On the Integration of Healthcare Emergency Systems in Europe: The WETS Project Case Study

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***Abstract*—The European Union (EU) is characterized by a large number of different emergency healthcare (EHC) systems. In this situation, a common policy for healthcare emergency handling is largely prevented and is a cause of an increase of the costs associated with such systems all over Europe. There is, hence, a need for a homogenization and integration of healthcare emergency systems in Europe. This turns out to be difficult because of the ethical, political, legal, and technological differences and peculiarities of the European scenario and the large investments that would be needed in this sector. The process of integration passes through the identification of the main functionalities—driven by the user needs in their real life conditions—along with the technologies that are best fitted for supporting them. In this paper, several aspects related to these problems are analyzed and a real case study, drawn from the Project "Worldwide Emergency Telemedicine Services" (WETS), supported by the European Commission (DG-XIII), is presented. Within WETS, several pilot sites (in Italy, Spain, Greece, Denmark, and Iceland) consider different aspects of the integration of healthcare emergency systems with particular focus on the sharing of solutions that "traditionally" belong to different environments (i.e., land, air, and sea). The involvement of important hospitals, ship companies, airlines, and emergency health institutions allows us to devote a large part of this two-year project (1998–1999) to validate and demonstrate the results of the development phase in real-life conditions. Some more concrete details are given for the Italian pilot site, where the authors operate.**

***Index Terms*— Biomedical engineering, emergency services, healthcare telematics, information technology, medical services, multimedia systems, telemedicine.**

I. Introduction

IN THE European Union (EU), different types of emergency healthcare (EHC) systems exist in the various member states and sometimes they differ even from region to region. Europe's long history of regional autonomy, strong national feelings, and heavily defended borders may well account for the diversity of such EHC systems (e.g., EHC systems aboard vessels). This leads to nonhomogeneous emergency medical treatments over the European territory that limits, to some extent, the free circulation of citizens. On the contrary, European citizens aim for continuity of care and an accessible healthcare service system. Homogeneity and effectiveness enhancement of the very complex topic of the healthcare emergency treatment have been addressed by the latest European Framework Programmes on different levels. Moreover, the Fourth Framework Programme (1994–1998) [1] has been focused on a number of EHC scenarios that have been addressed as separate entities. In fact, several projects have been funded by the European Commission, each of them dealing with a particular aspect of the EHC service. The largest group has been funded by the Telematics Applications Program (TAP) of DG XIII/C [2], [3], one of the 18 specific programs constituting the first action of the Fourth Framework Program (1994–1998). Such projects are managed specifically by the Healthcare Telematics Unit C4 [4], and they are conceived according to the following five-step structure:

1) user needs analysis;
2) functional specifications definition and design;
3) prototype/service development;
4) verification;
5) demonstration.

Specifically, the enhancement of EHC's over land, on the one side, and onboard sea vessels, on the other side, did receive particular attention. In this context, European projects such as HECTOR [5] and MERMAID [6], which address, respectively, land and sea emergencies, represent a valuable example of this general strategy. Their main results (in terms of realized products/services) are currently undergoing a large-scale validation phase, but they are still not ready for the market. Within the Fifth Framework Program (1999–2002), the EU will sponsor research and development applications that are able to bring concrete effects at a market level. The aim of future project pilots should not only prove the validity of an idea, but open the way to the implementation and commercialization of practical and useful tools, applications, and services. In the field of EHC, the (practical) integration of solutions, suited for different EHC scenarios, into a unique easy-to-use handling framework, turns out to be particularly effective since it leads to systems more appealing for the various European EHC handling institutions and, as a consequence, to a larger market. An integrated solution for EHC management will be more easily accepted and eventually funded by local European authorities. On the basis of the aforementioned conditions, the objective of last-generation Fourth Framework Programme funded projects, such as Worldwide Emergency Telemedicine Services (WETS) [7], is to integrate previous achieved results to design a system able to give global and useful solutions to a wider spectrum of EHC scenarios. The focal point of the integration idea is to yield a service to the final user that is not simply the sum of the services as provided now by the already existing pilots (e.g., HECTOR, MERMAID), but which contains instead a considerable added value in

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terms of effectiveness (quality of service) and efficiency (lower cost). Other projects, such as "Global Emergency Telemedicine Services" (GETS) [8] in the G7 context, have focused on feasibility studies of a general framework for a "global" (24 h and multilingual) emergency service. In WETS, the aim is to extend already existing EHC pilots to build a working and deeply integrated system, both on land, air, and sea.

The paper is organized as follows. A market analysis is conducted in the next Section (Section II). Section III deals with the functional aspects of a generalized healthcare emergency system, while Section IV refers to the technological issues involved. In Section V the WETS case study is presented, and Section VI draws the final conclusions.

II. The Market

The market for integrated EHC services can be seen from two different perspectives: the users (both professionals, such as physicians, general practitioners, and healthcare administrators, and citizens) and industrial and service providers (e.g., information technology industries, telecommunication providers). Even if difficult to quantify, the market for integrated EHC management applications is extremely large. Hints about the dimension of the user's market are given by the following figures: 1.4 out of 1000 people die from cardiac arrest each year worldwide; 50 000 deaths in the EU are from road-traffic accidents, 1.5 million injured; about 3.5 million deaths each year worldwide for accidents or violence; traumatic injuries (especially head ones) are among the major death factors in industrial countries; injuries account for more years of life lost before the age of 65 than heart disease and cancer together; regional differences in the proportion of road traffic accident victims that die before arriving at the hospital can range from 23 to 74%; 30% of such deaths could be avoided by prompter intervention.

These figures (main source of data: OECD and WHO) have obviously a relevant economic impact: the total cost of all accidents is about 1% of the Gross National Product (GNP) of a country, regardless of its stage of development (source: WHO); the total cost to society of road traffic accidents alone was 2.8 billion pounds in the United Kingdom alone (during 1995); healthcare is given the highest priority in many EU countries' budget.

Improvement and optimization of EHC has the potential to save both lives and money in many different ways, and different circumstances require different solutions: there is no such thing as the one-and-only solution for everyone and everything. EHC requires, more than other areas, a multidisciplinary approach to allow a better continuity of medical service. Continuity of care together with promptness and appropriateness of intervention can be facilitated and improved by technology. This leads to the second perspective, related to the market: industries and service providers. It should be preliminarily pointed out that the general lack of a healthcare telematic culture has a strong influence in the healthcare market and, particularly, in the area of emergency. The healthcare market is currently characterized by a deep fragmentation on a worldwide scale. In fact, if setting up a telematic infrastructure generally calls for "classic" pieces of equipment (e.g., video and audio acquisition, telecommunication links), the implementation of services, at the application level, requires different solutions for different target communities. This helps us understand the state of emergency telemedicine in Europe today: a large number of different systems, each one suited for a particular scenario (e.g., land, sea, air), which are almost never fully interconnected, particularly from the user point of view. However, emergency events (which have health implications) are characterized by a progressively increasing degree of complexity (e.g., earthquakes, flooding, fire, catastrophes) and this calls for a higher level of integration through the use of generic technology infrastructures. In fact, even if the added value for a quality service stems out at the level of application, it is clear that without a proper infrastructure the quality of the intervention is necessarily low. Going toward the delivery of integrated solutions will be a catalyzing factor for the promotion of a more uniform and potentially larger market for both services and equipment. This fact will constitute an enabling factor for making available a large variety of interoperable applications at an affordable cost. Nevertheless, it has to be stressed again that the market requires such an integration process to take into account, as much as possible, the currently available local emergency services for which experience already exists. Integrating means, therefore, to add features and not to substitute entire existing systems. It should be pointed out that, even if a good level of standardization has been today achieved at the technological level, this still does not hold true at the application level. Therefore, to overcome this gap, in the presence of the specificities of the various EHC scenarios, a modular approach (at architectural, hardware, and software level) should be followed in identifying the best appropriate solutions for the quality of the delivered service. Such a modular approach will count for the concrete achievement of interoperability of the proposed solutions. Interoperability has, in turn, obvious consequences in terms of both cost effectiveness and promptness of use of products and services in the various situations.

III. Functional Aspects

The first aspect of an integration process is represented by the verification and matching of the functionalities of already working services to the integrated system under development. Some recurrent key functionalities to be integrated are the positioning of mobile EHC units, the transmission of biomedical signals and images, the interactivity and coordination among the various actors, and the availability of multimedia medical tools.

As an example, a global ambulance network may exhibit an internal complexity if it is composed of several ambulance subnetworks belonging to, say, public hospitals, private clinical centers, and volunteer organizations. In fact, different groups of ambulances, which could have different intervention capabilities, might not be able to communicate efficiently. This, added to a potential lack of onboard medical expertise, could lead to a long "black period" (free therapy interval) from the activation of the mobile unit to its arrival in a medical center. On the other hand, the existence of different ambulance groups could be of value since each group could have a deep knowledge of its local territory, and therefore, it could achieve better dispatching performances. With reference to this example, the integration effort is to consider all ambulance groups as parts of a larger and better organized system that globally accounts for a better performance.

More in general, the current EHC management systems operate in a suboptimal manner due to the lack or the inadequacy of the following links.

- Hospital departments, responsible for treatment of specific accidents (burns, neurosurgery, etc.), very seldom are equipped with systems for an online update of the number of beds available; therefore, each hospital does not have a real-time picture of the internal situation, and in turn, the overall situation is not available to the healthcare emergency coordinating center; a (sometimes fatal) consequence is the largely ineffective and delayed dispatching of ambulances toward scarcely appropriate hospitals.
- Ambulances usually only have a radio connection with the healthcare emergency coordinating center; therefore, they are not able to communicate directly with the appropriate hospital departments, both while on the emergency scene and while carrying the patient; transmission of vital signals using different technologies (e.g., radio, GSM, telephone, satellite) is being experimented in few European local areas (e.g., the Lancashire, U.K., system briefly described in Section IV).
- Information sources and services are not usually connected and integrated; the plain old telephone system (POTS) is often the only mean for accessing them; police and fire brigades might have helicopters with cameras for road-traffic monitoring, the highway companies might have checkpoints installed with cameras and maps, but all these resources cannot be fully exploited in case of, say, a large car crash, if no integration exists.
- On the international side, the initiative for a common European emergency telephone number (112) has been accepted and implemented only in a minority of member states, while the adoption of a "healthcare passport," carrying relevant clinical information (such as blood group, chronic pathologies, allergies, etc.) in several languages has not been implemented at all up to now; recently, an initiative has been taken by the European Concerted Action (DG XIII) EUROCARDS to implement a standardized European emergency card (smart card).
- A recent survey demonstrated that only 39% of the population knows the emergency numbers.

From such considerations, the need arises for the modeling of a generic EHC scenario to better identify the actors along with their functional links.

The functional aspects of a EHC system can be modeled under several points of view. An important one is the interaction with the real environment. Key elements are how a telemedicine service can be accessed within a territory, how the collected information is processed, what kind of actions are to be taken, and how the system takes care of communicating back these actions to the real world.

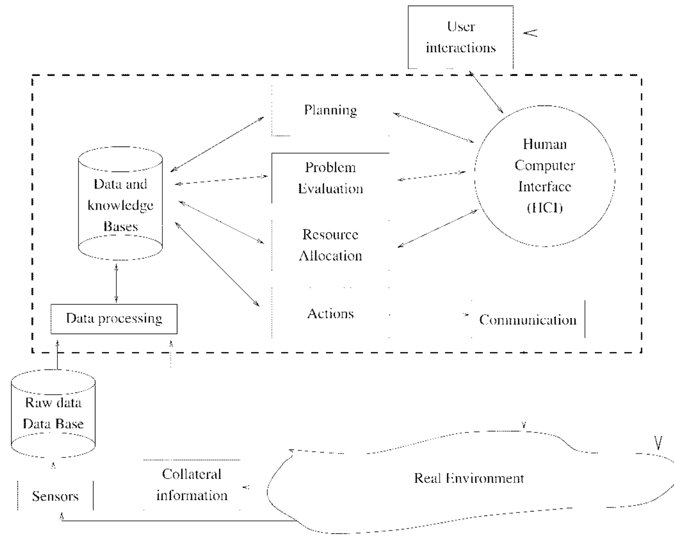

Fig. 1. Functional scheme of a generic complex emergency scenario.

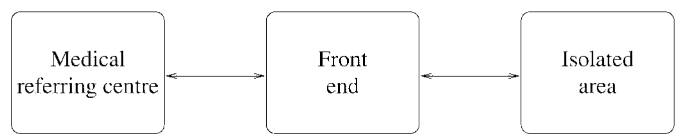

Fig. 2. Functional architecture.

Fig. 1 depicts the various components of such an approach along with their interactions. Data from the real world are often in raw formats, and different inputs may come from several sources: an input database that collects raw data should therefore be envisaged. Raw data acquired by the sensors, along with collateral information (e.g., environmental data, *a priori* data), have to be processed and fused to fit in a more structured data and knowledge base that can be easily accessed for carrying out tasks such as planning, problem evaluation, and resource allocation and for closing the loop by performing appropriate actions on the real environment. These tasks are carried out with the aid of processing elements that interact with medical doctors through a human–computer interface (HCI) module. The result is a set of actions that represent solutions for the emergency situation.

Within a general functional layered architecture, three levels of actors can be identified: the citizens, front-end support centers, and healthcare referring centers. Fig. 2 shows this scheme in a case in which citizens belongs to an isolated area (e.g., rural area, vessel on sea or on air, rig-oil). In Europe, a special effort has been spent in the nontrivial task of linking the end user and the front-end support centers (see, for example, projects such as HECTOR, MERMAID, and AMBULANCE [9]). It is, therefore, important to fill the gap concerning the interconnection between front-end support centers and the healthcare referring centers via a coordinating center (the presence of an authority is, in this sense, essential, especially in the case of multiple front-end centers). This requires the development and optimization of applications with highly user friendly interfaces.

As an example, within the WETS project, the Italian pilot site, located in Genoa, will extend a conventional regional territorial EHC system to the assistance of remote entities on sea and air. This will be achieved through an interconnection with the "Centro Internazionale Radio Medico" (CIRM), an already established specialized front-end center located in Rome that has been the key actor for vessel assistance for more than 60 years. Through this interconnection, seafarers will be given the opportunity to get in contact with high-quality healthcare centers to receive the best medical aid, when it is requested (i.e., onboard), in the shortest time.

IV. Technology Aspect

The process of integration of EHC systems faces several key technological aspects: the coordination of the various actors involved in the case of an healthcare emergency (e.g., ambulances, medical doctors), the acquisition of patient's data through biosensors and medical devices, and the communication facilities. Regarding the first aspect, the institutions in charge of it, as well as the procedural steps to be followed, are usually identified by law in the various countries for the various environments (i.e., land, air, sea). The many legal aspects related with an EHC situation impose some kind of regulatory activity. These rules have, hence, to be strictly taken into account in the design of an integrated coordination center. Since the rules are generally different from country to country (and sometimes from region to region), it turns out to be impossible, for the time being, to implement a "standard" EHC coordination center. On the other hand, under a mere technological aspect, those procedures always handle (at least) three core parts: a database, a set of communications facilities, and a user interface. Modern coordination centers usually adopt relational database management systems (RDBMS), a mature technology, largely standardized, which usually shows a high degree of interoperability with the other components of the system. The field of user interfaces is, on the other hand, not yet well standardized and, therefore, the data rendering is still an open issue. New technologies such as the "browser-based" ones (e.g., HTML, Java [10]) seem to promise improvements in this direction: Java, for example, has a component called Java DataBase Connectivity (JDBC) [11] by means of which it is possible to transparently interact with RDBMS. The Java Multimedia Framework (JMF) component, moreover, provides access to the media parts of a computer (e.g., microphone, camera), while the Java Telephony Application Programming Interface (JTAPI) [12] handles computer telephony applications. This new technology, which along with a user interface provides a so-called middleware framework [13], does not seem to be mature enough to be embedded in EHC systems yet.

Regarding the second aspect, new medical sensors and biological data acquisition devices generally allow some form of connectivity with low cost PC's through means such as PCMCIA, serial lines, or the like. Problems may arise from data representation with different formats among different pieces of equipment: this is still an open issue. On the other hand, the market of multimedia standards has largely improved, and the process of still images, sound, or video acquisition and rendering is, today, possible at very low costs.

The problems arise when it comes to transmitting such data, and this leads us to the next aspect: communication. The communication framework has to cope with two different types of information exchange: the one related to the coordination of the emergency resources (e.g., ambulances, hospitals, medical doctors), and the one related to the transmission of patient's data. Several advances have been done regarding the first aspect, while for the second aspect there are still open issues. The reason stems from the legal aspects related with a remote diagnosis. Medical doctors refrain from relying on patient's data that have been acquired by a paramedic and transmitted over a telecommunication channel. These techniques are still too young and the lack of long-term experience makes it very difficult to set objective quality thresholds to medical data. Nonetheless, there are many cases in which a remote diagnosis is the only viable one (e.g., vessels, airplanes, isolated communities, military camps): transmission of medical data along with a bidirectional audio/video connection with a specialist might largely improve the quality of the intervention. It is also worth noting that the transmission of medical data in more common situations (from the emergency site or from the ambulance) might be "simply" used for a better preparation of the resources at the medical referring center. This is a task that does not involve high legal responsibilities and enables a better continuity of service.

Among the many transmission means, the following are the most promising ones for the management of healthcare emergencies. The Integrated Services Digital Network (ISDN) [14] is the first widely available public network to provide support for integrated services and, being evolved from the public telephone system, is a circuit-switched network well suited to the transfer of real-time traffic. Despite its lack of bandwidth, which prevents the transmission of high-quality video streams, ISDN is based on international standards and it is therefore the obvious current choice to support wide-area telemedicine applications. This telecommunication mean is well suited for the exchange of information between fixed points, such as the front-end center and the medical referring center. Satellite links provide a valuable (and sometimes unique) means of transmitting data between geographically remote locations, for example, between continents or land-based stations and vessels on the open sea. They are also largely used for identifying the position of the emergency site (e.g., GPS [15], COSPAR-SARSAT [16]). A communication satellite system such as INMARSAT [17] provides telecommunication links, which can be leased from public telecommunication companies, through which it is possible to provide, for example, transatlantic data communications. Thanks to INMARSAT and other satellite systems, such as the Very Small Aperture Terminal, private or public companies may also lease capacity to provide data communication between remote sites as part of a Virtual Private Network; this has been planned, for example, for the Greek pilot within the MERMAID project. A problem with the satellite communication is still represented by the high transmission costs. The high transmission delay, which characterizes geostationary systems (the majority up to

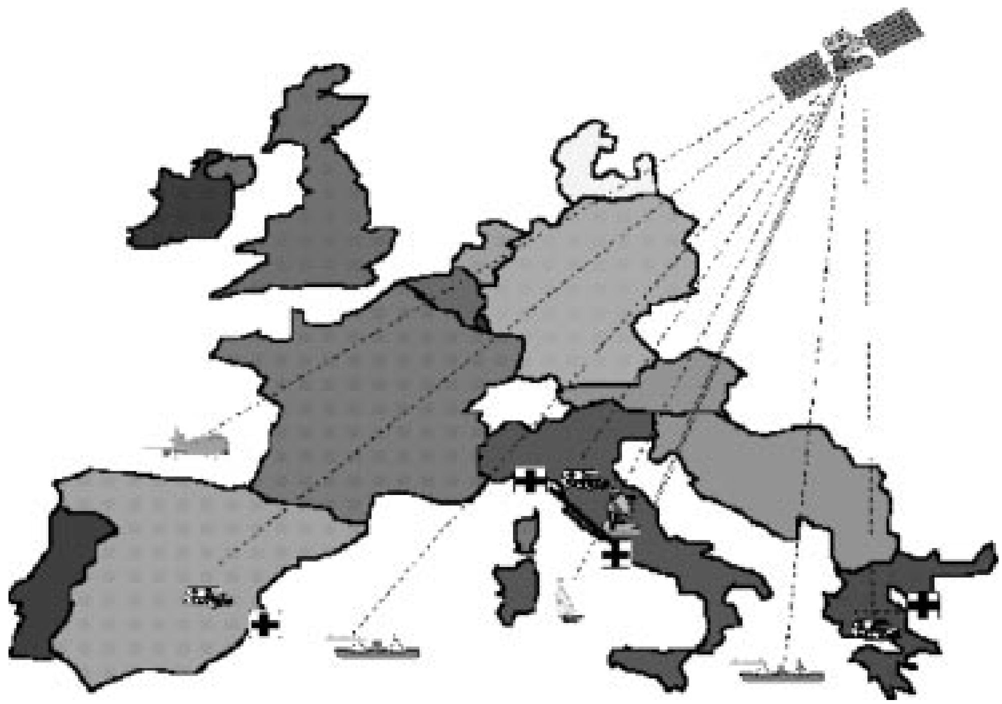

Fig. 3. WETS scenario.

now), may decrease the level of interactivity during a real-time session. Both of these problems are, however, being solved by the increasing number of users, which should help in decreasing traffic charges, and the increasing presence of Low Earth Orbit Satellite (LEO's) systems, which are characterized by a very low transmission delay. Mobile telephones (cellulars) are increasing their presence at a terrific rate. The European scene, a few years ago, was characterized by several (incompatible) analog cellular systems. Now the success of GSM [18] interoperable digital mobile telephones is causing a further growth in the dissemination of this communication tool. Many EHC handling systems are already adopting cellular technology (e.g., ambulances, small boats). A valuable example is given by the DataVision CVT 105 System used by the Lancashire Ambulance Service, which consists of a four video camera distributed system to be installed onboard emergency mobile units, which enables (low quality) video transmission over GSM connections to a medical referring center.

Nowadays, the Internet is also experiencing an incredibly fast dissemination. With reference to the domain of interest of this paper, the Internet lacks both the promptness (speed) of information transfer and the necessary bandwidth availability to cope with the "hot part" of EHC handling. Nonetheless, it can be profitable when used both for information dissemination and for transferring nonurgent information among the various healthcare institutions. The World Wide Web (WWW) [19], which is based on the Internet, has proven a very strong and popular information system, and browsers are being proposed as the universal desktop front end. The number of WWW sites is increasing at an incredible pace (about 130 in 1993, about 650 000 in 1997 [20]), and public institutions are also recently addressing efforts in setting up their own WWW servers with useful information for the citizens (also in the field of healthcare). This largely improves the transparency of public administrations and healthcare institutions. The Internet is currently used, in real-life conditions, in telematics applications in the area of healthcare information delivery to citizens (see, for example, the research and development project INFOCARE [21] or the project TEMeTeN [22]), even if some important issues related to security and privacy (including ethical and legal aspects) of critical data are not completely validated.

It is, hence, clear that the problem is not the lack of technology but the lack of integration among the different information sources, services, and operational procedures.

V. WETS Project Case Study

The WETS project belongs to the latest generation of the TAP healthcare telematics projects, and it started operating at the beginning of 1998. It heavily relies on two previous projects (inside the same program), namely, HECTOR and MERMAID, which have addressed the problem of healthcare emergency on land and on sea, respectively. The main goal of WETS, which has been proposed by the relevant partners of both the aforementioned projects, is to integrate their functionalities and results to design a system able to give global and useful solutions according to the various emergency scenarios. The main outcome will be an adequate management of the EHC event in the best possible way (in terms of time promptness and quality of medical assistance delivery) for the various potential users. As depicted in Fig. 3, within WETS, three major pilot sites, which will operate in parallel, are envisaged: Genoa (Italy), Thessaloniki (Greece), and Madrid (Spain). On top of this, additional sites will be implemented in Denmark and Iceland, both of them accessing and using the solutions developed by and acting as "quality assurance"

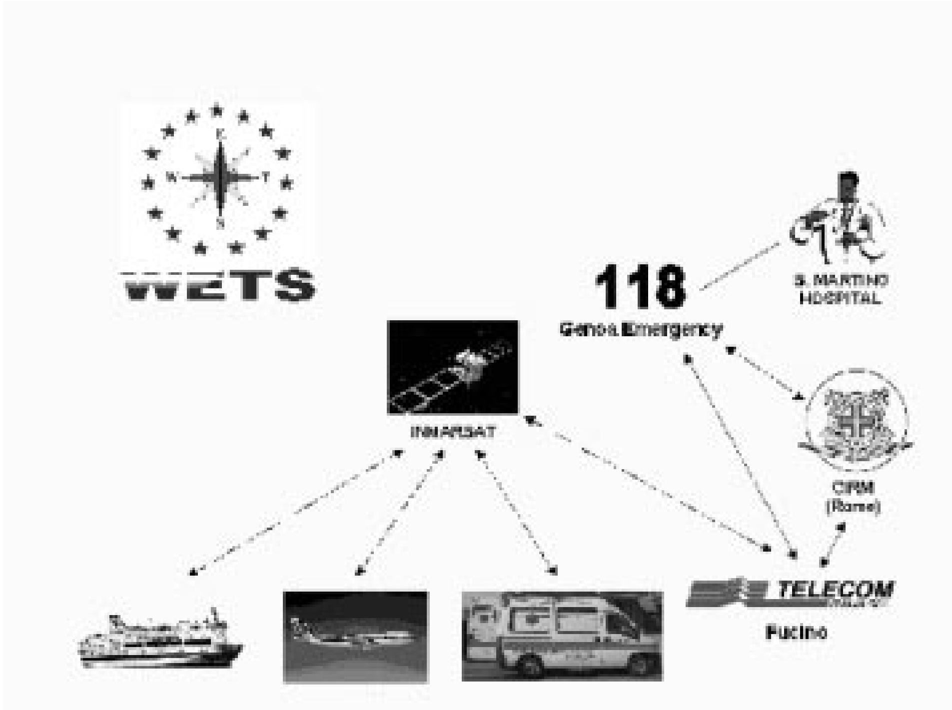

Fig. 4. WETS main actors in the Italian framework.

reference for the three aforementioned major sites. It is worth pointing out that, in conjunction with WETS, the Italian site is involved, as a pilot, in two other European Commission (DG XIII) projects, namely, In-Emergency [23] and Ten-Telemed [24]; the first dealing with the integration of the environmental and healthcare components at digital site level (Genoa), and the second being a more general feasibility study on telemedicine as an application of Trans-European Networks of Telecommunications (TEN TELECOM Program, DG XIII/A3).

Each of the WETS sites involves a target population of more than 500 000 citizens, and each of them will aim to integrate emergency over land, sea, and air. No new technology will be developed—only off-the-shelf solutions will be adopted—the main added value being the integration of already validated solutions with users in their real-life conditions. Within the scope of WETS, a very important task is the sharing of technologies and solutions, which, for the time being, only pertain either to the HECTOR or to the MERMAID pilots. This fact leads to the consideration of the scalability and interoperability features of the envisaged WETS pilot sites. The aim is the establishment of a concrete, scalable, and integrated operating service for EHC.

In the following, some more concrete details are given for the Italian pilot site, where the authors operate. A general skeleton is shown in Fig. 4.

The Genoa pilot site is located at the S. Martino University Hospital, which is the largest Hospital in Europe (about 3000 beds), acting as the main healthcare referring center for the entire Liguria Region (about 1.7 millions inhabitants over about 5400 km^2). Since 1996, the hospital has also been hosting the front-end emergency center "118 Genova Soccorso" (118 being the unique toll-free nationwide emergency telephone number in Italy) related to the territory of the Province of Genoa (about 1 million inhabitants). Having on the same site both the front-end center and the medical referring center represents a significant step toward the achievement of an integrated EHC chain, as outlined in Fig. 2. The "118 Genova Soccorso" belongs to a telematic wide area network (WAN) covering the entire Liguria Region territory. It is basically realized through the interconnection, via dedicated lines, of five front-end emergency centers [each one equipped with a local area network (LAN)] covering the various province territories of the region. With reference to the Italian National Healthcare Emergency management, the Liguria Region is the only one to have a telematic EHC network covering the entire regional territory. All other Italian territorial EHC systems only cover the province dimension. The architecture of the "118 Genova Soccorso" includes a LAN backbone that integrates a system for dial-up access through conventional telephone lines (118 access call number) and a radio system for the communication with the emergency mobile units. The center is also equipped with a continuous recording system of all emergency voice calls, and it is connected with the medical referring centers (e.g., hospitals, wards) in each distributed hospital belonging to the Province of Genoa through ISDN lines, mainly to know online the availability of beds. The control of both voice calls and radio communications is embedded in the telematics system to provide the operator a unique and integrated workstation (normally equipped with two monitors, one for the dialog with the application software and the other for the cartographic display). Regarding the software part, the system is based on a client-server architecture, including an RDBMS and a

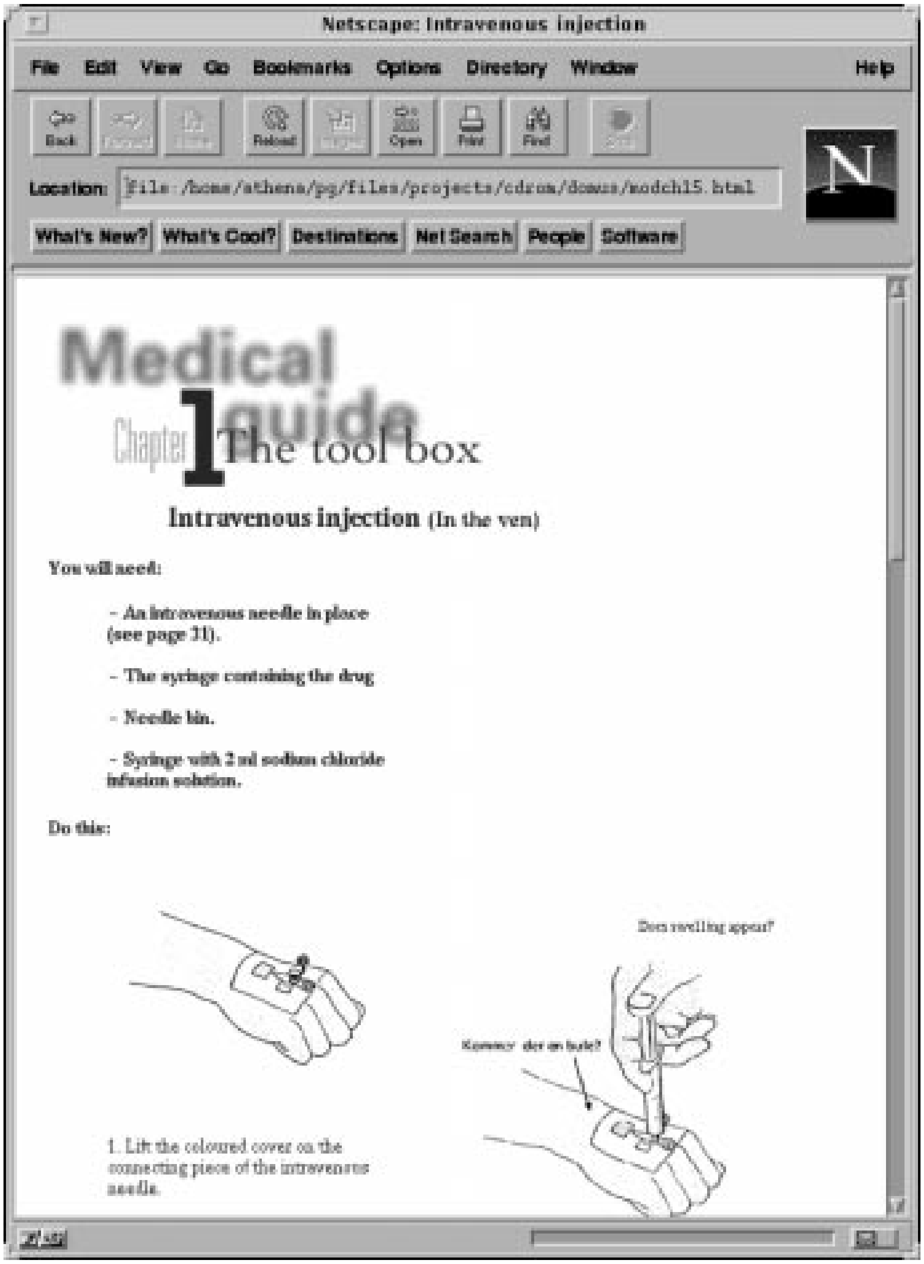

Fig. 5. Screen shot of the multimedia medical guide.

cartographic application (both raster and vectorial) to display, online, the current status of the mobile units over the territory of reference managed by the center. The Genoa center is currently coordinating 354 ambulances, two helicopters, and about ten rescue boats. In WETS, besides its normal territorial EHC coordination activity, the center will be connected via ISDN with the International Radio Medical Centre (CIRM), located in Rome, the main front-end EHC center in maritime and aeronautical environment for Italy.

CIRM was established in 1935 and is currently taking care of about 700 cases per year with a volume of about 7000 messages. Through this connection, the Genoa center will therefore act as the main healthcare referring center for both maritime and aeronautical healthcare emergencies. Both the Genoa center and CIRM will have enhanced functionalities through satellite telecommunications using INMARSAT connections. About ten vessels will be available for installing the necessary equipment to validate the integrated service in real-life maritime EHC conditions. WETS will address the cost-effectiveness issue and the telematics management issue associated with the practice of emergency telemedicine. Given the scarcity of relevant experiences and material on the particular subject, it is necessary to resort to the experiences of those that have been practicing telemedicine in isolated, rural, or remote areas for guidance. Concerning the development and application of multimedia products and services, the use of the Multimedia Interactive Medical Guide, as stemmed from the merchant ship maritime scenario, covered by MERMAID, will be extended to other environments, namely, land and air. This hypertextual guide contains, for the time being, all relevant information for dealing with typical maritime healthcare problems and has been developed by strictly taking into account the IMO recommendations [25], [26]. This information is in the form of text, images, sounds, and video clips, and it is accessible by any WWW browser since it is structured in an HTML form. It has also the important option of being remotely driven by a doctor, who can let appear (onboard) the correct page of an intervention (or medical transaction) to be carried out by a paramedic (or the like) on the vessel. A look-and-feel picture of the guide is shown in Fig. 5.

Actually, in the MERMAID project, the guide is a special part of a more complex EHC handling software application that has been designed particularly for remote communities. The system deals with three different levels of emergencies labeled as blue, green, and red according to the degree of severity. The blue level is associated with least-severe situations (e.g., "simple" illness with, generally, no need of interacting with a medical doctor), the green with middle severe accidents (a medical doctor opinion would be useful), and the red with very serious emergencies (e.g., poisoning, hemorrhage) for which medical consultation is essential. The system proposes a very short easy-to-fill-out questionnaire to help the paramedic to classify the type of emergency: the answers are recorded and can be sent (in a compressed form) to a medical doctor by utilizing a "cheap" transmission medium (e.g., INMARSAT-C). It is up to the doctor to choose the level of interactivity, which may range from message exchanges to audio/video connections. The possibility of increasing the communication functionalities in real time only when needed, ranging from, say, Inmarsat-C to Inmarsat A or B, allows us to keep the costs of the medical intervention as low as possible. The Multimedia Medical Guide, which is stored on a CD-ROM, can be also thought of as a tool for decreasing the costs of the medical intervention since very short messages control a huge amount of medical information.

VI. Conclusion

In this paper, the European scenario of the application of healthcare telematics to emergency has been addressed. In the first part of the paper, the problem has been tackled in general terms; in the last part, a real-life condition case study project (WETS) has been analyzed. The main conclusions are the following. The application of telematics to the management of emergency is a European priority for the healthcare domain, in which it can definitively represent a significative improvement in medical delivery in critical situation for the human life. Nevertheless, integration and interoperability of systems and services should be pursued to counteract and lower the barriers that nowadays still prevent European citizens, in critical life conditions, to receive uniform and high-quality medical treatment.

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