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PERFORMANCE ANALYSIS OF THE LoRaWAN PROTOCOL FOR DATA TRANSMISSION IN URBAN AREA SCENARIOS

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ABSTRACT
Long Reach Wide Region Organization (LoRaWAN) is a kind of organization for remote media transmission region intended to empower far off correspondence with significant distance correspondence and low piece rate. LoRaWAN can be utilized on correspondence networks that have a wide reach utilizing end gadgets. LoRaWAN offers a great many benefits to the test of IoT execution, however the ongoing execution of LoRaWAN innovation is still exceptionally restricted, requiring practicality testing and examination how much LoRaWAN innovation is equipped for being carried out in metropolitan regions in Indonesia. In this examination, an investigation of the exhibition of the LoRaWAN convention for information transmission with metropolitan region situations in Malang City is done. The strategy utilized in this study is to reproduces LoRaWAN convention in Organization Test system 3 (NS-3) application by changing the boundaries to decide the impact on the quantity of end gadgets, sweep of the passage reach, and information sending period to the boundaries throughput and parcel misfortune. From the aftereffects of exploration demonstrated that for the utilization of convention LoRaWAN in metropolitan regions, the more end gadgets utilized, the more prominent the throughput esteem and the more prominent the worth of bundle misfortune acquired. What's more, the more extensive the region required, the throughput and bundle misfortune acquired are steady. And afterward, the bigger the time of information transmission, the more modest the throughput esteem is acquired and the more modest the worth of bundle misfortune got

INTRODUCTION
The remote sensor network is a remote organization comprising of various hubs little, minimal expense planned with limits in memory, energy, and handling limit (Davcev, Mitreski, Trajkovic, Nikolovski, & Koteli, 2018). Ongoing advances in remote and electronic correspondences have been empowers the utilization of minimal expense, low-power innovation and multifunctional sensors that are little and can be utilized impart (Bankov, Khorov, & Lyakhov, 2016). Modest, savvy, sensors remote organization and is utilized in huge numbers gives numerous open doors that have never been occurred before to screen and control your home, town and neighborhood (Tiwari, Sadeghi, & Eseonu, 2020).

With various advantages LoRaWAN who is able to answer challenges application of IoT, some related research with LoRaWAN technology has been done (Butun, Pereira, & Gidlund, 2018). Research conducted by Davide Magrin applying LoRaWAN technology in urban areas area that aims to test the performance of LoRaWAN (Magrin, Centenaro, & Vangelista, 2017). Bankov, et al. (2016) also analyze performance and LoRaWAN network capacity in smart city through simulation with 100-5000 devices or end devices.

But in general, LoRaWAN technology application and research in Indonesia is currently still limited, even until now there are only two communities and nine gateways listed (Ertürk, Aydın, Büyükakkaşlar, & Evirgen, 2019)

Based on the needs and opportunities of research related to LoRaWAN further research is needed, the author conducts research by simulating data transmission by technology this LoRaWAN (Osorio, Calle, Soto, & Candelo-Becerra, 2020). The author researched and analyze LoRaWAN performance for implemented in the urban area of Malang City with test parameters and parameters specified simulation (Van den Abeele, Haxhibeqiri, Moerman, & Hoebeke, 2017). Research theme selected is "Protocol Performance Analysis LoRaWAN for Data Transmission in Scenarios Urban Areas". The hypothesis of this research is that the performance of the LoRaWAN protocol in terms of throughput and packet loss is decreasing along with the increase in end devices, the area area and rises in the period of data transmission (Casals, Mir, Vidal, & Gomez, 2017). To represent the urban area, the author designing and implementing values parameters that can affect data transmission performance in urban areas with conditions in the city of Malang is an example, including the area, path loss exponential (loss caused by weather, contour soil and others), spreading factor (factordistribution) and the type of propagation (Magrin et al., 2017)

Literature Review

Research conducted by Davide Magrin applies LoRaWAN technology in an urban area that aims to test performance of LoRaWAN. Bankov, et al. (2016) also analyzedLoRaWAN network performance and capacity in smart city through simulation with 100-5000 device or end device, using three main channel specified with data rate which is worth 0 to 5 and Packet Error Rate (PER) and Packet Loss Rate (PLR) (Yang, Karampatzakis, Doerr, & Kuipers, 2018).

Network Simulator 3

Network Test system 3 or shortened as NS-3 is an organization reenactment programming expected for exploration and training.

NS-3 is authorized under the GNU Overall population Permit (GPL) and created by client networks (Bouguera, Diouris, Chaillout, Jaouadi, & Andrieux, 2018).

By consolidating a few C++ objects that each class model a part of the organization, NS-3 can recreate complex organizations in a definite and sensible way.

LoRaWAN Protocol

LoRaWAN which represents Long Reach Wide Region Organization is a Low Power Wide Region Organization innovation (LPWAN) which is based on LoRa balance (Wixted et al., 2016). This innovation permits countless gadgets to impart remotely over significant distances (on the request for 5-15 km, contingent upon the proliferation climate) at low information rates. The situation where this innovation can be utilized is an IoT organization, where gadgets need to convey rarely and just need a short charge to send some data coming from a sensor. (Adelantado et al., 2017).

Data Transmission

Information transmission is the transmission of information in bundles that happen between the transmitter (end gadget) and collector (door) through a few transmission media (Rahmadhani & Kuipers, 2018). Information transmission media can be arranged into two sorts, in particular directed or unguided. In both transmission media, the correspondence that happens is as electromagnetic waves. With directed media, waves are controlled through actual pathways. Instances of directed media are wound pair,

coaxial link, and fiber optic. In the mean time, the unguided media gives a way to communicating electromagnetic waves however isn't controlled; a model is engendering in the air and ocean (Eldefrawy, Butun, Pereira, & Gidlund, 2019).

RESEARCH METHODS

The stages or methodology in this research can be described as follow:

Study of literature

This research requires a literature study to support the topic to be researched. In this section the author discusses the theory needed as a support in completing the research.

Test Environment Design

The design of the test environment serves to structure and prepare what will be done in the research. The design of the test environment contains the design of the scenario environment, the design of the test parameters, the design of the simulation parameters, the design of the topology, the design of the test and the design of data retrieval.

Implementation Test Environment

At this stage the authors implement the test environment that has been designed previously. At this stage, the installation of NS-3 and the addition of a LoRa module that functions to simulate the LoRaWAN protocol are carried out. In addition, the authors also implement the scenarios and parameters that have been designed previously.

Retrieval and Processing of Test Result Data

At this stage, a mechanism is carried out to obtain data from the implementation that has been done previously and then the data that has been obtained is processed so that it can be analyzed so that conclusions can be drawn.

Test Result Data Analysis

At this stage, an analysis of the results of the LoRaWAN performance simulation test is carried out. There are two component parameters to be analyzed, namely throughput and packet loss. In addition, at this stage a statistical analysis is carried out using the SPSS application which aims to test the statistical feasibility of the data as well as predict and test the effect of the independent variable (independent variable) on the dependent variable (dependent variable).

The closing contains conclusions from the results of testing and analysis of research that has been carried out as well as suggestions for further research.

This section describes the design and implementation of the test environment used to measure the performance of the LoRaWAN protocol with throughput and packet loss parameters.

Test Environment Design

To implement the simulation system to be tested, it is necessary to design a scenario first. First, it is necessary to determine the values for the parameters that are appropriate for the scenario. All parameter values for both urban area scenarios and for gateways and end devices are used as input into LoRa modules run by NS-3.

Implementation Test Environment

The first step that needs to be done in simulating the LoRaWAN protocol is to install the Network Simulator 3 (NS-3) application on Ubuntu and then add the LoRa module to the NS-3. The next stage is to create a script and implement a simulation of the LoRaWAN protocol with scenarios and parameters that have been designed previously. The next stage is data collection and data processing which will then be analyzed and drawn conclusions.

RESULTS AND DISCUSSION

Statistic analysis

The creator leads a measurable examination first, which intends to test the plausibility of the information genuinely as well as foresee and test the impact of the free factor on the reliant variable. The strategy utilized is quadratic relapse investigation. The application utilized for measurable investigation utilizes the SPSS application. The outcomes show that every single free factor and ward factors significantly affect one another.

Number of End Devices

The more the quantity of end gadgets, the worth of the level of bundle misfortune got increments. An expansion in the quantity of end gadgets is indistinguishable from an expansion in the quantity of parcels sent. All in all, the more prominent the quantity of parcels sent, the more prominent the likelihood of bundle disappointment being handled. The constraints of the entryway so it won't handle bundles from end gadgets (not any more gotten) notwithstanding parcel crashes that make disappointment be shipped off the door are likewise brought about by the "over-burden" of the quantity of parcels in the information transmission way that should be handled.

An expansion in the quantity of end gadgets causes an expansion in the throughput esteem. This peculiarity can happen on the grounds that the variety in the quantity of end gadgets handled is still little so the throughput esteem is as yet expanding.

Gateway Radius Distance

Gateway radius up to 10000 m packet loss is constant and

good because the distance of the gateway is still in a close area so that the reach of the gateway can cover all areas well.

Data Delivery Period

The longer the data transmission period, the lower the packet loss percentage value. This shows that the density when data traffic decreases, collisions between packets (interfered) decrease as well. Meanwhile, for no more received probability is relatively zero. This means that all packets had entered the transmission line and the packet delivery failure was only due to interfered (collision) between packets without any packets that did not enter the transmission line.

CONCLUSION

From the aftereffects of the reproduction and investigation that has been finished, the ends got are as per the following.

The results of the simulation show that the LoRaWAN protocol can be implemented in urban areas because it has advantages in the large number of end devices, wide gateway coverage distances and delivery time periods that can be used for short or long periods.

The exhibition qualities of the throughput esteem in view of the reenactment that has been done show that for the reproduction boundary the quantity of end gadgets, the more the quantity of end gadgets that are mimicked, the more noteworthy the throughput esteem acquired. For passage inclusion, the more extensive the region required, the throughput acquired is steady since it is still in one inclusion region. Then, at that point, the more noteworthy the information transmission period, the more modest the throughput esteem got.

The exhibition qualities of the parcel misfortune rate esteem in view of the recreation that has been done shows that for the reenactment boundaries the quantity of

end gadgets, the more the quantity of end gadgets that are reproduced, the higher the bundle misfortune esteem got. For passage inclusion, the more extensive the region required, the rate worth of parcel misfortune got is consistent on the grounds that it is still in one inclusion region. Then, the more noteworthy the information transmission period, the more modest the bundle misfortune esteem acquired.

REFERENCES

Adelantado, Ferran, Vilajosana, Xavier, Tuset-Peiro, Pere, Martinez, Borja, Melia-Segui, Joan, & Watteyne, Thomas. (2017). Understanding The Limits Of Lorawan. *IEEE Communications Magazine*, *55*(9), 34–40.

Bankov, Dmitry, Khorov, Evgeny, & Lyakhov, Andrey. (2016). On The Limits Of Lorawan Channel Access. *2016 International Conference On Engineering And Telecommunication (Ent)*, 10–14. IEEE.

Bouguera, Taoufik, Diouris, Jean François, Chaillout, Jean Jacques, Jaouadi, Randa, & Andrieux, Guillaume. (2018). Energy Consumption Model For Sensor Nodes Based On Lora And Lorawan. *Sensors*, *18*(7), 2104.

Butun, Ismail, Pereira, Nuno, & Gidlund, Mikael. (2018). Security Risk Analysis Of Lorawan And Future Directions. *Future Internet*, *11*(1), 3.

Casals, Lluís, Mir, Bernat, Vidal, Rafael, & Gomez, Carles. (2017). Modeling The Energy Performance Of Lorawan. *Sensors*, *17*(10), 2364.

Davcev, Danco, Mitreski, Kosta, Trajkovic, Stefan, Nikolovski, Viktor, & Koteli, Nikola. (2018). Iot Agriculture System Based On Lorawan. *2018 14th IEEE International Workshop On Factory Communication Systems (WFCS)*, 1–4. IEEE.

Eldefrawy, Mohamed, Butun, Ismail, Pereira, Nuno, & Gidlund, Mikael. (2019). Formal Security Analysis Of Lorawan. *Computer Networks*, *148*, 328–339.

Ertürk, Mehmet Ali, Aydın, Muhammed Ali, Büyükakkaşlar, Muhammet Talha, & Evirgen, Hayrettin. (2019). A Survey On Lorawan Architecture, Protocol And Technologies. *Future Internet*, *11*(10), 216.

Magrin, Davide, Centenaro, Marco, & Vangelista, Lorenzo. (2017). Performance Evaluation Of Lora Networks In A Smart City Scenario. *2017 IEEE International Conference On Communications (ICC)*, 1–7. Ieee.

Osorio, Alfonso, Calle, Maria, Soto, Jose D., & Candelo-Becerra, John E. (2020). Routing In Lorawan: Overview And Challenges. *IEEE Communications Magazine*, *58*(6), 72–76.

Rahmadhani, Andri, & Kuipers, Fernando. (2018). When Lorawan Frames Collide. *Proceedings Of The 12th International Workshop On Wireless Network Testbeds, Experimental Evaluation & Characterization*, 89–97.

Tiwari, Prashant, Sadeghi, J. Kiarash, & Eseonu, Chinweike. (2020). A Sustainable Lean Production Framework With A Case Implementation: Practice-Based View Theory. *Journal Of Cleaner Production*, *277*, 123078.

Van Den Abeele, Floris, Haxhibeqiri, Jetmir, Moerman, Ingrid, & Hoebeke, Jeroen. (2017). Scalability Analysis Of Large-Scale Lorawan Networks In Ns-3. *IEEE Internet Of Things Journal*, *4*(6), 2186–2198.

Wixted, Andrew J., Kinnaird, Peter, Larijani, Hadi, Tait, Alan, Ahmadinia, Ali, & Strachan, Niall. (2016). Evaluation Of Lora And Lorawan For Wireless Sensor Networks. *2016 IEEE SENSORS*, 1–3. IEEE.

Yang, Xueying, Karampatzakis, Evgenios, Doerr, Christian, & Kuipers, Fernando. (2018). Security Vulnerabilities In Lorawan. *2018 IEEE/ACM Third International*

Conference On Internet-Of-Things Design And Implementation (Iotdi), 129–140. IEEE.