

HERMES (sHort EmERgency Medical Summary)

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Abstract

The project involves the implementation of a prototype to test the use of mobiles phones by medical emergency teams, to obtain, on the spot, life-saving information on the patient they are treating.

Introduction

The project consists of implementing a system through which medical emergency services can obtain on their mobile phones a brief medical summary of the persons they are looking after. This summary will include the most important points of the patient's clinical record so the emergency services can have access to all the necessary information from the very beginning.

HERMES takes advantage of nowadays SIM cards' possibilities to supply healthcare emergency services with vital information about their patients, to enable them to act promptly and accurately to give them the most appropriate treatment.

While solving this specific problem, HERMES also creates a unique opportunity for operators and service providers to participate in a project with a very important image benefit, and to get in touch with big interesting customers: healthcare providers.

1.0 The problem

Healthcare emergency services that provide the first aid have to act on the spot to preserve the lives of their patients and prepare them to be taken to the hospital. These situations often involve taking important decisions in a very short time with very little information. Because of the importance of the results, it would be very beneficial for this decision-taking process to have access to the patients' medical records.

However, emergency services don't have patients' records immediately available. The need to act quickly makes it very difficult to take this information with them, even the life-saving

information that is already present in the clinical history. This vital information includes blood group, possible allergies, medicines the victim might be currently taking, previous serious illnesses, etc. With this information emergency services would be able to start the appropriate treatment right from the beginning.

That is the situation that HERMES corrects, as it brings this brief summary of the patient's clinical history in the hands of the emergency services, right where it is needed.

2.0 The solution

As a solution to this problem an architecture that uses the mobiles phones, specifically their SIM cards, to bring the essential information to the spot is proposed. This information has the form of brief medical summaries of the patients' clinical records, which include the most important points, enough for the emergency services to start with the most suitable treatment.

Given their availability and possibilities, mobile phones can act as non-expensive, flexible clients devices to allow healthcare emergency services to access these summaries on the spot or while travelling. Furthermore, modern SIM cards' unique possibilities allow for the implementation of a flexible and secure implement the flexibility and security system. To do so, HERMES relies on a server in charge of obtaining the information about the patients and sending it to the emergency services, while keeping record of all the transactions and preventing unauthorised access.

Simply put, using the HERMES architecture the right people can be connected with the right information when it is most needed, to help save lives

3.0 Project Description

3.1 The proposed system

To illustrate how HERMES works, the system workflow is examined:

1. A situation where medical emergency services are required occurs. For example, a car crash, a heart attack...
2. The *emergency services control centre* is notified and the patients involved are identified. The person reporting the emergency (a policeman, a member of the emergency services...) can do this following the usual procedure. Then, the *control centre* introduces the emergency data in the system and it also identifies the members of the emergency teams that will take care of the situation.
3. While travelling to the emergency location, the authorised members of the healthcare services can already access the emergency and patients' data (the summaries) in order to prepare their material and get ready.
4. On the spot, the emergency teams can use this information to provide better care to their patients. They can also contact the control centre to add more patients to the emergency, because they have been now identified, or to require more members to be authorised to access the emergency data.
5. Once the situation is solved, the control centre declares the emergency to be closed, and all the patients' data is removed from the mobile devices, as no further access is permitted.
6. All the transactions and communications in the system are logged and monitored to provide the security and confidentiality levels required, as medical information is considered of the highest sensitivity.

As it can be seen, HERMES will act as an add-on to the service already provided, so it doesn't interfere with the current workflow but it provides an added value.

3.2 Architecture

In order to provide this service, proposed architecture identifies the following key elements:

1. **HERMES applet:** This SIM card applet is in charge of providing access to the medical summaries to authorised members of the emergency teams. It is the emergency teams' members interface to the system.
2. **HERMES OTA application:** It acts as a proxy between the applet and the HERMES kernel, handling the communication between these two elements. It receives the SMS messages

from the applet and translates them into action requests to the kernel. Then it receives the answer from the kernel and translates it into SMS messages to be sent to the applet.

3. **HERMES Control Centre Monitor:** It is the emergencies Control Centre interface to the system, through which it can enter/close emergencies, assign emergency units to the different emergencies, and send them summaries... All these commands are sent to the kernel, which performs them and gives back an appropriate response.
4. **HERMES kernel:** It is the central application that implements the business logic of the HERMES system. It is in charge of two main tasks: First, to communicate with the external Healthcare Information Systems to gather the necessary information about the patients to be able to produce the medical summaries. Second, to answer the requests from the OTA application and the Control Centre Monitor and act appropriately. To perform its job, it uses a database where it stores and retrieves all the necessary data.
5. **HERMES database:** The repository of information of the HERMES system, it stores all the data about the emergencies, the emergency units, the summaries that have been sent, permissions given... and everything that is necessary for HERMES to function properly.
6. **External Healthcare Information Systems (HIS):** These are the sources of information to create the brief medical summaries used within HERMES. They could be part of the public health service, private medical insurance companies or any healthcare provider that has reached an agreement to use HERMES as an added value of its services. As these different systems will be heterogeneous, a common standard interface, using XML for example, would be developed to facilitate the interchange of information.

All the communications architecture is based upon XML, so all the implementations of the different parts can be easily modified without affecting the overall system.

The overall architecture is shown in Figure 1:

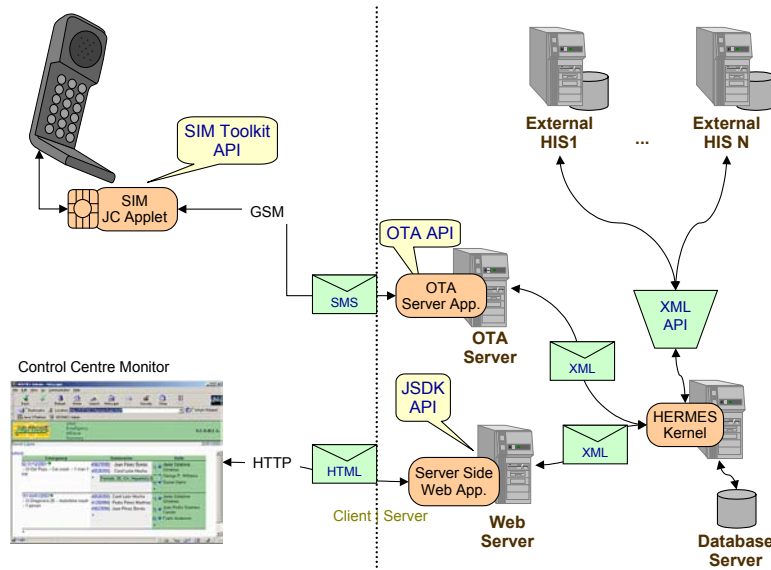


Figure 1: HERMES Architecture

3.3 Key features of the HERMES system

There are several features of the project that warrant attention:

- HERMES will help emergency services to save lives, and if there are goals that really deserve to be pursued, this is one of them.
- It is not a very complex system; hence it does not need a very large investment to get it up and running.
- In spite of its simplicity, it can be a first step in the ever-complex world of telemedicine. Therefore with HERMES a relatively simple but feasible service can be started, which can precede other more complex services, once it has proven itself and when new technologies arise (GPRS, UMTS).

3.4 Possible difficulties and their solutions

Even though the system is feasible and can be technically implemented, there are some hidden difficulties that need to be:

- **Identification of the patient:** One of the key points in the HERMES system is the identification of the patients, to enable the processing of the summaries of their medical records to the emergency services. However, depending on the situation it could be very difficult, or impossible, to find out the identity of a person being involved in an emergency situation. In this case, the HERMES system won't be able to help. Nevertheless, this is not a failure in the HERMES system, as it would be impossible for any kind of system to provide any information about a patient

that has not been identified. There are some ways to try to diminish the number of cases where this situation occurs, and they are mentioned in the *Future Enhancements* section.

- **Accessing the patient medical record:** The other critical point in the HERMES system is accessing the patients' brief medical summaries. The problem in this case is that it depends greatly on the situation of the Healthcare Information Services: In places where these services don't exist or lack information, HERMES wouldn't be able to help much. Again, this is not a failure of the HERMES architecture but an external situation that can affect its functioning. In this case, it wouldn't be advisable to start the HERMES service in a community where some minimum services are not implemented that can feed HERMES with enough information to be useful. Another solution would be to include HERMES as an added value inside a bigger agreement to implement such services where they are not already present.

3.5 Applicability

Taking into account the possible difficulties already mentioned, HERMES can be considered a service that could be successfully implemented. Some of the reasons why this may be so are listed below:

- It has a marketing appeal to operators and services providers due to its social implications.
- The general public may feel more "secure" in the event of being a patient.

- Governments are increasingly taking part in the world of telemedicine.

3.6 How to start such a service

In order to start HERMES, a steady path, that would include the following key steps, is recommended:

1. An operator and a service provider should be contacted to create the technologic foundation of the system. A first version of HERMES would then be implemented by the service provider and tested with the operator's cards and mobile devices.
2. An appropriate location with the required health information services (*see possible difficulties*) should be chosen to start the field tests. This location should be of the appropriate size and complexity, to allow for significant results to be obtained and analysed extracted. The impact of the operator on this area should also be taken into account when choosing the location, as it would require and adequate service to be provided during the tests.
3. Healthcare providers and emergency services of the area would then be contacted to invite them to participate in the system. It would probably be a good idea to start with the public services, as they would probably be more attracted by the social impact and usefulness of the system. Once the system has been well established, private healthcare providers would then more easily attracted, as they could offer it as an added value to their own services.
4. HERMES would then be tested in the chosen location and the results would then be used to further refine it, in order to provider a better service.
5. Once HERMES is ready, there are several possibilities that could be studied. One option would be to replicate the already tested system in more and more locations, thus spreading it through different regions. Other options might include trying to bring it to a different level and set HERMES as a basic public service, at a national (or international) level. This action would involve negotiating with the appropriate parties to create the necessary infrastructure to support it. In spite of its complexity, there's no need to mention all the business opportunities that this option would imply.

4.0 Implementation

After discussing the evolution and possibilities of HERMES, the work carried out to set up the test bed is discussed.

4.1 Scope of the prototype

The aim of the prototype is to test the system's feasibility and to create a prototype to show how HERMES would work. In this regard, what has been implemented is a real system with a "real" database underneath, to test the workflow of the system. Although the development of a system as close to the reality as possible was desired, two limitations have been introduced:

- The tests were not conducted on real mobile phones because this required the use of real SIM cards that would not be provided by an operator. However, this is not a very important limitation, as the simulators were good enough to allow for testing the parameters required. When transitioning to a real system, some minor modifications would probably need to be introduced to cope with the differences between the simulators and the real world.
- The system was not implemented with an external HIS because the sensitivity of real medical data. However, a mock implementation of a healthcare provider information system in the same database that we used for the HERMES prototype was created. As all the external HIS would be contacted through a standard API, once the standard is developed, connecting another HIS would require no extra work.

4.2 Prototype implementation

The implementation of the prototype was completely successful and all the elements that needed to be tested could be tested. Below we describe the implementation of each of the key elements:

1. **HERMES applet:** It was developed using the JavaCard standard and the SIM Toolkit interface. It provides a series of menus to access the emergencies and summaries authorised for the user of that SIM card. These menus are built dynamically depending on the responses sent from the HERMES kernel.
2. **HERMES OTA application:** Developed in Java using the OTA API, it communicates with the HERMES kernel using a self-developed XML library. As an implementation note, its design, which models a finite automata to keep the state of the communications with each ME, is very elegant and easily extensible, making

its maintenance and debugging very simple.

3. **HERMES Control Centre Monitor:** The Control Centre interface to the system was developed as an HTML server side application, using PLSQL-generated XML and XSLT sheets. This way the monitor can be accessed from any kind of computer with just the requirement of having a web browser. It also uses our self-developed XML library.
4. **HERMES kernel:** The core business logic of the system was developed using PLSQL, which in turn generates the XML that is sent to the different applications.
5. **HERMES database:** The chosen system uses an Oracle database, upon which the appropriate tables were created to maintain the necessary data.
6. **External Healthcare Information Systems (HIS):** As mentioned previously, one mock HIS was created inside the same HERMES database for the purpose of the tests.

5.3 Work accomplished

From the functionality point of view, all goals were fulfilled. These include the following features:

- New emergencies can be created through the Control Centre monitor and their data introduced in the database.
- Patients can be identified and their summaries added to the emergencies. The summaries are created automatically from the data extracted from the mock HIS.
- Emergency members, also called units, can be assigned to emergencies, giving them access to the summaries of the specified emergencies.
- Using the mobile phone technology, emergency units list the emergencies where they have been authorised, and they can also retrieve their data. Once they choose an emergency, they can also list their summaries and see their data.
- All the movements of an emergency unit (login, logout, summary access...) are traced and reflected at the Control Centre Monitor.

From the users' point of view, the system has been discussed and showed to a limited number of members of the healthcare community, obtaining a very positive feedback. Further feedback to refine and improve the system is being collected

5.4 Problems encountered

During the implementation of the prototype, no special problems during development were encountered. There were some minor bugs of the tools that were easily worked around. The greatest challenge, during the test phase, was the inability to use a real mobile phone and a real OTA server, to perform a life demonstration.

6.0 Future enhancements

HERMES is not only a service that could be turned into a reality right now, but it could be further enhanced to improve its value.

Some of the improvements that could be are:

- Small mobile devices for fingerprint or retina recognition could be attached to HERMES enabled mobiles to automatically identify the patients present in an emergency. This way the accuracy of the identification process would be greatly improved, as it would be done automatically within the same system. Other authorised personnel, as policemen, firemen... could also perform this identification
- Small printers could also be connected to HERMES enabled mobiles in order to print the summaries into small stickers that would then be stuck to small bracelets and attached to each patient. Thus avoiding confusion between the patients and their summaries and it would also help the people receiving the patient at the hospital, as they would be able to see the information immediately.
- Multimedia enabled mobile devices could use the same systemthe same system could be used to access more sophisticated data, as laboratory results, small medical images...

6.1 Conclusions

HERMES is a system designed to take advantage of modern mobile technology and SIM cards in order to help emergency services perform their job, which means saving lives. This would not only benefit patients, which is a very important goal, but it will also benefit all the parties involved in the system due to its social impact.

At the same time, HERMES does not only present an opportunity for the present, as the first step into the telemedicine world, but it also offers a promising future when the system and the technology evolve.

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