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# Using IoT technologies to prevent fires

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*Abstract-- This article explores various aspects of using the Internet of Things (IoT) to enhance fire safety. The main goal of the article is to provide an overview of modern IoT technologies used for fire safety, as well as discuss challenges, standards, and potential development of this field in the future. The introduction of the article presents the definition of IoT and its role in the modern world, the importance of fire safety and related challenges, as well as an overview of the article's structure and the goals of discussing examples. Contemporary IoT smoke and heat sensors, their operating principle, as well as examples of such sensors on the market, including Nest Protect and Halo Smart Smoke Detector, are examined. Intelligent alert systems and connections with emergency services, such as Birdi Smart Alarm and ADT Smart Home, are discussed. The working principle of such systems and examples of their usage are examined. The integration of IoT technologies into fire extinguishing systems is analyzed. Examples of IoT fire extinguishing systems on the market, such as Plumis Automist Smartscan and Viking QRFS, are provided, and the advantages of using IoT in fire extinguishing are discussed. The work is also devoted to the regulation and standardization of IoT technologies for fire safety. The importance of standardization and regulation, as well as the main standards and regulatory bodies in this area, are discussed. The article concludes and discusses potential directions for the development of IoT technologies in fire safety in the future. The authors highlight the potential of IoT technologies for improving fire safety and offer ideas for further development of this sphere. Overall, this article provides valuable information for fire safety professionals, engineers, developers of IoT devices, and all those interested in the development and application of IoT technologies in fire safety. This article serves as a valuable resource for those who want to familiarize themselves with contemporary approaches and solutions related to using IoT to enhance fire safety, as well as for those who aim to develop and implement new IoT technologies in their projects. In addition, the article can be useful for legislators and regulatory bodies looking to create or update norms and standards regulating the application of IoT technologies in fire safety. Analysis of existing standards and regulatory bodies in this field can serve as a starting point for determining the requirements for future IoT devices and fire safety systems. Ultimately, this article represents a kind of landmark study that can stimulate further developments and innovations in the field of IoT technologies for fire safety. It draws attention to a number of important issues and challenges facing this industry, and offers solutions. It is expected that IoT technologies will continue to play an increasingly significant role in fire safety in the coming years, and this article will help navigate this rapidly changing and developing field. The article also highlights potential advantages and opportunities offered by the application of IoT technologies for fire safety in various sectors, such as industry, housing, and transportation. Discussion of specific examples of IoT solutions in each of these sectors*

*demonstrates how the technology can be adapted and optimized to solve specific tasks and problems related to fire safety. Highlighting potential limitations and drawbacks of existing IoT devices and systems allows to identify areas for further refinement and development of the technology. This can encourage researchers, developers, and manufacturers to continue seeking new, more effective, and safer solutions for ensuring fire safety using IoT. Overall, the article is a valuable source of information for all interested parties, including fire safety professionals, engineers, architects, building and facility managers, as well as legislators and regulatory bodies. It underscores the importance of integrating IoT technologies into fire safety systems and demonstrates how these innovations can help reduce fire risks and save lives.*

*Keywords: Internet of Things, IoT, fire safety, smoke sensors, heat sensors, smart home.*

## I. INTRODUCTION

The Internet of Things (IoT) represents a concept in which physical objects, such as sensors, appliances, and machines, collect, exchange, and analyze data via the internet. IoT technologies provide the ability to manage and monitor devices remotely, facilitating daily life and promoting process automation in various sectors such as industry, agriculture, healthcare, and transportation.

The Internet of Things (IoT) has a revolutionary impact on many aspects of our lives, including the field of fire safety. Fires can be destructive and dangerous to human life and property, so it's important to utilize the latest technologies to prevent the occurrence of fires and mitigate their impact. IoT technologies offer new opportunities for fire safety, such as smart smoke and heat sensors that can warn of potential fires and timely alert to a fire occurrence.

Fire safety is a crucial aspect in ensuring the security of life and property. The primary challenges associated with fire safety include ensuring timely fire detection, effective alerting and response to fire, as well as the application of modern technologies to prevent fires and mitigate their impact.

The structure of the article is designed to provide readers with information about modern IoT technologies applied for fire safety. The article is divided into sections, each discussing different aspects of IoT technologies for fire safety, such as smoke and heat sensors, intelligent alert systems, fire extinguishing systems, and the application of IoT in various sectors. The purpose of the article is to give readers an understanding of the

possibilities of IoT technologies for enhancing fire safety and examples of successful application of these technologies in practice.

Smoke and heat sensors using IoT are devices that detect smoke and temperature changes, indicating a potential fire. These sensors are connected to the internet and transmit data about potential fire hazards to the owner's mobile devices or smart home platforms, as well as to other connected devices. This allows owners and security services to be promptly and efficiently alerted to a fire and to take steps to extinguish it.

*APPLICATION AND ANALYSIS OF IoT TECHNOLOGIES FOR FIRE PREVENTION:*

Nest Protect is a smart smoke and carbon monoxide sensor that uses IoT technologies for enhanced safety, shown in Figure 1.

- Detects fast-spreading fires, slowly smoldering fires, and carbon monoxide.
- Voice alert about the type of danger and location of the fire.
- The ability to receive notifications on the owner's mobile devices and interact with other smart devices in the home [1].

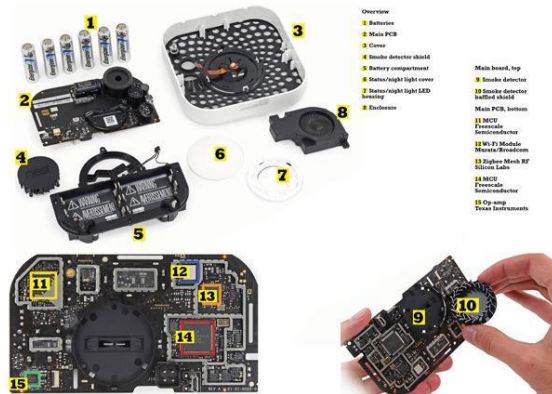


Fig 1. Internal structure of the Nest Protect sensor [2]

The Halo Smart Smoke Detector is a smart smoke sensor that combines photoelectric, ionization, and heat sensors, as shown in Figure 2.

- Internet connection and receipt of fire notifications on the owner's mobile devices.
- Integrated weather sensor and warning of approaching severe weather conditions.
- Compatibility with many popular smart home platforms such as SmartThings and Iris [3].

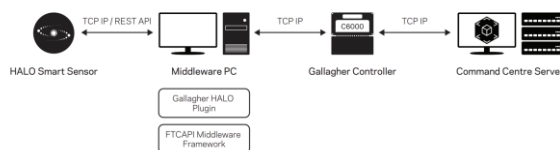


Fig 2. System Architecture for Integrating the Halo Smart Smoke Detector [4]

Kidde RemoteLync Monitor is an innovative device designed to enhance fire safety in the home. It serves as an addition to existing smoke and carbon monoxide

sensors, providing the ability for remote monitoring and alerting, reflected in the Figure 3.

- Remote Monitoring: The RemoteLync Monitor listens for alarm signals from existing smoke and carbon monoxide detectors in the home. In case a sensor is triggered, the device instantly sends a notification to a smartphone or another mobile device.
- Compatibility: The device is compatible with most smoke and carbon monoxide detectors available in the market, allowing it to be used with already installed security systems.
- Mobile Application: The Kidde RemoteLync Monitor has its own mobile application, allowing users to customize notifications, check device status, and monitor smoke and carbon monoxide detection.
- Expansion of Security System Capabilities: The ability to connect with other smart home devices, such as cameras, lighting, and automatic fire extinguishing systems, to create a more comprehensive and effective safety system [5].



Fig 3. Kidde RemoteLync Monitor Device [6]

First Alert Onelink Safe & Sound is a multifunctional smart sensor designed for home safety. It performs smoke and carbon monoxide detection functions, and also provides a smart home voice assistant and a speaker for entertainment and communication, illustrated in the Figure 4.

- Combined Sensor: Onelink Safe & Sound detects both smoke and carbon monoxide, warning of potential fires or carbon monoxide leaks in the home.
- Smartphone Notifications: The device connects to the Wi-Fi network and sends notifications to a smartphone or tablet when smoke or carbon monoxide is detected, even if the user is away from home.
- Amazon Alexa Voice Assistant: Onelink Safe & Sound has a built-in Alexa voice assistant, which allows you to control other smart home devices, listen to music, get news and information, ask questions, and much more.
- Built-in Speaker: The device is equipped with a high-quality built-in speaker, which can be used to play music or other audio files via Bluetooth or Wi-Fi.



- **Ease of Installation and Setup:** Onelink Safe & Sound is easily installed on the ceiling and connects to the Wi-Fi network, making it quick and easy to set up the device and start using its functions.
- **Compatibility with Other Smart Home Devices:** Onelink Safe & Sound can be integrated with other smart home devices to create a more extensive and effective safety and management system[7].



Fig 4. First Alert Onelink Safe & Sound Smart Sensor [8]

All of the systems listed are advanced smoke and carbon monoxide detectors, but like any other products, they have their drawbacks. Here are some of them:

- **High cost:** these products usually cost more than traditional smoke and carbon monoxide detectors, which can be a hurdle for some users, especially if multiple devices are required for installation in the home.
- **Wi-Fi dependence:** They rely on internet connection to transmit notifications to the user's smartphone and to integrate with other smart home devices. If the Wi-Fi network is unavailable or there is an internet connection failure, the functionality of the devices can be limited.
- **Compatibility with home automation systems:** may not support some models of smoke and carbon monoxide detectors and integration with all home automation systems.
- **Battery replacement:** battery-powered versions require battery replacement approximately every two years. Although this is not a significant drawback, it can be inconvenient for some users.
- **Lack of interconnect function:** they do not support the traditional interconnect function, which allows the smoke and carbon monoxide detectors in the home to trigger simultaneously.

## II. RESULT AND DISCUSSION

However, instead, the systems use their own wireless communication technology to synchronize with other detectors in the home. In addition to IoT smoke and heat sensors, which provide early detection of potential fires, there are other technologies aimed at improving fire safety. One such direction is intelligent notification systems and communication with emergency services. These systems not only promptly warn users about the occurrence of a fire but also automatically notify emergency services about the incident, which can reduce response time and save lives.

**Principle of operation of intelligent notification systems**  
Intelligent notification systems use IoT technologies for monitoring potential dangers, such as fires or carbon monoxide leaks, and automatically communicating with emergency services upon detection of such events. These systems can also alert owners and other authorized users about the occurrence of danger, giving them the opportunity to take necessary measures to reduce risks [9-10].

**Examples of IoT notification systems on the market**

Birdi Smart Alarm is an intelligent notification system that combines the functions of a smoke detector, carbon monoxide detector, and air quality sensor, demonstrated in the Figure 5. It uses IoT technologies to provide communication with emergency services and alert owners about the occurrence of danger. Birdi also provides air quality monitoring, warning about the presence of harmful substances and allergens [11-12].



Figure 5. Intelligent notification system Birdi Smart Alarm [13]

Despite many positive aspects, this device also has some drawbacks:

- **High cost:** Birdi Smart Alarm may be more expensive than other similar solutions on the market. This can be a barrier for some consumers looking for more budget-friendly options.

- **Internet connection dependence:** The device requires a constant internet connection via Wi-Fi for its operation. In case of internet connection issues, the device's functionality can be limited, which can lead to delays in receiving fire hazard notifications.
- **Setup complexity:** Some users may experience difficulties setting up and installing Birdi Smart Alarm, especially if they have no experience with similar devices.
- **Lack of support for the standard interconnect function:** Birdi Smart Alarm does not support the standard interconnect function that allows all smoke and carbon monoxide detectors in the home to trigger simultaneously. This can reduce the effectiveness of fire hazard notifications.
- **Need for battery replacement:** Unlike some other devices with hardwired batteries, Birdi Smart Alarm requires battery replacement every few years, which can become an additional costly and inconvenient factor for users.

ADT Smart Home is a comprehensive home security system that includes smart smoke and carbon monoxide detectors, surveillance systems, and access control systems, depicted in the Figure 6. Upon detection of a hazard, such as a fire, the system automatically connects with emergency services and notifies the owners through a mobile app. ADT Smart Home also allows owners to control and manage various security devices using a single app [14].



Figure 6. Comprehensive security system ADT Smart Home [15]

However, like any other device, ADT Smart Home has its drawbacks:

- **High cost:** ADT Smart Home may be an expensive solution, especially for those looking for budget-friendly options. In addition to the cost of the equipment, users are also required to pay a monthly subscription for monitoring services, which can quickly add up over time.

- **Long-term contract:** ADT often requires its customers to sign long-term monitoring contracts, typically for 3-5 years. If the contract is terminated, users may face penalties and additional fees.

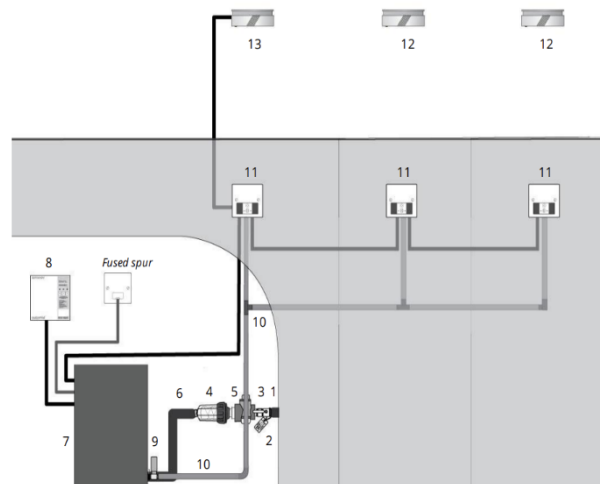
- **Professional installation:** ADT Smart Home requires professional installation, which can increase the cost of the system and cause inconvenience for users who prefer self-installation.

- **Limited integration with third-party devices:** While ADT Smart Home can integrate with some third-party devices, it is not as versatile as some other smart home platforms and may be incompatible with some popular products on the market.

- **Dependence on internet connection:** ADT Smart Home requires a constant internet connection to work. In the event of a lack of internet connection, the functionality of the system can be reduced, which in turn affects fire safety and monitoring. So, we have reviewed various IoT smoke and heat sensors, as well as intelligent alert systems and communication with emergency services.

However, the possibilities of IoT technologies for enhancing fire safety are not limited to these solutions. Now let's move on to discussing the benefits of using IoT in fire extinguishing systems, which can also significantly increase the effectiveness of fire fighting and prevent tragic consequences. The use of IoT technologies in fire extinguishing systems can bring a number of benefits, such as increasing the effectiveness of fire extinguishing, reducing the response time to fire events, reducing risks to people and property, and managing fire systems [16-17].

Examples of IoT fire extinguishing systems on the market. Plumis Automist Smartscan is an innovative fire extinguishing system that uses IoT technologies for automatic fire detection and extinguishing activation, visible in the Figure 7. The system is equipped with an infrared scanner that identifies the source of the fire and activates a network of fine sprayers to direct water mist at



the fire. Automist Smartscan can be integrated with other smart home devices and allows owners to control the system's operation via a mobile application [18].

Figure 7. Diagram of the Automist Smartscan system [19]

1. Stop valve, approved by the Water Regulations Approval Scheme (WRAS)
2. Label and cable tie
3. Single non-return valve
4. Filter and bracket
5. Pressure reducing valve
6. Stainless steel intake hose
7. Pump unit
8. Controller
9. Quick-connect junction with a control point for a pressure gauge
10. High pressure discharge hose
11. Assembled head
12. Wireless multisensory alarm
13. Specified wired detector

Viking QRFS (Quick Response Fire Suppression) is a modern fire suppression system that uses IoT technologies for quick response to a fire. The system includes smoke, heat, and humidity sensors, as well as devices for monitoring the operation of fire suppression pumps and valves. Viking QRFS allows for timely fire detection and activation of appropriate fire suppression devices, as well as remote monitoring and management of the system via the internet [20].

Despite their advantages, these systems also have several drawbacks:

- High cost: Installation can be expensive, especially compared to traditional fire suppression systems. This can make it less accessible for some consumers.
- Complexity of installation and maintenance: Installation and maintenance require a professional approach, which can be inconvenient for users who prefer to self-install and maintain their fire safety systems.
- Need for component replacement: Like other fire suppression systems, it requires regular replacement of components such as pumps, nozzles, and sensors, which can increase long-term costs.
- Potential compatibility issues: In some cases, the systems may be incompatible with already installed fire safety systems or other smart home devices. In such situations, integration and setup may require additional efforts and costs.
- Limited effectiveness under certain conditions: Although the systems are usually effective in quickly detecting and extinguishing a fire, their effectiveness may decrease under conditions where the fire occurs in enclosed spaces or when the fire spreads too quickly.

While the use of IoT technologies in fire suppression provides a range of benefits, such as rapid fire detection, notification, and localization, as well as integration with other smart home devices, it's also important to consider aspects of regulation and standardization. These factors play a key role in ensuring the safety, reliability, and compatibility of IoT devices for fire safety, which in turn facilitates the application of these technologies across various sectors and spheres of life.

**The Importance of Standardization and Regulation.** Standardization and regulation of IoT technologies for fire safety play a crucial role in ensuring compatibility, safety, and reliability of devices and systems. Thanks to standardization, manufacturers can create products that easily integrate with other devices and systems, ensuring efficient and safe operation. Regulation, on the other hand, helps to control product quality and ensure compliance with safety requirements.

**Overview of Key Standards and Regulatory Bodies.** Different countries have different standards and regulatory bodies responsible for controlling and certifying fire safety devices and systems. Some of them include NFPA (National Fire Protection Association), UL (Underwriters Laboratories), EN (European Norms), and IEC (International Electrotechnical Commission). They develop standards that set the safety, performance, and reliability requirements for IoT technologies for fire safety [21].

## CONCLUSION

After considering the regulation and standardization of IoT technologies for fire safety, as well as their application in various sectors, it's time to draw conclusions and outline potential directions for the development of this field in the future. The concluding part of the article presents a brief summary of the main points discussed earlier, and possible trends and prospects for the development of IoT technologies for fire safety are discussed.

In this article, we have looked at various aspects of the application of IoT technologies in the field of fire safety, the importance and use of the Internet of Things (IoT) in fire safety. The discussion included various types of devices, such as smoke and heat sensors, intelligent notification systems and communication with emergency services, as well as the integration of IoT technologies into fire suppression systems. Discussing different aspects and examples of IoT technologies helps better understand their potential and opportunities for improving fire safety in today's world.

First, we defined the basic concepts of IoT and its role in the modern world, as well as outlined the issues and challenges of fire safety. We then looked at examples of IoT smoke and heat sensors, such as Nest Protect and Halo Smart Smoke Detector, which can detect smoke and

temperature changes for timely notification of possible ignition.

Next, we studied smart notification systems and communication with emergency services, such as Birdi Smart Alarm and ADT Smart Home. These systems provide quick communication with emergency services and responsive response to fire situations, significantly reducing risks to life and property.

Integration of IoT technologies into fire suppression systems, such as Plumis Automist Smartscan and Viking QRFS, also has a number of advantages, including increasing efficiency, accuracy, and automation of the fire extinguishing process.

The importance of regulating and standardizing IoT technologies for fire safety cannot be underestimated, as they ensure the safety and compatibility of devices and systems. The article discusses the main standards and regulatory bodies influencing the development of IoT technologies in this sphere, we touched upon the issues of regulation and standardization of IoT technologies for fire safety and considered examples of their application in various sectors.

In the future, IoT technologies for fire safety can continue to develop and provide even more innovative solutions. Possible directions of development include:

- More accurate and reliable sensors: Improved smoke and heat sensors can detect fires at earlier stages, allowing timely response to fire hazards and reducing the risk of property damage and injuries.
- Integration with other technologies: IoT devices for fire safety can integrate with other systems, such as smart lighting, access control, and video surveillance, creating a unified environment of a smart building or city.
- Use of artificial intelligence: AI algorithms can analyze data from IoT devices for fire safety and predict potential fire hazards, allowing for preventive measures and preventing the occurrence of fires.
- Improved notification and communication systems: Developing more intuitive and effective notification systems can simplify the process of evacuating people in case of a fire and provide more prompt response from emergency services.
- Increasing accessibility: Reducing the cost and simplifying the installation and maintenance of IoT devices for fire safety can make them more accessible for mass use in various sectors and at different facilities.
- Development of standards and regulation: Continuous updating of standards and regulation in the field of IoT technologies for fire safety will help ensure a high level of protection and

compatibility between different devices and systems.

- Education and information: Development of training and information programs for users and professionals in the field of fire safety contributes to a wider dissemination of knowledge about IoT technologies and their benefits for ensuring safety.
- International cooperation: Enhancing international cooperation in the field of IoT technologies for fire safety can help develop common standards and approaches, as well as exchange experiences and best practices.
- It is also worth paying attention to the development of environmental technologies in fire extinguishing, such as the use of safer gases and chemical agents for extinguishing fires. The interaction of IoT devices with such technologies can provide more effective and environmentally friendly fire extinguishing.

For the successful development and implementation of IoT technologies in fire safety, continued cooperation between scientific institutions, manufacturers, regulatory bodies, and experts in the field of fire safety is required. This will allow taking into account all aspects and needs of the industry, developing standards and protocols to ensure the reliability and safety of IoT devices and systems.

IoT technologies for fire safety play an important role in the modern world and will continue to evolve to provide better protection from fires and save human lives. The implementation of these technologies in various sectors and at different facilities will contribute to improving the overall level of fire safety and reducing the risk of fires and their consequences.

The work was carried out at the Research Institute of Mathematics and Mechanics of the Kazakh National University named after al-Farabi.

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