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Use of TETRA Networks in Crisis Situations for Health Information Transfer Strategies

A. Lazakidou, A. Ioannou, K. Ioannou and F. Kitsios

ABSTRACT

Telecommunications have been evolved dramatically during the last ten years, laying solid foundation for the next generation of Web Technologies and ultimate automated information cyberspace. As a result of this evolution and the users' demands, the current efforts of the researchers, in the areas of Health Information Transfer in Crisis Situations, promotes formation of inter-disciplinary international teams of experts, in order to create a new generation of technologies which will facilitate the future health information systems. The TETRA network can enable existing information and resources to be extended out to the point of care, helping medical professionals deliver top medical care in a more timely and efficient manner. In medicine, time savings equals hospital savings. The objective of this paper is to study how simply a medical specialist can collect physiological data from mobile-remote patients and how reliably health information can be transferred from emergency places to hospitals through TETRA.

Keywords: Health information transfer, Tetra Network, Crisis situations, Quality of Services, Strategies

INTRODUCTION

Rapid advances in information technology and wireless communications are leading to the emergence of a new type of information infrastructure that has the potential of supporting an array of advanced services for healthcare.

One of the critical points for the Quality of Services (QoS) in mobile communications systems, which are used in modern health information transfer, is the dynamic channel – frequency management scheme for mobile communications systems that supports services in ubiquitous communications infrastructures for future technologies (Ioannou et al., 2003; Ioannou, Panoutsopoulos, & Kotsopoulos, 2006). The future demands of mobile communications and health services will require complex computing and communications infrastructures (Ioannou et al., 2004; Dimitriadou, Ioannou, Panoutsopoulos, Mougiakakou, Stavroulakis & Kotsopoulos, 2005; Ioannou, Dimitriadou, Ioannou, Panoutsopoulos, Garmpis & Kotsopoulos, 2006; Ioannou, Dimitriadou, Ioannou, Panoutsopoulos & Kotsopoulos, 2006).

According to all the mentioned above parameters, it is evident that mobile communication systems experience a rapid increase in the number of subscribers, which places extra demands on their health services and capacity. This growth rate increases the demand of the involved reliable and efficient operations. In terms of mobile communications, this growth leads to a new network architecture where the cells are designed to be increasingly smaller. The most serious problem that arises in this architecture is the handoff issue, which occurs when a mobile user moves from one microcell to a neighbouring one. This problem becomes more serious for high

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speed moving terminals, where the handoff rate increases and the probability that an ongoing call will be dropped, due to the lack of a free traffic channel is high.
Today's healthcare professionals need to be connected to the network always. Continuous connectivity is the watchword of these demanding users, who need to communicate over the network seamlessly and stay connected everywhere in emergency cases as health information transfers. TETRA technology provides several ways of protecting the privacy and security of communication, such as authentication, air interface encryption and end-to-end encryption (Stavroulakis & Ioannou, 2007; Dimitriadou, Ioannou, Panoutsopoulos, Garmpis & Kotsopoulos, 2005; Stavroulakis, Ioannou & Panoutsopoulos, 2007).
Using a TETRA network can benefit not only ambulance crews, but also medical personnel at remote locations. Even though doctors are rarely present in ambulances, they can use the transmitted medical data to make a formal diagnosis, enabling treatment to be started and saving several critical minutes before arrival at the hospital. The objective of this research is to study how simply a healthcare professional collect physiological data from mobile and/or remote patients can and how securely and reliably health information can be transferred from emergency places to hospitals through a TETRA network.

HEALTH INFORMATION TRANSFER

High quality health care requires individuals to share sensitive personal information with their doctors and other healthcare professionals. This information is necessary to make the most accurate diagnoses and provide the best treatment. It may be shared with others, such as insurance companies, pharmacies, researchers, and employers, for many reasons. If patients are not confident that this information will be kept confidential, they will not be forthright and reveal accurate and complete information. If healthcare providers are not confident that the organization that is responsible for the healthcare record will keep it confidential they will limit what patients add to the record. Either of these actions is likely to result in inferior healthcare. The privacy and security of personal health information has become a major public concern.

TETRA Network

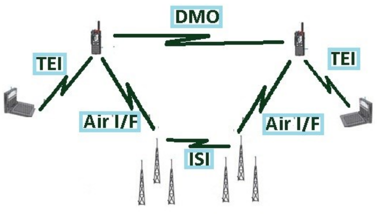

Fig. 1 TETRA Network

Terrestrial Trunked Radio (TETRA) comprises a suite of open digital trunked radio standards defined by the European Telecommunications Standards Institute (ETSI), in order to meet the needs and the demands of the most demanding of Professional Mobile Radio (PMR) users. TETRA is an Interoperability standard that allows equipment from multiple vendors to interoperate with each other. The digital coding and the rapid transmission enhance the sound quality and practically eliminate the problems with cracks and sound distortions. Contrary to analog networks, when using

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TETRA, one may address a voice connection to a single user or to a group of users. TETRA specifies the following essential interfaces:

- **Air Interface** ensures the interoperability of terminal equipment from different manufacturers.
- **Terminal Equipment Interface (TEI)** facilitates the independent development of mobile data applications.
- **Inter-System Interface (ISI)** allows the interconnection of TETRA networks from different manufacturers.
- **Direct Mode Operation (DMO)** guarantees communication between terminals also beyond network coverage.

Tetra Networks are completely secure. Network security is mainly important for organisations where the communication is secret. The network should ensure that one not belonging to the group is unable to listen to the communication but also unable to disturb the communication. It should also be impossible to follow a certain subscriber by tracing or recording the signalling on the control channel.

Also authentication that Tetra Networks specifies ensures that only mobiles with a valid key are able to use the network. In TETRA, authentication is done during the registration. The network rejects mobiles which return a wrong authentication key. In GSM, authentication is done during call set up and may be omitted during fast call set-up, Listening members in a group call are not authenticated in GSM ASCI since there is no uplink signalling during the call. This meansthat every mobile which has the group ID programmed to its SIM card, is able to listen to a group call. This is a high security threat for many PSS customers. In TETRA networks it is possible that the mobile authenticates the network. This mutual authentication enables the mobile to detect fake base stations, thus it will not register to base stations not belonging to the network. Pseudo mutual authentication is also possible by using dynamic authentication keys. In such case it is not possible for a fake network to authenticate a subscriber, since a new key is used for each registration.

Air Interface Encryption in Tetra Networks encrypts all signalling and call information on the radio path. Besides of the speech, it also encrypts the identities of the mobiles and the data messages on the control channel. This means that it is not possible to trace a mobile, for example, by following the signalling on the control channel. Air Interface Encryption is in use for both standards, GSM and TETRA. The TETRA algorithm uses longer keys and is supposed to be more secure than the one in GSM.

End-to-end encryption in Tetra Networks encrypts speech and data between the end-points of the communication. Encryption and decryption are done in the end-terminals. The network infrastructure offers a transparent transport layer which is supported by both technologies. Dynamic keys may be delivered to the terminals using SDS/SMS. Even though, end-to-end encryption completely protects against eavesdropping, it cannot encrypt signalling information. End-to-end encryption encrypts all information on the traffic channel but not on the control channel. Therefore end-to-end encryption has to be used in combination with Air Interface Encryption (Stavroulakis & Ioannou, 2007; Papadopoulos et al., 2011).

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The tremendous growth of the wireless/mobile users in mobile security networks, as tetra networks, coupled with the bandwidth requirements of multimedia applications requires efficient reuse of the scarce radio spectrum allocated to wireless/mobile communications. Efficient use of radio spectrum is also important from a cost-of-service point of view, where the number of base stations required to service a given geographical area is an important factor. A reduction in the number of base stations and hence a reduction in the cost-of-service can be achieved by more efficient reuse of the radio spectrum. The basic prohibiting factor in radio spectrum reuse is interference caused by the environment or other mobiles. Interference can be reduced by deploying efficient radio subsystems and by making use of channel assignment techniques. In the radio and transmission subsystems of TETRA Network, techniques such as deployment of time and space diversity systems, use of low noise filters and efficient equalizers, and deployment of efficient modulation schemes can be used to suppress interference and to extract the desired signal. However, co-channel interference caused by frequency reuse is the most restraining factor on the overall system capacity in the wireless networks and the main idea behind channel assignment algorithms is to make use of radio propagation path-loss characteristics in order to minimize the Carrier-to-interference ratio (CIR) and hence to increase the radio spectrum reuse efficiency.

The TETRA system can be improved to become an unique tool for security. One area of enhancement is the channel assignment methodology.

The most important aspect is that the advanced communication solutions have the potential to save more lives; the lives of the public and those who work for the emergency services. The new generation of communications is generally being implemented to support multi-agency operation, and include unique features demanded by emergency service users. Using a TETRA network, the authorities can benefit not only ambulance crews, but also medical personnel at remote locations. They can be sure that accurate patient diagnostic information is transmitted securely and reliably, allowing them to determine the correct treatment as soon as possible. Experts at the hospital can suggest proper treatment earlier, saving vital minutes. Knowing the history of the patient's condition on the way to the hospital will also cut delays when the patient arrives in the emergency room. The integration of data into the voice channel enhances the functionality of automated vehicle tracking systems and digitized mapping.

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the voice channel enhances the functionality of automated vehicle tracking systems and digitized mapping.

USE OF TETRA NETWORK FOR HEALTH INFORMATION TRANSFER

The TETRA network has many advantages over traditional analog communication systems. Digital coding and transmission greatly enhances the sound quality and practically eliminates the problems with cracks and sound distortions. Contrary to analog networks, when using TETRA, one may address a voice connection to a single user or to a group of users.

Another important feature of the TETRA network is the possibility to associate the connections with certain priority numbers so that the low-priority connections can be terminated in case the network is overloaded.

The most important aspect is that the advanced communication solutions have the potential to save more lives; the lives of the public and those who work for the emergency services. The new generation of communications has been designed specifically for the emergency services, are generally being implemented to support multi-agency operation, and include unique features demanded by emergency service users.

In crisis situations, every second counts. A life could be saved if a rescue crew can get an early, accurate diagnosis. Fast diagnosis could depend on being able to monitor and record the patient’s vital signs and transmit the data wirelessly to a medical expert for consultation.

Using a TETRA network, such a solution can be used to monitor and transmit hospital quality diagnostics to remote specialists. Experts at the hospital can suggest proper treatment earlier, saving vital minutes. Knowing the history of the patient’s condition during the trip to hospital will also cut delays when the patient arrives in the emergency room. The integration of data into the voice channel enhances the functionality of automated vehicle tracking systems and digitized mapping. Telemetry enables ambulance crews to transmit heart rhythms and other patient monitoring to hospital casualty units. Video enables also emergency units to view accident scenes remotely. Digitizing of the mobile network has the added benefit of improving the speed of traditional manual in-house processes such as: patient report forms, database management and vehicle management.

Wireless Healthcare

Fig. 2 Wireless Healthcare

The wireless networking for patient monitoring systems provide

- better process management,
- superior flexibility and
- increased efficiency.

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The healthcare services at

- home for patient monitoring
- rural health centers,
- ambulance vehicles,
- ships,
- trains and
- airplanes

are based on wireless technologies (figure 2).

CONCLUSION

According to the mentioned above, the health demands inspired the number of outstanding scientists and engineers in the past centuries to find new solutions to ease lives for all mankind. The emergence and accessibility of advanced data and telecommunications technologies combined with convergence of industry standards, as well as the convergence of data and telecommunications industries contribute towards the ubiquitous access to information resources via Internet. The future transportation environment and the next internet for the 21st century entered a new era of innovation and technological advancements (Papadopoulos et al., 2011; Kitsios et al., 2011; Angelopoulos et al., 2008; Lazakidou et al., 2011; Stavroulakis, 2007)
It is essential to continue in the developments of transport industry standards, communications technologies and health information transfers. Future efforts should be focused on designing intelligent transport and communication infrastructures especially in channel management schemes that will allow for optimal and instantaneous control.

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