CHORIST

Integrating Communications for Enhanced Environmental Risk Management and Citizens' Safety

A review of the Project

Alexandra Nychas

Course: Computer Networks

Supervision: Prof. Anastasios A. Economides

M.Sc. in Information Systems

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Project Overview / Summary

CHORIST is a European Commission project and part of the Information Society Technologies – FP6 Programme. The full title is "Integrating communications for enhanced environmental risk management and citizens' safety". The project had sixteen participants from eight European countries and was co-funded by the European Commission. The project lasted three years; from 2006 to 2009.

The CHORIST Project used existing technologies and new research to improve the authorities' response to environmental and natural disasters. The CHORIST system has three modules which correspond logically with the timeline of a disaster.

The first module deals with how the authorities learn of the event from citizens in the disaster area and/or monitoring systems. It also provides help in the decision-making process so that the authorities can quickly choose a course of action. CHORIST also developed a training system for the first module.

The second module deals with information flow in the opposite direction; once the authorities know of the situation, they must inform the population affected.

The third module is coordination of the response teams. When they arrive in the affected area, it is important that they are able to communicate immediately, reliably and independently of local infrastructure, which may have been destroyed by the disaster event. It is also important that they do their job as safely as possible.

The project developed these three modules, located problems at every level, proposed solutions and considered new research and technologies that could be applied. The CHORIST team defined user requirements, after consulting a User Advisory Board (UAB) which was comprised of authorities' representatives; citizens; and telecommunication and media operators. The UAB helped define the user requirements; system specifications where then set for the developed, demonstrated and target systems; CHORIST also developed prototypes and set standards for alert messages. They conducted a laboratory test and a system trial test was also conducted to test the programme.

Demonstrations were conducted and the partners participated in many conferences and produced many publications.

The CHORIST Project team members analyzed the expected impacts of the system, proposed future areas of interest and research and described the areas where technological advances are still needed in order for the system to work.

The system produced during the duration of the project is a simplified version. The target system, which is planned, will contain everything that is needed and will include many things that were not part of the developed and demonstrated systems.

Apart from the technical difficulties, it is interesting that there are social problems associated with the project as well. Education, languages, translation and training are all important aspects that need to be addressed if such a system is to work in a multi-cultural, multi-lingual Europe.

The technologies used throughout all three modules include existing monitoring systems, GIS systems for mapping and predicting the disaster area; call centers; GSM cell broadcasting, TV and radio message broadcasting; sirens; MANETs and TETRA TEDS radio.

Motivation / Key Challenges, Objectives

Natural disasters and industrial accidents are a threat to populations everywhere. The key to minimizing their impact are Early Warning Systems. These systems (CHORIST Consortium 2009a) have two functions: detection of an event and warning the population quickly. Existing warning systems monitor small areas (for example, earthquake sensors and tsunami detectors) and can only warn small parts of the population, usually with sirens.

However, there are potential threats that could impact large areas; affect many countries simultaneously and there is also the possibility of a multi-hazard event. These situations cannot be addressed effectively at present. Also, using many media channels for communication, instead of just using sirens, ensures that more people get the warning messages.

Another important aspect of Early Warning Systems is education and being prepared. Populations must know what do in the event of a crisis.

This disaster event timeline shows the importance of Early Warning Systems and being prepared.

Image 1: The three-phase disaster time model (CHORIST Consortium 2009a)

CHORIST provides an Early Warning System whose objective is to integrate communications and data in order to: provide a clear picture of the situation, so that the authorities can make decisions; warn the population immediately and effectively about what course of action to follow; and to provide on-field rescue teams with rapidly deployable mobile communication tools, which will help them do their job efficiently and safely.

The goal is to *"reduce the impacts of disasters on population and property"* (CHORIST Consortium 2009a)

Technical Approach / Methodology

The CHORIST Project approached the problem from three different angles and aimed to create three separate subsystems or modules.

The three CHORIST modules and their functions are clearly represented in the following image:

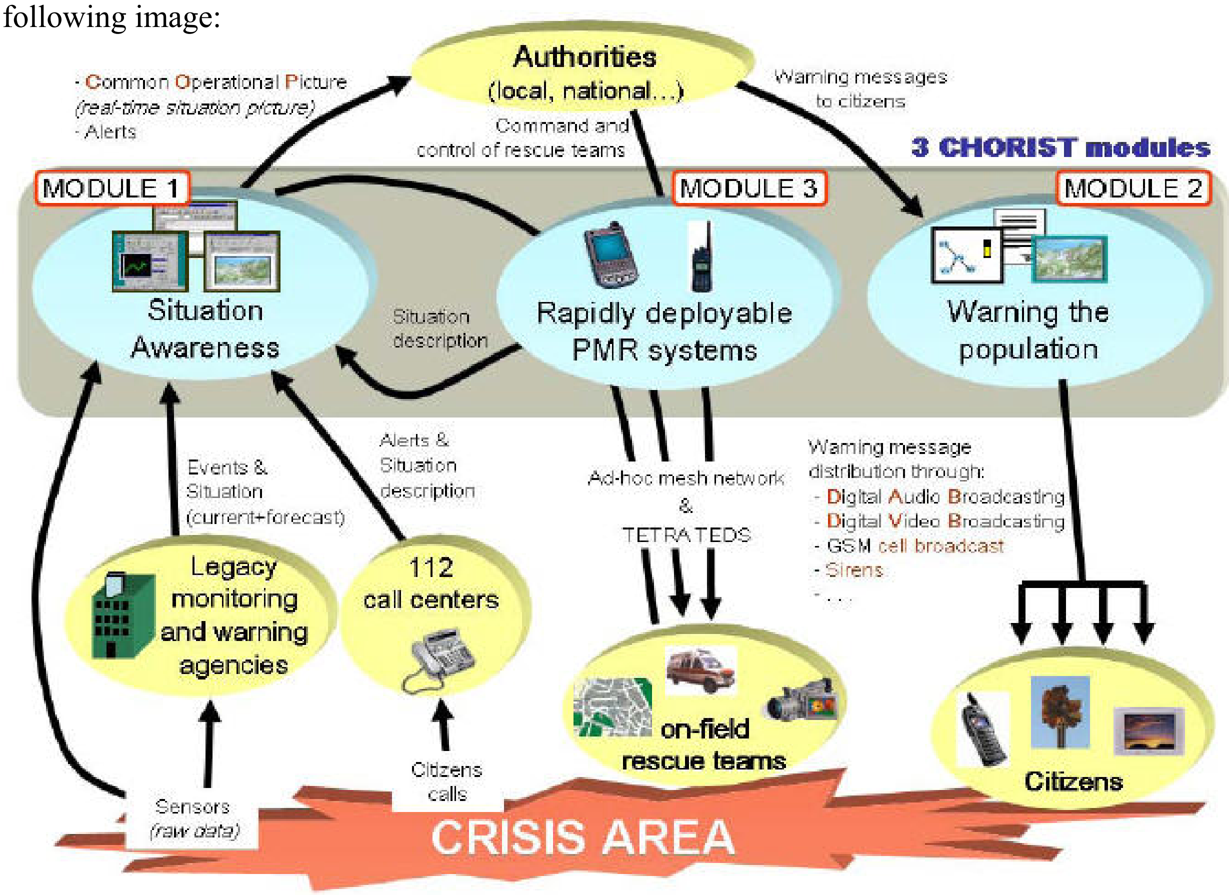
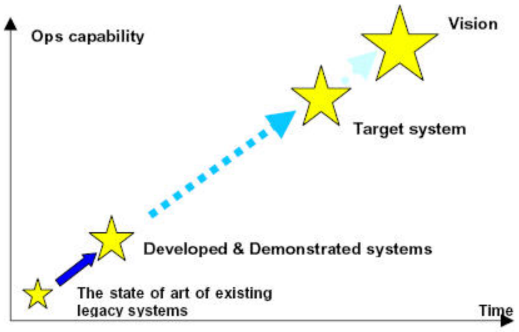


Image 2: The CHORIST modules (CHORIST Consortium 2009a)

The first module, also called the Situation Awareness Module, collects data from existing monitoring systems and calls from citizens, analyzes the information and provides a complete picture of the situation to the authorities. The system can also predict disaster areas and ultimately, it helps the authorities decide what to do, what parts of the population to warn and which areas are in danger.

The second module covers the next step; after the authorities have decided on a course of action, they must inform the population. Technologies used are Digital Audio Broadcasting (DAB), Digital Video Broadcasting (DVB), GSM (cell broadcast technology) and sirens. In Early Warning Systems, it is very important to reach as many people as possible (CHORIST Consortium 2009a). Using these technologies, the authorities will be able to alert and inform more people than they could in the past.

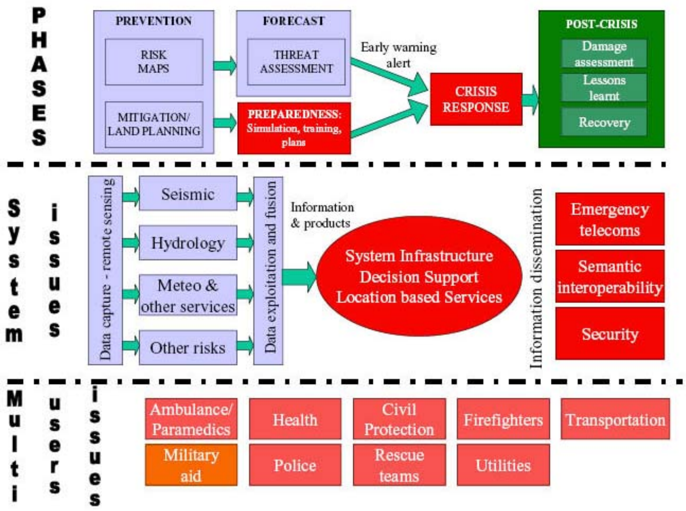
The third module consists of rapidly deployable telecommunication systems for on field rescue workers. Two technologies are proposed by CHORIST; an ad-hoc mesh network based on LTE/WiMAX technologies and a TETRA TEDS base station and terminal. WiMAX (Worldwide Interoperability for Microwave Access) is based on the IEEE 802.16 standard. It can provide speed up to 10 Mbps (Wikipedia 2010a). TETRA is a standard for PMR (Professional Mobile Radio). CHORIST proposes the use of TETRA TEDS (TETRA Enhanced Data Service) which is an improvement of TETRA (CHORIST Consortium 2009a).



These three modules make up what CHORIST calls the Target System. The CHORIST Project however only developed prototypes, parts of the modules, to prove the system works. This was due to budget constraints (CHORIST Consortium 2009a).

By creating the prototypes, CHORIST could demonstrate that the proposed solution works. The prototypes can perform the essential functions required. Eventually though, the Target System will be completed, it will contain additional features and it will be available for use. The image (Image 3) above (CHORIST Consortium 2007a) shows this progression.

A very interesting part of the CHORIST Project's methodology was the use of a User Advisory Board (UAB). The UAB consisted of representatives of future users of the Target System. These included the various authorities (they play an active role); citizens and organizations like public transport systems (they react to a crisis); finally, telecommunication and media organizations, who are an important part of the process as well (CHORIST Consortium 2007b). The UAB played a key role in identifying the areas of interest and what the CHORIST Project should focus on.



This image (Image 4) (CHORIST Consortium 2007b) illustrates all the different organizations involved in Environmental Risk Management (ERM). All these different elements need to work together in order to be effective.

The techniques used to assess the user requirements from the UAB were interviews, questionnaires, direct observation of users, written specifications, scenarios, brainstorming sessions and workshops (CHORIST Consortium 2007b).

The UAB (CHORIST Consortium 2009a) also developed scenarios for the Project demonstration and field tests. The scenarios included high winds, a flash flood and a chemical incident. It was important that the scenarios be "*operational ones, validated by the technical community*". The UAB also obtained feedback from the parties participating in those events and also observed parts of the tests.

An important part of the CHORIST Project was working with other projects (completed or ongoing) as well as various standardisation groups (CHORIST Consortium 2009b).

Description of Deliverables

The CHORIST Project deliverables are organized into six categories.

The first category concerns the CHORIST Project scope. There are three reports (Chorist Consortium 2008a, 2009c, 2009d) describing dissemination methods for the project and it's findings. Similar to the previous three reports is the "Report on actions taken to raise public participation and awareness" (CHORIST Consortium 2009e) which describes the workshops, conferences, demonstrations and publications of the project.

The deliverable "Report on the Open Seminar on communications for environmental risk management" (CHORIST Consortium 2009f) analyses the conference that took place in Istanbul in June 2009. The deliverable "Report on perspective assessment and recommendations" (CHORIST Consortium 2009g) contains a list of expected project results and recommendations and guidelines for future projects and research.

The "Report on standardisation activities" (CHORIST Compendium 2009h) contains all the standards that were used in the project. The "Report on Impacts Analysis" (CHORIST Consortium 2009i) describes how impacts can be assessed and describes the expected impacts from the project. The "Publishable Final Activity Report" (CHORIST Consortium 2009j) is the final document in this category and it contains a summary of the entire project.

The second category of deliverables concerns the whole CHORIST system and users. The report "User inputs methodology" (CHORIST Consortium 2007b) describes how the project partners collected information about user requirements. The "Report on user advisory board organization and operational methods" (CHORIST Consortium 2006a) contains material that is covered in the previous report.

The "Report on user practices and telecommunication state-of-the-art" (CHORIST Consortium 2006b) describes the protocols and technologies that would be used in the project as well as other projects that working in related fields. The "Report on user requirements and initial supporting cases (CHORIST Consortium 2007c) describes the requirements for the scenarios. The "Systems specifications" (CHORIST Consortium 2007d) deliverable lists the system specifications for the CHORIST systems.

CHORIST produced three yearly progress reports on the User Advisory Board activities (CHORIST Consortium 2007e, 2008b, 2009k). Finally, the "Report on the final supporting cases" (CHORIST Consortium 2008c) describes the final scenarios for the trial and the demonstrations.

The third category contains documents about the CHORIST Module 1: Risk assessment report subsystem.

The "ERAW and ERAS system definition and design" (CHORIST Consortium 2007f) provides a description of the Environmental Risk Awareness and Environmental Risk Assessment systems. The "Report on training system scope and methodology" (CHORIST Compendium 2009l) describes the training system for the ERAW and ERAS systems. The "Report on training system definition and design" (CHORIST Consortium 2009m) further describes the training system.

The "ERAW and ERAS system test plan" (CHORIST Consortium 2009n) describes in detail how the ERAW and ERAS systems will be tested. Finally, the "Training system test plan" (CHORIST Consortium 2009o) describes the test procedure for the training system.

The fourth category of deliverables contains documents concerning the CHORIST Module 2: Communication to the citizens subsystem. The "Meta definition and general categorization for citizens early warning messages" (CHORIST Consortium 2009p) contains lists of environmental and other hazards for which European countries are prepared; information about the methods already in use to warn citizens; categories of warning systems. Finally, it explores the potential benefits of having a library of warning messages.

The second deliverable from this category is "Communication channel technical specification and open interface specification & Communication network architecture definition and requirements – Content Casting Network" (CHORIST Consortium 2009q) describes the Content Casting Network and it's function. This includes the system which works with the Risk Assessment system (Module 1) and the message dispatch methods (Module 2). It includes interesting details about encrypting the messages sent from the system to the broadcast media and also addresses other security concerns.

The "Broadcasting Networks Gateway technical specification" (CHORIST Consortium 2008d) describes the DVB-DAB SP3 Gateway subsystem. This subsystem creates the features of the warning messages. The messages should be short and clear and tell citizens what the situation is and what they should do. The "Public Announcement Network Gateway technical specifications" (CHORIST Consortium 2008e) explains the sirens' interface. The "Personal Communication Networks Gateway technical specification" describes "*the interface between the Message Dispatcher and the Cell Broadcast Center*" (CHORIST Consortium 2007g).

The "Library of warning messages" (CHORIST Consortium 2009r) explains the composition of a warning messages library. The "Study into MBMS as communication bearer" (CHORIST Consortium 2008f) is an in-depth look at Multimedia Broadcast / Multicast Service (MBMS) and how the technology can help to broadcast alert messages to the public.

"Mechanisms to distribute warning messages – Messenger and Chat Services" (CHORIST Consortium 2007h) is an interesting study into whether MSN Messenger and IRC Chat could be used to broadcast warning messages. The conclusion is that IRC would be easier to adapt for this function.

"Multilingual aspects in Public Warning" (CHORIST Consortium 2009s) addresses issues such as messages in many languages; how to ensure that the warning messages are different from regular messages; what language the messages should be in. For example, radio and television messages could be in the same language as that used in the current radio or TV program.

The "Report on the technical possibilities of using one European Alarm Channel for Cell Broadcast messaging, with multiple European languages" (CHORIST Consortium 2009t) is an analysis of Cell Broadcast and it's role in the warning system.

"Design of a prototype Cell Broadcast reporting application, to be used on symbian based handsets" (CHORIST Consortium 2009u) analyses the Cell Broadcast Manager and it's phone application, a system which documents received messages, thus verifying whether a message was received in a specific area.

Finally, “Lessons learned by Delft University of Technology on Emergency Warnings” (CHORIST Consortium 2009v) is a study into the factors to consider when sending alert messages to the population. It includes conclusions from field tests and also contains a study of generating automatic text.

The fifth section of deliverables concerns the CHORIST Module 3: Emergency telecommunication subsystems on crisis site. The “Report on user needs and interoperability requirements” (CHORIST Consortium 2007i) describes the functions of the rapidly deployable networks for the on-field rescue teams and what services are required by the users.

The “Report on Telecom services definition” (CHORIST Consortium 2007j) describes all the proposed functions of the SP4 systems. The functions are divided into two services, voice and video.

The “Reports on improvements to existing legacy PMR and broadband systems” (CHORIST Consortium 2007k) recommends ways to make legacy systems work with the CHORIST systems and it also analyses why the existing broadband systems are not sufficient. The “Report on Wideband network definition and design” (CHORIST Consortium 2007l) contains the development of the TEDS demo system phase 1. The system supports point-to-point video transmission with simultaneous uplink and downlink.

The “Report on Broadband network definition and design” (CHORIST Consortium 2007m) analyzes the broadband ad-hoc systems developed by CHORIST and designed to work with other systems on the crisis site. The system contains improvements of the WiMAX technology with label-switching. Desired functions were “*fast deployment, QoS, priority management and interoperability*”.

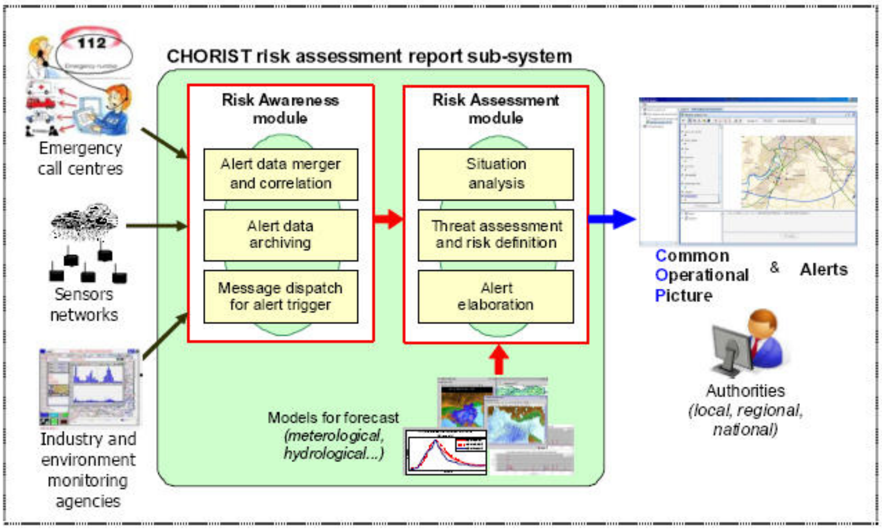
The “Report on Autonomous architecture and protocols” (CHORIST Consortium 2007n) describes the Public Mobile Radio (PMR) Mobile Broadband system, which is based on WiMAX. The “Report on PMR broadband / narrowband gateway” (CHORIST Consortium 2007o) describes in more detail the PMR system. Finally, the “Detailed report on broadband prototype implementation and updated system specifications” (CHORIST Consortium 2009w) is an update of the deliverable “Report on broadband network definition and design” (CHORIST Consortium 2007m).

The last section contains documents referring to the CHORIST laboratory integration, field trials and demonstration. The “Report on system demonstration trial definition” (CHORIST Consortium 2009x) describes the three scenarios for the trial and lists the objectives, principles, protocols and location of the trials. The “Report on demonstration assessment methodology” (CHORIST Consortium 2009y) describes how of the developed and target systems can be assessed.

The “Report on system assessment and recommendations for further work” (CHORIST Consortium 2009z) is an evaluation of the project after the field tests. Finally, the “Report on system demonstration” (CHORIST Consortium 2009aa) describes the project demonstration and the whole CHORIST Project.

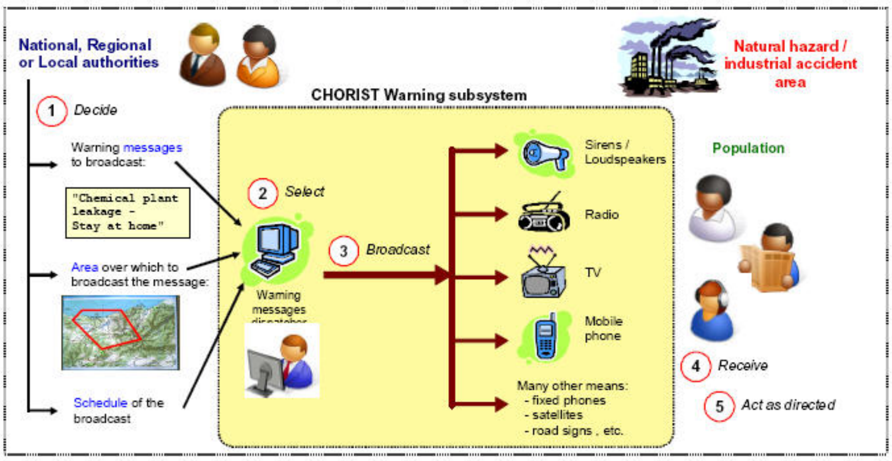
Results / Findings

The CHORIST Project consists of many different elements and there are many results associated with each one.



For Module 1, a prototype was developed by Avanti Communications, Elsag Datamat and the EC Joint Research Centre. The Module has two parts, the Environmental Risk Awareness detection (ERAW) and Risk Assessment (ERAS). They share a database and they are incorporated in one graphical user interface. ERAW collects data from monitoring systems and analyzes the data to detect developing dangerous situations. It uses color codes that easily identify the severity of the threat. ERAS uses GIS data and maps to assess areas that are in immediate danger and to predict possible areas that could also be affected. This report is what the authorities receive (CHORIST Consortium 2009j). Image 5 (CHORIST Consortium 2009j) shows the first module and the ERAW and ERAS systems.

Since it is vital that the appropriate personnel are able to use these systems, training systems using simulations were also developed. The simulations created were for the three scenarios that CHORIST designed for the demonstration, but the system can be used for other scenarios as well. CHORIST also developed a simulator for the European Emergency number 112 that can be used for any scenario (CHORIST Consortium 2009j).



The second module is the system used to warn the population. The Module 2 prototype was developed by Komcentra, one2many, SPMM, TUDelft, VODAFONE and Tradia Telecom.

It works as follows: authorities create warning messages using a Message Creator and Dispatcher. The messages are then sent through a sirens network; DVB and DAB networks; and a GSM network (CHORIST Consortium 2009j). It's illustrated in Image 6 (CHORIST Consortium 2009j).

There is a general format for the warning messages, although it is not necessary that it be used. In order to select the area that will receive the message, all the operator has to do is draw a polygon on a GIS map. The system then forwards the message through the appropriate channels.

The cell broadcast channel is available in most GSM networks but it is rarely used. This channel will be used by the CHORIST system to send messages to mobile phones. The smallest area that can be selected to receive a message is a GSM cell (CHORIST Consortium 2009j). For the sirens, a gateway was created to connect them to the system. It is possible to send voice messages over the sirens, although it is doubtful if they would be effective.

Digital Video Broadcasting (DVB) is used to send a warning message directly to a television. The message is broadcast and received by TV antennas (elevated towers). The message will appear as text on the screen, over the normal program. The viewer can then move the message or delete it. The messages are displayed in more than one language (CHORIST Consortium 2009j). Image 7 shows how a message could look (CHORIST Consortium 2009j).

Digital Audio Broadcasting (DAB) is used to send a voice message to radios. It replaces the normal radio program and can be targeted by area, so that the appropriate message will be heard in the correct area (CHORIST Consortium 2009j). Image 8 (CHORIST Consortium 2009j) shows the DVA system.

The third module consists of the rapidly deployable telecommunication systems (CHORIST Consortium 2009j). The two prototypes for this module were developed by THALES Communications, EURECOM, TKK (Helsinki University of Technology) and EADS Defense and Security.

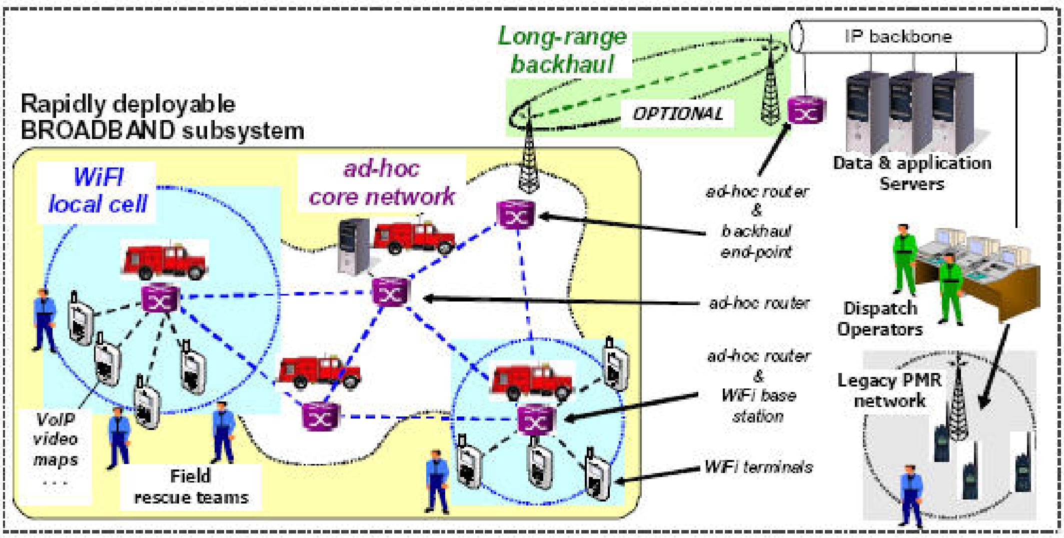


Image 9: Module 3 (CHORIST Consortium 2009j)

The first prototype is a rapidly deployable broadband ad-hoc mesh network. It uses label-switching and it provides "*long-range coverage and QoS*". The MAC layer uses labels and the nodes can route traffic for several labels simultaneously. The mesh network connects to an IP network. When IP packets enter the mesh network, they receive a label (CHORIST Consortium 2009j).

In addition to the previous system, the project also used WiFi for pedestrians to connect to the mesh network. Mobile WiMAX was considered better for this function, but it wasn't available. WiFi doesn't provide QoS and there were problems with trasmission, especially when sending video. CHORIST is confident though that applications can provide solutions to the issues that WiFi can't control (CHORIST Consortium 2009j).

CHORIST also created an application for VoIP that functions in a peer-to-peer way. One of the nodes can be connected to a TETRAPOL dispatcher and therefore, connect the two systems (CHORIST Consortium 2009j).

The second prototype is a base station that uses the TEDS standard. It includes WiFi extensions although the prototype has limited functions compared to final system that will eventually be produced (CHORIST Consortium 2009j).

There are many interesting findings as far as user participation is concerned. It is important to work with authorities from the beginning of a project and through all the stages. Apart from the technological aspect of a project like CHORIST, it is necessary to study the behavior of populations in order to assess their reaction to warning messages, a crisis event and to the authorities' recommendations. It is also important to test a system with citizens in order to gain feedback. Finally, it will be necessary for authorities and political forces to cooperate in order to make a European-wide system a success (CHORIST Consortium 2009a).

Expected Impact / Implications

The deliverable from the CHORIST Project titled “Report on Impacts Analysis” (CHORIST Consortium 2009i) analyzes the potential impacts of the systems proposed by the project. The impacts are grouped into three categories: social, environmental and economical.

The first category, the social impacts, is further divided into seven subcategories.

Under “way of life” and as far as the authorities’ work is concerned, the CHORIST solutions could provide the following benefits: authorities will have a better command of on-field rescue teams and they can take the appropriate operational response; the authorities can better deal with multi-hazard, regional, national and international events and can better identify the appropriate response.

In addition, rescue teams will be safer when doing their work. The CHORIST system can also be used for training and it is expected that there will be increased cooperation between rescue teams from different agencies and countries.

The 112 call centers will become more efficient, since they will be part of the CHORIST system that gathers data and therefore, they will have to conform to higher standards.

The modular aspect of the Project means that it can be enhanced in the future.

Costs and negative impacts for authorities’ work are the following: there is a high cost associated with training all the personnel who will be using the new system. It is also possible that some public safety workers will not want to learn a new way of doing things or new technological tools. However, the Project developers are confident that a successful use of the system will convince them of it’s importance and value.

When a system becomes more technologically advanced, it also becomes more vulnerable to technical failures. This is a risk, but it has been taken into account as the developed system is designed with redundancies and the target system will have even more safeguards. It is also possible that the new system will put pressure on the authorities, because the human factor in the decision-making process is the most likely to slow the response time down. However, the system’s job is in aiding the authorities and should not be considered as showing the authorities’ shortcomings.

Finally, training the authorities to be better prepared does come at a high cost but it is an essential part of the system.

Continuing with the social impacts to way of life, as far as people’s lives are concerned, the Project developers have identified the following benefits: populations will be better protected and they will be better informed after an event. This information will then improve their response as they will know how to act without causing panic and making the situation worse. If the populations are trained about the CHORIST system and if the system is used throughout Europe, this will enable people to follow instructions from the authorities without hesitation. Training the population will also have the benefit of increasing the percentage of the population who are able to understand the alert messages.

The second aspect of the social impacts is culture. An expected benefit is a better understanding of natural events and of risks associated with various industries.

The third aspect of the social impacts is community. There are two potential benefits in this category: the populations' response will be consistent (provided the populations are correctly trained about how to respond) and populations will become more responsible (again provided the populations have been educated properly).

The fourth aspect of the social impacts concerns the political system. The first benefit will be recognition of the importance of having standardised warning messages. The second expected benefit is that political forces will realize how important it is to educate the population.

The fifth aspect of the social impacts is health and well-being. The expected benefits are that lives will be saved and there will be less injured people (who require treatment).

The sixth aspect of the social impacts concerns personal and property rights. Early warning means that people can protect their property.

The last aspect of the social impacts concerns fears and aspirations. On-field rescue teams will feel safer; the population won't be so afraid of a sudden disaster and will feel better protected by the authorities. Finally, the populations will not be afraid of industrial plants (provided the system doesn't send out alerts for insignificant events because that would only scare the population).

Negative impacts could be a feeling of fear for those who don't want to use the new technologies, they might feel that since they don't understand them, they are at a greater risk. Also, if the populations become aware of lots of problems, they could become more worried instead of feeling reassured.

Environmental impacts include less polluted areas and less risk of pollution while transporting chemicals (because the system can predict the potentially affected area and actions can be taken).

A negative impact is that if systems are put in place for CHORIST, they could affect the environment visually or create some kind of pollution (for example electromagnetic). However, it is possible to hide sensors and in any case, most sensors already exist and the new system will just utilize them in a better way.

Economic impacts include new markets and new jobs in those markets. Also, benefits are expected from use of Intellectual Property Rights. There will also be a need to validate standards and propose new standards. There are new fields of research that could provide opportunities to universities and various other institutions.

It is also expected that costs during the recovery phase following an event will be lower, both in terms of healing the population and in repairing infrastructure.

A negative economic impact is the large cost associated with implementing the necessary infrastructure to support the system and even the minimum requirements have a high cost.

These expected impacts are very significant but it is important to note that they come with caveats from the developers. There is a lot of work that still needs to be done and the effectiveness of the system depends on more than just the technical and technological solutions.

As far as the ad-hoc mesh network and the TETRA TEDS base station are concerned, CHORIST developers predict that they will be *"the equivalent 3G revolution for* *professionals that GPRS and UMTS were for the public some years ago"* (CHORIST Consortium 2009a).

It is also important, though, to note that *"CHORIST is a proof-of-concept and therefore it's benefits would be unlikely to be available in the short-to-medium term"* (CHORIST Consortium 2009a). Specifically, Module 1 will be available in 5-10 years, Module 2 in 2-5 years, Module 4 (ad-hoc mesh network) in 5-10 years and Module 4 (TEDS base station) in 1-2 years (CHORIST Consortium 2009a).

Therefore, while the expected impacts are truly remarkable, these will not be realized until the target system is available and operational.

Future Research

According to the deliverable "Report on perspective assessment and recommendations" (CHORIST Consortium 2009g) there are many fields to be considered for future research.

They include evaluating how reliable the information received by the ERAW system is and research into whether multi media messages could be used to warn populations.

Models could be created to evaluate warning messages and the citizens' reaction to them. Through simulation, the authorities would be able to assess possible effects of the messages (CHORIST Consortium 2009a).

Another interesting area of research is whether high resolution video could be transmitted through DVB. Related to this is whether the video could also include embedded audio. Also, the option of sending alert messages to DAB devices remains to be explored (CHORIST Consortium 2009g).

Research into developing new DVB receivers that would use a new channel (not available yet) to send an acknowledgment that the alert message was received.

Research into mobile ad-hoc networks using IPv6 and mobile IP.

For the on-site systems, network services that are able to organize themselves would minimize the need for human involvement. This is a field that needs to be explored.

Research into the development of applications that support more than just voice for the mobile ad-hoc networks. Another interesting area of study is "*net-centric application architectures with distributed rather than server-based information*" (CHORIST Consortium 2009g).

Finally, there are security issues in mobile ad-hoc networks that need to be studied and resolved.

New standards need to be developed for: the Common Operation Picture; the interface between the Message Channel Dispatcher and the Gateways; the content of the warning messages as well for the way they appear to the citizens (CHORIST Consortium 2009g).

Finally, a cell broadcasting capability in LTE needs to be specified (CHORIST Consortium 2009g). LTE (Long Term Evolution) is a new air interface for mobile communications. It is considered a 4G technology and will offer higher speeds (Wikipedia 2010b).

The "Report on perspective assessment and recommendations" (CHORIST Consortium 2009g) also describes new industrial products that need to be developed. They include real time models to predict situations. Sensor networks need to monitor events and transmit data in real time (CHORIST Consortium 2009a). The prediction models should be able to combine data from many sources. This is especially useful when dealing with multi-hazard events.

Another product to be developed are devices for warning message reception. Devices targeted at the visually and audibly impaired are a priority (CHORIST Consortium 2009a).

Gateways need to be developed to sensor networks, call centers and the various monitoring agencies (CHORIST Consortium 2009g).

Phone calls from citizens must be viewed as another means of data collection. Authorities need to be trained to handle these calls, gather and assess the data collected (CHORIST Consortium 2009a).

It is also important to develop various Common Operational Pictures, for example static or animated, synthetic or detailed (CHORIST Consortium 2009g). Also (CHORIST Consortium 2009a) although CHORIST proposes tables and advanced GIS maps, 3D models could provide an even better representation of the ongoing situation.

Various groups of people, such as security staff at universities or shopping centers, will need to be informed before or at the same time as the general population. This will allow them to carry out agreed upon emergency procedures. How this will be done remains to be investigated (CHORIST Consortium 2009a).

A set of text messages for warning citizens needs to be created (CHORIST Consortium 2009g).

Supplementary channels that should be studied include the usage of satellite paging networks, road signs and other technologies that could help deliver warning messages (CHORIST Consortium 2009a).

Mobile ad-hoc equipment must be developed for the rescue workers. It must support full features; namely voice, data and video (CHORIST Consortium 2009g).

Regarding regulations, warning messages to the population need to be regulated. This will be at European level. Also at European level, the frequencies used in ad-hoc networks need to be regulated. (CHORIST Consortium 2009g).

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