APPROACHES TO THE ORGANIZATION OF DISASTER-RESISTANT MOBILE NETWORK ARCHITECTURE IN UZBEKISTAN

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Abstract

Natural disasters and man-made disasters can negatively affect the operational efficiency of any technical system. In such cases, technical systems must be able to withstand possible adverse effects. This paper addresses several issues in creating an architecture that is resilient to natural disasters and man-made disasters.

Keywords: natural disaster, man-made disaster, mobile communication system, power supply, cloud technology, touch network, optical network.

Introduction

In recent years, many natural and man-made disasters have been observed in various parts of the world. Depending on the statistics of natural and man-made disasters over the years, the regions can be conditionally divided into levels of danger. It should be noted that no region of the world can be said to be completely free of such threats.

The Republic of Uzbekistan can be included in the category of areas where such threats are relatively rare. One of the largest natural disasters in the region to date has been the 1966 earthquake. From the natural and man-made disasters observed in different regions of the country in 2020, such as Syrdarya, Bukhara, Jizzakh, it can be concluded that the ability to predict when such natural phenomena will be observed is still incomplete. Therefore, all sectors of the economy must be ready for such processes. Because such processes can not only cause great damage to the state’s economy but, sadly, the panic that can be observed among the civilian population can lead to even greater losses. According to preliminary estimates, the man-made disaster in the Syrdarya region caused $150 million in damage to our economy. Of this, $1.3 million was directed to communication and communication systems, $6.8 million to the reconstruction of electricity networks.
The main part

According to the data, in 2014, the number of mobile devices exceeded the world’s population, and by 2019, the number of mobile devices reached 11.5 billion. In turn, in terms of these indicators, Uzbekistan does not lag behind world statistics. Data on this are shown in Figures 1 and 2.

Mobile communication systems provide the necessary services for our daily lives, which have great potential to help us in times of natural and man-made disasters. It is known that after such events, the need for communication and other information exchange services will increase more than ever.

Unfortunately, at a time when meeting these needs is a problem, there is no guarantee that any part of the communication infrastructure will fail. Because telecom operators and current telecommunications networks are not fully prepared for such high loads [13].

Energy efficiency planning based on renewable energy for the mobile network in the disaster zone.

It is known that the main and at the same time the weakest part of the communication infrastructure is related to this power supply. Much of the research on improving the viability of a mobile system is focused on improving the system’s energy efficiency, saving it, and providing renewable power supply. We also see renewable energy base stations as a solution with relatively stable service capability during natu-
eral disasters [1]. However, this solution has to solve several problems such as unstable power supply, complexity and cost of design, large areas required for equipment placement, and long-term optimization. It may not be possible to provide all base stations with renewable energy sources [3]. In such cases, it will be necessary to supply the required number of batteries to the base stations. Figure 3 shows the structure of renewable energy wireless networks.

Fig.3. The structure of wireless networks that run on renewable energy in the event of a natural disaster

Given that the majority of costs incurred by mobile operators are related to electricity consumption and the main cause of the observed network outages is unstable electricity, we propose the following energy-saving algorithm.

Fig.4. Renewable energy supply to neighboring base stations on a cost-effective basis
This unique approach can be applied in areas where the electricity sector is not perfect and can be further strengthened through the following research:

- Calculation of the maximum energy demand of the network through a scheme that takes into account the mode of energy collection to achieve an energy-saving result;
- Calculation of energy-saving result based on the maximum value, guaranteeing the maximum capacity of the network;
- Design of a single renewable energy source for adjacent base stations.

The architecture of communication networks built using cloud technologies.

This stable network architecture allows information and communication technology (ICT) services to be launched in a short period. It is also ensured by implementing the overall architecture of the communication network in a three-tier system during natural disasters, which physically and logically reduces sustainable and flexible ICT resources. As cloud processing operates as a parallel enhanced infrastructure, the proposed approach and network design can increase the efficiency of cloud computing services for developing countries and increase the reliability of ICT services during natural disasters [5,14].

Disaster response measures can be divided into two main categories.

1. Pre-disaster measures. To make the communication system more reliable and viable, there must be a strategy to deal with the frustrations caused by natural disasters. It is necessary to install a backup base station at points resistant to natural disasters in the city or various districts of the city [4]. Introduction of a signal transmission system to the base station when various events are monitored through various sensor sensors. All of these sensors communicate with a remotely defined station using a permanent hoc network [6,11]. They can separate the signal zone by MAC or IP address. Figure 6 shows the scenario concept before the natural disaster.
The following solutions should be implemented to increase the sustainability of the network before natural disasters [9,10].

A. Intra-network solutions.
- Continuous monitoring of the network connection.
- Manage communication channel blockages.

B. Offline solutions.
- Ensuring uninterrupted power supply.

2. Post-disaster measures. We assume that the events of this time, the communication network is organized in the above way.

Load balancing is an important element of any network, which should ensure a high level of availability when performing small tasks in traffic. In the event of a sudden increase in congestion, cloud technology is the best choice. Maximum calls are routed to the cloud layer, and all servers in the system can balance communication network elements and loads. It will also be possible to implement the following important features. First, existing connections will continue to get a good hoc. Second is the belief that new connections will be redirected to other nearby base stations that are less loaded. Finally, the residual life of the base station batteries in the area is significantly extended.

Restoration of the network after a natural disaster should perform the following tasks.

A. Quickly set up new emergency networks.
- Based on portable nodes.
- Based on user devices.

B. Effective maintenance of the network.

![Fig.7. Presented network architecture.](image1)

The interior design and involvement of the Remote Base Station Vehicle in the process are shown in Figure 8.

![Fig.8. Conceptual diagram of the operating system installed in the vehicle.](image2)
When you need to connect to the Internet, it is also possible to create a WiFi-based multi-network connection using mobile devices in the network [7,12]. This approach does not require additional hardware such as network interface cards or pre-installed multihoc routing protocols on mobile devices, as is the case with conventional ad-hoc networks. Instead, it uses the WiFi available on the mobile device to connect to the Internet at nearby nodes.

Fig.9. WiFi-based multi-band connection for Internet connection

Protection of channels consisting of optical communication systems during natural disasters.

Mobile communication systems need high-speed and high-volume data transmission channels. Mainly communication channels use radio communication systems. But the main communication channels consist of optical communication systems [8]. This paves the way for high-speed and reliable data transmission. Unfortunately, this system is also not protected from post-disaster damage. It takes relatively less time to wirelessly restore points where interruptions occur under the influence of external forces. Points that were previously relatively weak can be backed up using this method. The proposed architecture is shown in Figure 10.

Fig.10. Schematic of an optical fiber with multiple failure points.

In this case, it is necessary to use systems that allow continuous operation between wireless and optical fiber transmissions. Of course, there are many such systems nowadays and they are selected from each other depending on how effective they are in the environment in which they are used. We illustrate such a system in Figure 11 according to the above scheme.
The following play an important role in determining the best performance networks:

- Network management technology to detect changes in network performance;

Information on the data configuration through various open-access systems is presented in Figure 12. It consists of Open Flow-based cognitive wireless switches, simple cognitive wireless connectors, and simple wireless switches consisting of various networks and an Open Flow-based wireless network manager. Wired networks such as FTTH can also be used as access networks [2]. Cognitive wireless switches periodically monitor network status at multiple locations and send the observed network status information to the cognitive wireless manager at the disaster site. All data obtained is collected in a cognitive wireless controller and evaluated to select the best access network by measuring the available networks. The satellite network is used as an Open Flow-based control channel for the exchange of information between cognitive keys. Each cognitive switch determines which network to send the packets of access packets that connect the messages from the wireless cognitive controller to the network.
- Optimal selection method to select the best access network;
- Package management technology by Open Flow to connect to the best access network and change the route.

When monitoring a packet delay, a ping tool is used between the tracking server and the cognitive wireless switch, taking into account the serial travel time of the approved packets over a specified period.

This system has a wireless cognitive key network management function to detect changes in in-network status.

Tracking mode includes the following parameters:
- Conductivity;
- Mutual visit time of the tracking server and each wireless cognitive key;
- The rate of packet loss between the tracking server and each cognitive key.

**Conclusion**

In this study, we considered the architecture of mobile communication systems resistant to natural and man-made disasters, depending on the level of development of telecommunications networks in Uzbekistan, i.e. using the capabilities of existing communication networks. In this study, the primary architecture and network architecture, which can be organized as quickly as possible, were mainly considered.

In particular, the following issues were studied in this study:
- Energy efficiency planning based on renewable energy for the mobile network in the disaster zone. This issue is a topical issue that needs to be addressed, given the high number of power outages in Uzbekistan and the fact that the system has the highest rate of disability during natural disasters.
- The architecture of communication networks created using cloud technologies is presented.
- Protection of channels consisting of optical communication systems during natural disasters was considered.
- The architecture of the data transmission system through open access systems during natural disasters was considered.

**References**

