Fire Detection System in Peatland Area Using LoRa WAN Communication

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Abstract: Land and forest fires are one of the threats in a tropical country, especially in Indonesia with forestry land and additional caused of type of land which peatland that easy to getting fire in the summer season. Currently, many techniques to detect fire hotspot and land fire but some of the technique can not apply in peatland case. This research proposes a new technique that can be applied to this case in Riau province, Indonesia which the land with peat type. Long Range Wide Area Network (LoRa WAN) used in the detection land and forest fire, with advantages of low power and long-range transmission in LoRA WAN very applicable in this detection of fire with the distance of fore hotspot very far and large of an area. The simulation result shows good performance and verification used mathematical modeling to check that the system is working and application to implement. The sensors deployed in the area which indicate for a forest fire in the simulated distance to detect the potential of fire then the information sent to the monitoring system in the data center. The proposed LoRa WAN method gives good response and recommended to implement in the peatland area which located in Riau Province, Indonesia.

1 INTRODUCTION

The significant emerging and development of technology in wireless network has expressively changed and enhance the natural environment control system compared to current methods that use satellite ground detection methods, such as wireless sensor networks. thread (WSN) (Khajuria and Gupta, 2015). This system can provide new data for environmental and potentially fatal warning applications such as land and forest research and flood detection. The benefits of ground level detection can be divided into three aspects (Chee-Yee and Kumar, 2003; Boubiche et al., 2018; Jie et al., 2015).

Sensor button; low cost, low power, strong, low pollution and environmental disturbance; communication; low data rate, remote detection and correction and errors; Information processing; nodes, microcontrollers and small operating systems for low power systems. With the advent of IoT technology and Long Range (LoRa) (Wixted et al., 2016; Lavric and Petrariu, 2018; Carvalho et al., 2018), WSN and connectivity are becoming more reliable, stronger and faster. With this technology it is possible to develop intelligent monitoring systems to detect forest and land fires (Lee and Ke, 2018; Kadir, 2017; Kadir et al., 2018).

Therefore, this research focuses on developing intelligent fire detection systems, especially in the peat field, based on the detection and monitoring of environmental behavior in terms of temperature, humidity and gas. To provide new methods and technologies for detection and surveillance systems that use low-power wireless data communications with LoRa WAN technology. Sensor integration with LoRa WAN technology affects local communities where users have access to real-time database information at any time.

The method for detecting the surface of the earth will be used in other regions, regions and regions in Indonesia. This solution is a faster and cheaper alternative to obtaining satellite data currently in use, which will certainly benefit social welfare and economic development. In addition, developing real-time perception will require some support from policy makers to understand how the system works and at the same time to understand the outcome models to take appropriate action.

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2 LORA WAN DETECTION AND MONITORING SYSTEM

Detection and monitoring systems are widely used for objects or parameters that require continuous time. Currently, many types of monitoring systems are based on the objectives and parameters to be monitored. Fire detection and environmental monitoring are carried out in different organizations or organizations to verify the current environmental situation. Commonly used technology is the use of satellite data to detect fire points.

This technology has a number of drawbacks and limitations, including proper fire detection and, in some cases, no possibility of satellite imagery passing through the clouds. The new method proposed in this system is designed to detect smoke, temperature, particle changes, etc. LoRa sensor. He uses the LoRa WAN, where he is placed in a high risk fire area to collect data. Figure 1 shows a series of hot spots in Riau province.

Figure 1: A map of Riau province with number of fire hotspots used satellite images.

That information collect by the sensor is sent to the sensor gateway as base station to transmit data have been collect by the monitoring system, because of the distance between the sensor and the base station of the monitoring system. is far enough in some areas. For correct data, a large numbers of WAN LoRa sensors are installed in the area because external sensors can transmit up to 15 km. In addition to the LoRa WAN sensor, it is mounted on each base station with a high-resolution camera to analyze aerial imagery before and after the fire, then train the data to analyze changes in the image of the environment.

Selected sites likely to cause high forest fires have been identified in the peat area as shown in Figure 2, installed systems have been approved by local authorities such as the Local Council of Ria and the Indonesian Ministry of Agriculture. Browser. Environment and Forests. Again, the links between Riau Islamic University and local authorities should be integrated into the decision-making process and facilitate access to installation, monitoring, data analysis and communication. Improving forest fire monitoring with intelligent ground detection and LoRa WAN technology can be an early indicator for better disaster risk reduction decision making. This project benefits from new designs and new developments thanks to the latest LoRa WAN technology and research on signal transmission.

Configuring sensor base stations in different areas to gather information from the WAN LoRA sensor network being developed in the peat area. The information collected by the sensor base station is stored in an internal database and sent to the data center because the sensor base station is located in remote rural areas for more than 100 km. Sensors can be detected and alerted immediately before a fire occurs with the responsible agency for preventive measures. The next step will be to configure some sensors and base stations that will cover the entire province of Riau and build this project as a prototype system in another Indonesian country. The proposed LoRa sensor scenarios also allow analysis of the behavior and environment before and after the fire is analyzed through a new image processing method, particle detection, sensor data and system. the media. Data Figure 3 shows a proposal to implement a data network scheme to monitor WAN and environmental sensors.

Figure 2: Actual condition of land and forest burn on the field.

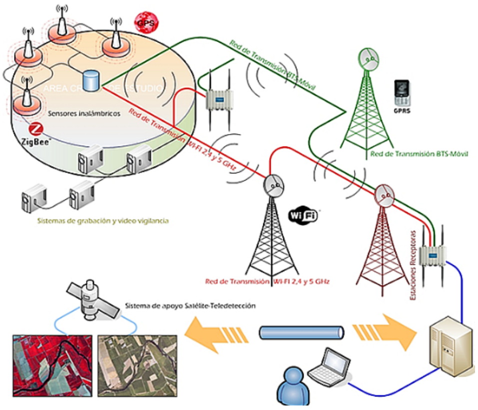

Figure 3: LoRa WAN block diagram for forest fire monitoring system.

3 LORA WAN SOLUTION FOR PEATLAND MONITORING

The recommended LoRa WAN solution uses a powerful LoRa module made by Semtech technology for long-term transactions. It is a standard of the LoRa alliance that creates mechanisms for formatting, provisioning, access agent, message security and protection, and device management. Figure 4 shows the LoR WAN that forms a star topology around the gateway, which acts as a packet sender between the terminal and the core Network Server (NS). The NS is to control for manage the Medium Access Control (MAC) layer for processing and perform as a gate between application that running to the end of devices and application server. The standard of LoRa WAN can be define in three classes; so the final device can respond to various scenarios such as network topology A, B and C (Abeele et al., 2017).

Class A devices often have their own transceiver in deep sleep conditions and rarely wake up to send data to NS. Wireless media access in the WAN LoRa adheres to the ALOHA method, does not use listening before speaking, and is therefore limited to most parts of the world when used. In Europe, in sample, the 868 MHz band contains different subbands, with the CDR between 0.1% and 10% and 1% most common (Zainal et al., 2017).

3.1 LoRa WAN Networking

Recent technology for sensing system and network technology is introduced by LoRa WAN with capability to send in long distance. Furthermore, the low power transmission make power long life and good for the maintenance device. As mention in the previous section, the recommended scenario for network architecture in this WAN loop is a level network of architecture that meets traditional internet standards, such as Internet Protocol version 6 (IPv6). Expect rapid integration of all LoRa WAN systems and systems. One-way nodes of the WAN ecosystem are fast and heavy. However, the transmission capacity of the WAN LoRa technology is very limited, which means a limited throughput and a small package size. Therefore, it is not easy to integrate an IPv6 datagram directly into LoRa-WAN packages and a compression mechanism is required. The proposed solution provides an IPv6 connection to the LoRa node using the LoRa WAN connection, while a multi-computer (MEC) -based architecture is used to achieve this integration: network access, MEC node, bidirectional flow can be created between LoRa and LoRa, as shown in FIG. IPv6 is responsible for translating compressed or uncompressed packages into network segments. WAN and IPv6 (Sanchez-Iborra et al., 2018).

The proposed solution can contribute to the extensive LoRa network, including:

- A true extension of IPR6 in LoRa has been developed and tested.
- LoRa WAN button LoRa is used in bank testing to deliver environmental data via IPv6 links to WAN links.
- The LoR WAN environment for smart environment detection is configured to be ready for users.

3.2 LoRa WAN Physical Error Model

Physical error is one of parameter have to check, after changing the Physical Signal Error Model (PHY), the output data is cleared to increase the entropy of the source. Note that in a small simulation the Bit Error Rate (BER) information is obtained from a balanced distribution, and therefore the entropy of the source information is within the maximum limit. Before the bleached current is sent to the modulator, the modulator is mapped. It generates a whole sequence that is sent to the LoRa WAN sensor button. At the LoRa sensor node, the N number of the complex base sequence sample is changed to N with the time created by the phase accumulators indicated by (1), where N is the sample with a base band symbol equivalent to 2BF (fs. / BW) . An entire entry determines the time shift (Abeele et al., 2017).

$$m(i) = \begin{cases} \exp(-j\pi), & \text{if } i = 0 \\ m(i-1)\exp(jf(i)), & \text{if } i = 1, \ldots, N-1 \end{cases} \quad (1)$$

where the instantaneous of frequency can write as

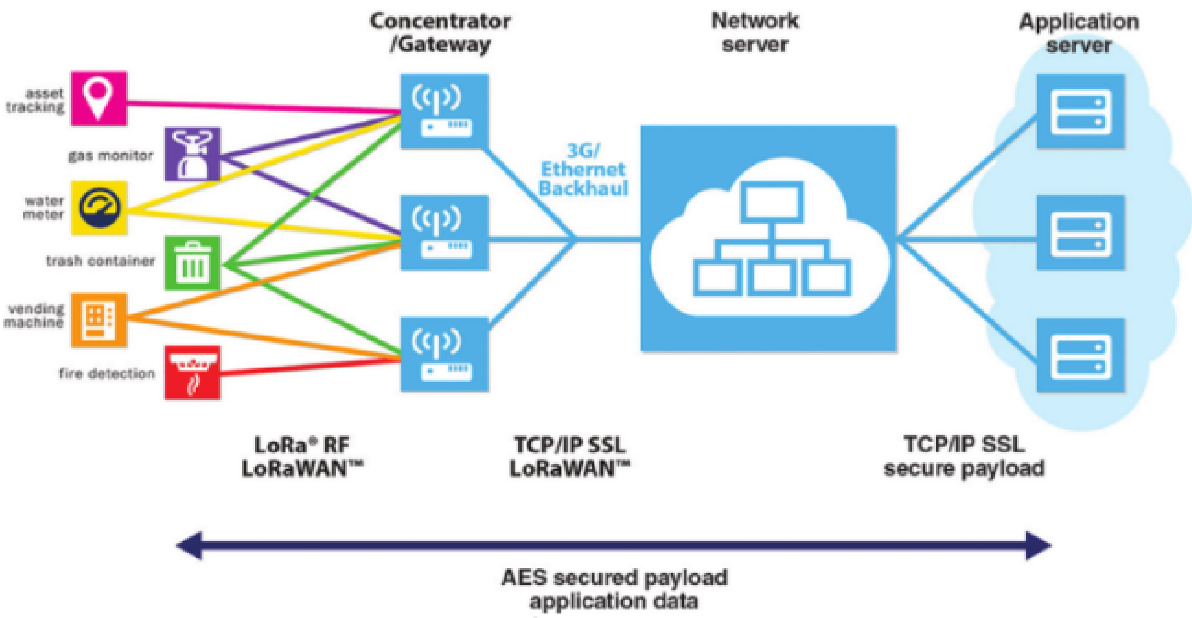

Figure 4: LoRa WAN overview in hierarchical architecture refer to Semtech technology.

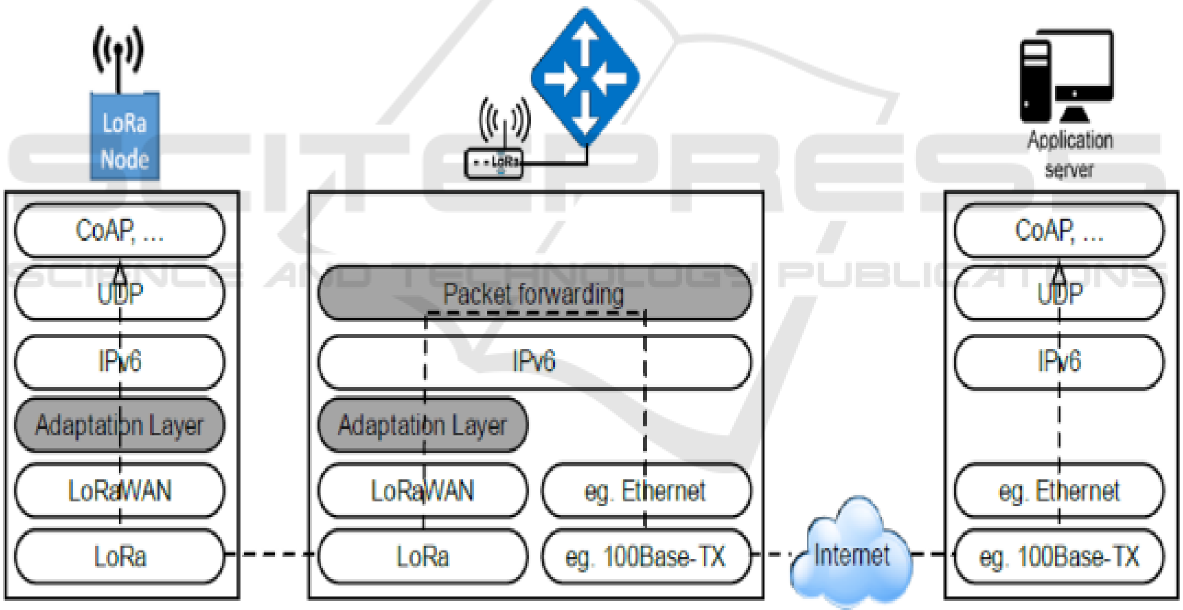

Figure 5: The IPv6 Architecture of LoRa WAN networking solution stack.

$f(i)$ is given by

$$f(i) = -\pi + \frac{i}{N}2\pi, \text{ for } i = 1,\dots,N-1 \quad (2)$$

The number of samples in the WAN LoRa symbol was then sent via Gaussian White Noise (AWGN) for a given SNR parameter

$$c(i) = m(i) + \sqrt{\frac{E_s}{2\text{SNR}}}[\mathcal{N}(0;1) + j\mathcal{N}(0;1)] \quad (3)$$
$$\text{for } i = 0,\dots,N-1$$

where N (0; 1) is the normal of standard distribution and SNR = 10SNRdB/10. Take note that the energy in each symbol is one for the LoRa WAN sensor button. Finally, the LoRa WAN decoding uses a demodule-based relationship in decoding in which the receive symbol as associated with all known LoRa symbols. Symbolic decisions are shown by choosing the LoR icon with the highest correlation value. The value of correlation physical error to the model of LoRA WAN application in land and forest fire detection can be write as the number of area going to detect compare to the number of sensor nodes in LoRa WAN deploy.

4 CONCLUSIONS

A system for detection of land and forest fire use LoRa WAN technology is proposed. Results show the simulation and mathematical modeling based on calculation gives good response and the system applicable to apply for the alert system in the detection of the forest fire. LoRa WAN system can send information in long-distance over than 10 miles, thus very applicable in the detection of forest fire in large of an area. The system can be integrating to the several sensing systems and collect the information to become a group of information to send to the data center for monitoring system.

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