

Research paper

Performance improvement of fast warning systems based on IoT (NB-IoT) technology using smart sensors network and the fifth generation GSM network (5G)

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Extended Abstract

Gradually, the significance of automatic information receiving systems and intelligent response in real-time has become increasingly apparent, and solutions based on it have made significant progress in most industries. Aggregation, Integration, and real-time operations on data are among the most important benefits of these systems and platforms.

Data aggregation platforms based on IOT technology and telecommunication infrastructures have the task of automatically collecting information from the desired centers and terminals (terminals and remote centers), besides sending on a secure telecommunication platform, receiving, processing, displaying, and archiving information with the ability to access different users) and send commands if needed. One of these systems is the quick warning system related to identifying incidents. Given the importance of telecommunication infrastructure to connect remote terminals with the center of the system, both in the field of access and in the area of infrastructure, the advancement of telecommunication technologies in these two sectors will improve the performance of these types of systems, based on the location and the importance of the information of these infrastructures can include things such as wire, terrestrial wireless, satellite, mobile phone, and others. In this article, an attempt is made to investigate the effect of technological change in the field of infrastructure on improving the performance of early warning systems.

Introduction

As mentioned, the importance of systems based on information gathering and quick warning is increasing daily; due to the development of technology in the telecommunications and computing sectors, the efficiency and speed of these systems are growing daily. These systems' primary importance is sending data quickly, without delay, and correctly making accurate decisions based on data. These systems have specific systems for different applications, including sensors and data collectors, modems, and communication interfaces. The sensor is the infrastructure (environment) of

telecommunication data transmission to send information over long distances and is the center of control, command, analysis, and monitoring [1,2]. Considering the use of different technologies in each of the other parts of these types of systems, we will first introduce the general introduction of these parts and their application [3].

I. Introduction of fast warning systems

Due to the high costs of natural and unexpected events and the possibility of better and faster handling using rapid warning systems, these systems' importance has

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increased daily. The general definition of these systems includes a set of telecommunication systems and computational analysis used in three parts: access, infrastructure, and analysis center. The concepts of Telemetry and SCADA in these systems as a set for data recording and their automatic transmission to the control center are used for monitoring, monitoring, and analysis. On the one hand, personalized telecommunication modems have the task of reading, storing, receiving, and collecting information from terminals by communication protocols. On the other hand, it has the task of sending coded data on a secure telecommunication platform[4], which includes internal software. It is suitable for communication of input and output information and communication protocol. Based on the architecture, this system consists of different parts, including the central processor, required interfaces, storage space, and one or more analog/digital inputs/outputs. The information access section includes telecommunication data transmission infrastructures in these systems. Local and data transmission are used. To connect remote terminals with the dispatching center, a suitable telecommunication infrastructure or channel is needed, which, based on the location and importance of the information of this channel, can include things such as wired infrastructure, terrestrial wireless, satellite, telephone. Along with other things, in the dispatching center, monitoring is the main center of the system where the information in the terminals is collected, processed and displayed. If necessary, this center sends appropriate control commands to the terminals. In this center, according to the system architecture, the central software of the system will include the required modules such as graphic display in real-time, presentation of the terminals outputs in the form of graphs and data, etc.[5]

This article focuses on rapid fire warning systems with a wide range of information on parks and other natural resources. This system will discuss GSM technologies in the infrastructure sector and NB-IOT technology in the access sector.[6]

A. The concept of the Internet of Things (IoT)

Generally, it means connecting all existing equipment, such as household appliances, sensors, control equipment, etc., to the network. In a specific and industrial sense, it includes creating an intranet network or the Internet with appropriate information technology infrastructures and integrated sensors to achieve particular goals. It is like the control and Integration of access and optimal management of the system. In general, by using IoT, sensors, and devices can be connected to an integrated network through which they can interact with each other and with their users.[7]

Considering what kind of data the system will send, it uses various sensors in the data collection section. It will be

examined according to the architecture of the wireless sensor network system.[8]

B. The necessity of using a fire alarm and notification systems

Considering the extent of real-time data, removing the operator from the cycle of automatic measurement and sending and receiving up-to-date, valuable information, as well as the possibility of analyzing and monitoring the existing situation in comparison with its history, the primary necessity and importance of IoT-based systems is [9]. These are as follows:

A- Early detection of fire

B- To mechanize all the steps of recording, sending, and collecting information in the required scope to reduce human error and integrate data.

C- Collection and Integration of required data at the same time in the central data center

D- Creating a suitable software system to analyze the collected data.

E- Sending necessary warnings to subordinate systems or devices to perform related operations

F- The Ability to connect to all kinds of sensors

G- Providing all types of required report

H- An integrated platform with the ability to record geographic information - GIS

II. integrated fire alarm system

C. System architecture

The system and integrated dispatching center for the quick-fire warning is a centralized and integrated system responsible for automatically collecting information from the desired centers and terminals (terminals and remote centers - here is the wireless sensor network) based on LORA and GSM telecommunication technologies. provides [10]

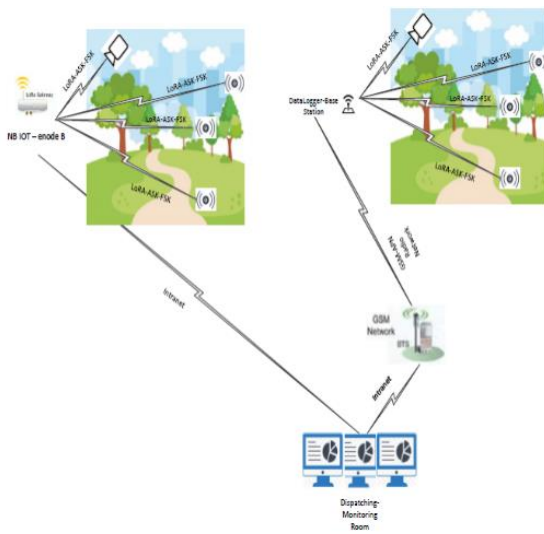


Fig. 1: Architecture of the integrated fire alarm system

This system is responsible for sending, receiving, processing, displaying, and archiving information on a secure telecommunication platform (with different access capabilities for users) and sending commands if needed, which includes the following sections.

D. Network of sensors - wireless sensors (the first layer and access are considered.)

Recent advances in electronics and wireless communication have given the Ability to design and manufacture sensors with low power consumption, small size, reasonable price, and various uses. These tiny sensors, which can perform actions such as receiving different environmental information based on the type of sensor, processing and sending that information, have led to the emergence of an idea to create and expand networks known as WSN wireless sensor networks. A sensor network consists of many sensor nodes widely distributed in an environment and collects information. Another unique feature of sensor networks is the ability to cooperate and coordinate between sensor nodes. Each sensor node has a processor on its board. Instead of sending all the raw data to the node's center responsible for processing and concluding information, it performs a series of primary and straightforward processes on the information it has obtained and then Sends semi-processed data.

Although each sensor alone has little capability, the combination of hundreds of tiny sensors offers new possibilities. The power of wireless sensor networks is in the Ability to use a large number of small nodes that can be assembled and organized and used in many cases, such as simultaneous routing, monitoring environmental conditions, and monitoring the health of structures or equipment of a system [11].

The scope of application of wireless sensor networks is vast and includes agricultural, medical and industrial applications to military applications. For example, one of the most common applications of this technology is monitoring a remote environment. For instance, the fire alarm and extinguishing system, which requires many sensors, such as parks, which have a lot of fire capabilities, will have many uses.

The structure of each terminal in this assembly consists of several sensors, a radio transceiver (or any other wireless communication device), a small microcontroller, and a power source (usually a battery) [12].

E. Data collector - Telecommunication modem - Sensor interface

It is a microprocessor-based control device that, on the one hand, has the task of reading, storing, receiving, and collecting information from terminals through communication protocols. On the other hand, it has the task of sending coded data on a secure telecommunication platform, which includes suitable internal software for communication of input and output information and communication protocol. Based on the architecture, this system consists of different parts, including the central processor, required interfaces, storage space, and one or more analog/digital inputs/outputs.[13]

F. Telecommunication infrastructure (GSM-LORA telecommunication infrastructure layer)

To connect the remote terminals with the dispatching center (control center - data center), a suitable telecommunication infrastructure or channel is needed, which, based on the location and importance of the information of this channel, can include things such as wired infrastructure, terrestrial wireless, satellite, telephone accompanied by other items. GSM infrastructure is considered in this project.[14]

G. Dispatching and monitoring center

It is the main center of the system where the information in the terminals is collected, processed, and displayed. If necessary, appropriate control commands will be sent to the terminals through this center; as we explained at the

beginning, the dispatching system based on the desired architecture and application can include parts of the above systems that have capabilities such as instant aggregation of information in The center from different points, monitoring and monitoring information; remote and intelligent decision-making and control; The processing and storage of information provides the production of the required reports. In the following, we will discuss the impact and improvement of communication technologies in the two sectors of infrastructure and access [15].

III. Advancement of telecommunication technologies and effects on early warning systems

H. The characteristics of the fifth generation of the GSM network and improving the performance of the IoT system

As it is known, the architecture of this system is based on GSM (3G module). LORA NB-IOT is used, which has the task of transmitting the aggregated signals on the WSN to the control center. IDC Data predicts that around 150,000 devices will be connected to the network every minute by 2025, and a strong network is essential for this data exchange. The fifth generation of GSM technology has features that provide high speed in the discussion of telephone communications (Voice) and create more advantages in data transmission, especially for quick response systems. [16]

Considering the nationwide coverage of the network in the desired points in different countries, which is in the form of 3G, the transformation of the infrastructure to the 5G network in the following sections can improve the system's performance.[17]

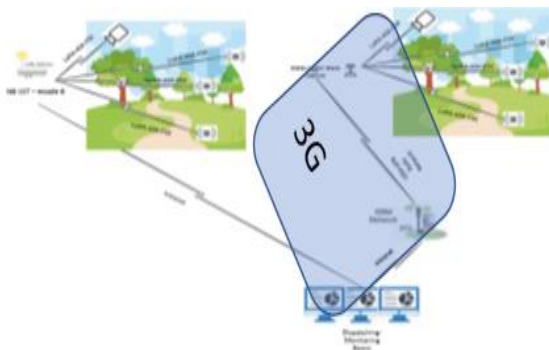


Fig.2: The importance of GSM communication infrastructures in improving system performance

I. Increasing speed and bandwidth

The higher speed of this technology in sending information, reducing the time, and increasing the bandwidth provided can improve the performance of transmitting data in the channel and give the possibility of adding other video features.

J. reducing latency

Latency in the network is the time it takes to send a request from the source to the destination. It is the time that a request is sent from the source to the goal, and then the response to the request is returned to the original. According to the definition of latency, the closer the value of this parameter is to zero, the better the network performance is evaluated.

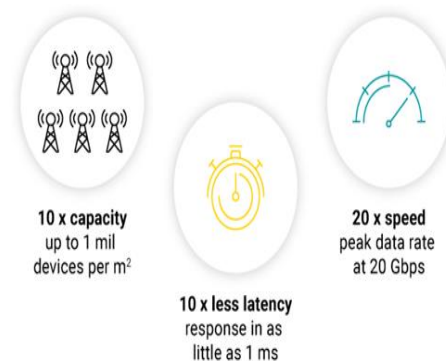
Due to the architecture and application of these systems, known as quick warnings, a significant reduction of this option will improve performance significantly.[18]

K. Ability to support large equipment (sensors equipped with GSM module) in a particular area.

It is expected that using 5G technology; it will be possible to connect more than 1 million devices per square kilometer based on the number of BTSs and network calculations.

L. Significant reduction in energy consumption

Considering the lack of access to equipment in the terminals, energy consumption will be an essential factor in developing these systems. To receive information from sensors and send information, stability modems (modem-data logger) are used, which brings more capabilities to this type of equipment due to the reduction of energy consumption.[19]



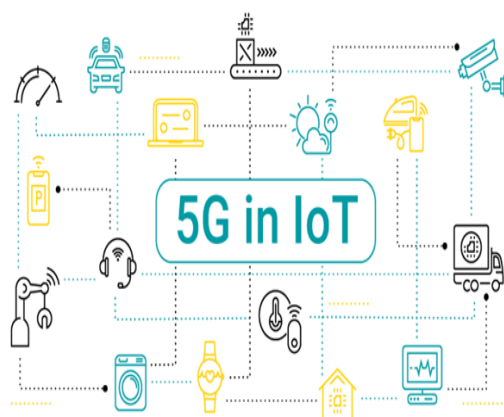


Fig.3: The new capabilities of the 5G network concerning improving the performance of the infrastructure of rapid warning systems

M. 3-2- NB-IoT network and improving the performance of local networks to collect quick information

Narrowband IoT is one of the LPWAN technologies that enables many devices and services to be connected through cellular networks. NB-IoT is a technology developed by the 3GPP standards organization to support the Internet of Things. This technology aims to focus on low cost, longer battery life, indoor coverage, and support for a large number of devices. Using a very narrow bandwidth of 200 kHz (180 kHz plus inter-band protection), the technology can provide transmission rates of several tens of kilobits. This technology has been developed based on telecommunication standards similar to LTE or 5G networks. Of course, unlike these two technologies designed to transfer a large amount of data based on high bandwidth, NB IoT uses less bandwidth at a shorter distance. And less energy is used. Which has the following merits.[20]

N. More extended time efficiency (reduction of energy consumption)

Reduced battery consumption in technologies such as NB-IoT offers significant potential in terms of energy efficiency.

With the increasing expansion of IoT technology and the acceleration of connecting equipment in a world with billions of Internet of Things devices, it is simply not possible to change the battery every six months, especially in the field of sensors such as forest fire prediction that will be installed in remote locations.

O. Reduction of installation and maintenance costs

According to the technology used in NB-IoT and other similar equipment (frequency range and simplification), in addition to reducing energy consumption, the production

of its chips also becomes cheaper, which will be more beneficial for both businesses and consumers. On the other hand, the maintenance cost will also be reduced due to the dispersion in remote places.

P. Reliability

As mentioned in the previous section, NB-IoT networks use simplifications that, unlike other standards, are designed for different usage patterns. This means that in addition to being very energy efficient and economical, NB-IoT is a very robust and reliable technology.

Q. Integration with existing technologies

Due to the use of international standards, the mentioned systems will be able to coordinate properly with other devices and up-to-date infrastructures. For this reason, this system has been used in this article along with the fifth generation 5G systems.

Conclusion

With the advancement of technology and the production of cheaper and more accessible equipment, the growth of related systems has taken an upward trend. Predictions indicate that by 2027, 23 billion devices will be connected to the network through this technology.

The main reason for the growth of this industry can be found in the sectors that have made it possible to connect more systems by increasing facilities and reducing costs. One of the developing systems based on this technology is the integrated rapid fire alarm system based on wireless sensors, NB-IoT, and the fifth generation GSM infrastructure.

Using these dispatching systems based on emerging technologies is at the beginning. Still, with the growth of technology and the increase of connectivity up to 1 million per square kilometer and other facilities mentioned, these systems are expected to be used shortly. Integrate other information systems.

The simplicity and cheapness of the technology, the Ability to coordinate with other technologies, reliable infrastructure, etc., were among the advantages that 5G and NBIOT have given to the growth of this industry.

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