a HWS was proposed, in order to allow the construction of broad technical solution for all such existing systems.

However, these systems have many specifications, among which the flow of information. How the hierarchical different institutions must receive and disseminate information is an important issue and it is very relevant for the generic solution sought for HEWS.

Methods

To identify the more relevant information providers, end-users and to map their generic interaction it was decided to study several scenarios and micro-scenarios. The criteria to decide which scenarios should be approached was to select 8 to 10 health threats defined in TN1.1, of which two should be the two scenarios chosen by the HEWS consortium for the solution demonstration. From these choices, we

proceeded to the identification of the involved institutions and the description of the respective relations and information.
Finally, main information providers and end-users were listed and information flow was abstractly characterized.

Conclusions

From the several threat scenarios and micro-scenarios chosen to illustrate the key entities involved in the Health Warning systems, and though our approach was as international as we intended it to be, it seem possible to generally and abstractly propose that

- Health Authorities,
- Civil protection Authorities,
- Reference laboratories,
- Emergency Institutions,
- Police and Army forces, are indeed key actors for the actions and warnings that any generic HWS issues.

There seems to be the need to carefully address each HWS individually because different scenarios have specific need of information flow between institutions. The different interactions that we were able to appreciate were in fact a proof of this, raising our awareness as we entered into WP1.4.

Generally these institutions are linked through the normal means of communications. Some situations like severe earthquakes, nuclear attacks, etc., can generate a disruption on the normal communications flux, and in such cases additional means of communications may be needed. In some cases, for the control of situations, additional communication resources may be required to interconnect the institutions and their intervening units.
We would further assess this situation in WP1.4, in order to better define users requirements.
Relations between different institutions and HWS information flux seemed to be dependent on each individual system. Apparently, information and institutional contact must be prioritized ad hoc, following what is recognised in each system.
The work prepared during this WP allowed us to contact important institutions, both information providers and end-users. Their diversity helped us understand the different needs to which the HEWS must be adapted.

The fact that many entities are involved in very different scenarios is also an essential conclusion, as we must guarantee that all specific necessities are met, to all possible intervention areas of one end-user or information provider.
Two good examples of this issue are the IM and the ANPC. As an information provider, IM operates in the fields of climate (temperatures and winds), seismology, and others. Being the main actor on Civil Protection, the ANPC is also responsible for several different situations, such as fires and earthquakes.
A HEWS shall serve them in all these areas, exploiting for each of them the best way to be an effective contribution to the success of their work.

These findings are also evident on the African scenario, to which two other factors must be added: the lack of communications and the poor infrastructures.

The African scenarios were not defined so clearly, given the possible, and often necessary, presence of many external actors, which results in a more demanding situation in terms of information and response coordination.
Given this situation, a Health-threatening situation may involve the coordination of different national and international actors, further challenging the HEWS design.

ANNEX – List of contacts

In order to prepare this TN, a number of entities were contacted, mainly in Portugal:

- an ANPC representative was present at the last consortium internal meeting. Following his invitation, a meeting was arranged on the ANPC headquarters, where the team did a tour of the facilities and had the opportunity to clarify some questions regarding the scenarios;
- the INEM was also represented at the last consortium internal meeting. After an invitation by the designated representative, the team is now trying to arrange a convenient date for a joint meeting, where important issues pertaining to WP1.4 shall be clarified;
- a representative from the PJ has also been designated and was present at the last consortium internal meeting. He provided some information on their work and informed the team of his availability to meet us when necessary;
- the IM had been previously contacted and a representative was also designated to work with the project;
- contact was also established with the DGS, who also indicated a representative to cooperate with the project.

Contacts have also been initiated regarding African scenarios, particularly with the Paediatrics Hospital in Luanda and with the Angolan MoH.

ESA/HEWS/DLV/TN1.4/D6.0 – TN1.4: Data and Information Flows

The objective of this work package was to identify the types and flows of data and information between input providers and output users to conduct epidemiological analyses and to monitor, alert and respond to Health Risk for the citizens. This will serve as the base for the definition of key functionalities of the HEWS and their translation into Technical Specifications.

More in detail, the following type of data were considered in TN1.4:

- Epidemiological (field data, laboratory data, physician reports, etc.);
- Environmental (weather information, water quality, indicators of pollution, radiation, geographical positioning and geographical information systems, etc.);
- Sociological, historical, cultural, etc...

The highly detailed description of these data formats and of their interfaces to HEWS is not presented here, but it is part of the scenario Workbooks (inclusive of mock-up data) and will be translated in Technical Specifications during WP2 related activities.
The same holds for the epidemiological data processing output to the users.

The needs for satellite technologies (for *e.g.* Telecommunication techniques and services, Positioning and Navigation Systems, Earth Observation) were identified according to the data types. Data flows and processing chains were analysed in relation to the scenarios.
In Portugal is currently pending the standardisation of the communication language and terms between the different entities involved in emergency response.
If the new standard will be available in time, it will be included in HEWS.

Introduction

In the previous work done in the HEWS project, a list of Health threats to the European and African population was presented in TN1.1.
In technical note TN1.2, a generic model for a HWS was proposed, in order to allow the construction of broad technical solution for all such existing systems.
In TN1.3 the providers and users of both epidemiological information and health warning services were identified and contacted in order to obtain information from the daily reality of these individuals. Their interrelationships were studied in detail for 6 European scenarios and for 2 African Scenarios, one taking place in Angola and one in Mozambique.
The analysis in work package 1.4 is focused on “what” the HEWS must be able to do with regard to the way in which the different institutions and actors receive, process and disseminate information.
The work of this work package will bring to the first issue of Users’ Requirements.
As a result of WP1.4 activities it is possible (at beginning of WP2) to have the software system specification *i.e.* the highest level description of the software containing the users requirements.
The results of the activities of this work package will be reassessed and refined during the first phase of WP2 at the light of the new information that will be available after an International Workshop including Portuguese and African Countries Representatives that will be held in Lisbon in June 2007, so to obtain the refined Software Requirements Specification (SRS).

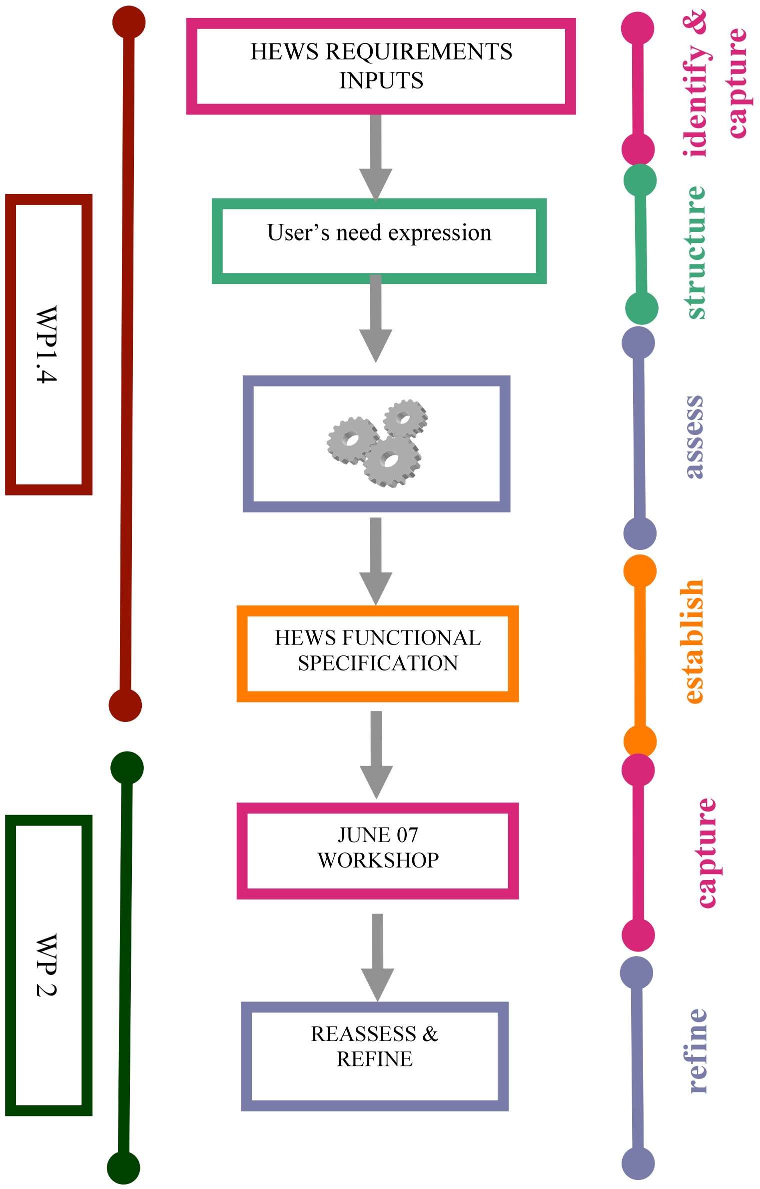


Figure TN1.4 - 1 - WP1.4 and WP2 relation

Methods

The TN1.4 was based on the scenarios studied in TN1.3 with major emphasis on the scenarios that will be demonstrated, the path of the data, their format, and the way in which they are transmitted, the way in which they are processed and converted from data to information.

This study considers the vertical paths (bottom, top down) between field operators or front line services up to central decision makers, as well as the horizontal paths of communication for entities operating at the same level (for example communication from field operator to field operator). This study includes contacts and interviews to

the main actors including International and Angolan representatives and a working session with the Portuguese actors that took place on May 15th.
The results are presented as a table in which the Requirements are organised by subject.

Conclusions

The objective of Technical Note 1.4 was the gathering of users' requirements in order to allow for the definition of HEWS functionalities. These activities were done with regard to the scenarios that will be demonstrated during the project development, and already detailed in TN1.3. Nevertheless, general requirements for a wider use of HEWS were also considered.
Contacts were held with the different end-users already identified, both in Portugal and Angola, which was essential for the identification of their requirements, being clear that all involved institutions want it to have a full set of functionalities. Their feedback to our approach was rather positive, but definition of requirements was not much detailed regarding political and operational characteristics. These definitions entail another level of and decision-making, not addressable at this project phase. However, the degree of end-users participation and interest shows their growing commitment to the project, encouraging our team to persevere in its contacts with different end-users.

ANNEX – Requirements tables

<u>Lisbon 15th May National Entities Users Needs Meeting</u>
The results of the meeting are presented in the tables below.
Participants to the Meeting were:
- Dr. Cunha da Cruz (Civil Protection National Authority)
- Dr. António Dias (National Medical Emergency Institute)
- Inspector José Pires and Inspector Rui Prata (Investigation Police)
- Dra. Lurdes Monteiro (as a representative of the Angolan team).

Several inputs were also collected from intermediate meetings with Meteorology Institute and General Directorate of Health.
All the members of the consortium were present at the meeting.

Requirements: Managed Data

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 1	**DATA**	ALL	***Managed data***	ALL	15-05-07	Mandatory	TBC	1	1
UR 11	**DATA**	ALL	HEWS shall allow the registration of information regarding health events (occurrences).	ALL	15-05-07	Mandatory	TBC	1	1
UR 12	**DATA**	ALL	Information registered by HEWS shall be:	ALL	15-05-07	Mandatory	TBC	1	1
UR 121	**DATA**	ALL	- Description of the occurrence:	ALL	15-05-07	Mandatory	TBC	1	1
UR 1211	**DATA**	ALL	- **What** happened	ALL	15-05-07	Mandatory	TBC	1	1
UR 1212	**DATA**	ALL	- **How**	ALL	15-05-07	Mandatory	TBC	1	1
UR 1213	**DATA**	ALL	- Target (**who**)	ALL	15-05-07	Mandatory	TBC	1	1
UR 1214	**DATA**	ALL	- **When** - Date/time	ALL	15-05-07	Mandatory	TBC	1	1
UR 1215	**DATA**	ALL	- **Where** (Place + Geo-reference)	ALL	15-05-07	Mandatory	TBC	1	1
UR 122	**DATA**	ALL	- Attachments (images, video, sound, ...)	ALL	15-05-07	Mandatory	TBC	2	3
UR 123	**DATA**	ALL	- Affected people	ALL	15-05-07	Mandatory	TBC	1	1
UR 1231	**DATA**	ALL	- Identity	ALL	15-05-07	Mandatory	TBC	1	1
UR 12311	**DATA**	7	- Family members and other human contact	ALL	15-05-07	Mandatory	TBC	1	1
UR 1232	**DATA**	ALL	- Place	ALL	15-05-07	Mandatory	TBC	1	1
UR 1233	**DATA**	ALL	- Clinical history	ALL	15-05-07	Mandatory	TBC	1	1
UR 12331	**DATA**	7	- Background (nearby deaths, funeral attendance, ...)	ALL	15-05-07	Mandatory	TBC	1	1
UR 12332	**DATA**	7	- Clinical symptoms	ALL	15-05-07	Mandatory	TBC	1	1
UR 12333	**DATA**	7	- Evolution of medical situation	ALL	15-05-07	Mandatory	TBC	2	2
UR 124	**DATA**	ALL	- Collected samples and laboratory results	ALL	15-05-07	Mandatory	TBC	1	1
UR 125	**DATA**	ALL	- Meteorological information (winds and rain)	ALL	15-05-07	Mandatory	TBC	1	1
UR 126	**DATA**	ALL	- List of actions undertaken	ALL	15-05-07	Mandatory	TBC	1	2
UR 13	**DATA**	ALL	Information should use the standard typology for events, actions, commands and language and shall include data of the entity that registers the event.	ALL	15-05-07	Desirable	TBC	2	3
UR 14	**DATA**	ALL	HEWS shall manage generic/fixed information.	ALL	15-05-07	Mandatory	TBC	2	3
UR 15	**DATA**	ALL	Generic/fixed information shall be:	ALL	15-05-07	Mandatory	TBC	2	3
UR 151	**DATA**	ALL	- Standard operational procedures	ALL	15-05-07	Mandatory	TBC	2	3
UR 152	**DATA**	ALL	- Agent name and description (antidote and treatment)	ALL	15-05-07	Mandatory	TBC	2	3
UR 153	**DATA**	ALL	- Available means of intervention	ALL	15-05-07	Mandatory	TBC	2	3

Table TN1.4 - 1 - Requirements Managed Data

Requirements: Data Control

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 2	**CTRL**	ALL	***Data Control***	ALL	15-05-07	Mandatory	TBC	1	1
UR 21	**CTRL**	ALL	HEWS shall allow registration of occurrences by authorized users at any of the participant entities, via central or local computers.	ALL	15-05-07	Mandatory	TBC	1	1
UR 22	**CTRL**	ALL	Occurrence info shall be updatable at anytime, by all authorised entities (person/group), via central or local computers, or mobile devices.	ALL	15-05-07	Mandatory	TBC	1	1
UR 23	**CTRL**	ALL	The information update history shall be maintained by HEWS, and viewable on demand.	ALL	15-05-07	Mandatory	TBC	2	3
UR 24	**CTRL**	ALL	The user shall be able to forward inserted or updated info to other entities by the chosen means of communication.	ALL	15-05-07	Mandatory	TBC	1	1
UR 25	**CTRL**	ALL	All users shall define the means of communication by which they wish to receive information.	ALL	15-05-07	Mandatory	TBC	2	2
UR 26	**CTRL**	ALL	Possible means of communication should be:	ALL	15-05-07	Desirable	TBC	2	2
UR 261	**CTRL**	ALL	- E-mail	ALL	15-05-07	Desirable	TBC	2	2
UR 262	**CTRL**	ALL	- SMS	ALL	15-05-07	Desirable	TBC	2	2
UR 263	**CTRL**	ALL	- Phone call (using text-to-speech technology)	ALL	15-05-07	Desirable	TBC	3	3
UR 264	**CTRL**	ALL	- Fax	ALL	15-05-07	Desirable	TBC	3	3
UR 27	**CTRL**	ALL	The system shall allow the definition of conditions of access to information.	ALL	15-05-07	Mandatory	TBC	1	1
UR 28	**CTRL**	ALL	By default, all users will be authorized to view all information, add information and correct its own information.	ALL	15-05-07	Mandatory	TBC	1	1
UR 29	**CTRL**	ALL	By default, users will not be able to change information inserted by other users.	ALL	15-05-07	Mandatory	TBC	1	1

Table TN1.4 - 2 - Requirements Data Control

Requirements: Data Availability

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 3	**AVLB**	ALL	***Data availability***	ALL	15-05-07	Mandatory	TBC	1	1
UR 31	**AVLB**	ALL	Occurrence info (specific, variable) shall be available for query at anytime, by all authorised entities (person/group), via central or local computers, or mobile devices.	ALL	15-05-07	Mandatory	TBC	1	1
UR 32	**AVLB**	ALL	Generic/fixed info shall be available for query at anytime, by all authorised entities (person/group), via central or local computers, or mobile devices.	ALL	15-05-07	Mandatory	TBC	1	1
UR 33	**AVLB**	ALL	Information shall be printable.	ALL	15-05-07	Mandatory	TBC	2	2
UR 34	**AVLB**	ALL	Information shall be available for exporting into other applications, in order to allow for the preparation of reports.	ALL	15-05-07	Mandatory	TBC	1	3
UR 35	**AVLB**	ALL	All HEWS modules shall be able to work while disconnected from the others.	ALL	15-05-07	Mandatory	TBC	1	1
UR 36	**AVLB**	ALL	Only relevant information shall be available in the HEWS mobile module when working off-line, particularly: generic information and specific information about the event (does not include information about other events or information update history).	ALL	15-05-07	Mandatory	TBC	1	1
UR 37	**AVLB**	ALL	An automatic SMS or email shall be sent in case of alarm or reached threshold, or simply in case of new entry records, as configured in the system	ALL	15-05-07	Mandatory	TBC	1	2

Table TN1.4 - 3 - Requirements Data Availability

Requirements: User Interface

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 4	**UI**	ALL	***User Interface***	ALL	15-05-07	Mandatory	TBC	1	1
UR 41	**UI**	ALL	HEWS shall provide the following user interface channels	ALL	15-05-07	Mandatory	TBC	1	1
UR 411	**UI**	ALL	- Web channel	ALL	15-05-07	Mandatory	TBC	1	1
UR 412	**UI**	ALL	- Desktop channel	ALL	15-05-07	Mandatory	TBC	1	1
UR 413	**UI**	ALL	- Mobile device channel	ALL	15-05-07	Mandatory	TBC	1	1
UR 42	**UI**	ALL	HEWS user interface channels shall support the following interface types:	ALL	15-05-07	Mandatory	TBC	1	1
UR 421	**UI**	ALL	- Text (reading / writing)	ALL	15-05-07	Mandatory	TBC	1	1
UR 422	**UI**	ALL	- Speech (listening / recording)	ALL	15-05-07	Mandatory	TBC	1	1
UR 43	**UI**	ALL	HEWS user interface channels should support the following interface types:	ALL	15-05-07	Desirable	TBC	3	2
UR 431	**UI**	ALL	- Speech-To-Text	ALL	15-05-07	Desirable	TBC	3	2
UR 432	**UI**	ALL	- Text-To-Speech	ALL	15-05-07	Desirable	TBC	3	2

Table TN1.4 - 4 - Requirements User Interface

Requirements: Communication Interfaces

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 5	**COMM**	ALL	***Communication Interfaces***	ALL	15-05-07	Mandatory	TBC	1	1
UR 51	**COMM**	ALL	Communication between HEWS modules shall use both terrestrial and satellite communication technologies (by manual or automatic choice).	ALL	15-05-07	Mandatory	TBC	1	1

Table TN1.4 - 5 - Requirements Communication Interfaces

Requirements: Interface to Users' Software

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 6	**EXT**	ALL	***Interface to Users' Software***	ALL	15-05-07	Mandatory	TBC	2	2
UR 61	**EXT**	ALL	HEWS shall allow registration of occurrences via automatic communication technology, from external systems, via defined API interface (for example, web services).	ALL	15-05-07	Mandatory	TBC	2	2
UR 62	**EXT**	ALL	HEWS shall make information available to other systems, via defined API interface (for example, web services).	ALL	15-05-07	Mandatory	TBC	2	2
UR 63	**EXT**	ALL	Epidemiological systems shall be able to access HEWS for data querying for epidemiological analysis.	ALL	15-05-07	Mandatory	TBC	2	2
UR 64	**EXT**	ALL	Epidemiological systems shall be able to register occurrences in HEWS (for instance, alarms).	ALL	15-05-07	Mandatory	TBC	2	2

Table TN1.4 - 6 - Requirements Interface to Users' Software

Requirements: Usability

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 7	**USAB**	ALL	***Usability***	ALL	15-05-07	Mandatory	TBC	1	2
UR 71	**USAB**	ALL	HEWS interface shall target users that are experienced in the use of software applications.	ALL	15-05-07	Mandatory	TBC	1	2
UR 72	**USAB**	ALL	HEWS targets rapid response scenarios and therefore HEWS interface shall allow fast access and registration of information.	ALL	15-05-07	Mandatory	TBC	1	2
UR 73	**USAB**	ALL	HEWS interfaces should have character/icons/pictograms of the dimension that allows users with presbiopia up to.... To read/write without eyeglasses Or should have a toggle button to pass to this size.	ALL	15-05-07	Desirable	TBC	1	1

Table TN1.4 - 7 - Requirements Usability

Requirements: Scalability

code	category code	Scenario	Description	User	Date	Verbal form	Maturity	Priority	Severity
UR 8	**SCAL**	ALL	***Scalability***	ALL	15-05-07	Mandatory	TBC	1	1
UR 81	**SCAL**	ALL	HEWS shall be scalable to < 500 concurrent users, including external systems.	ALL	15-05-07	Mandatory	TBC	1	1
UR 82	**SCAL**	ALL	HEWS prototype shall be usable by < 20 concurrent users, including external systems.	ALL	15-05-07	Mandatory	TBC	1	1

Table TN1.4 - 8 - Requirements Scalability

Angolan Team Report

Two members of the INSA team in charge of the Angolan Scenario sundry related activities and Implementation, Laura Brum and Lurdes Monteiro, travelled to Angola from 21st April to 2nd May, in order to collect directly from the local MoH in Luanda and other Health Institutions and facilities (Hospital of Uige) the Users' Requirement and Data Flow for HEWS taking into consideration also the specificity of the Marburg virus scenario.

European Scenarios data flow and users Requirements

Given the envisaged use of the HEWS in European settings, the necessity to know how information on risk is provided and exchanged in this setting is high.
The design of the HEWS must account for these needs, and as such the consortium deemed it important to define some scenarios of possible use for the HEWS and to know how information was shared in these specific scenarios.
A particular relevant issue is the interaction at supranational level, given the ever growing integration of policies and actions at the European Union (EU) level.
The connection to EU and WHO Systems, being mostly a matter of technical interfaces, will be defined on the basis of the scenarios to be implemented during WP2 phase of Requirements refinement and of Technical Specification.
The detail of the scenarios was presented in TN 1.3.

Conclusions

To establish the set of user requirements herein presented, several steps were undertaken. The active involvement of the end-users was considered fundamental and was sought thoroughly. At first a structure questionnaire was designed, prepared and sent to all involved end-users. At a later time a meeting was scheduled to discuss the pre-communicated requirements.
The questionnaire was designed having as basis the generic structure defined in TN1.2. The collaborating end-users were asked to address requirement for the two scenarios envisaged by HEWS for demonstration purposes (bio-terrorist attack and Marburg virus) and plus one scenario at their will. Feedbacks on the questionnaire and on what were the aims were very positive. But only about 50% (slightly more) of the end-users involved sent in requirement ideas, reporting mainly generic information and awareness of difficulties.
Vis-à-vis meetings in Angola with African Partners and in Lisbon with Portuguese partners were more fruitful. It was clear that the HEWS potential is well percept, and that all involved institutions want it to have a full set of functionalities.
But overall the same difficulties arose. For most desirable early warnings the underlining service/system may not yet exist. Sometimes it is percept that HEWS could or should fill the existing void. For example, the most discussed scenario was the terrorist attack, and it was clear that the respective system/service (that should be gathering information and hints) does not exist. Moreover, there are clear doubts about who will be the owner of the information, and who is able to see what. In the end of the working session, it was settled between the consortium and the users that

at this stage political and operational decision, shall be avoided, and it was clearly stated that the objective of the project is to show to the decision makers that is possible to act in a different and more fruitful manner, if satellite communications are widely used.

The interest and degree of participation of end-users in the working session clearly showed the high level of commitment of the several parts and encourages the consortium team to continuously involve more and more end-users during project duration.

ANNEX – List of contacts

In order to prepare this TN, similarly to the previous work package, a number of entities were contacted, mainly in Portugal:

- An ANPC representative was present at the last consortium internal meeting. Following his invitation, a meeting was arranged on the ANPC headquarters, where the team did a tour of the facilities and had the opportunity to clarify some questions regarding the scenarios;
- The INEM was also represented at the last consortium internal meeting;
- A representative from the PJ has also been designated and was present at the last consortium internal meeting. He provided some information on their work and informed the team of his availability to meet us when necessary;
- The IM had been previously contacted and a representative was also designated to work with the project;
- Contact was also established with the DGS, who also indicated a representative to cooperate with the project.

Contacts have also been initiated regarding African scenarios, particularly with the Paediatrics Hospital in Luanda and with the Angolan MoH. The trip of team members Laura Brum and Lurdes Monteiro to Luanda, from 21st April to 2nd May, allowed for a deeper discussion with envisaged partners and the Users Requirements were identified.

3.2 Work Package 2 – Functional and System Design of the Envisaged HEWS

3.2.1 Developed Activities

During Work Package 2, enlarged discussions with the end-users took place. These allowed for a better definition of the Functional and System Design, enabling the envisaged HEWS to be as close as possible to the end-users requirements and necessities.
This work was also useful on advancing needs that might arise during scenario preparation activities.

3.2.2 Deliverables

ESA/HEWS/DLV/TN2/D7.0 – TN2: Functional and System Design

The document was the very first version of the HEWS functional and system design. Due to the fact that HEWS project follows a user driven approach, the first step was to detail each of the demonstration scenarios together with the end users, so that the team could clearly identify both the functional, equipment and communication requirements. Based on that, and after a deep analysis of the scenarios design, we start to design the system. The documents that support the scenarios definition shall be considered as a relevant base while reading this document.
Despite the large amount of inputs, namely user requirements that the project team has already gathered, there is still a long way to go until a final decision is reached on the definitive design that will support the development of the prototypes to be used as technological support for the demonstration activities.
To ensure that user requirements were completely met and not lost during analysis and design phases, the consortium decided to follow an entity-process model that directly reflects the users' interactions with the system. Therefore a set of entities and processes that shall be part of the system are presented. To better gauge user needs, some low fidelity screen prototypes were designed and are presented in the document as examples to be considered in further phases of the project.
A survey on information systems was already started, but still not concluded in all entities that will participate in the scenarios demonstrations. Besides the ongoing status of this task, it is already clear that most of the entities lack strong and robust information systems, and particularly that there is a lack of integration between intra and inter entities.
As a preliminary conclusion we can assure that HEWS will for sure enhance the operational processes of all entities involved as end users in the project.

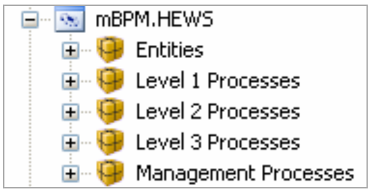
Objectives

The objective of this work package was to design the system that would support the demonstration scenarios. This process, although supported on the requirements of the scenarios, will be inline with End-Users expectations even in different operation

modes and situations. The collection of the requirements was done during WP1.4 and was refined during this WP in several working sessions held with end-users.
In the end of the work package the system design must be complete in order to start the development activities in WP3. Complete system design will be accomplished whenever entities, processes and user interfaces are fully identified and detailed. Besides that, system architecture as well as communications infrastructure must be depicted in this document.
Another task must comprise procurement activities for some of the equipments and services to be used during the demonstration.
Interoperability, scalability, reliability and system security will also be deeply analysed in the scope of this work package activities.

Functional Design

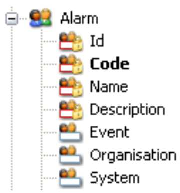
This chapter presents the functional design of the system, including adaptations made regarding the field usage in the context of the Marburg Scenario demonstration.
The first two sections will depict the entities and processes involved in the system's normal operation. Later, on the third section a traceability matrix will be done in order to easily identify how user requirements are being accomplished.
Functional Design will be presented by modules for an easier reading (and as seen on the figure below). A Module groups objects closely related, from a specification point-of-view or from an interaction point-of-view. A Module works as a semantically related Processes aggregation element.



Entities

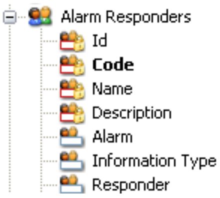
This section will depict, one by one, the entities that will be part of the system.

Alarm



The ***Alarm*** entity will allow the system to aggregate the information needed to issue an alarm. An alarm has its origin on a system, or after an evaluation of an event or a set of events. Following, the most relevant fields of ***Alarm*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Event: This field identifies the event that was the motive to issue an alarm. This field must be of ***Event*** type.
Organisation: This field identifies the organisation that hosts the system. This field must be of ***Organisation*** type.
System: This field holds the identification of the system where the detector is hosted. This field must be of ***System*** type.

Alarm Responders

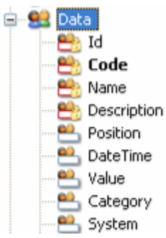


The ***Alarm Responders*** entity allows responder organizations to be associated to specific type of alarms, so the system knows at all times which responder should be notified when an alarm is generated.
Following, the most relevant fields of ***Alarm Responders*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Alarm: This field holds the alarm that should be assigned to which responder, and must be of ***Alarm*** type.
Information Type: This field will host the type of information that the alarm contains, and must be of ***InformationType*** type.
Responder: This field will host the responder assigned to the alarm, and must be of ***Organisation*** type.

Communication Channels

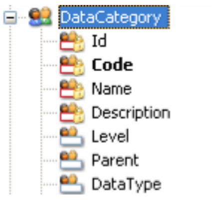
The entity ***Communication Channels*** holds the description of the communication channels existent on the system. The objective is to easily manage the communications that the system will deal with during its normal operation. Examples of communication channels are satellite or cable.
Following, the most relevant fields of ***Communication Channels*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Data



The ***Data*** entity is the one that will hold scientific data originated by the several systems, including the field and laboratory data collected by the HEWS system. The Data can be organized by system origin, category or position.
Following, the most relevant fields of ***Data*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Position: This field details the position where the data was collected. It shall include latitude and longitude parameters.
DateTime: This field saves the information regarding the date and time of the occurrence to which the data refers to. It shall include day, month, year, hour, minutes and seconds.
Value: This field saves the value of the instance of the entity.
Category: This field identifies the category to which the data belongs to. This field must be of ***DataCategory*** type.
System: This field holds the identification of the system that originates the data. This field must be of ***System*** type.

DataCategory



The ***DataCategory*** entity is the one that permits to aggregate data in categories for easier management and treatment of Giga and Giga bytes of information. The ***DataCategory*** allows the generation of different subcategories through the identification of the category *Level* and *Parent* category.

Following, the most relevant fields of ***DataCategory*** entity are depicted for a better understanding of the systems' functioning.

Name: This field names the instance of the entity.

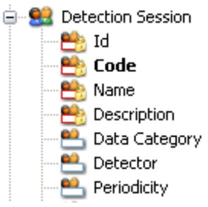
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating entities treatment.

Level: This field indicates the category level. If the value is '0', the category is a top category, if the value is '1,' it is a subcategory, etc, etc.

Parent: If the *Level* field is different of '0', the field *Parent* must enclose the name of the parent category of the sub-category.

DataType: This field holds the type of information that the data represents. This field must be of ***InformationType*** type.

Detection Session



The ***Detection Session*** entity is the one that permits to store the configuration of data to use in some executions. It should host the detector to execute, data category associated and the periodicity that should be used.

Following, the most relevant fields of ***Detection Session*** entity are depicted for a better understanding of the system's functioning.

Name: This field names the instance of the entity.

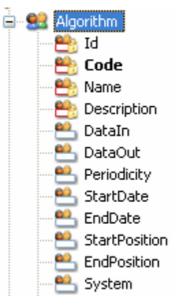
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Detector: This field indicates which detector should be used in every specific detection session. This field must be of ***Detector*** type.

DataCategory: This field identifies the category to which the data belongs to. This field must be of ***DataCategory*** type.

Periodicity: This field will define with which periodicity the detector must be run. It can hold values has *hourly*, *daily*, *weekly*, *monthly*, *yearly* or *other*. This field must be of ***Periodicity*** type.

Detector

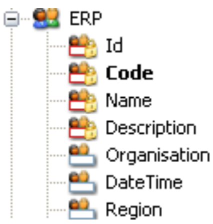


The ***Detector*** entity will allow the system to communicate with different scientific detectors in order to get realistic interpretation of scientific data. This entity supports the definition of the characteristics of the system's interface with each new detector coupled with the system. A new added detector will create a new instance of the entity. Following, the most relevant fields of ***Detector*** entity are depicted for a better understanding of the system's functioning.

Name: This field names the instance of the entity.

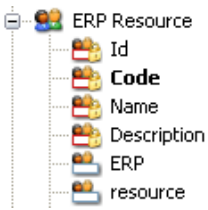
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
DataIn: This field will host the definition of the data that will serve as input for the detector, and must be of ***DataCategory*** type.
DataOut: This field will host the definition of the data that will result as output of the detector, and must be of ***Event*** type.
Periodicity: This field will define with which periodicity the detector must be run. It can hold values has *hourly*, *daily*, *weekly*, *monthly*, *yearly* or *other*, and must be of ***Periodicity*** type.
StartDate: This field will hold the start date and time of the detector. It's an obligatory field.
EndDate: If the field *Periodicity* value is *other*, then besides the start date and time, it is necessary to define an end date and time. This field is only obligatory in case the *Periodicity* field is *other*.
StartPosition: Similarly to time ranges, the detector can use positioning data. This field will represent the upper left corner of a rectangle that determines the geographical range of the detector.
EndPosition: The field represents the lower right corner of a rectangle that determines the geographical range of the detector.
System: This field holds the identification of the system where the detector is hosted. This field must be of ***System*** type.

ERP



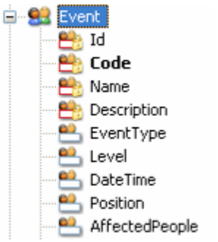
The entity ***ERP*** holds the description of an ERP (Emergency Response Plan) created on the system. It has information about the organisation that leads it, the region affected and the date after when it's valid. Following, the most relevant fields of ***ERP*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Organisation: This field identifies the organisation that coordinates the ERP. This field must be of ***Organisation*** type.
DateTime: This field holds the date and time when the ERP will take place.
Region: This field identifies the region affected and must be of ***Region*** type.

ERP Resource



The entity ***ERP Resource*** crosses the resources entity with the ERP entity providing all resources available for each ERP. Following, the most relevant fields of ***ERP Resource*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
ERP: This field identifies the selected ERP associating it to the selected resource. This field must be of ***ERP*** type.
Resource: This field identifies the selected resource associating it to the selected ERP. This field must be of ***Resource*** type.

Event

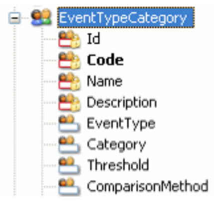


The ***Event*** entity is the one that will hold the results of the detectors computation or events reported directly by external systems. Events can be organized by type, level or position.
Following, the most relevant fields of ***Event*** entity are depicted for a better understanding of the systems' functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
EventType: This field permits the aggregation of the events by type for an easier management. This field must be of ***EventType*** type.
Level: This field will indicate the level of criticality of the event on a numeric scale. Different levels will raise different actions on the system, including the operational level change.
DateTime: This field saves the information regarding the date and time of the event. It shall include day, month, year, hour, minutes and seconds.
Position: This field details the position where the event occurred. It shall include latitude and longitude parameters.
AffectedPeople: This field shows the number of affected persons (real or expected) by the event.

EventType

The entity ***EventType*** holds the description of the type of events existent on the system. The objective is to easily manage the large amount of events that the system will deal with during its normal operation.
Following, the most relevant fields of ***EventType*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

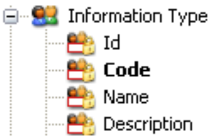
EventTypeCategory



The ***EventTypeCategory*** entity is the one that crosses information relating Data and Events.
Following, the most relevant fields of ***EventTypeCategory*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
EventType: This field holds the type of event that is to be compared. This field must be of ***EventType*** type.
Category: This field holds the category that is to be compared. This field must be of ***DataCategory*** type.
Threshold: This field value defines the threshold to each pair ***EventType*** – ***DataCategory***. If the threshold is reached the system will perform an action.

ComparisonMethod: This field defines the comparison method to be used to the threshold. The values it can have are: *major then*, *minor then* and *equals to*.

Information Type



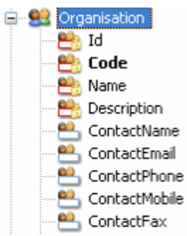
The entity ***Information Type*** holds the description of the type of information existent on the system. The objective is to easily manage the large amount of information that the system will deal with during its normal operation.

Following, the most relevant fields of ***Information Type*** entity are depicted for a better understanding of the system's functioning.

Name: This field names the instance of the entity.

Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Organisation



The ***Organisation*** entity is the one that identifies each institutional participant that interacts with the system. Each ***Organisation*** may have different contacts for different types of alarms. Following, the most relevant fields of ***Organisation*** entity are depicted for a better understanding of the system's functioning.

Name: This field names the instance of the entity.

Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

ContactName: This field holds the Person's name to be contacted in case of alarm.

ContactEmail: This field holds the email to which alarms shall be sent.

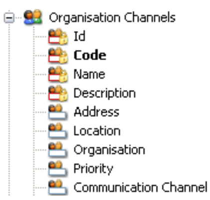
ContactPhone: This field holds the telephone number to which a call shall be made in case of alarm.

ContactMobile: This field holds the mobile number to which a SMS shall be sent in case of alarm.

ContactFax: This field holds the fax number to which a fax shall be sent in case of alarm.

Responder Type: This field holds the type of the responder (primary, secondary …). This field must be of ***ResponderType*** type.

Organisation Channels



The entity ***Organisation Channels*** holds the association of the different organisations on the system to their active communication channels. The objective is to easily define at any time which channels can be used for communication purposes.

Following, the most relevant fields of ***Organisation Channels*** entity are depicted for a better understanding of the systems' functioning.

Name: This field names the instance of the entity.

Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Address: This field contains the network address of the knot selected. It can be an IP address or a MAC address for instance.

Location: This field details the position where the knot is located. It shall include latitude and longitude parameters.

Organisation: This field identifies the organisation that defines the knot. This field must be of ***Organisation*** type.
Priority: This field contain the priority that the communication channel has. High priority channels shall be used first.
Communication Channel: This field identifies the communication channel that will be used by the knot. This field must be of ***Communication Channels*** type.

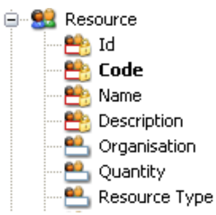
Periodicity

The entity ***Periodicity*** holds the description of the type of periodicity existent on the system. The objective is to easily define the time intervals in which detectors will be executed.
Following, the most relevant fields of ***Periodicity*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Region

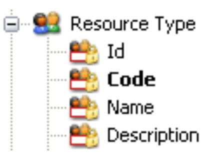
The entity ***Region*** holds the description of the regions existent on the system, so it's easier to locate the region to which an ERP is applicable. Following, the most relevant fields of ***Region*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Resource



The entity ***Resource*** holds the description of all resources existent on the system. Those Resources are associated to the organisation which has them available.
Following, the most relevant fields of ***Resource*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Organisation: This field identifies the organisation that defines the knot. This field must be of ***Organisation*** type.
Quantity: This field identifies the number of available selected resources.
Resource Type: This field identifies the type of resource selected. It can hold values like "human resource", "preventive measures", among others. This field must be of ***Resource Type*** type.

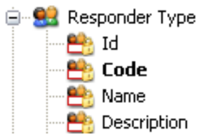
Resource Type



The entity ***Resource Type*** holds the description of the type of resources existent on the system. It holds preventive measures, training material, among others to categorize the resources.
Following, the most relevant fields of ***Resource Type*** entity are depicted for a better understanding of the system's functioning.

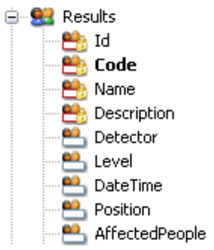
<u>*Name:*</u> This field names the instance of the entity.
<u>*Description:*</u> This field allows the addition of further information to the name of the instance with the aim of facilitating entities treatment.

Responder Type



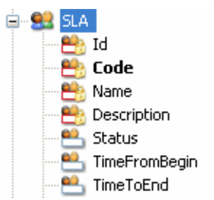
The entity ***Responder Type*** holds the description of the type of organisation existent on the system. It holds primary responders, secondary responders, according to the urgency or role that they will have in the event.
Following, the most relevant fields of ***Responder Type*** entity are depicted for a better understanding of the system's functioning.
<u>*Name:*</u> This field names the instance of the entity.
<u>*Description:*</u> This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.

Results



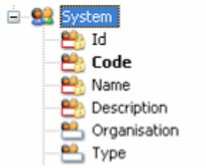
The entity ***Results*** holds the results received from the execution of a certain detector. The results can be organized by level or position.
Following, the most relevant fields of ***Results*** entity are depicted for a better understanding of the system's functioning.
<u>*Name:*</u> This field names the instance of the entity.
<u>*Description:*</u> This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
<u>*Level:*</u> This field will indicate the level of criticality of the result on a numeric scale. Different levels will raise different actions on the system, including the operational level change.
<u>*DateTime:*</u> This field saves the information regarding the date and time of the result collected. It shall include day, month, year, hour, minutes and seconds.
<u>*Position:*</u> This field details the position where the results were obtained. It shall include latitude and longitude parameters.
<u>*AffectedPeople:*</u> This field shows the number of affected persons (real or expected) by the event that originated the result.

SLA



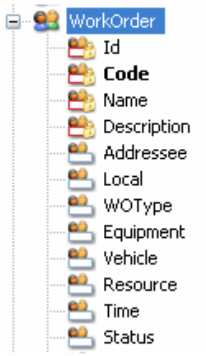
The ***SLA*** entity defines the Service Level Agreement for each Work Order. ***SLA*** can be defined either from the time of beginning or from the time to end. Following, the most relevant fields of ***SLA*** entity are depicted for a better understanding of the system's functioning.
<u>*Name:*</u> This field names the instance of the entity.
<u>*Description:*</u> This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
<u>*Status:*</u> This field declares the status associated to which the ***SLA*** refers to. It can be *New*, *Assigned*, *Accepted*, *Execution*, *Finished* and *Closed*.
<u>*TimeFromBegin:*</u> This field measures the permitted time from the beginning of the task.
<u>*TimeToEnd:*</u> This field measures the permitted time until the end of the task.

System



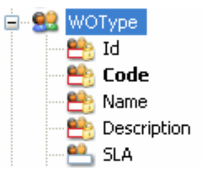
The ***System*** entity identifies each system that interacts with the HEWS system. Following, the most relevant fields of ***System*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Organisation: This field identifies the organisation that hosts the system. This field must be of ***Organisation*** type.
Type: This field characterizes the system.

Work Order



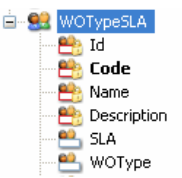
The ***WorkOrder*** entity identifies a set of instructions that need to be dispatched while an emergency is present. Following, the most relevant fields of ***WorkOrder*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
Addressee: This field identifies the organisation that will receive the work order. This field must be of ***Organisation*** type.
Local: This field characterizes the location where the work order is to be executed.
WOType: This field characterizes type of work order. This field must be of ***WOType*** type.
Equipment: This field details the equipment necessary to execute the order.
Vehicle: This field identifies the suitable type of vehicle to execute the order.
Resource: This field identifies the suitable kind of human resources to execute the order.
Time: This field identifies at what time the order shall be executed.
Status: This field holds the status of the order allowing the orders' tracking.

WO Type



The ***WOType*** entity identifies the type of work orders available in the system. Following, the most relevant fields of ***WOType*** entity are depicted for a better understanding of the system's functioning.
Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
SLA: This field characterizes the level of service agreed to a particular type of order. This field must be of ***SLA*** type.

WOTypeSLA



The ***WOTypeSLA*** entity is the one that crosses information relating WOType and SLA. Following, the most relevant fields of ***WOTypeSLA*** entity are depicted for a better understanding of the system's functioning.

Name: This field names the instance of the entity.
Description: This field allows the addition of further information to the name of the instance with the aim of facilitating the entities treatment.
SLA: This field characterizes the level of service agreed to a particular type of order. This field must be of ***SLA*** type.
WOType: This field characterizes the type of work order. This field must be of ***WOType*** type.

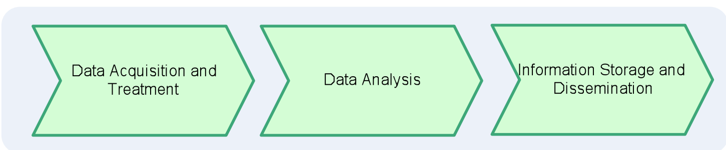
Processes

In the scope of Public Health, the system must be seen as a monitoring and surveillance system with the capability of supporting Early Response and Reaction activities in case of a Health crisis, therefore the system will act in three different levels of monitoring: Normal, Emergency Alert and Real Emergency Presence.
Each level is characterized by a set of processes that shall be performed by a predefined set of actors, in case particular conditions occur. In the next sections, the detail of each Monitoring Level is presented.
To each process 4 sections are shown:

- Diagram – Detail on the activities that need to be performed in order to achieve the envisaged result for the process. Each process has a Start activity (●) and an End activity (⦿).
- Description – Describes in human language the diagram that details the activities within a process.
- Forms – Shows, whenever possible, the screen that will allow data collection or data visualization. It can vary from channel to channel (for instance the same form can appear in a desktop channel or a Pocket PC channel).
- Inputs/Outputs – Identifies the type of entities that are consumed and/or produced by the execution of the process.

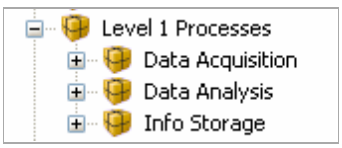
Monitoring Level 1: Normal Conditions

While no risk alarm threshold is reached, the system works on monitoring level 1.



Monitoring Level 1 - Macro Processes

Main activities in the monitoring level 1 consist on acquiring and treating data, analysing and storing it. The information, even tough no risk is present, may be disseminated to particular players that are interested in it. The solution is organised by modules and sub-modules that group similar processes, as seen below.



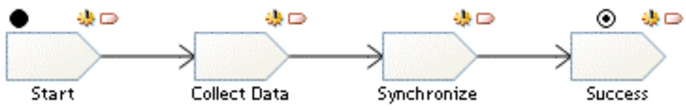
Level 1 Processes Sub-Modules

Data Acquisition Module

This module groups the list of processes that deal with data acquisition and preliminary treatment (like turning it available). Following sections depict each nuclear process of this module.

Collect Field Data

Diagram



Description
This process allows data collection directly into the system through multiple forms depending on the category of data to be collected. The forms can be displayed in different channels such as PDA, Laptops, Desktops or even mobile Phones.
Input/Output
Data Entity Instance/Data Entity Instance

Collect Laboratory Data

Diagram

Description
This process allows data collection directly into the system from laboratory equipments. The process will support the seamlessly integration of laboratory equipments data, with no need of human intervention. Depending on the laboratory equipment to be integrated a different *Collect Data Task* will be configured. Web services will be preferentially used, whenever possible due its easy maintenance.
Input/Output
Data Entity Instance/Data Entity Instance

Collect External Systems Data

Diagram

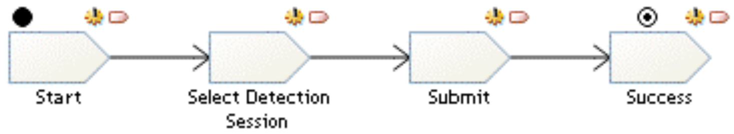
Description
This process allows data collection directly from external systems, such the ones hosted in different organisations. The process will support the seamlessly integration of data originated in external systems within HEWS system, we no need of human intervention. Depending on the system to be integrated a different *Collect Data Task* will be configured. Web services will be preferentially used, whenever possible due its easy maintenance.
Input/Output
Data Entity Instance/Data Entity Instance

Data Analysis Module

This module groups the list of processes that deal with data analysis. Data analysis can be done by external detectors (running in external systems) that gather information from the HEWS, and send to HEWS results after data processing. Following sections depict each nuclear process of this module.

Configure Data Analysis

Diagram



Description

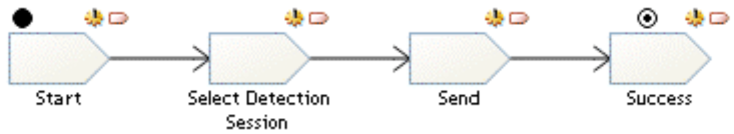
This process selects which detector shall be run, with which data source and which periodicity or period. After detection session submission, the process invokes the system in which the detector is running to send the detection session parameters.

Input/Output

Detection Session Parameters/ Detector Entity Instance

Send Data to Analysis

Diagram



Description

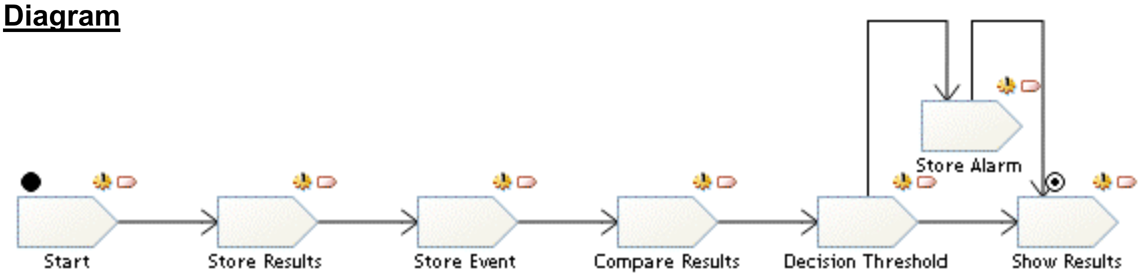
This process sends the Data required to run a specific detector. The Data is defined according to the detection session.

Input/Output

Detection Session Parameters/ Data Entity Instance

Receive Results

Diagram



Description

This process receives the results from a detector and stores it on a system as Events. Then uses Events parameters to validate the overtaking or not of the threshold.

Input/Output

Detector Results/ Event Entity Instance

Issue an Alarm

Diagram

Description

This process allows the user to issue an alarm manually regarding an event that hasn't been detected during the detection phase by the system. The alarm will be designated to one organization and then one or more addressees from that organization will respond to it.

Input/Output

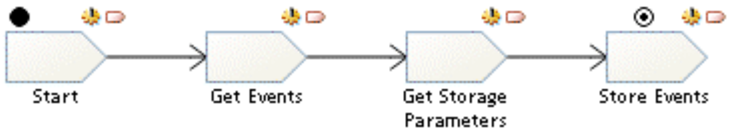
Comparison Results/ Alarm Entity Instance

Info Storage Module

This module groups the list of processes that deal with information storage and dissemination on regular operation. If and alarm is issued, the information is stored for historical purposes but a new process is raised (see Level 2 Processes).

Store Information

Diagram



Description

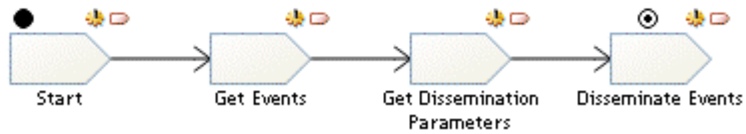
This process stores the resulting events accordingly to a set of definitions previously set on the system relating data formats and scheduling of storage.

Input/Output

Storage Parameters/N.A.

Disseminate Information

Diagram



Description

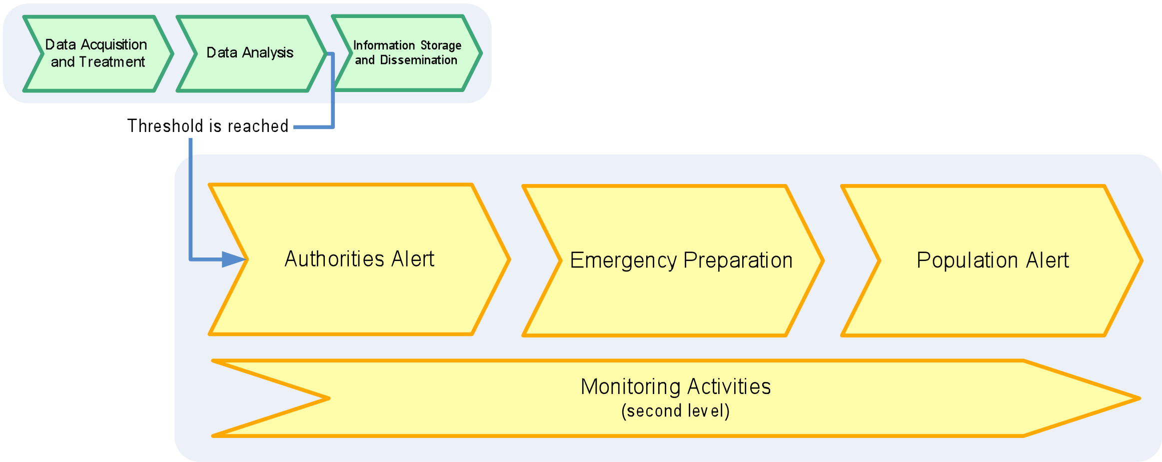
This process disseminates stored events accordingly to a set of definitions previously set on the system.

Input/Output

Dissemination Parameters/ Events

Monitoring Level 2: Emergency Alert

System Monitoring Level 2 happens whenever a threshold is reached. This level requires a deeper understanding of the epidemics or disease situation, implying more accurate analysis and in some particular cases even different methods of analysis. Opposing to the Monitoring Level 1, Level 2 has a lot of different institutions and organisations acting in its processes, namely public authorities and media. This level is only surpassed in case the epidemics are a reality, that is, in case an infection, natural or made man disaster with public health implications is detected and confirmed. Also in this level, all the preparation for a real emergency situation is done. It can go from assuring the existence of drugs supplies in a specific location, to training of the medical teams in case of real epidemics.



Monitoring Level 2 - Macro Processes

The solution is organised by modules and sub-modules that group similar processes

Level 2 Processes Sub-Modules

Authorities Alert Module

This module groups the list of processes that deal with alarms. After an alarm is issued to primary responders, it needs to be analysed, evaluated and confirm prior to dissemination to secondary responders.

Receive and Confirm an Alarm

Diagram

Description

This process allows Primary Responders to receive, analyse and confirm the existence of relevant occurrences to send an alarm to Secondary Responders. While confirming alarm type, primary responders can and should add relevant information to secondary responders.

Input/Output

Alarms / Alarms (with Extra Information)

Configure Secondary Responders

Diagram

Description

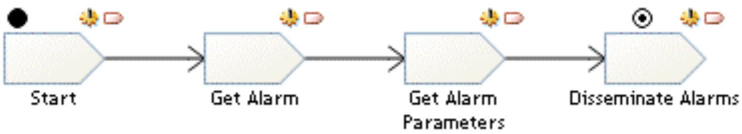
Depending on the type of alarm secondary responders may differ, therefore is necessary to configure to a specific alarm which kind of secondary responders shall be in the loop as well as the type of information that need to be passed to them, when and how (namely type of communications to be used).

Input/Output

Alarms / Secondary Responders Configuration.

Disseminate Alarm

Diagram



Description

This process disseminates analysed alarms accordingly to a set of definitions previously set on the system (please refer to 0 to further detail).

Input/Output

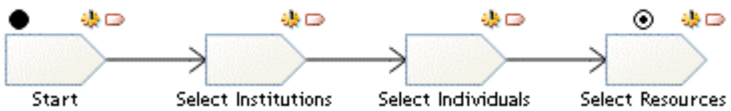
Dissemination Parameters/ Alarms

Emergency Preparation Module

This module groups the list of processes that will allow the generation of an Emergency Response Plan (ERP), specific to deal with the occurrence that originated the alarm issuing.

Select Organisations

Diagram



Description

This process selects Organisation, Institutions and Individuals that shall be included in the ERP.

Input/Output

Organisations/ N.A.

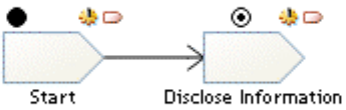
Get Information

Diagram

Description
This process uses the selected organisations to request information relevant in the scope of the ERP, namely available resources, preventives measures, drugs and medicines available stock, etc.
Input/Output
Organisations/ N.A.

Disclose Information

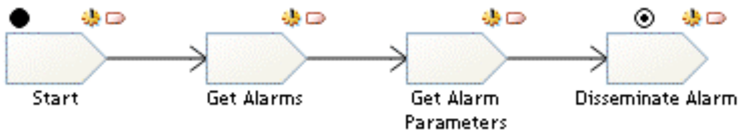
Diagram



Description
This process discloses information to the selected organisations. Information can be disseminated through different means and channels and can be either preventive measures or training material.
Input/Output
N.A. / Info

Define ERP

Diagram



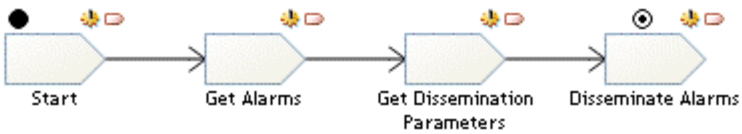
Description
This process supports the elaboration of an ERP.
Input/Output
Gathered Information / Emergency Response Plan

Population Alert Module

This module groups the list of processes that deal with population alarms. After an alarm is analysed it may be disseminated to the population as a preventive measure. The issuing on an alarm to population shall be present on the ERP.

Disseminate Alarms

Diagram



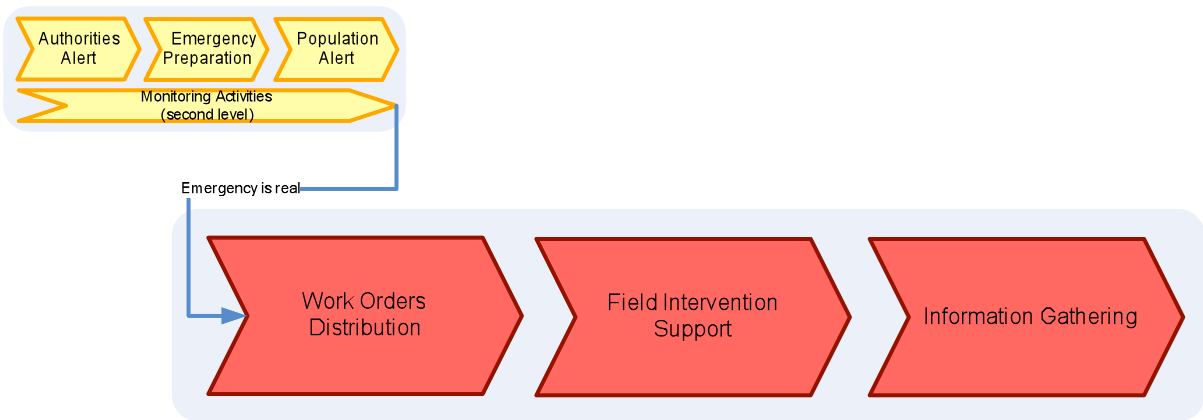
Description
This process disseminates pre-analysed alarms accordingly to a set of definitions previously set on the system.
Input/Output
Dissemination Parameters/ Alarms

Monitoring Activities Module

While working in the Monitoring Level 1 monitoring activities can be limited to certain areas and specific types of measures. Once Level 2 is reached, monitoring activities are extended to all the areas foreseen to be affected in the next future (exploiting not only mobile units but also pre-existent facilities and laboratories (Hospitals, private laboratories). Also thresholds are refined for this particular status. Analyses are more accurate and deeper. All data must be stored due to its high relevance in historical analyses and emergency prediction. This module comprises the three modules defined under Level 1 Module, although the type of inputs and analysis can be slight different to encompass more accurate results as well as relative positioning of the events that better support emergency preparation activities.

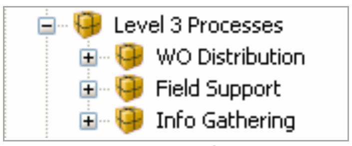
Monitoring Level 3: Real Emergency Present

Monitoring Level 3 is reached when the forecasted evolution of the epidemics or other negative natural or manmade event (CATEV), becomes reality. For example, in case of an epidemic, the new cases are really increasing beyond alarm threshold. Also monitoring level 3 is reached whenever local resources are considered insufficient to prevent/control the Health Risk situation.
Monitoring level 3 includes monitoring and field operation support. If an epidemic is a reality, meaning that infection continues to increase beyond alarm threshold, Emergency Response must be activated. Once more it can embrace different actions depending on the type of emergency but the main processes are the ones presented in following sections.



Monitoring Level 3 - Macro Processes

These processes happen in cycle, and even simultaneously until the end of the epidemics/CATEV. Since the Emergency Response Plan is continuously updated, the work-orders keep changing and must be distributed while emergency remain active.
The solution is organised by modules and sub-modules that group similar processes.



Level 3 Processes Sub-Modules

Work Orders (WO) Distribution Module

This module groups the list of processes that deal with Work Orders distribution. After an alarm is issued, work orders must be created and dispatched to different actors.

Prepare Work Orders

Diagram

Description
This process supports the preparation of work orders.
Input/Output
Alarms/ Work Orders

Dispatch Work Orders

Diagram

Description
This process supports the dispatching of work orders.
Input/Output
Work Orders/ Work Orders

Field Support Module

This module groups the list of processes that deal with Field Support activities.

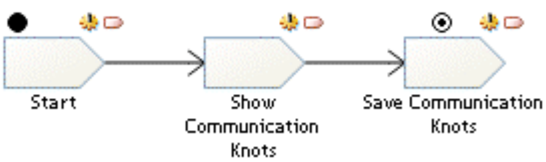
Location Instructions

Diagram

Description
This process sends information to field teams regarding events location.
Input/Output
Team Positioning/ Instructions

Support Communications

Diagram



Description
This process shows which communication channels are active for each knot and allows the user to add or remove channels.

Input/Output
Knots / N.A.

Weather Forecast

Diagram

Description
This process sends information to field teams regarding weather conditions.
Input/Output
Team Positioning/ Weather Forecast

Info Gathering Module

The processes under this module are quite similar to the ones presented in the monitoring activities sub-module. Information gathering is similar to Data Collection, although with a different status. For instance after a catastrophe the number of casualties is a relevant indicator of the impact of the catastrophe, therefore one can consider that the processes are similar, however the type of Data is different.

System Design

This chapter is mainly dedicated to the design of the system. On the first section the system architecture will be defined, as well as the communications infra-structures, that, due to its high relevance on this system development deserves an independent section. As a result of the analysis of the previous sections, third section will present the summary of the equipments and devices that will be a part of the system. A set of preliminary services that the system will be able to provide, will also be presented. Last but not least, some considerations about system user interfaces, of major importance since the use in emergency scenarios may be quite restrict, will be presented and must be considered during development stage.

System Architecture

For the system architecture definition we needed to understand which monitoring entities are involved in the process and be aware of their needs and procedures, in order to guarantee the development of effective, robust and timely responsive systems to health threats, disasters and outbreaks. One of the main concerns was to design a system capable of maintaining connections and exchanging critical information between all the actors involved, even in calamity scenarios.
The main focus of the system is the exchange and analysis of health-related information between public and private entities, fixed warning and monitoring systems, field units and mobile labs, regional and national centres. Different location, cultures, behaviour patterns and languages are issues that must be covered to facilitate the required European implementation.
The development of the system will cover the following main points:

- Interoperability and low cost of the different components

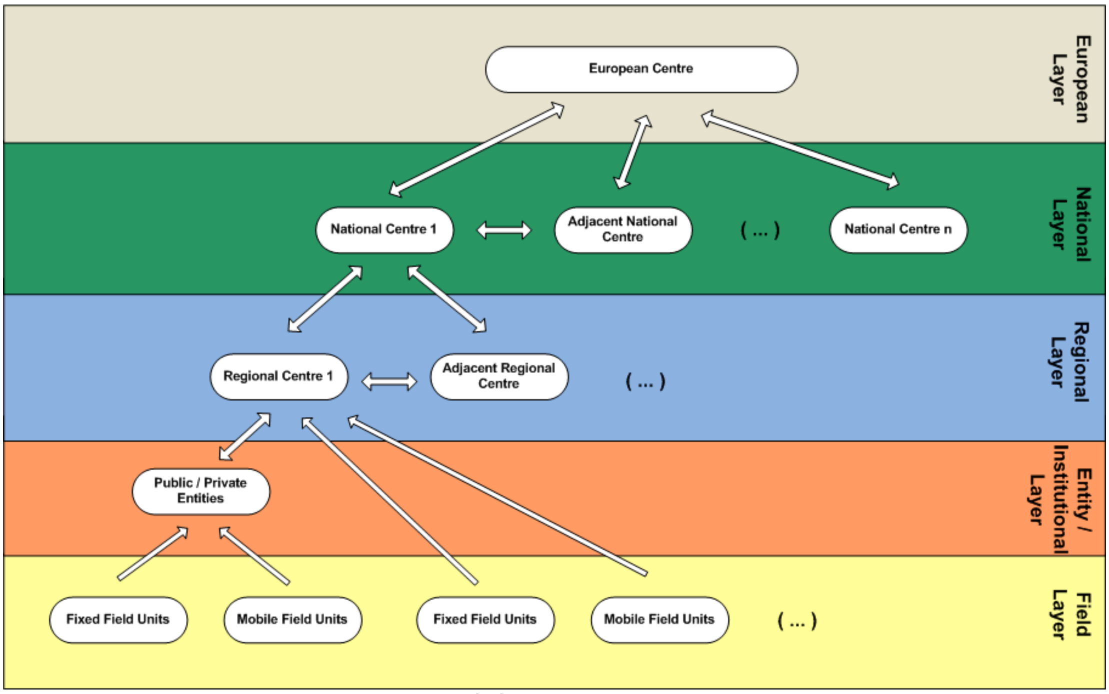
- Standard data communication and architecture (extendable for new situations and scenarios)
- Security and redundancy of the gathered and analysed information
- Robust and intelligent disaster management

The system will help the existing warning and monitoring systems to exploit and enlarge their capabilities by using and interacting with the HEWS mechanisms and tools. The system will include permanent observation and analysis of the data supplied by these systems in conjunction with the data gathered by the system deployable mechanisms. The main objective is to be able to access critical data at anytime, from anywhere, under any conditions.

To reach this objective, communication profiles need to be identified by the involved organizations, covering all the possible locations and conditions from which the system data will be accessed. For each profile, at least one or more communication channels will be available. From the accessible channels, the system will automatically select which channel is more appropriate for that particular situation, in order to reduce the overall communication costs whilst guaranteeing correct and timely information dissemination. The envisaged communication channels are: GSM, GPRS, 3G, Cable, DSL, Optical Fibre and Satcom.

System scalability is assured by n-layer, considering system instances location, granularity and characteristics:

- The field layer
- The entity/institutional layer
- The regional layer
- The national layer
- The European layer



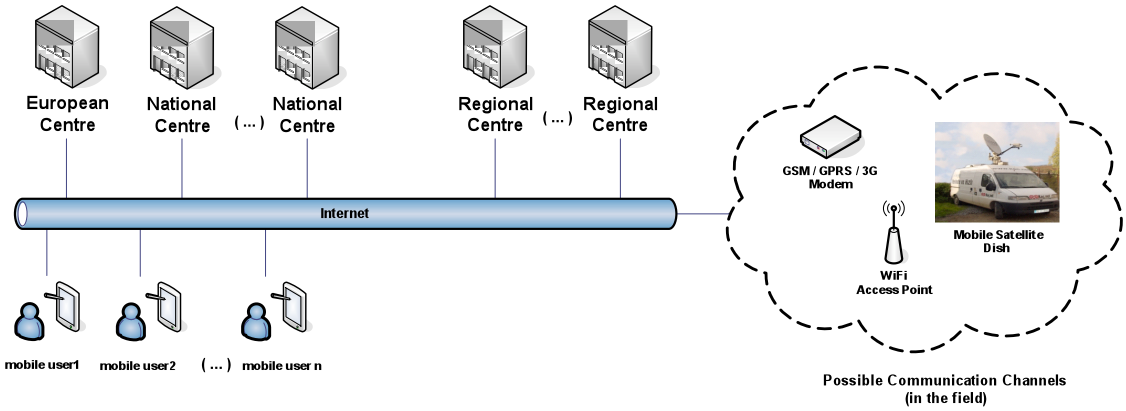
HEWS Operational Layers

At the field layer we can make a sub-division: between fixed and mobile field units. The fixed units comprise the legacy systems, i.e. the existing monitoring and warning systems. Fixed unit could be at a new emergency health site (school, hospital, mall, etc.) establishing communication link to institutional level or higher and mobile unit can be on the collecting epidemiological data and clinical samples where new cases are emerging from.

The following intrinsic characteristics of system, fully dependent on its scalable architecture guarantee that it can overcome the many challenges that it faces:

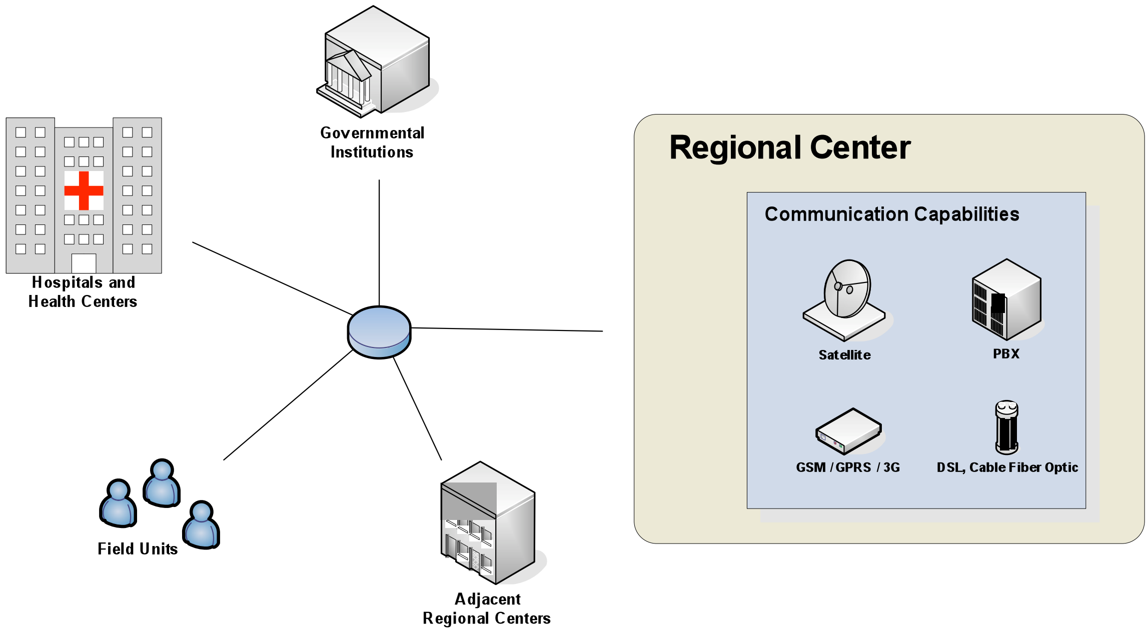
- **Awareness**: the system knows at any moment which is the state of the environment at both local and worldwide levels.
- **Autonomy**: the system can collect and process information without human intervention.
- **Dynamic**: the system automatically adapts to changing environment conditions without disturbing the monitoring and warning systems.
- **Continuity**: the information is gathered and processed in a continuous base to decrease response delay and improve preventive forewarnings.
- **Communicability**: all the actors will have the ability to understand, communicate and exchange information with all the other related elements of the system.
- **Modularity**: the system will be able to collect, process and disseminate information and alerts even in adverse conditions.
- **Interoperability**: the system will be capable to successfully integrate the legacy monitoring and warning systems.
- **Security**: all the information will be gathered and disseminated through secure channels and mechanisms, avoiding malicious data corruption or misappropriation.
- **Reactivity**: the system will be able to analyse the possible threats, response and trigger early warnings in a timely way.
- **Redundancy**: all the data of the system will be replicated in different formats and locations, in order to guarantee recovery even in catastrophic conditions.
- **Reliability**: the system will have mechanisms to ensure that all the data gathered, processed and disseminated is accurate.

The proposed layered architecture will be achieved by installing a ***HEWS instance*** at different physical locations. Regional instances will be installed at regional centres, national instances will be installed at national centres and one instance will be installed in the HEWS European centre. The instances are equal in functionality and communicate with each other to exchange the necessary data. This assures that each instance can work stand-alone. For example, data pertaining only region-wide events may or may not be managed only by the respective regional centre instance. This simple plain architecture is depicted in the following figure.



Plain communication architecture

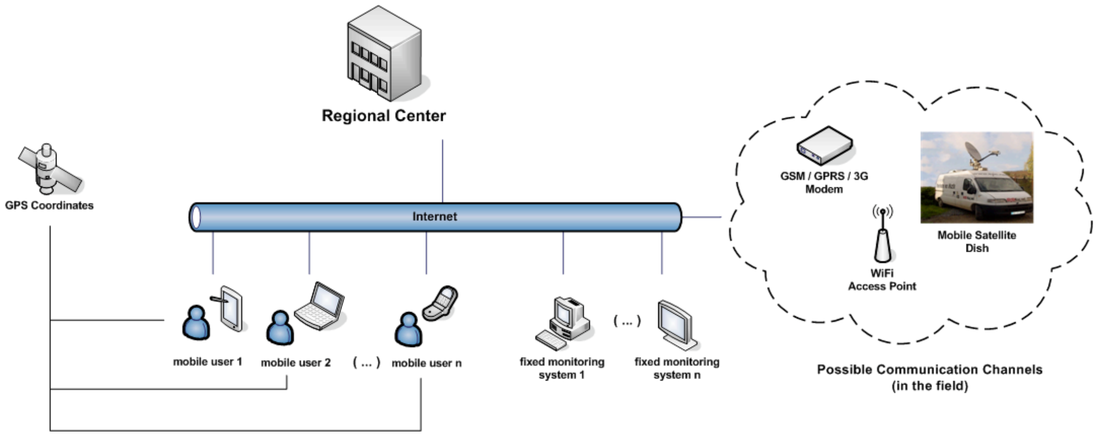
The mobile field units will have a Pocket PC device having the HEWS Pocket PC channel installed. The HEWS Pocket PC channel can communicate with any of the HEWS centres, regional or European, although operationally it makes more sense to communicate with the closest regional centre.
HEWS will receive inputs from Governmental Institutions, Hospitals and Health Centres, other HEWS instances and field units (fixed and/or mobile).



Regional Centre architecture

Each Centre is equipped with a vast number of systems for telephony, cellular, wired or satellite communications, for both inbound and outbound connections. Each actor of the system will communicate with the Centre through the most appropriate communication system and vice-versa. The modularity of the system makes it possible for the Centre to communicate with the upper and the lower layers, even in adverse situations.
The field units, namely the mobile ones, are the key to ensure that the system can monitor the widest areas and scenarios as possible since they can be deployed in areas without monitoring systems, due to disasters or lack of existing facilities. Therefore, the communication capacities are essential to ensure that the monitored

information is disseminated to the Regional Centre. In the figure below we can see the common elements in the field units' interaction with the Regional Centre.



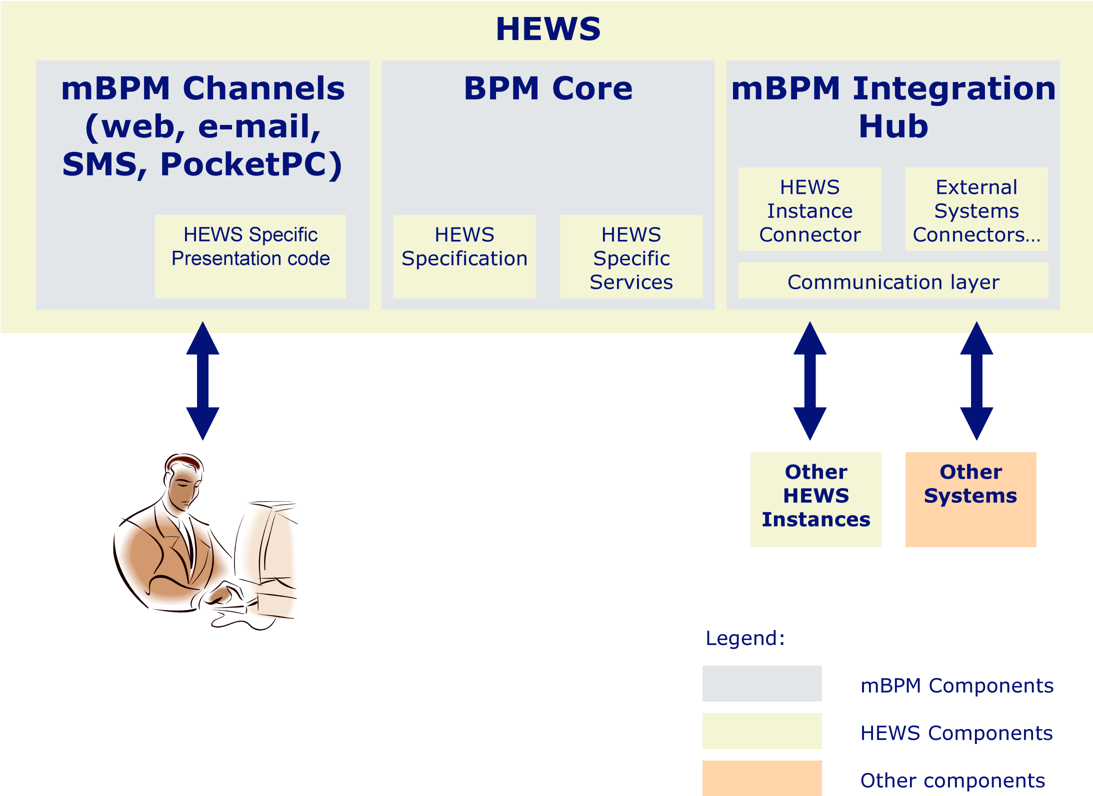
Regional interaction and communication capacities

The field units, both mobile and fixed, communicate with the Regional Centre via Internet, using GSM, GPRS, 3G, Wi-Fi hotspots and Satcom for mobile units and typically Ethernet for fixed units. The most relevant and interesting scenario is when for a specific region there is no fixed monitoring system or it fails because of a disaster or terrorist attack, for example. In both cases, a mobile unit is assigned and deployed in that region, ensuring that no crucial area is left unmonitored. All the actions and data of the mobile unit are geo-referenced for tracking purposes.

If the mobile unit isn't able to communicate with the corresponding Regional Centre it will forward the information to other Regional Centres and/or to the related National Centre. In any case, all the information gathered and disseminated is stored in the mobile unit, for security and redundancy purposes.

HEWS architecture

The architecture of a single HEWS instance, which is based on TEKEVER's mBPM platform (multi-channel Business Process Management), is shown in the following figure.



HEWS conceptual architecture based on mBPM platform

- ***BPM Core*** - The BPM core is responsible for running business processes identified within the scope of HEWS, based on specific Business Processes specification. It already includes basic processes for administration and template functionality.
- ***HEWS Specification*** – Specification of HEWS processes.
- ***HEWS Specific Services*** – module containing specific HEWS functionality not available in BPM Core.
- ***mBPM Channels*** – User Interface channels exposing specified business processes:
  - *Web channel*: provides access to specified processes via web.
  - *Pocket PC*: provides relevant functionality for mobile field units, in a Pocket PC device that connects to the BPM core for data communication. This component is installed in the Pocket PC device and can communicate with all HEWS instances' servers.
  - *E-mail channel*: within HEWS, sends e-mails to users with relevant information.
  - *SMS channel*: within HEWS, sends SMS's to users with relevant information.
- ***HEWS Specific Presentation code*** – Specific user interface functionality not already provided by mBPM Channels.
- ***mBPM Integration Hub*** – A component responsible for managing different connectors to provides integration with external systems, including standard connectors for some of the most common systems and technologies available in the market.

- *HEWS instance connector* – Used to communicate with other HEWS instances for information exchange.
- *External systems connector* – Used to communicate with other HEWS instances for information exchange.
- *Communication layer* – Manages different communication means (wired, wireless, satellite) in a way that is transparent to the connectors.

Communications Infra-structure

All HEWS components (fixed and mobile) will communicate with each other via internet. No dedicated communication means are used. Satellite Communication will be performed via specific Satellite-based Internet Services, as described in the following section. It is not important for HEWS which specific service is used, as long as an internet connection is obtained.
A specific communication layer switches between available internet connections, preferring wired to wireless or satellite. This allows the communication mean to be transparent for the other components of the system.
It is important to understand that each HEWS instance is able to work individually even during the failure of communication. In such case, exchange of information between the faulty instance and the remaining instances is not possible, but the faulty instance will continue working constrained to the information stored locally.
The HEWS mobile channel is able to connect to any HEWS fixed instance. If a mobile team cannot connect to its Regional Centre, it will be able to connect to other regional centres or its national centre. The fact that all HEWS instances have the same functionality assures this. Replication of user credentials is therefore necessary.

Equipments, Devices and Services

The most relevant equipment needed for both scenarios is the Car for the HEWS technical support mobile crew equipped with a mobile knot. Most of the participant entities have already all the communication infrastructure (namely satellite communication dishes), although it's use it's not optimized. As far as possible the already communication infrastructure will be used for demonstration scenarios purposes, and based on the results new infrastructures and equipments will be suggested. More accurate information on these issues will only be possible to achieve during demonstrations field surveys that must occur, as soon as the demonstrations scenarios are settled.
The Devices needed for communication and data recording are:

- Cellular phone
- PDA
- GPS
- Camera (electronic)
- Bgan
- Satellite fixed terminal for Angolan Hospital and/or MoH
- Laptop computer
- Fingerprint reader
- Barcode reader

With regard to handheld devices (PDA and cellular phone) we recommend a rugged PDA capable of Barcode reading and GPS. HTC, HP, Fujitsu-Siemens, Acer, Nokia, Sony, LG (as many other commercial producer) offer PDAs at prices ranging from

600 euros to 800 euros but they are not rugged, that is they are not fall and water resistant.
To avoid jeopardizing the scenario implementation due to the occasional failure of the PDAs we strongly recommend the choice of rugged devices (one to be used, one for back up). This selection shall be done in close relation with the teams both in Lisbon and in Angola.
More in details between the “rugged PDA” the best choice is possibly the TDS Recon 400 handheld computer from Tripod Data Systems because of its modularity (two Compact Flash (CF) slots allows to add GPS, GPRS, digital cameras, bar code scanner and other devices). It has the following features: Bluetooth wireless, Windows Mobile® 5.0 software, MIL-STD-810F military standard for drops, vibration, humidity, altitude and extreme temperatures.
The main service needed for demonstration purposes, besides the ones already existent in most entities like internet broadband connections, is a satellite broadband connection providing Internet access, voice, data and video capabilities. Map services will also be considered in order to use geo positioning and navigation, particularly in event response situation.
Since the satellite coverage in Europe is quite good, and there is a good range of available services, at this stage our main focus was on Angolan Service Providers. The satellites that are currently covering the sub-Saharan area are the following: Panamsat (45°) West, Newskies NSS7 (22° West), Eutelsat W3A (7° East), Arabsat 2C (26° East), Intelsat 906 (64° East), Panamsat 10 (68,5 East).
Their basic capabilities with regards to the scope of the HEWS project are here below listed.

Name	Bandwidth	Terms (contract months)	Internet	Region
Newskies NSS7	128 kbps	12	yes	Sub Sahara
Eutelsat W3a	64-512 kbps in kbps 1024 kbps out	12	yes	Sub Sahara
Arabsat 2C	128kbps-10Mps in			
128kbps-45Mps out	3, 6, 12	yes	West and Central Africa, Sahara, Gulf region	
PanAmSat 10	128kbps-18Mps out			
128kbps-4,2 Mps in	12	yes	Europe Sub Sahara	
Intelsat 906	128kbps-45Mps out			
128kbps-10 Mps in	3 with monthly renewal	yes	Europe, Africa, Middle East	

More in detail with regards to Angola there are two main International Satellite Service Providers that are covering the country and offering their services. They are Thuraya and Hughes.
So far, we selected Thuraya because of its good image with regard to services provide to African governments alike support to election officials in the Democratic Republic of Congo and on the mobile satellite service needs of the African Union peacekeepers in Sudan's Darfur region. Thuraya's services in Angola are distributed by two service providers: IEC Telecom and Cicci Angola Lda. Direct contacts with these providers will be carried out with the HEWS team while in Angola for scenario preparation. The decision shall be taken in close collaboration with local authorities participating in the scenario.
Of course many other smaller services providers are selling their services, but they do not offer any advantage on bigger companies.

User Interfaces

Usability is a key word while talking about equipments and devices to be used in the Health sector. The theme become even more relevant if one considers the use of equipments in emergency scenarios. Although usability best practices will be used whist designing and developing the user interfaces, resorting to the use of touch screens and iconography whenever possible, the challenge remains.
Tests will be realized with the end-users in order to collect the most complete feedback from them, during development phase. During functional analysis some low fidelity prototype of user interfaces were done (already presented in the document) in order to evaluate users response and ability to interact with the system. The main objective at this stage was four folded:

- Explore system usage;
- Model major user interface elements;
- Model minor user interface elements (like input fields, lists, containers, etc.);
- Explore the usability of the user interface.

During system development phase the choice of the equipments will rather influence the usability of the system. Some particular characteristics will be considered:
- Use of touch screens: there are two main reasons to its use, on one hand touch screen is easier to visualize rather than a traditional keyboard, and on the other hand the room occupied by a keyboard is huge considering laboratories with room restrictions;
- Equipments for outdoor usage shall be resistant to hard environments, namely water, dust and smoke;
- Voice input shall be used whenever possible, due to the faster record of the information, particular in emergency and post disasters scenarios;
- System authentication shall use, whenever possible biometric identification, therefore there is no need of memorizing any kind of passwords or carry cards or other type of authenticators;
- System must be multilingual, so it can be used by international teams with no cumbersome due to language barriers.

Interoperability

For scenario demonstration purposes, a first survey and a brief functional analysis of the systems was done. Gathering information from some entities was an ongoing process. This activity was performed by several consortium team members that have visited the entities' premises, debriefed the operational teams on the HEWS project and objectives, and collected not only the info on the systems already in use, but also the needs that operational teams experience during their daily operations particularly regarding communication and information sharing. This task was an ongoing process until the closure of the scenarios definition, approved by the participants and by ESA.

Scalability

System scalability is guaranteed by the nature of the distributed architecture already described. More HEWS instances may be installed at different locations, without stressing already running instances. This assures that the system is scalable to any imaginable number of instances. If a region has too much activity overloading a HEWS instance, an option is to divide this region in two or more parts, and manage health events in separated HEWS instances.

Reliability

A variety of solutions exist for software and internet application reliability assurance. These are independent of the nature of the application and guarantee that data is not lost and the system is up and running nearly 100% of the time. The level of implementation of such systems is variable and we do not propose any specific configuration at this point. However, here are some common interesting solutions:

- Web farms: replication of web servers to assure system availability
- Database clusters: data is automatically replicated between two or more database server machines, transparently to the systems that use the data.
- RAID (Redundant Array of Independent Disks): hardware-based solution based on using several hard drives to prevent data loss, either by replication of data or by error check and correction.

Regarding HEWS specific reliability solutions, this is assured by the existence and possibility of re-use of different HEWS instances.

System Security

All channels implement user authentication processes, and all device-side execution is restricted to the user's permissions. Since all interaction between channel-side and server-side components are limited to user, channel and process execution credentials, compromising integrity is very hard to accomplish.
User profiles are defined and access rights are configured for:

- Access to specific HEWS instances
- Management of data inside HEWS instances
- Access to specific functionality (for instance, system administration)
- Access to external systems

HEWS instances can access only those external systems that authorised its use. For instance, the Criminal Police may restrict access to its information to users or centres.
User credentials must be replicated between systems to allow users to re-use other centres' HEWS instances when their own is unavailable. Replication of user credentials is controlled and configurable. User profiles must be mapped between instances to maintain access control at each centre, for example: "All users with global access in Spanish National Centre will have restricted access in Portuguese National Centre".

3.3 Work Package 3 – Development and Integration

3.3.1 Developed Activities

During Work Package 3, the system was developed and implemented in multiple sites. The typical development activities were done. Unitary, System and Acceptance tests were also assured during Work Package 3.
Contact was maintained between the technical team and the rest of the project team, as well as with end-users in order to assure the success of activities.

3.3.2 Deliverables

ESA/HEWS/DLV/TN3/D8.0 – TN3: Development and Integration report

The document describes the detailed functional and system design of HEWS undergone during the Development Phase, as a refinement of the design described in ESA/EWS/DLV/TN2.0.

The HEWS project is strongly oriented towards demonstrating the use of the underlying technologies in demonstration scenarios that closely resemble real situations. In this context, and although HEWS is designed as a generic system to function in different types of situations, its usage within specific scenarios requires further refinement of the system's design to guide the development process. This document presents the refined functional and system design considering the Marburg Virus scenario.

The document also presents the equipment selected and acquired for usage within the scenarios. The system's design was influenced by equipment choice, especially regarding the PDA devices' capabilities for user interface, communications and location.

The objective of this work package was to perform the system's implementation and integration in accordance to the design created in work package 2.0.

The project considers two different scenarios: a Marburg Virus epidemic in Angola and a terrorist attack with Anthrax on a major European Capital. Since the focus is on demonstrating the scenarios, the system's design and development is heavily influenced by scenario requirements, instead of just generic requirements for an overall early warning system. This document presents the reviewed functional design in accordance to the Marburg Scenario requirements.

The main activities performed in Work Package 3.0 are:

- Operational Service development, based on the design produced in previous WP, including developing the telemedicine system and relevant services;

- Definition of a suitable test plan to verify key functionalities of the service in a simulated operational environment;

Following ESA's approval of the test plan, the performance of the agreed test plan.

User Requirements Traceability Matrix

Req. ID	Compliance Level	Module/Process
UR 1		--
UR 11	**Total.** The data introduction can be done either directly on HEWS interface or on a system that interacts with HEWS	Data Acquisition / Collect Field Data Data Acquisition / Collect Laboratory Data Data Acquisition / Collect External Systems Data
UR 12	--	--
UR 121	--	--
UR 1211	**Total** Compliance depends upon the definition of the Events Entity	Data Acquisition / Collect Field Data
UR 1212	**Total** Compliance depends upon the definition of the Events Entity	Data Acquisition / Collect Field Data
UR 1213	**Total** Compliance depends upon the definition of the Events Entity	Data Acquisition / Collect Field Data
UR 1214	**Total** Compliance depends upon the definition of the Events Entity	Data Acquisition / Collect Field Data
UR 1215	**Total** Compliance depends upon the definition of the Events Entity	Data Acquisition / Collect Field Data
UR 122	**Partial** Compliance depending on the device used to collect data.	Data Acquisition / Collect Field Data
UR 123		--
UR 1231		--
UR 12311	**Total.** Personal information regarding affected people will be of restricted use due to privacy issues.	Data Acquisition / Collect Field Data
UR 1232	**Total.** Events Entity considers the positioning of the event.	Data Acquisition / Collect Field Data
UR 1233		--
UR 12331	**Total.** Personal information regarding affected people will be of restricted use due to privacy issues.	Data Acquisition / Collect Field Data

Req. ID	Compliance Level	Module/Process
UR 12332	**Total.** Personal information regarding affected people will be of restricted use due to privacy issues.	Data Acquisition / Collect Field Data
UR 12333	**Total.** Personal information regarding affected people will be of restricted use due to privacy issues.	Data Acquisition / Collect Field Data
UR 124	**Total.** Different interfaces will be considered for each equipment.	Data Acquisition / Collect Laboratory Data
UR 125	**Total.**	Data Acquisition / Collect External Systems Data
UR 126	**Total.** Each Event will be recorded for history purposes.	Data Acquisition / Collect External Systems Data
UR 13	**Total** Compliance depends upon the definition of the Events Entity	Data Acquisition / Collect Field Data Data Acquisition / Collect Laboratory Data Data Acquisition / Collect External Systems Data
UR 14	**Total.**	Data Acquisition / Collect Field Data Data Acquisition / Collect Laboratory Data Data Acquisition / Collect External Systems Data
UR 15	--	--
UR 151	**Total.**	Data Acquisition / Collect Field Data Data Acquisition / Collect Laboratory Data Data Acquisition / Collect External Systems Data
UR 152	**Total.**	Data Acquisition / Collect Field Data Data Acquisition / Collect Laboratory Data Data Acquisition / Collect External Systems Data
UR 153	**Total.**	Data Acquisition / Collect Field Data Data Acquisition / Collect Laboratory Data Data Acquisition / Collect External Systems Data
UR 2	--	--
UR 21	**Total.** Users Profiles will decide who is authorized to do what in the system.	Data Acquisition / Collect Field Data Management Processes / Users Profile Management
UR 22	**Total.** Each Event will be recorded for history purposes.	Data Acquisition / Collect Field Data
UR 23	**Total.** Each Event will be recorded for history purposes.	Management Processes / Events Management
UR 24	**Total.** Each Event will be recorded for history purposes. Events are updatable by authorized users.	Management Processes / Events Management Management Processes / Users Profile Management

Req. ID	Compliance Level	Module/Process
UR 25	**Total.**	Management Processes / Communication Channels Management
UR 26	--	--
UR 261	**Total.**	Management Processes / Communication Channels Management
UR 262	**Total.**	Management Processes / Communication Channels Management
UR 263	**Total.**	Management Processes / Communication Channels Management
UR 264	**Total.**	Management Processes / Communication Channels Management
UR 27	**Total.** Users Profiles will decide who is authorized to do what in the system.	Management Processes / Users Profile Management
UR 28	**Total.** Users Profiles will decide who is authorized to do what in the system.	Management Processes / Users Profile Management
UR 29	**Total.** Users Profiles will decide who is authorized to do what in the system.	Management Processes / Users Profile Management
UR 3	--	--
UR 31	**Total.**	Management Processes / Events Management Management Processes / Users Profile Management Management Processes / Data Management
UR 32	**Total.**	Management Processes / Events Management Management Processes / Users Profile Management Management Processes / Data Management
UR 33	**Total.**	Management Processes / Events Management Management Processes / Users Profile Management Management Processes / Data Management
UR 34	**Total.**	Management Processes / Events Management Management Processes / Users Profile Management Management Processes / Data Management
UR 35	**Total.**	Defined by system architecture
UR 36	**Total.**	Defined by system architecture
UR 37	**Total.**	Data Analysis / Receive Results Data Analysis / Issue an Alert
UR 4	--	--
UR 41	--	--
UR 411	**Total.**	Defined by system architecture
UR 412	**Total.**	Defined by system architecture
UR 413	**Total.**	Defined by system architecture
UR 42	--	--
UR 421	**Total.**	Defined by system architecture
UR 422	**Total.**	Defined by system architecture

Req. ID	Compliance Level	Module/Process
UR 43	--	--
UR 431	**Total.**	Defined by system architecture
UR 432	**Total.**	Defined by system architecture
UR 5	--	--
UR 51	**Partial** Compliance depending on communication means availability	Defined by system architecture
UR 6	--	--
UR 61	**Total.**	Data Acquisition / Collect External Systems Data
UR 62	**Total.**	Info Storage / Disseminate Information
UR 63	**Total.**	Info Storage / Disseminate Information
UR 64	**Total.**	Data Acquisition / Collect External Systems Data
UR 7	--	--
UR 71	**Partial** Compliance depending on devices characteristics.	Defined by system user interfaces
UR 72	**Partial** Compliance depending on devices characteristics.	Defined by system user interfaces
UR 73	**Partial** Compliance depending on devices characteristics.	Defined by system user interfaces
UR 8	--	--
UR 81	**Partial** Compliance depending on the systems that will interact with HEWS during operational phase.	Defined by system architecture
UR 82	**Total.**	Defined by system architecture

Requirements Traceability Matrix

3.4 Work Package 4 – Operational Service Performance and Validation

3.4.1 Developed Activities

During Work Package 4, scenario demonstrations were held both in Angola and Portugal. Besides some minor system improvements, the majority of the activities were related with the scenario preparation: definition of the demonstrations' scripts, meeting with demonstrations' participants, logistical issues, filming and post-production results, collecting results from each of the participants.

3.4.2 Deliverables

ESA/HEWS/DLV/TN4/D9.0 – TN4: Operational Performance and Validation Report

Communications in Emergency Response

Mobile communication is one of the key pillars of emergency response, as it allows coordination of actions between all involved parties to achieve common goals, particularly communication among first responders acting on the field. Nevertheless, history says that traditional mobile communication, such as GSM, can easily be jammed in case of crisis, therefore alternative communication channels need to be found, and satellite communication will certainly take a significant role in this quest.

In an emergency scenario, communication needs have to be evaluated at several levels:

1) **Infrastructure:** Fixed-Fixed vs. Fixed-Mobile vs. Mobile-Mobile
    a. Fixed communications are usually applied between command structures of the same or different organizations
    b. Wireless communications are needed to support interaction with and between field personnel
2) **Organization:** Intra-organization vs. Inter-organization
    a. Intra-organizational communication is used between personnel belonging to the same organization. Homogenization of communication protocols is easier to achieve.
    b. Inter-organizational communication is user between structures from different organizations. Communication usually happens within a scenario of heterogeneous protocols and infrastructures.
3) **Content:** Voice vs. Text vs. Multimedia
    a. Voice communications are frequent as the sole communication mean with and between frontline emergency responders, and as an immediate and informal channel with and between command structures;
    b. Text communications usually support more formal processes as they are more suitable for tracking and analysis

c. Multimedia communications provide support for more advanced communications like retrieving field data (e.g. video streaming from the field) or supporting video-conference.

Angola – Current Environment

Emergency Communications

The communications referring to the safeguard of human life such as epidemiologic alerts and the situations of health emergency have absolute priority. It is the obligation of the suppliers of the Global Mobile Personal Communications System to give priority to messages motivated by exceptional circumstances, for instance in the case of accidents and help requests.
The national emergency numbers are:
- Police: 113
- Firemen: 115
- Medical Emergency/Ambulances: 116

Infrastructure

There are phone communications through fixed lines in the capital and in the majority of the provincial capitals. There are five fixed communications networks: Angola Telecom, Mercury, Nexus, Mundo Startel and Wezacom. There are two mobile communications networks, a public (Movicel) and another one private (Unitel), covering the main areas of Luanda, Cabinda, Cunene, Benguela, Huíla, Huambo, Namíbe, Zaire. There is the possibility of using a roaming service through the mobile private network that is compatible with the European system.

Fixed Communications

Landlines do not cover the whole country on an uniform manner, and therefore cannot be relied upon in case of emergency. Nevertheless, some zones of the country, like Luanda, are well covered, although failures of service may occur. In case of service failure, the dedicated emergency numbers (shown above) have priority access.
Emergency services providers, medical personnel and police communicate through landlines when these are available, resorting to wireless communications when necessary.

Wireless communications

Wireless networks do not cover the entire country uniformly. Luanda is quite well covered, but service failure is common and to be expected.
Emergency service providers, medical personnel and police sometimes communicate through mobile phones, but no dedicated communication system exists. Radio communications are used by field teams.

Organization

The Government of Angola (GoA) has been developing systems to coordinate interventions responding to natural disasters, epidemics and other emergencies.
The National Cholera Task Force meets regularly at national level and in cholera-affected provinces under the leadership of the Ministry of Health. UNICEF, the World Health Organization (WHO), Médecins Sans Frontières and the International Federation of Red Cross and Red Crescent Societies (IFRC) attend these meetings

amongst other GoA and NGO actors. The national response to flooding in 2007 was coordinated by the national Civil Protection Commission, with the Provincial Governor's Office of each province affected coordinating partners locally.
The Ministry of Transport and Communications is the supervisory organ of the telecommunications activity and therefore is responsible for the application of the policies that rule the granting of the Global Mobile Personal Communications System via satellite in the National territory.
The Angolan Institute of Communications (INACOM) is the regulating organ of this activity and is responsible for the regulation of the licenses, the allocation of frequencies and the services' approval procedures.

Content

Communications are now mainly based on phone, and therefore on audio. Data on patients and events is also sent in written form through mail or fax. Some information is also shared through computer means, although it's not common.

Information Systems Scenario

Existing IS (intra-institutions)

During the Marburg crisis of 2005, the notification forms and the list of cases were delivered by the sanitary units (mobile teams, health centers, hospitals) to the Provincial Directorates of Health and then to the National Directorate of Public Health. There were databases at the provincial as well as central level. The transmission of information was mainly done via telephone, fax or Internet. Information arrived to decision-makers a few weeks after the occurrences, therefore actions on the field could not be taken in the proper time.

Existing IS at national level (inter-institutions)

There is an ongoing cycle of massive investment in technology and information systems taking place in Angola.
In the scope of the Decentralization and Local Governance Project, the Angolan Government has sought to prepare or update Municipal profiles and install a comprehensive and reliable information system with the purpose of strengthening local administration at Provincial, Municipal and Communal levels. Despite that, one must not forget that power supply to rural areas is scarce, so information systems are not the solution by itself.

Field Requirements

Communication Requirements

Good means of communication between field teams and entities on different places of the country are needed, given the size of the country and the needs of its population.
Given that the establishment of an efficient fixed line system would be very costly, as would probably be a system of wireless communications (if there's no commercial profitable ends) the use of satellite systems as a communication mean could prove very interesting, although it may prove very costly to be used as a permanent system.

Information Requirements

Information to be available to field emergency teams and other entities involved on answering to health emergencies should include information on patients, their living and social conditions, other relevant socio-economic and geographical and meteorological information, which should be constantly updated. Given the size of the country and the population movements that may occur, it is essential that a full view of the situation is available at any moment to all relevant professionals involved in the process. Information should be available on electronic form, in order to be sent through a computer and therefore be available for all at any given moment. Nevertheless, good voice support will be needed, as that is the favourite and most effective means of communication in emergency situations.

Portugal – Current Environment

Emergency Communications

Infrastructure

Fixed Communications

Traditional landline communications are still the main communication channel used by emergency responders in Portugal to link central and local command structures of an organization, or between command structures of cooperating institutions.

The usage of fax and traditional mail is slowly being replaced by email, although most communications occurring between cooperating institutions still rely on these methods. This issue is also highly related to the fact that most institutions are still in a very primary stage of adoption of information systems, thus lacking the appropriate electronic support for most data.

In the last decade, the majority of institutions have already adopted internet usage, although email is still used as an informal channel replacing voice communications.

Wireless Communications

Communication between mobile personnel is supported by GSM, Radio and, most recently, TETRA:

- GSM: Portugal has a GSM coverage of nearly 100%, which allows the majority of mobile emergency responders to use regular GSM cell phones to communicate.
- Radio: Some institutions have developed their own communication systems relying on the usage of radio:
    - ANPC:
        - REPC: VHF/FM Radio national network that connects all national and regional structures. REPC has 43 semi-duplex channels and 18 simplex channels. Communications are limited to voice.
        - ROB (Operational fire-fighter network): VHF/FM Radio regional network, using semi-duplex and simplex channels. ROB is mainly used to support theatre operations in fire-fighting situations, supporting communications at local and regional levels.
- TETRA: SIRESP – Emergency and Security Network Integrated System
  SIRESP is a communication system, currently in implementation by the Portuguese government, destined to support communication between security

and emergency institutions. SIRESP comprehends a nation-wide integrated TETRA communication infrastructure. SIRESP is currently in use in Lisbon, providing TETRA voice and data communications to emergency responders and police agents. Please refer to section 0 for further information.

The usage of satellite communications is restricted to small sets of units in each organization that are mainly used for voice in international simulacrum activities:

- INEM has 1 Iridium terminal in each CODU (there are 4 CODUs)
- ANPC has 10 Iridium phones, a few Thrane&Thrane BGAN terminals and old but operational Inmarsat terminals;
- DGS has 1 Inmarsat terminal

Organization

While a complete communication flow map between all institutions involved in an emergency response scenario is not available, the project team has identified relevant examples of communication flows between organizations:

- INEM – ANPC: In appropriate situations, 112 calls received by INEM initiate a voice call between INEM and ANPC to originate a response to a particular situation by ANPC;
- DGS – INEM: INEM interacts with primary healthcare institutions, communicating each patient's health status by voice while in transit in emergency vehicles;
- ANPC – IM: IM provides weather information to ANPC as contextual information for emergency situations. ANPC requests information by voice, and receives weather text information by email or fax.

Information flows for several crisis situations in Portugal, are presented in the **Errore. L'origine riferimento non è stata trovata.**, of this document.

Content

The vast majority of communications occurring within an emergency response scenario is based on voice.

Text content is mainly used to provide formal support for communication between institutions at high organizational levels, or as a mean to disseminate top-down commands and policies.

Multimedia content is very scarcely used within the emergency response context in Portugal. Some institutions use video-conference, mostly for internal communication between different locations, but this practice is still very rare. No evidence of multimedia communications with the field was observed during the project.

Information Systems Scenario

Since the beginning of the project, the project team made a huge effort to collect the maximum information about information systems in public institutions in Portugal. After more than 12 months, one can easily realize that despite Portugal being a country where its citizens are very keen of new technologies (special remarks can be done for mobile phones and internet domestic use), the same does not happen within the public sector. Several plans are already under development, a few e-Government initiatives are in place, but still on a very premature stage.

Field Requirements

Communication Requirements

Voice communication is the core channel to all emergency and crisis situations, and it is supported usually by GSM, Wi-Fi and TETRA Networks. In a few cases, it was reported the failure of all of these channels, and therefore satellite was used. These situations occurred during forest fires, when even radio repeaters were destroyed and vehicle repeaters were not enough to fully support field teams' communications.
It was also reported that GSM fails very often during sports events or other type of events where a large number of individuals uses GSM very frequently.
In the majority of reported cases, voice is the main mean of communication, although data are considered as helpful but not crucial. So far, video is considered as accessory, unless in some particular cases related with telemedicine, when a specialist cannot be present at a particular place.

Information Requirements

Information between institutions flows, although it happens at a slow pace, and in some case critical information is lost or not used due to its late arrival to the addressees.
It was also referred that errors occur quite often due to misunderstandings arising from voice communication. These errors could be corrected if there was a set of predefined messages to be used by voice or by other means of communication.

3.5 Work Package 5 - Cost Benefit and Sustainability Analysis

3.5.1 Developed Activities

The Cost Benefit and Sustainability Analysis conducted allowed for the definition of a possible roadmap for HEWS further development or implementation. This was done after consideration of lessons learned during the scenario and after conversations with end-users.
This roadmap is also included in this report, on section 4.2.3, and can only be totally comprehended when regarded as an element vital to the analysis of Future Perspectives and Recommendations for the project.

3.5.2 Deliverables

ESA/HEWS/DLV/TN5/D10.0 – TN5: Cost Benefit and Sustainability Analysis

HEWS Implementation Benefits

The HEWS project allowed the project team to have a thorough understanding of the benefits that can arise from the usage of a system like HEWS. By demonstrating HEWS on two different scenarios (Portugal and Angola), the team was able to understand the role of HEWS in extremely different situations.
The development and demonstration within the Portugal scenario allowed the project team to identify the following major benefits:

- **Data fusion**: the existence of multiple organizations, with non-integrated information systems, originates separate data storage, which only allows intervenients in the monitoring and early response processes to have a partial view of events. The implementation of HEWS would be of great benefit to the creation of a more complete view over health-related data, by crossing and analyzing data originated or stored in multiple information systems;
- **Inter-organizational coordination**: one of the great challenges of executing the Lisbon scenario of HEWS was the identification of regulatory and operational processes, and interactions between the multiple intervenient entities. Each of these entities has its own procedures, regulations and systems, and coordination between entities is not supported by a common information system. The usage of HEWS would allow information sharing between institutions, contributing to increased efficiency in operations and resource allocation.
- **Contingency communication channel**: in Portugal, early responders rely mainly on the existing GSM networks and private radio systems (usually restricted to each institution, although a nation-wide TETRA system is under deployment). In this context, and with a near 100% GSM coverage, communication channels are properly assured. However, there is no contingency communications system in use, and HEWS could provide an

answer to this situation: the creation of satellite-based information and communication system for situations where the main systems are not available.

Occurring in a totally different environment, the Angolan scenario provided the project team with a through understanding of the huge benefits a system like HEWS could bring to a country like Angola. Monitoring and Early Response actions are not supported by ICT, and there is very little coordination or exchange of information between institutions. All these actions can be directly supported by HEWS, that could be used as a tool for:

- **Operational information support**: Directly supporting the operation of institutions involved in monitoring and early response activities, while simultaneously retrieving and storing operational data for further analysis;
- **Operational communication support**: providing satellite communications to support operations in locations with low or inexistent wireless network coverage;
- **Alarm generation**: early identification of potentially unsafe situations, which in Angola can very easily mean the avoidance of an epidemic spread of disease.

HEWS Implementation & Operation Costs

The implementation costs of HEWS comprehend different components and are inherently dependent of the ICT context. With inherently different characteristics, the Portuguese and Angolan scenario will be analyzed separately in the following sections.

Portugal Scenario

In order to simplify this analysis, costs will be roughly categorized into Information System costs and Communication Infrastructure costs:

Information System

The implementation of HEWS in Portugal involves the following main challenges:

- The requirements analysis and organizational impact phase must include all the institutions involved in the public health value chain (ranging from Civil Protection to Healthcare Organizations);
- Configuration must have in consideration the inter-organizational and intra-organizational requirements of all the entities involved, making HEWS usable in a real-life environment;
- Integration between HEWS and the relevant information systems at each institution must be accomplished, to guarantee the proper information flows and process correctness;
- In order to achieve its results, HEWS must consider, fuse and analyze a great amount of data being generated from multiple data sources. Computing infrastructure is thus a central concern to a HEWS implementation – the appropriate capacity must be in place to insure a proper and efficient use of HEWS.

Considering the aforementioned points in a 1½ to 2 year project, involving a team of about 10 to 15 consultants, engineers and technicians, the total cost of services involved in setting up HEWS in Portugal could then be roughly estimated between 2 and 3 Million Euros. As for computing infrastructure, the initial investment costs may

vary greatly depending on the type of model chosen (e.g. acquisition of infra-structure vs. outsourcing at a monthly fee).
According to common ICT industry metrics, annual system maintenance costs are roughly 20% of total implementation cost. In this context, annual maintenance cost for HEWS would be of about 400K to 600K Euros.
Communication Infrastructure:
In an European scenario, HEWS would mainly use existing communication infrastructure (fixed and mobile), complementing it with satellite-based communications when needed. Based on the organizational structure identified regarding public health related institutions, the project team believes the approach towards creating an infrastructure should be based on:

- National and regional satellite communication hubs for HQs of major institutions related with Public Health (like Civil Protection, Medical Emergency and General Health Directorate) using Fixed Satellite Services;
- Field command & control center vehicles or installations using Mobile Satellite Services like VSAT or even BGAN terminals;
- Field personnel using mainly satellite phones for voice, or BGAN in cases where data transmission is needed (e.g. for team leaders using mobile computing devices).

A rough estimation would point to having a total initial investment of 2 to 3 Million Euros, considering 10 Hubs, 100 Field Command & Control Stations and 1000 Field Personnel Devices (considering 80/20 ratio on voice/data needs).
Since satellite communications are considered as an alternative to existing fixed and wireless communications, the expected annual satellite communication costs can be considered low. Most communication costs would come from mandatory service subscription fees (e.g. the BGAN units used in the HEWS scenarios have a monthly cost of about 50 Euros). The calculation of the precise annual communication costs would then depend on the type of service and payment plans subscribed. A rough estimation considering an average cost of 750 Euros/year for each unit would give us a total annual cost just below 1 Million Euros.
Based on the previous estimations, total project implementation costs would then be of about 4 to 6 Million Euros, considering both Information System and Communication Infrastructure implementation, plus about 25%/year operational costs.

Angola Scenario

The main challenges of implementing a system such as HEWS in Angola are related to poor infrastructure and know-how in ICT:

- **Infrastructure**: Apart from the major cities, most of the Angolan territory has poor energy and ICT infrastructures. This poses a challenge to the implementation of HEWS, yielding the need for the investment in creating a sustainable environment from proper operation of HEWS, namely regarding energy and computing capabilities in central and regional HQs.
- **Training**: in order to adequately train users from public health related institutions in the use of HEWS, training has in most cases to be extended to basic ICT training, mostly due to the low level ICT knowledge in the country. This is a central challenge for the project, as implementation would have to undergo a national level training cycle in basic use of ICT and HEWS.

- **Local support:** due to the harsh environmental conditions in Angola, local technical support is a fundamental issue for guaranteeing continuous support to HEWS operation. During the project implementation, involving local IT personnel is thus a fundamental issue, creating nation-wide support teams responsible for technical and user support.

The estimation of costs for implementing HEWS in Angola demands deeper knowledge on the existing infrastructures and global ICT context, as well as on the typical local ICT service costs in Angola. The project was unable to obtain this information from Angola authorities, and thus is unable to perform trustworthy cost estimation for implementing HEWS in Angola.

3.6 Work Package 6 – Perspectives and Recommendations

3.6.1 Developed Activities

The final activities on the project were undertaken in this work package. Several meetings were held with consortium members and also with the demonstrations' participants in order to evaluate the results of the project. Discussions were based not only on project results, but also in the scope of the current policies as well as the future policies that are already being discussed both in Angolan and Portuguese parliaments. Finally, an analysis was performed in order to evaluate the most suitable applicability of satellite communications technologies at different levels and in different organizations.

The project finalized with a public presentation of the demonstration scenarios, and a discussion whose results were included in Technical Note 6.

3.6.2 Deliverables

ESA/HEWS/DLV/TN6/D11.0 – TN6: Perspectives and Recommendations

HEWS on the prevention of epidemiological risks and outbreak mitigation

The prevention of epidemiological risks, the issue of differentiated alerts and of early warnings and of public health actions have been demonstrated as fully feasible using the proposed and developed HEWS system solution.

The proposed modularity of the system allows as many institutions as available to integrate the system and to define their own alerts, or alerts that assemble involved institutions data included in the system or that the system may have access to.

Besides the optimal use of integrated institutions in the system knowledge, it is also flexible enough to quickly integrate new institutions, and serve as bridge point interacting between functioning systems when other existing ones fail.

The potential of HEWS is essential in extreme situations, since it's been thought for those situations in particular. However, it has also a strong potential as a routine system, depending on the investment and the will of the integrated institutions, since it is flexible to accommodate new information and knowledge as it becomes available. Some alerts may not be immediately possible just because evidence hasn't yet emerged. Therefore this flexibility is an important factor in this kind of system.

Particularly in Africa, while there's no widely developed communication network, a system like HEWS, relying substantially on satellite communications, can function as a tool for health improvement. With slight improvements, like adding biometric measuring devices, HEWS could serve as a simple medical and health registration basis, allowing optimal resources management, e.g. proper registration of vaccination programmes, centralized medical records, geo-reference of diseases surges, etc. Once such information is available all respective monitoring schemes and alerts can be set and be used to improve population's health.

HEWS seen by its End-Users: AS IS and future developments

Overall involved institutions (health, civil protection and police authorities) in all the HEWS system development considered this an important project. It was always acknowledged as an important tool that properly framed could generate health and lives gains. System operational demonstration was always envisaged as the common goal and overwhelming resources were affected to it by all parties.

In Portugal the system development brought to all institutions an unusual awareness of the importance of working together. It was clearly visible, from the meetings' evolution, that all that was established on paper did not always work on reality, requiring additional importance of the remaining institutions/partners and re-adaptation of each one to its real role on the situation.

In Angola, local authorities gave the project an outstanding help. The harsh conditions essayed showed that such a system as HEWS can contribute to improve population health in a very sound way. In fact, HEWS could help in several ways, gathering health information, improving and promoting health, optimizing health resources, and structurally. While infrastructures are not fully operational or available, HEWS could centrally gather information, for instance with a back up at INSA - Lisboa, in full protocol with the Angolan Ministry of Health and its Public Health Institute, and in Angolan institutions with the best conditions, and as local communication networks improve their conditions a better distribution of databases can be made available at local levels. Distributed local HEWS terminals could be used as telemedicine support to remote areas where physicians are not available.

The HEWS prototype showed to be highly intuitive and usable at the desktop/laptop level within institutions. But in the field of operations, when things are happening, the essayed devices used – those that are commonly available to the public – where referred by users as non practical. Devices as normal PDA posed lots of difficulties, from difficulties in managing and introducing data while wearing gloves; or sometimes being unable to see what's in the PDA monitor, due to solar reflection.

It became clear to the end-users that a different paradigm is necessary to introduce structured information in the HEWS forms and to manage them. Generalised opinion was that some wear-ware integrated with voice recognition and transcription should be developed, to allow a quick and easy collection of structured information on the field of operations. Otherwise this becomes an almost impossible mission.

HEWS in Angola

Satellite as main communication channel

Given the actual state of communications infrastructure in Angola, the satellite is a plausible choice as main communication channel in case of emergency. However, wide economic growth in Angola would probably lead to the development of a GSM/wireless network, for the use of the population. In that case, satellite use as main communication channel could be diminished. Nevertheless, this situation is not foreseen on the near future.

Inter-organizational coordination and information sharing

As stated previously in this document, information sharing between emergency responders in Angola is nearly inexistent. While on field, data is rarely collected, and paper still is the most common support for data collection. Emergency responders act on their own experience and vision, and do not have a complete sight of the event. Data collected in the field is usually transferred to central agencies, such as ministries, but only for statistical and assessment purposes, since it arrives with such a delay that is impossible to take real measures to control a crisis. The army is very commonly in charge of coordinating emergency situations on the field, but even tough, collaboration between different actors is made *a la carte*, since no standard procedures are defined.

Infrastructure for HEWS implementation

In case of a HEWS-like system implementation in Angola, it will be very difficult to benefit from previously existent infrastructure. Computers and other electronic devices are not very commonly used, except in Luanda, and power supply (when exists) has frequent breaks. Landline and GSM networks coverage are very far from the full country, and if present, these networks are frequently jammed and are definitely not appropriate for emergency situations. As a conclusion, one can affirm that in case of HEWS-like system implementation in Angola, complete technological infrastructure will be needed.

HEWS in Portugal

Satellite as a fall-back for SIRESP

In the last decade, the Portuguese government has been developing a new communication system for emergency situations: Sistema Integrado de Redes de Emergência e Segurança de Portugal (SIRESP), Integrated System for Emergency and Security Networks in Portugal.
SIRESP objective is to enable communication among first responders and health, security and civil protection agencies in case of crisis or emergency situations. Until now, only a part of the national territory is covered by SIRESP, namely the Lisbon district, but in the near future full coverage of the country is expected.
SIRESP communications are based on TETRA technologies. SIRESP contains a communication layer and also an application layer. Portable devices used by agents on the field, allow a single signal on to the system, keeping the link always on, even when jurisdiction changes. The system allows peer-to-peer voice and data communication as well as conference capabilities. All the information collected on the field, is accessible through the application layer available in the headquarters of the several agencies.
Until now, the results have been quite good and agents on the field are satisfied with the simple usage of SIRESP, however as far as we could assess there is no fall-back system in case of failure of radio communications.
It was clearly stated by all the representatives that participated in the project that despite the fact that satellite communications are not of common use by first

responders in Portugal, it was critical to have satellite communications, as a fall-back technology in case of SIRESP failure.

Inter-organizational coordination and information sharing

One of the project objectives, although not the primary, was to raise the awareness to inter-organizational lack of coordination and information sharing. Coordination exists but in a very small scale, and its high level of complexity obstructs the optimized procedures in case of emergency. Government infrastructures acting on emergency scenarios depend on three different ministries, which leads us to a first barrier that is who can be the owner and manager of a system like HEWS. It was often revealed by institutions representatives that information and communication networks ownership was an issue that can retard the development of a system like this.
Meanwhile, since this lack of coordination is of public domain, a new government directive will nominate a General Security Authority that may act above the ministries in case of an emergency or crisis situation. Project team, evidently, saw this change as an opportunity for implementing a HEWS-like system in Portugal in a near future.

Infrastructure for HEWS implementation

As stated in previous documents of the project, all project participants already had satellite communication equipments available, although its use is expected only for an exceptional situation, and in the majority of the cases equipments were never used. Besides that, all project participants showed that they have very good communication networks, both for voice and data, available and in use. So, if one considers infrastructure related issues, HEWS implementation will occur seamlessly with no drawbacks predicted.

4 Conclusions

4.1 Demonstration Results

4.1.1 African Scenario

Once in Angola, the first major challenge faced by the project team was getting the proper authorization from the local authorities to perform the necessary activities. As the project team turned out to realize, the local authorities hadn't been informed of the authorizations given by the central authorities, and therefore weren't ready to authorize demonstration and filming activities. After two days of intense communication between all the parties (project team, Central Angolan authorities, and Local Angolan authorities), the situation was finally solved and the project team was given the proper authorization to proceed.

Having the authorizations in hand, the team proceeded to gather the necessary conditions to perform the scenario demonstration. This regarded selecting and preparing scenario locations and demonstration personnel. The major challenge at this point was finding personnel that would pose as patients for the scenario, given that there was no clearance to film any real patients. Fortunately, the team was able to contact the local theatre group that agreed to participate in the project.

Figure 1 - Caxito Theater Group

Regarding system setup, the major challenge was dealing with constant energy interruptions and lack of communications. Although the system is designed to work in crisis situations, in which communication and energy outages can occur, server side components require good working conditions (i.e. constant energy and communications). In order to cope with this situation, the team decided to use satellite communications between all components, including to support the HEWS Server. Although increasing the level of difficulty of the initially planned demonstration, these conditions really demonstrated the need for satellite communications, even in more developed African towns.

Given the tight schedule, there was very little time to train demonstration personnel on how to use the system. The team decided to teach personnel only basic system usage, and prepare and preload all data to allow an easy usage during the demonstration.

Figure 2 - Filming a Marburg patient examination procedure

Due to logistical restrictions, it was necessary to adapt the scenario to the real field conditions. All changes were made having in mind the main purpose of demonstrating the real usefulness of HEWS in a Marburg-like outbreak, in locations where communications are very hard to establish and the geographic barriers are enormous. The main changes made to the original script were:

- The scenario was held in fewer locations and with fewer scenes per location. The original script depicted many scenes of patients arriving at several locations and several information updates on those patients. The real field conditions only allowed the team to access two health centres where potential patients would arrive.

Figure 3 - Scene filming at Mabubas Health Post

- It was not possible to film the live teleconference planned in the scenario. This was due to restrictions that the team was not able to surpass. First of all, the intended participants where located in different parts of the country (Luanda and different locations of the Bengo province), for which the practical distance is almost 1 day. Additionally, there was only one film crew available, which prevented simultaneous filming. Nonetheless, the team was able to perform several live conferences using the system, demonstrating these capabilities to both the local and central health authorities, which were very enthusiastic about this particular system feature.

After having performed the demonstration and filmed the scenes in the best possible conditions, the general feeling was that the demonstration was successful. There was full comprehension of the system capabilities and usefulness from all the participants, and a great deal of enthusiasm in having this type of capability available to deal with outbreak situations. The most commonly used expression was “a system like this would really save thousands of lives in an outbreak scenario”… and having experienced the extreme field conditions, there is no doubt it would.

**Figure 4 - Nurse using the HEWS Mobile Application,
and using a mobile satellite antenna to communicate information to the HEWS Server**

The scenario demonstration was recorded in video, then edited and publicly presented at the Project Results workshop. This video is also included in the DVD sent to ESA.

4.1.2 European Scenario

Scenario demonstration was evaluated by all participants as positive. Most of the entities considered that this was also an opportunity to test their internal procedures in case of a terrorist attack as well as to check and evaluate inter-organizational cooperation. It was clearly stated by all of them, that some procedures need to be redefined, and better, faster and more efficient collaboration is expected.

Regarding the system, entities declared that satellite communication is relevant, but only for exceptional situations, and not for their ordinary operations. Equipments to be used by field teams must be voice enabled, and haptic interfaces must be used. Voice transmission is considered vital because field agents need to have both hands free to render assistance to the victims or to carry equipment. However, the recording of voice transmission and the possibility of voice to text conversion were some of the features that the field teams required. After text conversion, information can either be stored in the system or disseminated among interested parties.

The flow of information between entities was very well received, since it currently requires substantial improvements. It was also referred that inter-institution information sharing is strongly required in the top layers of the institution in comparison with the operational layers. This presupposes that the system shall be seen as a support for decision makers much more than for operational agents.

The Lisbon scenario demonstration was also recorded in video, then edited and publicly presented at the Project Results workshop. This video is also included in the DVD sent to ESA.

4.2 Recommendations

4.2.1 Interoperability

Interoperability is commonly defined as the ability of first responders, whether they are emergency medical services, civil protection or police, to communicate with each other during an emergency or crisis situation. The existence of interoperability allows for:

- The facilitation of rapid and efficient exchange of information and interaction among public and private entities.
- Provision of immediate and coordinated assistance in day-to-day missions, and extraordinary mass casualty incidents.
- Improvements for the ability of first responders to save lives and properties.

It was clear during project development that HEWS can be an interoperability enabler, therefore, HEWS implementation nationwide, or even Europe-wide will certainly improve interoperability, and directly minimize the negative consequences of an emergency situation.

One can state that the greater the severity and geographic extent of the emergency, the more responders are needed and the greater the need to communicate, coordinate and share information across jurisdictions. Since both Europe and Africa (where demonstrations scenarios occurred) are quite heterogeneous in the distribution of population and interoperability components (such as technology backbones, field communication devices and human resources), the interoperability capacity shall be developed according to the needs. For instance, higher population density increases the impact of disasters, but nevertheless remote areas also require interoperability, and in this particular case mobile communication, either supported by GSM/GPRS or satellite shall be seen as crucial.

Based on the results achieved during the project, the proposed logic model to reach interoperability through HEWS usage is the following:

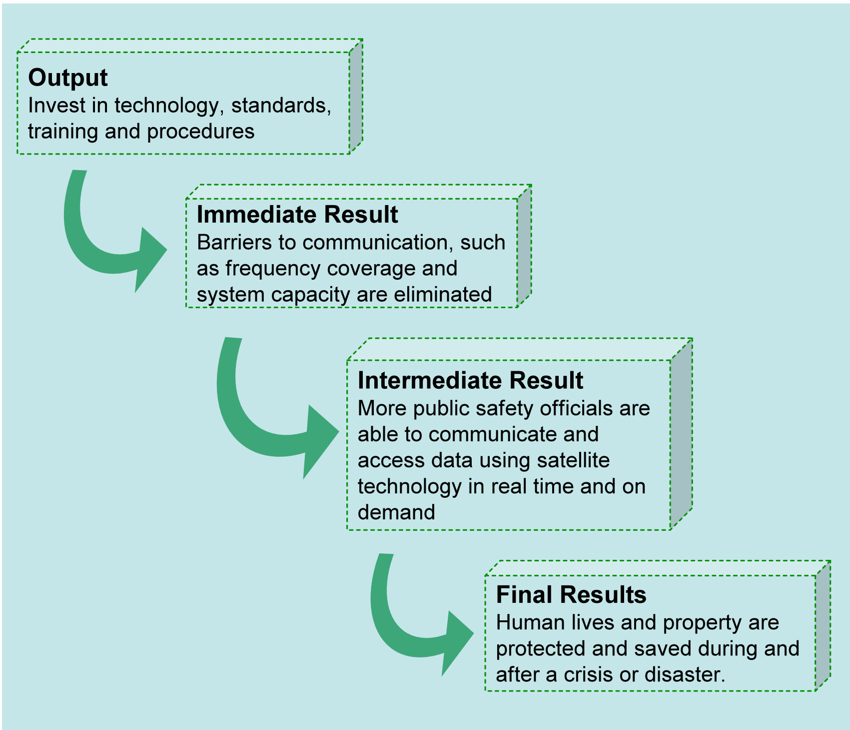


Figure 5 - HEWS Implementation Logic Model

4.2.2 Better Communications for Emergency Responders

Recent crisis situations both caused by natural disasters and man-made terrorist attacks raised serious questions about whether European governments need new strategies to organize rapid response by the wireless, wire, cable and broadcast satellite industries. Furthermore, it is clear that first responders ought to have a resilient, mobile wireless data network they can share notwithstanding the technology that supports it.

Nowadays, Europe does not have an operational system that allows emergency responders to communicate reliably and effectively in a cross-border crisis. Each country has its own *modus operandi*, and unless a disaster assumes transnational dimension, cooperation and interoperability among different countries poses many challenges.

Although the majority of emergency responders already use wireless communications based on radio and GSM technologies, extraordinary events can easily prove that these technologies, that gained reputation for our personal use, are not the most appropriate in case of emergencies. Therefore, it's urgent to define a new set of communication technologies suitable for this particular set of users. Satellite technologies, particularly mobile satellite technologies, like BGAN are in the forefront of this group due to its flexibility, usefulness and reliability even in challenging environments. Nonetheless, despite the communication technology, European Governments should allocate a part of the communication spectrum to an emergency response system.

After the spectrum allocation is defined, the next step is to specify the allocation mechanism. Good practices in Wi-Fi networks and on the internet can be reused in this particular situation, and governments and communication authorities should define the technology standards to be applied.

Using standard off-the-shelf technology, emergency responders can receive pages, talk to each other, do simple text messaging, transmit photographs and retrieve maps. Responders can easily be equipped with devices as simple as their existing mobile phones, and still carry through their activities in the field.

A robust and stable communication network also has a series of central nodes that must stabilize and strengthen the network. With the operational architecture presented in Figure 6 , the most effective way to do this is to use mobile or portable satellite antennas for the mobile field units, and fixed satellite antennas for the other units in the different layers.

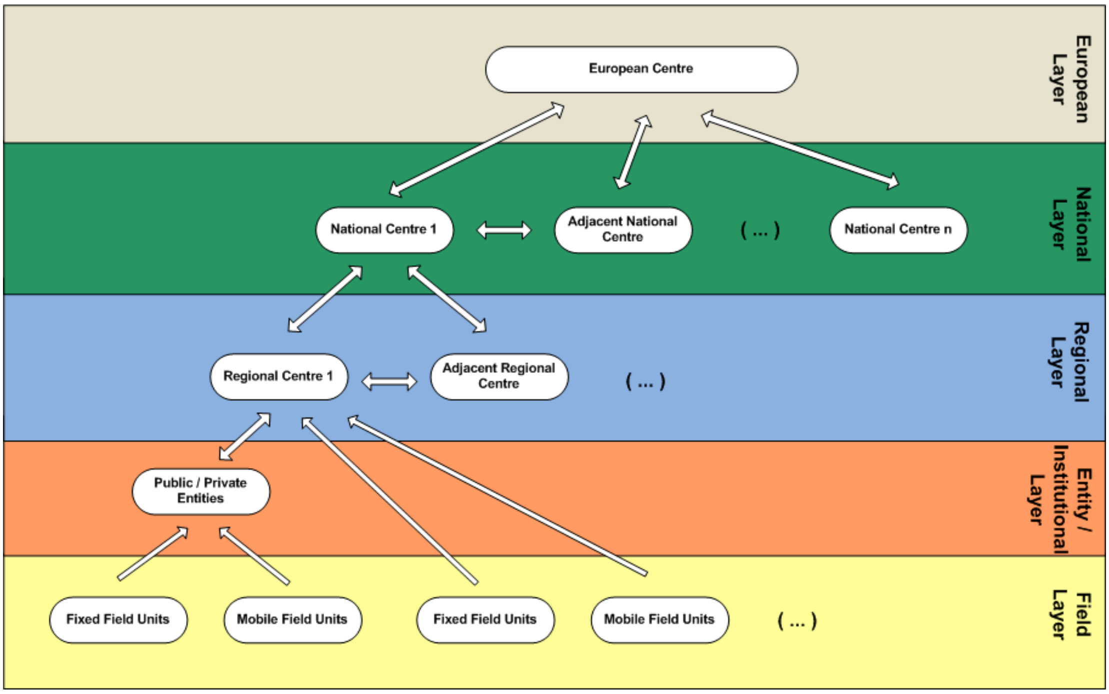


Figure 6 - HEWS Operational Architecture

These mobile field units, if equipped with an antenna connected to a computer, can form a mobile base station, which can be placed in a van, an ambulance, a helicopter, an airplane, a fire truck or just be a portable part of an emergency responder kit. With this architecture, if a disaster takes place, as soon as people and equipment are mobilized, the communication networks gets stronger.

4.2.3 HEWS Roadmap

Based on project results, we can assume that the perspective roadmap for European and African contexts, are in a certain way similar, in spite of the starting point being different, particularly if one considers the differences in technological infrastructure and digital illiteracy.

By surpassing these differences on starting points, one can state that in both cases we start from a situation where interoperability and collaboration between institutions don't exist, and in both cases we are willing to explore it to the maximum. The consortium decided to come up with an analysis based on five axes: Usage, Standard Operating Procedures, Technology, Governance and Training & Exercises.

Figure 7 - How to reach maximum coordination through HEWS usage

Usage

Regarding system usage, in both sets we have started at the same point: the planning of an event (bioterrorist attack in Lisbon, Marburg outbreak in Angola) and the use of the HEWS system for that specific purpose. Using a system only for planned events for a certain amount of time is helpful on an early stage of system implementation, since we can calibrate system features while real end-users practice directly on it, and obtain a user-oriented solution. The next step is to make the system operational in a certain region. Localised emergency events can therefore be managed through the system and the level of interoperability is restricted to local authorities. When the system usage on local departments is duly prepared, one can raise the level of complexity and bring to the system national coordinators, giving them the ability to fully handle a national crisis. Last but not least, the maximum level of interoperability is achieved, when the system is used not only in extraordinary situations, but also in ordinary daily activities.

Standard Operating Procedures (SOPs)

A Standard Operating Procedure (SOP) is a set of written instructions that document a routine or repetitive task carried out by an organization. SOPs detail the regular working processes that are to be followed within an organization and its use minimizes variation and promotes quality of service, regardless of the type of institution. In this axis, the first step is to define SOPs within the institution. This corresponds to the reality in Europe, but in Angola, SOPs are quite absent, or when existing, are insufficient and results obtained through its usage are scant. The foreseen evolution on this axis, is similar to the one presented in the above mentioned Usage axis: After the individuals SOPs are established, cross institution SOPs can be defined and trained, first for planned events and later on for real emergencies. National communications based on SOPs and an Integrated European Incident Management System are the final steps for full interoperability achievement.

Technology

Technology axis is the enabler of the whole system and must be considered as crucial by the competent authorities. The final objective is to have standard-based shared systems with cross-national influence. From single use equipments and passing through shared channels, there is still a long way to cover until the final objective is reached. Technology implementation is highly dependable on SOPs and Governance axis, and then it cannot advance by itself, since the risk of developing a system that does not meet users' objectives is elevated.

Governance

Both contexts, European and Angolan, already surpassed the first step of Institutions working independently and informal coordination among entities exists for several situations. Nonetheless staff collaboration on a regular basis is very difficult to achieve, since emergency response operates with different ministries and sometimes it is very difficult to reach the necessary engagement to make things work. Recent changes in the Security Coordination Cabinet in Portugal can eventually facilitate the evolution of this sector towards a fully interoperable scenario.

Training & Exercises

Last but not least, emergency responders need to receive training on the system's use in order to achieve the expected results. This axis crosses all the others and must follow the degree of implementation of the system, starting from general orientation on equipments and system to a regular and comprehensive national training and exercises program. Particular attention must be paid to technological issues as well as usability of device and equipments on the field.

4.2.4 Conclusions

After the analysis presented above, it's time to evaluate if satellite communication is or is not the most adequate technology for emergency responders. First, one must consider the heterogeneity of responders: some of them act on the field; some just have to coordinate actions from the headquarters, and some act both as coordinators and rescue personnel. We have already seen that HEWS architecture should be based on layers (please refer to Figure 6), and each layer shall have different architectures, according to the type of players acting in each of them.

Considering 3 types of responders – field responders, field coordinators and general coordinators – we shall propose the use of communications according to their needs. As we have already concluded terrestrial communications technologies can easily fail in case of a disaster, we will focus our analysis on satellite communications.

Field Responders: This kind of operatives act on the field and their primary mean of communication is voice. While on the field, operatives don't have time to provide written information and/or to use devices that request the use of both hands. Therefore, telephones and radios are the most adequate equipments to be used by them. Nevertheless, as far as we could conclude in the several meetings held with field teams, the ideal device will be a haptic one, where both hands can be free to handle the emergency, while satellite communications are available for voice transmission. **In this case telephony through satellite sounds like the most appropriate choice, although the haptic equipments aren't available yet**. It's also mandatory that multicast communication mode is made available, since *n-to-n* communication is crucial in emergency contexts. Regarding data, it was clear that it's not relevant for field responders, since it doesn't immediately bring added value.

Field Coordinators: These agents act on the field, and they have coordination responsibility over the field teams, whilst serving as communication hubs for general coordinators. While communication with field responders shall be mainly done by voice, communication with higher individuals in the command chain shall be done in a structured way preferably using standard messages. Therefore, field coordinators have two different needs: voice and data communication. Whilst satellite telephony can be used with field responders, data cannot be transferred based on it, so **the proposed technologies are VSAT or BGAN**. In the first case, a VSAT antenna can be installed on the top of a vehicle (advance command post) and the vehicle can act as a base station which allows information transmission between the field and the decision makers. But in some cases, it's not possible to have a VSAT on a van, so BGAN, easy to use even in extreme scenarios, becomes the most adequate choice. Although BGAN is the most fickle satellite technology, VSAT is less expensive, so it shall be considered as first choice. However, BGAN is always a flexible alternative.

General Coordinators: These are the professionals that need to have a full view of the occurrence. They're generally installed in buildings, out of the affected area, so VSAT technology is definitely the most appropriate, since it's quite easy to install a VSAT antenna on the top of a building. In some organizations, these antennas can act as a communication hub for other organizations that cannot hold the management and operation of such technology. Nonetheless, one must not forget that in case of an attack, earthquake or other catastrophic event, even the structure that support VSAT can be destroyed, so a BGAN portable antenna, must be the solution to these particular situations.

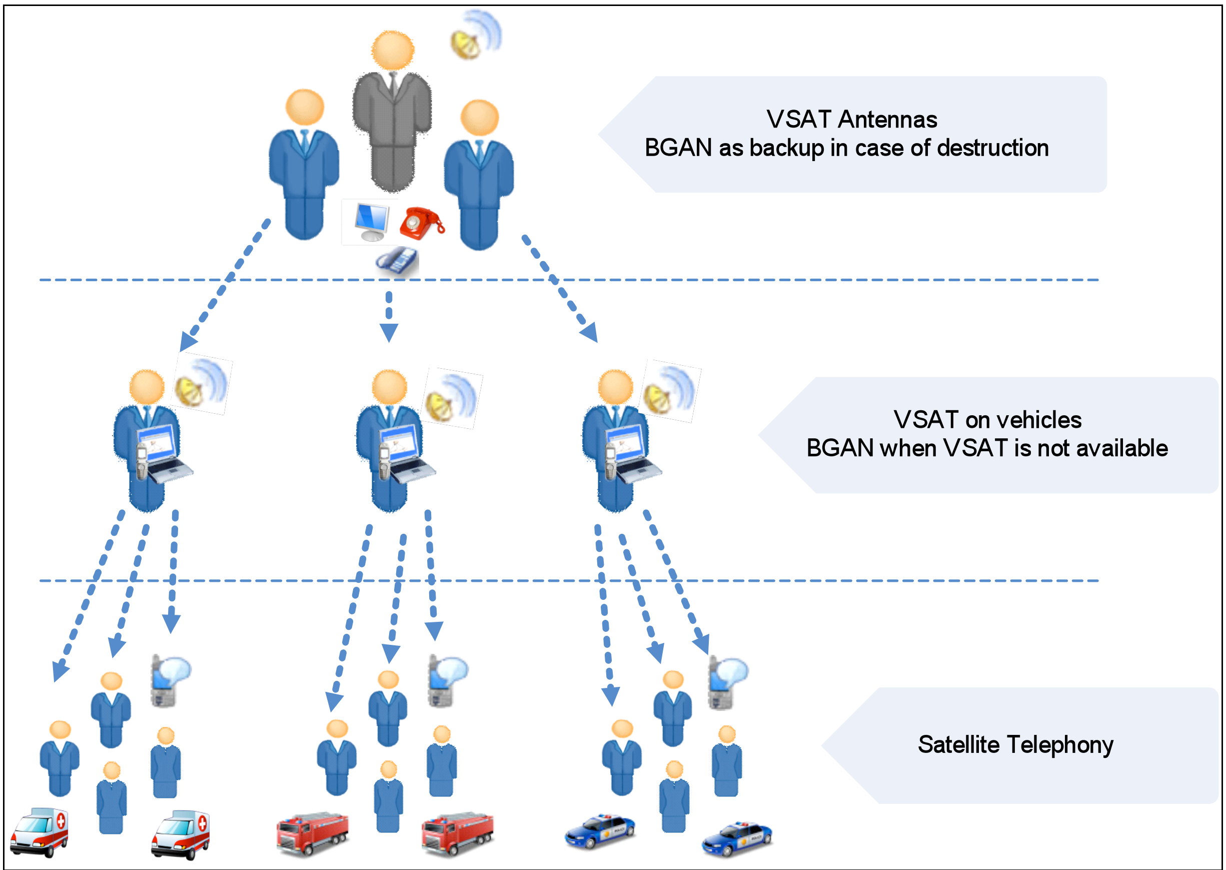


Figure 8 - Satellite Technologies to each type of Emergency Responders

Satellite communications are definitely the most appropriate choice for emergency management, but the proposed architecture must concern different satellite technologies for different users. Besides communication issues, equipments to be used in the field with satellite communications need to be easier to use than the common satellite phones existent in the market.

5 Final remarks

The development of this project has helped the consortium to understand the complexity of acting in such a multi-organization environment, given the different needs of users, security and privacy issues, questions of authority and control over data and so forth.

Our analysis of the project problems and difficulties just confirmed this question, as our main obstacle was the contact with the multiple organizations, that would intervene in a complex scenario as that in which a system like HEWS would be used.

Nevertheless, we concluded that a system such as this would be helpful and relevant for the increased well-being of populations. Involved organizations would welcome a better opportunity to interact and act together with effective results.

The value of such a coordinated intervention was the basis of our project and was confirmed by project development.