# Personal Mobile Support for Crisis Management Using Ad-Hoc Networks

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## Abstract

The proliferation of small mobile devices and wireless networks has resulted in an increasing demand to support the applications found in wired environments on mobile devices. In real time replication systems, such as collaborative systems, this trend gives some new problems to address. The properties of wireless networks are low bandwidth and high latency, which change dynamically over time. The risk of the network getting congested is therefore high with the result that the user will not receive the important information in time. Consequently there is a need to develop algorithms and methods for adaptive work environments and adaptive data distribution, to minimise the traffic load.
An architecture based on multi- and mobile-agents is proposed as a solution. Personalized behaviour is included in a flexible and extensible system. A prototype of the architecture has been implemented in a crisis environment and was used for an evaluation. It is assumed that each individual in the field is equipped with a PDA that can communicate with other PDA's in the surrounding and remote servers. Users can report about their environment using a personalized iconic language. Each user is supervised by a personal agent. In case of emergency users are routed outside a dangerous area using a personalised dynamic routing system, called PIRA 'Personal Intelligent Routing Assistant'. The system and results of testing will be presented in this paper.

## 1 Introduction

Currently networks are increasingly supporting mobility. Wireless networks make the replication of data objects in nodes more complex, because the accessibility of the mobile nodes depends on the environment it is in. Dynamic properties, such as bandwidth and position, influence the way data is distributed to mobile clients. With low bandwidth a user may want to receive only high priority information, while he is also interested in background information should the available bandwidth increase. Therefore, to support mobile clients, a context aware replication algorithm is needed. Important dimensions of data adaptation are relevance, fidelity, and timeliness, where relevance is determined by user's interest and priorities; fidelity is dictated by computing platform's capabilities; and timeliness is determined by the requirements of the task. The user provides the relevant information to state his interests, the device and the application determine the fidelity of the data, and timeliness issues time constraints to data delivery. Evaluation of data with respect to the three dimensions results in a priority. An example application in the real world could be a crisis environment application for situational awareness on the crisis field and safety of the rescue workers and victims involved. Rescue workers, equipped with wireless communication devices, have to base their decisions on their observations and received data. Crisis workers in the control room are dependent of the observations in the field. So data on context awareness and safety is of highest priority.

The paper emphasises the potential of collaborative systems that use the context information to provide social awareness between people being in (possible) different physical areas. To solve the problem of communication overload and unified messaging, we propose a hybrid communication network of wired and wireless communication layers. Each individual in the field has a PDA with an adaptive, adaptable interface/system which depends of the position, functionality of the user and is sensitive to features from the context.
In the next sections we will discuss the architecture. Next, the human computer interaction environment and the dynamic routing/escape service are presented. We end up with some test results and conclusions.

## 2 Related work

The context-awareness systems are aimed at using the context knowledge to provide the mobile users with access to information and services. The use of context to support individual behaviour has recently become an

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increasingly high potential research topic. In the beginning such systems were mainly restricted to location-aware mobile applications. A list of some previous researches on context-aware systems and applications is presented in (Chen & Kotz, 2000). The elements of the research presented in the current paper have been developed, parallel to some of the previous projects.

The Foundation for Intelligent Physical Agents (FIPA) has developed specifications for interoperability among agents and agent-based applications. The Personal Travel Assistance Specifications (PTAS) (PTAS, 2000) provided by FIPA support mobile platforms in travel domain. The context and location awareness define well founded concepts for interfacing with environmental devices and human actors. The operability in smart spaces is based on the interaction with controllable devices such as video conference systems, domestic appliances, cameras or others, by using specific loadable remote controls on the users' mobile devices (Kalkbrenner & Köppe, 2002). The paper (Bardram & Hansen, 2004) introduces for the first time the concept of context mediated social awareness as a notion to express how context-aware computing can be used to facilitate social awareness and further proposes the AWARE architecture to support context-mediated social awareness. The European MOBIlearn project (Lonsdale, Baber, Sharples & Arvanitis, 2003) includes context-awareness technology for supporting the learners using mobile devices. The dialog is based on relevant information to what the user is doing, where and how he/she is doing it and so according to the learner's goals, situation and resources. Great efforts have been focused towards applying the context-awareness methodology on working spaces to help people to perform optimally. In the case of hospitals, Electronic Patient Records (EPR) have been adapted to communicate with context aware pill containers and context-aware hospital beds that react and adapt to various working contexts (Bardram, 2004). Further on, the AwarePhone system of (Bardram & Hansen, 2004) is designed to support context-mediated social awareness among hospital clinicians. Social-awareness has been used for improving the quality of social interaction and tourist guiding. GUIDE system (Cheverst, Mitchell, Davies & Smith, 2000) offers the visitors of Lancaster city the possibility to interact with a model representing the city via handhelds. The physical location of visitors is represented in the information space in order to enable a form of social awareness among the city visitors. The visitors are able to change the information content also by augmenting existing descriptions with their own ratings on the city attractions. The CRUMPET European (Schmidt-Belz, Zipf, Poslad & Laamen, 2003) project applies emerging technologies for offering individualized information and services to heterogeneous tourist population.

Finally, platforms for crisis context assessment have presented new tendencies by integrating novel and multidisciplinary methodologies. The recent RESCUE (Responding to Crisis and Unexpected Events) project (Mehrotra et al., 2004) aims at gathering, managing, analysing and disseminating information when responding to man-made and natural catastrophes. The CAMAS (Crisis Assessment, Mitigation and Analysis System) stands for the test-bed within the mentioned project. One important difference between our approach and the aforementioned architecture is that we use language-independent messaging system for reporting instead of natural language text. The reason is that the natural language processor (NLP) may induce some errors while trying to find the semantic of the report. In addition to that, the interface must be user-oriented and so it aims at making the reporting process as natural and easy as possible.

In this paper, we introduce the use of icons as a communication means (see section 6). As human communication involves the use of concepts as internal mental model of an object, an action, or a relation, an icon is understood as a representation of a concept (Perlovsky, 1999). An icon functions as communication means by virtue of a resemblance between the icon and the object or the movement it stands for. Evidence showed that humans have already used icons since pre-historic times, e.g. graphical communication means of ancient Egyptians.

Currently, icons are still used to communicate information that is often substantially different visually speaking across languages, e.g. device instructions, road signs, etc. They are also used in almost every GUI-based computer software to represent a program, resource, state, option or window. Icons give benefits from its direct manipulation for a fast interaction and evoking a readiness to response (Littlejohn, 1996). A research showed that direct manipulation with a pointer has a better time performance than form filling with Soft Input Panels or handwriting recognition (Boren & Ramey, 2000).

With development in computing, recent research has been done in computer-based iconic communication. A deep research by (Leemans, 2001) use the iconic language as universal language based on the notion of simplified speech. A user can select a set of icons using the developed system as a realization of his/her message. The system translates it to a natural language text. One of the interface proposed by this paper adopted ideas from (Leemans, 2001). We developed this interface much further for a mobile use context and more specific for a fast interaction in reporting a crisis situation.

## 3 Distributed PIRA model

The PIRA system is an application running on a handheld device providing communication between users and central server. It provides the user with an up-to-date personalized advice how to escape from dangerous areas based on current available information. An important aspect of the PIRA system is that it relieves the user of having to find the best escape route. By determining the position of the user using GPS or other techniques the system is able to optimize the route from the user and update the advice as the user travels and new information becomes available. In order to communicate with different types of users in different kind of situations, the PIRA system provides a multimodal interface to the user. This means the communication can be based on speech, icons, text or graphical interface, depending on the preference of the user and the situation the system is used. To optimally fit the desires and demands of the user, the system keeps track of the preference of several users. These preferences can be changed by the user, but the system also tries to learn the user preferences from the day-to-day use.

In order to route the users, the system uses the static information about the environment such as the street plan with the required distances. But advising the users about the best route to his destination requires accurate information about the dynamic changes in the environment and routing algorithm to find the optimal connection between his current location and the destination. Since the position of each user is known at each moment, the system can compute the actual travelling speeds. Another source of information is the observations from the environment provided by the users. The quality of the advice of the PIRA system depends of the quality of the user input. All users realize that they have to work together in providing the system with high-quality complete information. Another aspect of the PIRA system is that it generates a personal advice. The goal of the PIRA system is not to optimize the routing of the whole group of users but the routing of individuals. The users get a tailor made advice instead of a general advice. As handhelds become more and more powerful every day it will be possible to run a large part of the application on the handheld device. Ultimately the application will completely run on the handheld device and depending on the information which is available optimizes the advice for the user. This information can come from the nearby users which are also using the PIRA system, for instance by using ad-hoc networking techniques or by using dial-up or UMTS or GPRS-based mobile internet connections to gather the required information about the positions and travelling speeds.

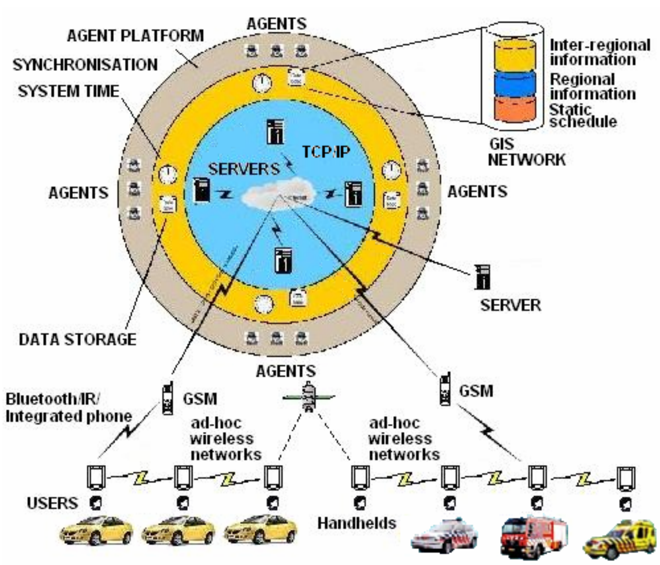


Figure 1. Distributed PIRA model

The PIRA system consists of individual hand-held applications, gathering and exchanging information each-other and trying to individually optimize the advice for the user. Emerging from this behaviour is the distributed application of autonomously functioning hand-held application which distribute and exchange information over the ad-hoc connection among the devices and Internet connection, where is available. If there is no other information available, the individual application will still try to give the best advice to the user, based on static information stored on the hand-held device.

Figure 1 shows the model of the distributed PIRA system. The system is based on several servers that are connected by Internet shown by the blue inner circle. The yellow synchronization layer realises synchronized system clock. Also each server stores a copy of the static street map of an area. Interregional information is synchronized across the servers. Finally, each server runs a JADE agent platform shown in the brown outer layer, which all-together form a single fault-tolerant agent platform. The agent platform is used by the agents to communicate with the rest of the system. The system connects to external web-sites in order to import relevant information. Hand-held devices connect to each-other by wireless connections (for instance wireless LAN) to form an ad-hoc network. Each of the ad-hoc networks connects to the Internet by (built-in) mobile phones using GSM data, GPRS or UMTS connections to contact the distributed server back-end.

# 4 System design

As shown in figure 2, the PIRA system has two user interfaces: a management interface and a handheld interface. The management interface is used for viewing and modifying the system configuration. The handheld interface is used by travelers using a handheld device to communicate with the system. A central role is played by the distributed agent platform that runs personal agents for each individual traveler. In order to give an optimal advice to the traveler, the personal agents receive information about the best route to the destination, given the current delay situation and occurring delays during the trip. Using the user position it is possible to determine whether the user is experiencing a delay. This information about delays is also communicated back to the system itself, to actualize the stored delay information. Assuming that the system receives several delay notifications from users that pass a certain route segment, it may automatically conclude that a possible crisis event i.e. an accident has occurred in the area. Every time a set of observations is available, the system performs a classification of the type of event and the causes that generated that event. For instance, the handheld device components of some users passing a tunnel transparently report delay information to the system. The system automatically tries to determine if the event is a delay event and the cause of the delay and so takes into account a set of crisis-related hypothesis. Each hypothesis may be assessed in a probabilistic way from the knowledge. Further, the state of reasoning process is updated dynamically, according to the new reports coming from users that witness the event (Figure 2). The new observations are assumed to increase or decrease the confidence of any of the hypothesis taken into account. Every hypothesis triggers some scripts, anticipating the future behavior of the user. In case of a bomb explosion specific area will be blocked so that no new users enter the dangerous area. Users in the dangerous area are routed outside. So users are not only routed to their destination in an optimal way but sometimes the destination is adapted or changed completely.

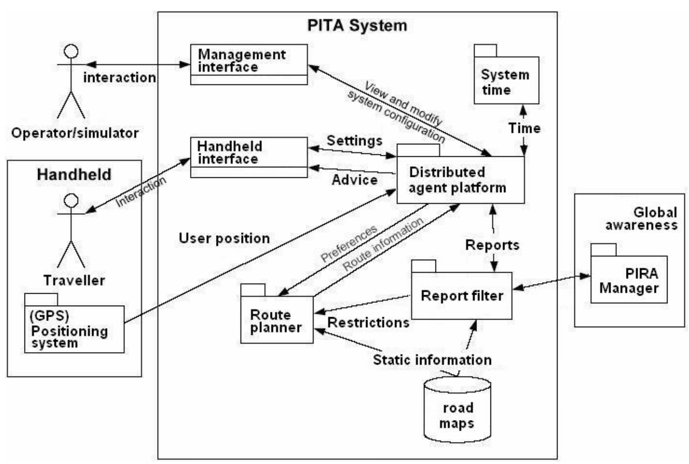


Figure 2. The use case diagram

In crisis events, such as natural disasters, technology failures, aviation accidents, and acts of terrorism, a global infrastructure breakdown is inevitable. The intelligent system would construct an internal representation of the crisis situation related to the environmental world and based on that it would give the users the help for avoiding dangerous actions and eventually to escape. The internal knowledge of the system is created based on various incoming notifications. On one way, the users that are in the crisis context would report about what is actually happening in the area. By using hand-held computers, they are able to use iconic messages for reporting details of a given crisis event and also some specifications related to that i.e. the magnitude of the fire, location, how many

people were affected of that. One challenging task is to provide the system with such a mechanism so as to automatically filter the irrelevant or infidelity reports of a certain crisis event. That comes from the fact that these kind of reports are based on human observations and these tend to be rather subjective or incomplete. These qualifications may also come from the fact that usually common users don't have a proper instruction to help them to mainly report the essential items of a crisis observation. As examples, suppose that there is a fire in one building.
The fire can be seen by users that are in different locations i.e. streets, and depending on that, observations relate to different human perceptions. Another case is when user handhelds have different time settings and time labels do not match among observations. Finally users are located on different positions and view the crisis from different view-points and angles.

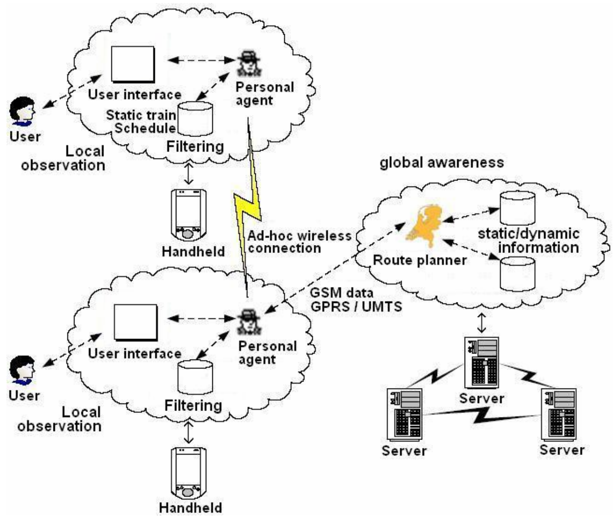


Figure 3. The system components' interconnections

An accurate representation of the event may only be created by fusing all the incoming reports. In this way, the ambiguity of individual reports can be solved. Information can be completed and errors can be removed. It occurs when people can not estimate exactly the parameters that relate the crisis event. One example is when the exact location of the event is reported with some errors. The people can see the event from different locations, and they may have quite different representations of that.

A second type of crisis event reporting would come from the observation of qualified people, as firemen, policemen or medical personnel. While handling the incompleteness and ambiguity of crisis reports, the intelligent system has to take into account the source of each report. As concerning the common users, the system has to analyse also their user profiles. This measure is assumed to handle the objectivity of the human observers. In the same manner, the reports whose source relate to qualified personnel, would have to have a high priority on determining the properties of one crisis event for the internal representation of the system.

Currently, the reasoning process that works on fusing distinct observations relies on a rule-based system. Specific rules are considered for estimating the correct status of the crisis event. Ongoing work is aimed at enhancing this process with a probabilistic approach based on Bayesian Belief Networks. The system relies on an internal representation for further making any decisions to minimize the costs of the crisis event. In the case of common users, that implies to give advices to the people to escape from the dangerous area. In the case of qualified personnel, it means to direct each type of individual to the most important location i.e. the fire-fighters to the source of the fire that, if not put out, would possible cause other explosions, the paramedics to the wounded and the police to secure the area. The system is designed to help people in crisis contexts. The system feedback is given to the users on their hand-held applications (Figure 3). However, there are some cases when more informational media are available. More than that, assuming that the user handheld is out of battery or there is no connection to the local or global ad-hoc network, the system is not able to guide the user by using handheld interface. There may be still possible to reach the user by using other modalities, as mobile phones, road panels or other emergency devices.

The research is ongoing for determining the optimal modalities for communication and for finding formatting mechanisms to automatically convert between different media devices. The context-awareness system has information related to each of its users. That is useful for presenting the system response according to user availability and preferences. Further, information related to each user can be used during the process of solving the report ambiguity.

# 5 Dynamic Routing

## 5.1 Routing problem

One of the main services offered by the system is dynamic routing (Rothkrantz, 2004), (Tatomir, 2004). For that the system needs information about the current state of the traffic. That information can be for example the load of the parts of the network but a more direct and therefore more practical type of information is the time it takes to cover a road. Vehicles send information about their covered route to the system: the time necessary to cover it, accidents or other events they met in their way (see Figure 4). From that information the system computes the traveling-times for all roads and stores it in the memory. The route finding system uses this information to compute the shortest paths for the vehicles.

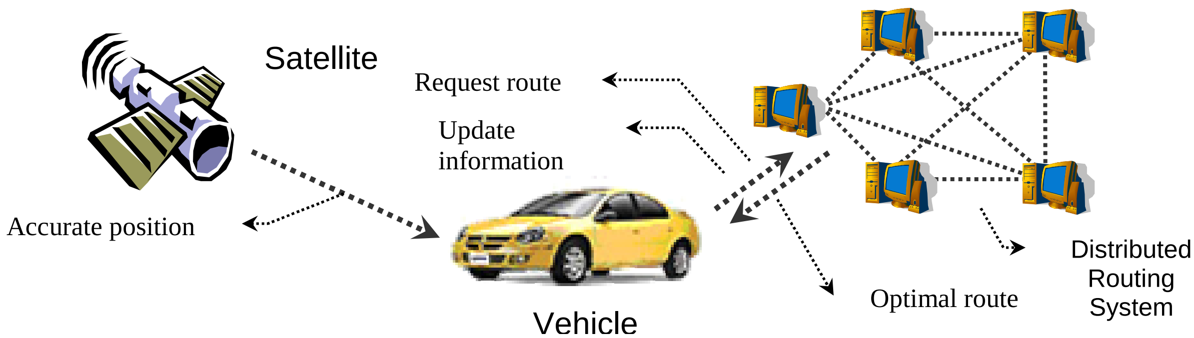


**Figure 4:** Communication with the system

## 5.2 Ant-based control

The Routing system uses an Ant Based Control algorithm (Di Caro & Dorigo, 1997). The algorithm was inspired by the emergent behaviour of natural and was applied with success to solve the routing problem in packet switched networks. We applied this idea to our traffic network, i.e. the composition of the roads and their intersections (see Figure 5). This network is represented by a directed graph. Each node in the graph corresponds to an intersection. The links between them are the roads.

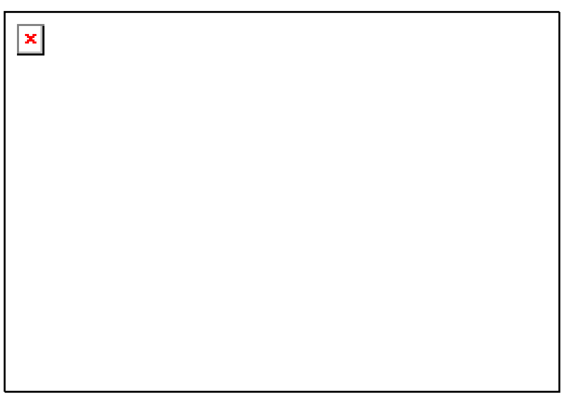

**Figure 5:** Example traffic network

**Table 1:** Routing table in node 7

| | **Next Neighbor** | | | |
|---|---|---|---|---|
| **Destination** | **2** | **6** | **8** | **12** |
| **1** | 0.51 | 0.45 | 0.02 | 0.02 |
| **…** | … | … | … | … |
| **6** | 0.03 | 0.93 | 0.01 | 0.03 |
| **8** | 0.04 | 0.01 | 0.92 | 0.03 |
| **…** | … | … | … | … |
| **20** | 0.02 | 0.07 | 0.43 | 0.48 |

Routing is determined through complex interactions of network exploration agents. The behavior of these agents is modeled on the trail-laying abilities of natural ants. The agents move across this virtual network between randomly chosen pairs of nodes. They are divided into two classes, the forward ants and the backward ants. The idea behind this subdivision of agents is to allow the backward ants to utilize the useful information gathered by the forward ants on their trip from source to destination.

As the forward ants move, pheromone is deposited as a function of the time of their journey. That time is influenced by the congestion encountered on their journey. They select their path at each intermediate node according to the distribution of the simulated pheromone at each node. Each node in the network has a probability

table for every possible final destination (see Table 1). The tables have entries for each neighbouring node that can be reached via one connecting link. The probabilities influence the agent's selection of the next node in their journey to the destination node. The probability tables only contain local information and no global information on the best routes. Each time an agent visits a node the next step in the route is determined. This process is repeated until the agent reaches its destination. Thus, the entire route from a source node to a destination node is not determined beforehand. Agents are launched at each node with regular time intervals with a random destination node. Once the destination is reached, a backward ant inherits the data collected by the forward ant and uses it to update the routing tables of the nodes. Based on this principle, no node routing updates are performed by the forward ants, whose only purpose in life is to report network delay conditions to the backward ants.
The backward ants update the probabilities for the destination entry $d$, with a reinforcement value. This is a function of the time $T$, the ant computed and its mean value $\mu$.

$$r = \begin{cases} \frac{T}{c\mu}; \frac{T}{c\mu} < 1, c > 1 \\ 1, otherwise \end{cases}$$

$$P_{dj}^{'} = P_{dj} + (1-r)(1-P_{dj}) \text{, if } j = n \text{ the next node chosen by the ant}$$

$$P_{dj}^{'} = P_{dj} - (1-r)(1-P_{dj}) \text{, for } j \neq n$$

The Routing system computes the optimal path for the vehicles choosing, all the time as next intersection, the one with the higher entry in the probability table.

## 5.3 Escape

Another service provided by the system is escaping from a dangerous area. The goal is to route the traffic as soon as possible out of a certain zone via some safe exit points. The problem is similar with dynamic routing using multiple destinations which can be any of the exit points. A virtual node (**VNode**) is introduced in the ant network. It represents the collection of all exit points (see Figure 6). Each routing table will contain, for this virtual node, an entry as possible destination (see Table 2).

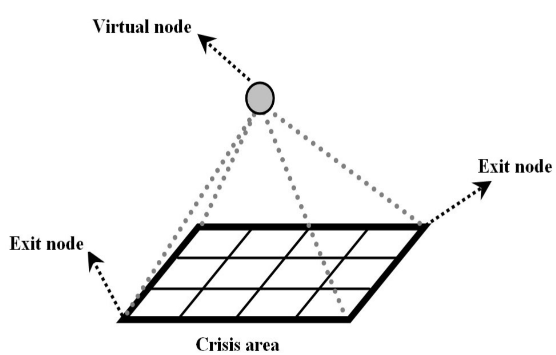


**Figure 6: Virtual node**

**Table 2:** Routing table with virtual node

| | Next Neighbor | | | |
|---|---|---|---|---|
| **Destination** | **2** | **6** | **8** | **12** |
| **1** | 0.51 | 0.45 | 0.02 | 0.02 |
| **…** | … | … | … | … |
| **6** | 0.03 | 0.93 | 0.01 | 0.03 |
| **8** | 0.04 | 0.01 | 0.92 | 0.03 |
| **…** | … | … | … | … |
| **20** | 0.02 | 0.07 | 0.43 | 0.48 |
| **VNode** | 0.48 | 0.45 | 0.04 | 0.03 |

All the traffic inside the crisis area will be evacuated. Each vehicle will have the virtual node as destination. In similar way can be solved the evacuation from a building. Instead of vehicles we will have people carrying PDA's connected to the escaping system.

# 6 Icon based-communication

In order to provide the system with any reports, the users have to use their personal handhelds. The reporting process has a natural interaction style and is based on a graphical user interface. They focus on the relevant description of the situation as good as possible. In order to avoid misinterpretations on describing a situation, the system must rely on some representation with high potential across language barriers. For example, assume that there are people that speak different languages in the crisis area. More precisely, it would be based on icons and other concepts from semiotics that have enough representational power. If the reporting process is based on natural language text, the users will only be able to report what they've just observed by using their native language. The system would have to deal with extracting the correct meaning from each report that is given in a different format depending on the each user.

## 6.1 Icon language

The use of icons to represent concepts or ideas makes user interaction on both user and system interfaces particularly suitable for fast interaction in language-independent contexts. The user handheld has an iconic interface that is designed for reporting a situation using a sequence of icons (Figure 7). A user can select a set of icons as a realization of his/her observations on a crisis situation i.e. accidents, fire, explosions, etc. The icons would be chosen as in a possible certain sequence forming a sentence (see Figure 8).

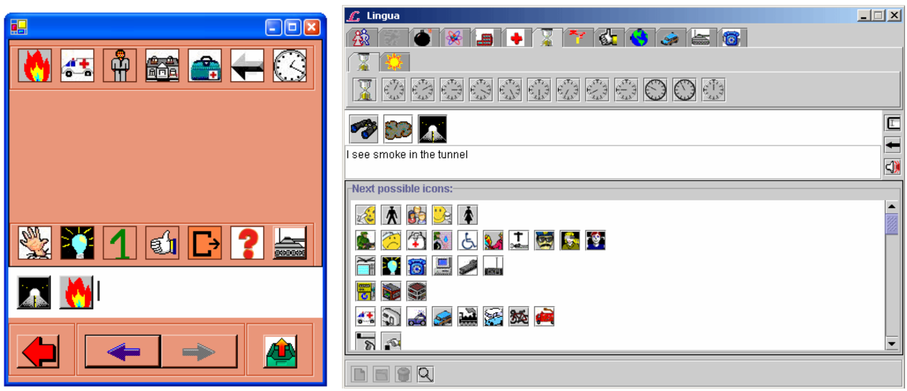


Figure 7. Two experimental interfaces for human-computer interaction. The examples show icon sequence-based reports having the messages: 'The tunnel is on flames' (left side) and 'I see smoke in the tunnel' (right side)

Each icon that composes an icon sentence is chosen according to some context-dependent metaphors. It represents important keywords of the message and so provides a portion of the semantic of the sentence. The iconic interface is able to send the observation reports to other user devices in the ad-hoc network. In the case of other users, the interface can also interpret the icon sequence and convert it into a human natural language text.

We notice that the interface is adapted to the user. Firemen, policemen and naive users are provided with an adapted set of icons.

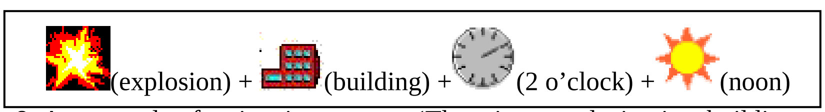


Figure 8. An example of an iconic sentence: 'There is an explosion in a building at 14.00'

The information regarding user profile has to be used to determine the language of the user. Currently, our system prototype can only translate the icon representation into English text messages. The translation is according to some grammar rules structured as a Backus-Naur-Form and English grammar. Each icon is grouped into categories, such as: nouns, pronouns, proper-nouns, verbs, adjectives, adverbs, prepositions, and quantifiers, to define terminal. A parser checks an input against the grammars. If the input is syntactically correct, seven slots are created: prefix (for question words), subject, infix (for a to-be, an auxiliary and a negation), verb, object, preposition, and suffix slot (for a question mark, an exclamation mark, or an archaic word, e.g. "please"). The position of the slots depends on the type of a sentence, for example: for a question sentence, the infix slot may be located between the prefix and the subject slot. After transforming the input into the slots, some extra rules are fired to complete the sentence. They specify conversion of an iconic sentence into a natural language sentence based on the semantic context of the iconic sentence. Some examples are rules for changing word's format, for adding prepositional, question words, an auxiliary verb, a to-be, or an article, etc.

The handheld devices running the application can form an ad-hoc local network. The system typically has a decentralized collaborative architecture. Though, there are cases when additional support is given by processing the evidence in a centralized way. Some of the handhelds may have connection to some other ad-hoc networks or to the

Internet. In these cases, one central component creates a global representation and the knowledge is used for fulfilling specific tasks. Such tasks may imply providing the user with a detailed map of the area or granting direct access to some crisis services.

Our developed iconic interfaces provide navigations for users around icons. We approached this by grouping related icons with the same set of concepts. Besides supporting a compact interface, this grouping is a powerful way to hint where an icon can be found. The reason is that the meaning of icons almost exists in the context of other icons. During icon selection, both interfaces also provide a distinctive appearance of a selected icon from the rest unselected icons. While creating an icon string, particularly, the interface provides a real time distinctive appearance of which icons can be selected according to syntactical grammar rules. Besides to prevent error, the interface also offers an opportunity to mobile users who cannot devote their full attention to operate the application. The design concept of both interfaces also supports a fast interaction by providing an icon prediction system. We adapted an n-gram word prediction technique, which estimate the probability of an icon string using Bayes rule:

$$P(s) = P(w_1, w_2, ..., w_n) = \prod_{i=1}^{n} P(w_i \mid w_1, ..., w_{i-1}) = \prod_{i=1}^{n} P(w_i \mid h_i)$$

,where $h_i$ is the relevant history when predicting $w_i$ (icon$_i$). It operates by generating a list of suggestions for possible icons. A user either chooses one of the suggestions or continues entering icons until the intended arrangement of icons appears. Besides to prevent error and improving the input speed, the interface also offers an opportunity to mobile users who cannot devote their full attention to operate the application. Our developed iconic interface collects the data from user selections during interactions.

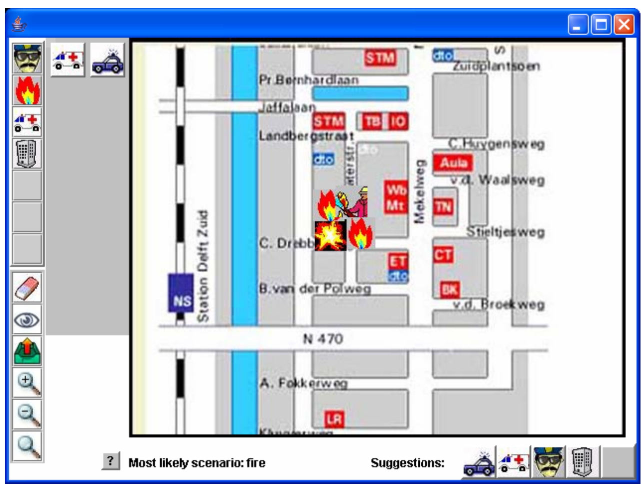

Figure 9. ISME interface

## 6.2 Icon map

Some people are used to describe their observations by sketching on a piece of paper to support their verbal explanation. Bringing this idea to an iconic interface, we developed Icon-based System for Managing Emergencies (ISME) on a PDA (Figure 9). A user can report about a crisis situation by placing icons on a map where the event occurs. The iconic interface creates a scenario that describes situations on the map and sends it to a collaborative information system for further processing.

The system is able to fuse observations from different users, remote in space and time. The system keeps track of the current world model and this information is sent as a feedback to the user. The meaning of an individual icon in this interface also represents a word or a phrase. To provide extra information, each icon also has some attributes. For example: the icon “explosion” has three attributes: status (e.g. under control, danger), size (e.g. small, big), and intensity (e.g. low, high). We notice that the system is again adapted to the user. Given the location of the user, the user will receive an adaptive part of the work so that he can report about events occurring in front of him.

# 7 Conclusions

The current paper proposes a new approach of an intelligent context-awareness system for handling crisis situations. It shows a tremendous potential of minimizing the costs of destruction when thinking to memorial and dramatic events that have happened in the near past. Such systems may improve the efficiency of rescue operations and implicitly can lead to saving lives. The main goal is to build mechanisms for assessing the real crisis situations as well as possible and to offer easy and effective interfaces for human computer interaction. The system interfaces are usability oriented and do not require prior knowledge of usage from the user.

The observers are able to report facts about events by using graphical interfaces. An efficient modality is based on iconic representation. Further on, additional research is set to create graphical interfaces to give users the option to draw sketches related to the concepts they want to report directly on their handheld device. The idea is to give users more modalities of representing their observations according to their preference. Such interfaces would allow input of text, graphical representations and signs.

A user test was performed to assess whether users are capable to describe situations solely using a spatial arrangement of icons. This test also addressed usability issues of system interfaces. From the results, it appeared that our target users were able to express their concept and ideas in mind using icons on the interfaces. The results also indicated that our target users still had problems in finding their desired icons. Some of the reasons were referring to problems in recognizing some icons. Other reasons were related to: (1) adaptation time; (2) the cognitive process to find more relevant concept to represent their message; and (3) due to limited provided icons, which made the user should have rethought another concept that could fit with the problem domain.

Ultimate endeavours target to system interfaces that are able to assess the user's emotional state by transparently analysing the input he/she gives to the system. That can be done by extracting specific features as voice tonality and inflexions or trembling of writing or drawing. Beside the user profile knowledge, the information can be very precious when trying to solve the ambiguity-related problem. The final intelligent system would be capable of converting subjective observations into objective facts about some crisis situation.

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