Method Using IOT Low Earth Orbit Satellite to Monitor Forest Temperature in Indonesia

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Abstract. **The ultimate goal of this paper is to ensure the proper functioning of the Monitoring Forest Temperature program in Indonesia using the IoT Narrow-Band Low earth orbit Satellite. As a new technology for monitoring the temperature continue to expand, its implementation in developing countries particularly in Indonesia requires strategic guidance of how the whole process will be executed. Nevertheless, due to this, cross-sectoral partnership in technology, policy, budget, industry is essential to be addressed. The World Bank has recorded the loss from forest fire where 28 million people directly affected including 19 people who died and over 500 thousand people suffered from respiratory problems. Smokes from forest and land fires have also struck Malaysia, Singapore, and Brunei Darussalam respectively. To respond to this, the IoT (Internet of Things) now comes with an extensive feature, using the capability of satellite reach. The Narrow Band Low Earth Orbit Satellite has released a feature for IoT connect to Low Orbit Satellite and transmit the data from the sensor directly. Therefore, we argue that this technology is crucial and needs to be functioned immediately to monitor forest temperature in Indonesia.**

Keywords: **Narrow-band IOT, LEO Satellite**

I. INTRODUCTION

IoT products that are widely offered in the market is the IoT using the WiFi or the 4G connection, or both, to transmit its data. IoT uses the narrow-band Low Earth Orbit Satellite to transmit its data using the capability of the satellite. This type of IoT can be installed in the middle of the forest with the temperature sensor and transmit its data using Narrow-Band frequency to Low Earth Orbit Satellite [1]. Low Earth Orbit Satellite, is the satellite that operates at approximately 600 km from the earth's surface. Unlike the GSO (Geo Stationer Orbit) Satellite or the MEO (Middle Earth Orbit) Satellite, The LEO (Low Earth Orbit Satellite) can be operated at the most affordable cost, since Low Orbit enables the IoT box to function using minimum electricity. Thus. it can be installed as an install and forget scenario because it does not require any maintenance as the sensor will be placed in the middle of the forest.

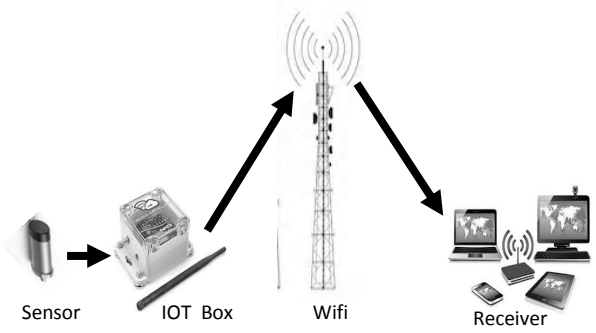

Figure 1. Sensor and IOT using Wifi

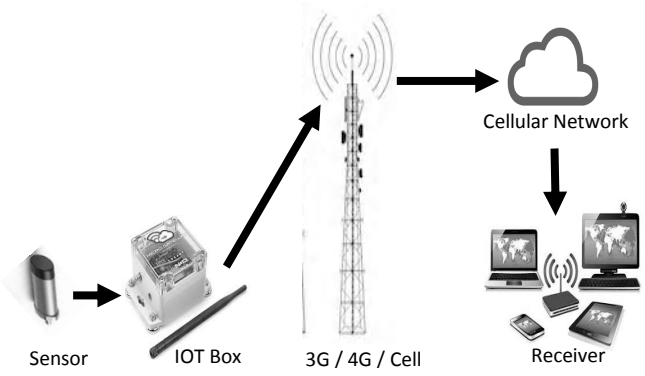

Figure 2. Sensor and IOT using Cell

Figure 1 and Figure 2 display the type of IoT solution using Wifi or Cellular signal, though, it is difficult to identify a tower for Wifi or Cellular in the middle of the forest. It requires an extra effort to build one as well as a significant amount of investment to finance the entire signal across the forest.

As displayed in Figure 3, a tower is not necessary for, between the devices, the sensor can send the data to IoT box and transmit it to Low Earth Orbit Satellite, where the Low Earth orbit Satellite has a Global downlink to be sent to the cloud, and eventually, users will get all the data to connect to the cloud provided by the Satellite operator[2].

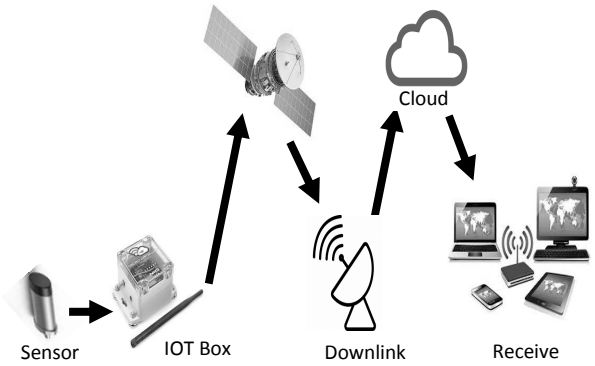

Figure 3. Sensor, IOT LEO Sat, Downlink, Cloud and Receive via equipment

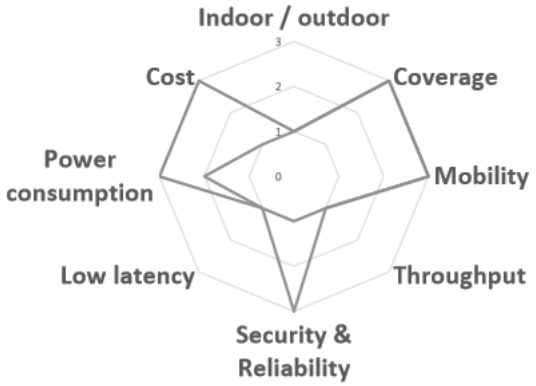

Figure 4. The requirements of essential range radar for the environmental monitoring system.

As depicted in the radar diagram in Figure 4, the critical range, bandwidth, and quality of service requirements for environmental monitoring applications are met accordingly by satellite communication platforms. However, the presence of satellites demands a relatively high-cost and high-power solution for this area. Even so, the energy self-sufficiency of many environmental monitoring applications (e.g. those utilizing solar panels), and the absence of competitor networks operating in remote locations means that satellite communications remain the most viable solution for environmental monitoring in a short and medium run. In contrast, a lower-cost, lower power satellite solution would offer significant value for users in this area.

II. Related Work.

The forest fire must be avoided through the involvement of stakeholders at all levels including the community organization, local government, private entity, operator, and society in general [3-5]. Public Awareness, Policy, and Law Enforcement are amongst the most instrumental factors to comprehensively function the project[6-9]. The center of the focus shall be revolved around the following:

1. The Budget – Palm Oil Operator and Government: many areas where forest fire took place, are identified as areas where the Palm Oil companies operate. These forest hazards were even accelerated due to land clearing in the area where companies burned land to speed up and minimize the cost of operation, neglecting the fact that winds will keep the fire uncontrolled and wildly spread across another area, including the forest. Dealing with budget efficiency, Palm Oil Operator shall put the sensor during operation. The amount of the sensor will be determined based on the total acre of land that Palm Oil Operator has. This needs to be regulated in the regional law by the local Government. Furthermore, the local Government shall carefully measure the equipment for them to put in the forest. Prof Bambang Hero Saharjo, an expert witness of various forest fire cases, through his research, explained that a company that will open land for business through forest/land burning to pursue the highest possible profits. This is mainly since the targeted areas are contained by peatlands where we know peatlands have a low PH. Moreover, once the peat is fired, the PH increases consequently and the company does not need to afford the cost for lime to increase PH. For operating companies, burning land/peatland and used their ashes as a fertilizer is a smart and efficient strategy so that companies do not have to overload fees for the purchase of fertilizer. In addition to that, burning land will eliminate pests and diseases. Thus, consequently, companies do not need to buy pesticides. Forest or land burning has many benefits for the operating companies, as opposed to societies affected by the drawbacks. Hence, this needs to be taken into action particularly when it comes to the issuance of the license.
2. Law Enforcement: Local Government needs to reinstate public awareness programs to socialize the urgency of this solution, including Palm Oil Operator, Community, and people in the area respectively. Palm Oil Operators need to harmonize their execution and monitoring at the end. It is mandatory and needs to be put as the pre-requisite for their license extension. Local Government needs to possess the expertise to monitor the companies so those network operators can be smoothly delivered. It is also crucial for the government to monitor all equipment installed by Palm Oil Operator.
3. Community and People: Participation of community and people in the area is amongst the key element. Community engagement through focus group discussion is essential to prevent forest fire. Their participation can be invested as the resource of information of most Palm Oil operations particularly regarding where the fire was started and which area has burnt the most.
4. Education Institution: Education has an instrumental yet pre-emptive role in sustaining the awareness of this agenda. The school shall start to relate the children with interactive games related to forest fire prevention including the benefit of keeping the forest away from fire, and how does it affect people at large if forest fire repeats. Through this activity, children can engage in a conversation

with their parents that prevents them to harm the forest. This early-stage prevention will be sustained much longer in their respective community.

5. Media: Local media exposure is instrumental to publicize this project by reporting it every week. Different media portals such as local television, local radio stations, and the local newspaper are to be involved regularly. The system will display a live feed to the local television and local radio stations to monitor the area and directly identify places with the high temperature where the community can react to it immediately to check and do preventive actions in those areas.

These five elements are the key succesful foundations to sustain the implementation and monitor forest temperature.

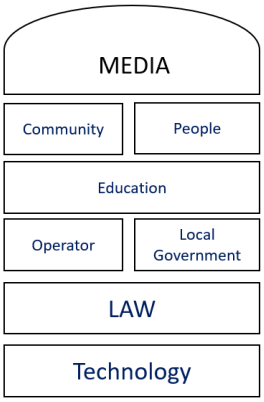

Figure 5. The pyramid of stakeholder participation

III. METHODOLOGY

A. Overview of a System Design.

This research aims to design and to implement a working tested model of a temperature forest monitoring system based on IOT using narrow-band low earth orbit satellite. These are steps to do :

1. Gather all relevant data and information regarding the Forest Fire Map, and pair them with the GPS location.
2. Prepare and set up the IoT Box equipment. This shall include the sensor, modem, battery, solar panel, and antenna. Make sure the monitoring device can work properly.
3. Pre-install the installers at locations where forest fires occurred previously
4. Install the sensor and the IoT box at the location correctly. Make sure the position is locked, the solar panel heads towards the sun directly, cover it with box, so it will not move if an animal hits it. Make sure everything runs properly before leaving out the sensor.
5. Perform connection testing. Make sure the sensor can receive data to the station without any packet loss.
6. Data receiving testing. Make sure the data received as it is sent.
7. To make the implementation handy, the computer that receives the data from the sensor can use the Global Downlink from the satellite operator. It means, the satellite operator already has a downlink, and pass through the data to the Cloud that is connected to the internet. The receiving side needs only a computer that has an internet connection to receive it. The downside of this option is that only the internet from the receiving side will go off, then the data will not be received until the internet gets recovered.
8. Creating a downlink at the receiving facility is a better option because it does not depend on the internet connection, but it has a significant impact on the pricing part. Since the local government and the palm Oil Operator are the main participants of this project, this type of infrastructure must be the option to implement.
9. Data and Information monitoring server has to store all data packet downlink from the satellite
10. Data connection to all related stakeholders is to be distributed. Stored data will be published to the Government, people in the area, Media (Radio, Television, and Newspaper), and to the city hall. The data usage needs to be streamlined since steady internet connection will be a challenge in that particular area (Slow internet connection)

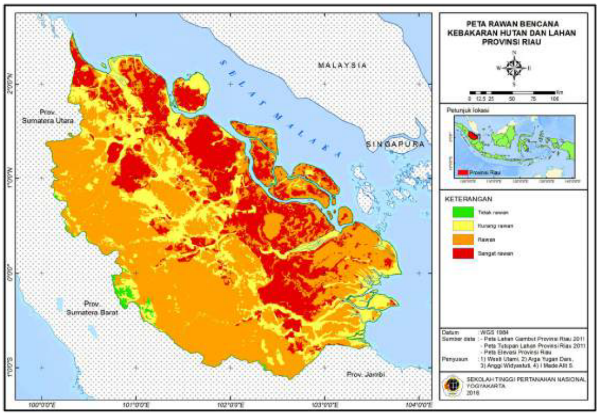

Figure 6. Riau Forest fire map

B. Preliminary Project Requirements

The operator that runs the IoT narrowband using a low earth orbit satellite needs to be trained both in theory and practice. Therefore, the following requirements shall be met:

a. Maps Mapping Division: personnel who will be tagging the location, and decide where to put the sensor across the forest by comparing across all data when the forest fire happened, this also includes the location accessibility to install the sensor.
b. Installer: the personnel who installs the sensor equipment in the forest.
c. Transportation: this person will be responsible to bring the Sensor Installer to the marked location in the forest. This includes transporters on land, sea, and air. Besides, we also need a person who will

handle all-terrain, whether they need vehicles such as helicopter, car, boat, motorcycle, or even horse ride and sprinter. They must be familiar with the forest, they need to be able to predict the time, when to go to the forest and how to handle the safety of the Installer's sensor from the wild or poisonous animal.

d. IT and Network: This personnel is responsible for the connection, and the connectivity between the sensor to the head Office. This includes all the software required for the operation.
e. Equipment: this person is responsible for the sensor and the IoT box. All equipment must be checked and tested correctly before the Installer takes it and install it in the forest.
f. Quality Control: this person is responsible to check the whole system now and then, from the sensor, IOT Box, transmission, satellite transmission, downlink, and data received at the client-side.

IV. Conclusion

There are numerous technologies to detect monitor forest temperature, but then the prototype projected to the Government, Industry (Palm Oil), people, and the media are the most instrumental ones. The action that needs to be taken once the temperature rises to a certain level is essential for all stakeholders to prevent forest fires. Using IOT sensor over satellite will have Real-Time Data accuracy. Moreover, fast action can be throughout to response the high temperature.

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