# A REVIEW ON EFFECTIVENESS OF EMERGENCY TELECOMMUNICATION SYSTEMS IN IRAN

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## ABSTRACT

Emergency telecommunication systems play fundamental role in disaster risk management, before, during and after the crisis. In fact, any data about disasters and all the information about damages and casualties should be collected and transmitted through reliable telecommunication channels to relevant authorities in appropriate time, to be used for decision making and planning for providing necessary responses. Therefore, developing a comprehensive emergency telecommunication network and empowering the capacity of the existing systems should be considered as one of the DRM priorities in all countries subjected to natural hazards. Furthermore, resiliency of telecommunication services should be considered as one of the main goals for assuring proper data transmission at the time of disaster. In this line, besides of robustness of the physical instruments and redundancy in providing necessary services, it is essential to develop relevant telecommunication protocols for the time of crisis (such as ETSI in Europe) and to provide basic training to people and authorities for telecommunication after disasters. In addition, having appropriate autonomy in implementing the plans at the time of crisis is another requirement of reliable emergency telecommunication.

In this paper, having a look on the importance of telecommunication services in earthquake risk mitigation and management, the existing telecommunication system in Iran will be introduced and its shortages and problems to be used as emergency telecommunication system will be discussed. Then having a look on the similar systems in other countries, a proposal for improvement the existing conditions will be presented and discussed.

## INTRODUCTION

Developing a comprehensive emergency telecommunication and information network should be considered as one of the main priorities in disaster risk mitigation and management in all the countries subjected to earthquake or other natural hazards. For this purpose many items should be taken into consideration, some as follows:

- Providing redundancy in telecommunication services to be applicable at the time of crisis and emergency conditions;
- Ensuring proper network operation at the time of disaster;
- Providing physically resistance conditions against earthquake;
- Creating broad coverage of network services.

In this paper having a look on the international experiences to improve telecommunication systems to be used for the emergency conditions, the existing condition of available fixed and mobile systems in Iran

will be introduced. Then some strategies will be presented to improve the existing condition that can be used in Iran and other countries having similar challenges (Amini Hosseini et al., 2009).

## INTERNATIONAL EXPERIENCES IN EMERGENCY TELECOMMUNICATION

In Japan after the Great Hanshin-Awaji earthquake in Kobe, Japan (1995), due to disconnection of phone lines, emergency response operations encountered several difficulties. However, in that event, the main problems occurred were not due to damage of major communication equipment or buildings, but it was mainly because of the damages to non-structural elements (i.e. displacement of accessories such as batteries and cables). The network damages caused considerable delay in receiving the rescue services that in turn increased the earthquake damages and casualties. The results of that earthquake depicted the importance of developing emergency communications network. In Japan one of the most advanced telecommunication systems is now operational. This system is supported by many different elements (Figure 1).

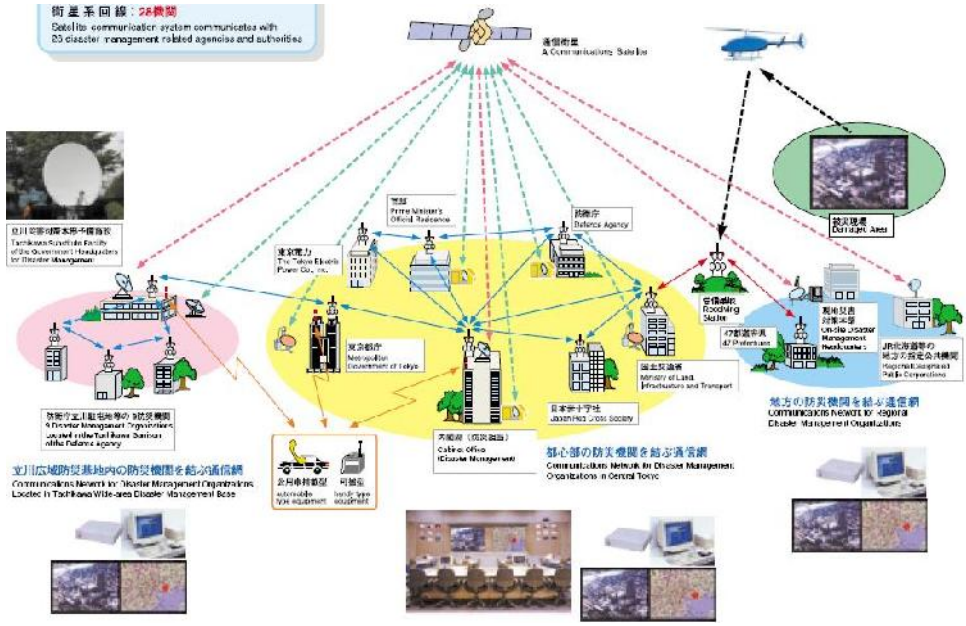

Figure 1. Emergency communication system in Tokyo

As show, currently a special emergency communications system for the time of disaster has been created to make connection between government agencies, fire organizations and disaster management headquarters at the local to provincial levels. The system has been developed by this assumption that the phone network in urban areas will be damaged by earthquake or interrupted by call traffic. As a result the contacts between the centers related to disaster management will not be possible through normal lines. In addition to this fixed system of communication network and hot lines for conversation or sending fax, some other means for sending video and audio information and data received by helicopter and patrol units at the level of the city is also in use now. Moreover, a satellite network between all the centers is available for emergency cases.

Emergency communications system in Europe is called EMTEL (Emergency Telecommunication). The system has different protocols for different levels and target groups. For example, to communicate with people in emergency conditions radio, television and the internet are in use while for communications between operational centers and disaster management teams (such as fire, emergency, civil defense, etc.) other equipments such as radio (wireless), satellite and mobile phones are in use. Besides of the hardware, there are also different standards for organizing emergency telecommunication including:

- TS 102 181 regarding the communication between officials in emergency response management (ETSI TS 102 181, 2008);
- Standard TR 102 182 regarding the communication between officials and people at the time of disaster (ETSI TR 102 182, 2006);

- Standard TR 102 410 regarding the communication between the people at the time of the disaster (ETSI TR 102 410, 2007);
- Standard TR 102 444 regarding emergency messages, SMS and CBS (ETSI TR 102 444, 2006);
- Standard TR 102 445 regarding the readiness and flexibility of network in crisis (ETSI TR 102 445, 2006).

Emergency telecommunication network was established in USA in 1962 due to crisis condition between that country and Cuba. After that, President Kennedy ordered established a special committee in the National Security Council to facilitate emergency telecommunication at the time of disasters. The system developed further later in 1984 and now is a part of US Department of Homeland Security, with 24 members from different agencies. The main responsibilities of this committee are the following:

- Providing professionals requirements for planning, implementing and maintenance of the telecommunication system in emergency situations;
- Conducting necessary studies, research, and assessments for improvement the effectiveness of telecommunication systems in emergency;
- Providing necessary guidelines and advices to related organizations;
- Participation in preparing and revising relevant policies, standards and laws;
- Monitoring programs in other countries and providing technical assistance to them.

## INTRODUCING IRAN'S TELECOMMUNICATION SYSTEM

Almost in all of the recent strong earthquakes in Iran, the telecommunication networks have failed to work aftermath and it caused significant delay in rescue and relief activities. Therefore, improving emergency telecommunication is one of the priorities in the county's DRM plans. Currently, the Ministry of Communications and Information Technology (IT) is the main responsible for telecommunication in Iran. In addition to this governmental body, there are some other private or semi-governmental companies in Iran that provide different services of telecommunication.

However, still there is only one company that provides fixed telephone lines to its subscribers. The infrastructures that are in use for such purpose include telephone set, switching equipment to be connected with subscribers, cable and radio transmission links. The key role of the public telecommunication service is to provide high quality voice and data telecommunication services to the general public throughout the country. Three hierarchical networks form the STD network, long distance calls, to/from province, are exist as shown in figure 2.

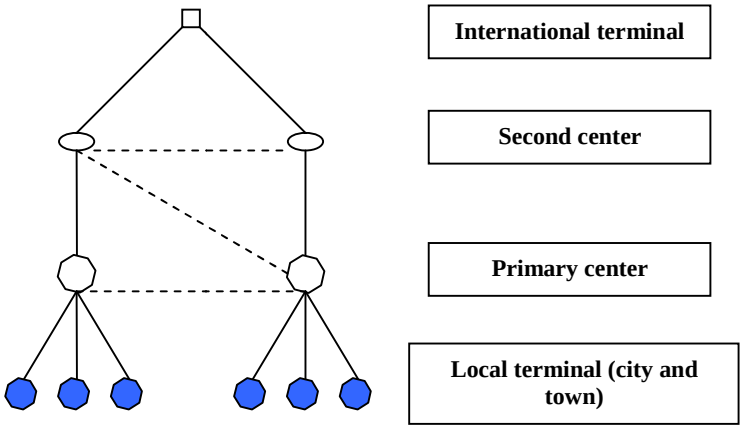


Figure 2. Standard telephone network system in Iran

The transfer of data in most cities is designed to form loops and multi-paths, both of which have high reliability and thus are less likely to systems failure at the same time. Regarding the switching system, phone network in major cities is generally in the form of multi-point or multi-stations (LS) and depending on the dimensions of cities there may be some local switching stations. Today, digital switching systems have replaced the older analog ones, but some analog devices may still active in local networks. Important is that most phone switching stations in city centers and commercial areas are usually vulnerable to seismic events. The capacity of switching stations, are between 40.000-90.000 lines, approximately.

At present, most of the cities are connected by optical fibers and microwave systems and at the same time, PMC cable and analog transmission system still exist in many cities. Underground cables often installed within ducts which are more resistant to earthquakes. The most vulnerable part of telecommunication network, is the access from main box in the central distribution building to the telephone communications subscribers (Figure 3):

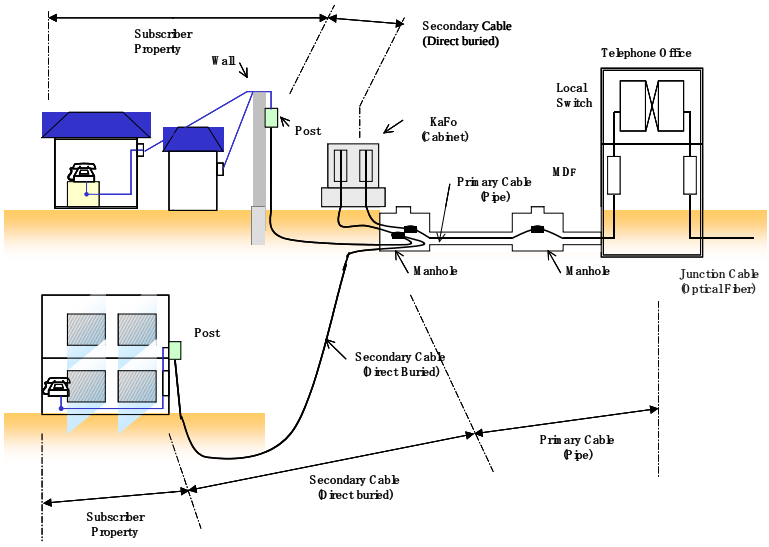


Figure 3. Subscribers' cable network (JICA and TDMMO, 2004)

The second biggest existing telecommunications system of the country is mobile phone network. The great advantage of this phone system is easy installation compared with the cable system that usually needs digging. The phone system can easily increase capacity to cover more subscribers. Mobile phone system in Iran is now active by two main suppliers one governmental (depending to Telecommunication Company of Iran) and second private (Irancell). However, recently third and fourth operators also have been added to them, having more limited subscribers.

There are generally four management and control sectors available in the GSM mobile system in Iran. BTS stations are installed within every 300-500 m radius in the cities, and they are monitored and controlled by the above master stations. It can be observed in site inspection that the antenna of mobile phone is fixed in various installation practices, which can be categorized into four types from the viewpoint of earthquake resistance. Each type is described as follows:

- Around 20 m guyed tower on the roof in the existing telephone building;
- Tower fixed to sidewall of roof in the existing telephone building (4-5 m above roof top);
- 20-30 m self-supporting tower and steel pole above the ground;
- About 10 m tower on the roof of private and other organizations' buildings.

Examples of antennas installed are shown in the Figure 4.

Figure 4. Fixed GSM antenna over the roof and tower

Besides of fixed and mobile phones, the satellite communications system is also available for disaster management in Iran. The necessary services are provided by some foreign companies (such as Thuraya and Inmar-sat) under supervision of Telecommunication Company of Iran. They now provide several ranges of services from mobile satellite phone to VSAT systems. Considering the relative safety of these equipments against earthquake, they are currently under consideration for such plans in DMS of Iran.

Despite of the indicated shortages in Iran's telecommunication systems, but there are some good experiences in Tehran for developing emergency telecommunication systems by using existing fixed and mobile networks supported by satellite systems. Figure 5 presents the proposed configuration of this system. The proposed system includes the following components:

1- Seismic Intensity Data Collection system that works permanently (24/7) to monitor seismic intensity data for an unexpected disaster outbreak. The seismic data is used for estimation of damage scale just after the outbreak to set up suitable organization for search and rescue operation immediately;

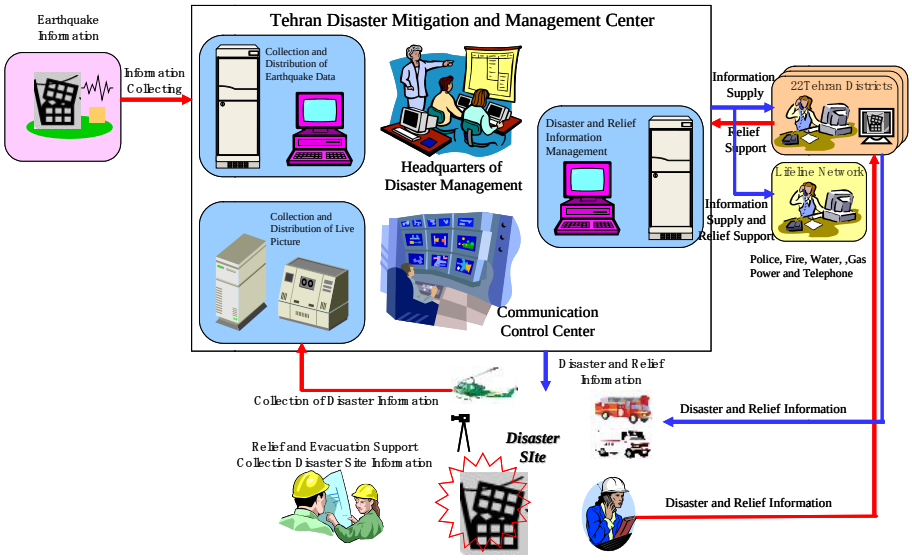


Figure 5. Emergency disaster communication network components (JICA and TDMMO, 2004)

2- Disaster and Rescue Information system to support search and rescue operation effectively, among relevant headquarters and all other associated organizations such as Government, Police, Fire department, Gas and Water companies and Red Crescent Society;
3- Voice Simultaneous Announcement system for transmitting of emergency instruction, such as damage level and evacuation information by speakers mounted on the tower or pole in each sub-district site.
4- Disaster Information systems for Communities Concerned to gather necessary information for community such as medical, lifeline (gas, water), and road condition in order to share the required information about what is happening around them

## CONCLUSIONS

According to what presented in this paper, the following strategies can be presented in order to secure telecommunication system of Iran to be operational at the time of crisis:

1- Empowerment of existing telecommunication networks: In order to improve the capability of existing systems for emergency conditions, at the first step the network vulnerability should be assessed at the local levels. According to the experiences gained from recent seismic events, earthquakes may cause the following damages to telecommunication systems:

- Power failure due to damages of power network, power generators, batteries, etc.;
- Damage to the racks, connections and insulators;
- Rupture of aerial cables.

In Iran since different institutions have responsibility for installation of telecommunication networks, some standards measures should be considered to reduce the potential damages that some of them are as follows:

- Some equipment is only placed on raised floor without support. It should be firmly fixed from concrete floor below to prevent the equipment from turning over;
- Tall equipment is only fixed at the bottom part. The equipment should be fixed at top part as well to prevent the equipment from its turning over;
- Precious measuring equipment and spare panels are only placed on movable rack. When earthquake occurs, the rack shakes and the precious equipment will fall down, so the rack and equipment should be fixed somewhere;
- The cable hole for cabling vertically on the floor is left open without cover. The hole should be covered in order not to spread fire as a chimney effect;
- DEG and Battery fixture in some stations is insufficient. A tighter fixture is required in the heavy equipment as well as the main telecommunication equipment;
- There are roughly four types of fixture practice for mobile antenna. Considering that Iran is an earthquake-prone country, the fixture method seems to be insufficient in several stations.

In addition to the above points, Telecommunication Company of Iran (TCI) should formulate its own standard manual of installation practice fully considering earthquake resistance. The installation finishing by several suppliers can be acceptable for TCI if done according to the manual thus contributing to upgrade quality of service. Supporting facilities such as DEG, battery and Rectifier as well as main telecommunication equipment should be also firmly fastened for earthquake resistance. Furthermore, transmission network should be formed in loop and/or multi-path configuration to provide more than one spare system. Finally, seismic diagnosis program of the existing buildings should be considered in this plan, and it is recommended to diagnose the telephone buildings as well.

2- Developing special emergency communication network: Strengthening existing telecommunication network needs special design, considerable cost and high volume of work and this procedure is time consuming and expensive. Moreover even after strengthening, the risk that the network goes down after strong earthquakes still may exist. Therefore to resolve this issue, a new network for disaster information and communication is necessary to be provided. Such network should be used to communicate the following information:

- The next possible earthquake or aftershocks;
- Health of family, relatives and friends;
- Details of the earthquake specification (such as the earthquake epicenter and intensity);
- The number of victims in each area that for them organizing search, rescue and relief teams are necessary;
- The closure of roads;
- Evacuation places and routes;
- How to provide food and water.

This type of communication should be organized and classified to be implemented without interruption of existing networks.

3- Evaluation of efficiency of different systems of emergency communication: General belief is that the radio systems in the disaster are much better and powerful than cable systems. In recent earthquakes no serious damages were observed in the radio networks existed in the affected areas. Therefore, selecting the radio communication for data transfer can be considered as a good solution in emergency communications. Of course selecting radio communications is depends on the local conditions and facilities that must be considered in advanced. So for selection any type of communication, the following advantages and disadvantages for each system should be considered:

a- Wireless radio systems: Systems based on radio (wireless) have several applications in normal condition among different institutions (such as police, military and so on). Although under normal circumstances, these systems can be appropriate for the information units, but suffer from the following weaknesses:

- Transmitter and receiver equipment located on the towers or buildings, only can receive and send data if the towers are earthquake resistant; while in most cases these facilities are not designed as earthquake-resistant structures;

- Infrastructure required for wireless systems in many affected areas are not available in advance (such as areas affected by Balakut earthquake in Pakistan). Therefore, the use of these systems is limited.

b- Mobile phone systems: Mobile phone services expanded rapidly in Iran. Selecting the system as a communication network in the disaster has the following advantages:

- If the adjacent relay station work, this system can continue to work if any other stations are failed;
- In damaged areas it is easy to install portable relay systems to establish the communication (as observed in Bam case);
- Mobile phones, due to wide distribution among residents and its size and weight can provide good assistances in disaster affected areas.

Of course, the disadvantages of this system were also discussed earlier (such as vulnerability of most installed antenna, shortages of its coverage, call traffic at the time of crisis, etc.).

c- Satellite systems: The advantages of satellite systems in cases of disaster are:

- Satellite antenna designed somehow that can resist against cyclones and the very strong winds. Thus, the possibility of overthrowing the antenna when the earthquake happens is very low;
- A satellite system can cover the whole country;
- Now the satellite phones are very small and portable by hand;
- At the same time several points can be in contact with the satellite;
- IP Based Technology for satellite communications can be used for data transfer, video, audio and so on;
- Data transmission speed via satellite can vary from 64 KB per second for terminal manual to more than 4 MB per second for portable VSAT antenna up to 40 MB per second for fixed systems.

The only problem of using satellite telecommunication systems are its cost and political limitation of using it in some countries. Figure 6 shows different satellite systems that can be used for emergency communications.

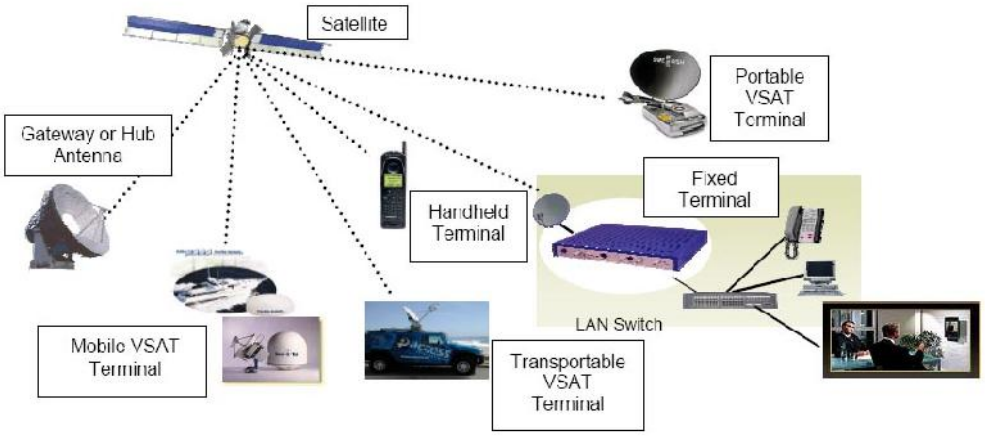


Figure 6. Types of satellite telecommunication systems applicable in emergencies

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