ZIBELINE INTERNATIONAL PUBLISHING

ISSN: 2590-4043 (Online)
CODEN: AEMCDV

Acta Electronica Malaysia (AEM)

DOI: http://doi.org/10.26480/aem.02.2020.51.55

RESEARCH ARTICLE

CONSTRUCTION OF LORA DATA POWER SENSOR FROM GIOT AND ACSIP USING SQL TECHNIQUE

Satrio Yudho

Fakultas Telematika Energi, Institut Teknologi PLN, Cengkareng, Jakarta Barat, Indonesia.
**Corresponding Author Email: satrio@itpln.ac.id*

ARTICLE DETAILS

Article History:

Received 12 January 2021
Accepted 20 February 2021
Available online 26 March 2021

ABSTRACT

LoRa is one of developing data commuication infrastructures which can be enabled sensors on a large scale, wide area operations, and low energy consumption.the benefit of Low energy consumption in LoRa impacted on the length of data, the spread factor and the type of operation. by the challanges in smart building, LoRa can be best solution to cover wide area sensor network. and one of the critical points is how to ensure the data can be trusted. The purpose of this research is to observe the data taken from the power used in single phase electrical in residential consumers. the LoRa infrastructure used to deliver the data is using GioT and Acsip as the gateway and End Node, then involving SQL technique as a programming tools to refine the data.

KEYWORDS

LoRa, Single Phase Residential, GiOT AcSip, Data Sensor, SQL.

1. INTRODUCTION

The terms of internet of things referred as real time data transmission using internet from sensors to a cloud database system, its mechanism need a adequate internet infrastructure and data storage to store and process the data to be developed with artificial intelligence or machine learning for better service and productivities. Long Range radio communication or known as LoRa is one of emerging IoT infrastructure specialized in data communication in wireless sensor network which low battery consumption and wide area coverage (Zhou et al., 2019; Petäjäjärvi et al., 2017). Low Power Wide Area Network refers as Engagement of large number of Sensors in large scale and need to be carefully manage in terms of data captured from each sensor.

Understanding the data sent by each LoRa sensor (End Node) in LoRa is necessary and critical due the error rate possibilities, every End Node data quality affected by transmission parameter such as channel, spread factor, and received signal strength indicator and core data structure which following the transmission parameters (Afisiadis et al., 2020). This paper presenting the systematic activities to observe and construct the data strucutre from LoRa End Node sensor taken from single phase residential power usage. the are three main activities involved in the experiment. First is the LoRa sensor Construction using ACSip Module and GioT system as the sensors gateway, second is the middleware layer contains protocol Message Queueing Transport Telemetry and Internet Protocol to ensure the data transmission able to sent over it and Node.Js with Database Driver to enabling data store. And the last is Stuctured Query Languange layer to construct the form of database and the refinement each record in a table.

2. LITERATURE REVIEW

Managing electricity consumption has been a challenge in a smart building recent publication indicates that optimization in load to create optimum usage coined at algorithm and programming and a valid data is mandatory to support further research, the information delivery from day-to-day usage need to be deliver correctly, accurately and integrated in the norm of information (Pinzon et al., 2019). To achieve the smart objectives data acquisition is critical (Ahuja and Khosla, 2019). Stable form of electrical data (Power, Current and Energy) as a resource to develop a smart system using artificial intelligence algorithm and machine learning to improve many services majorly in residential demand response in smart building of smart grid architecture (Ma et al., 2016; Krishna and Prasanna, 2018).

The engagement of LoRa system has a signifant result in smart system development in renewable energy from photovoltaic, and energy storage monitoring system and applied in other smart system development eg. Smart parking, utilize its ability of wide area coverage showing best results in smart meter implementation published and focusly in power measuring showing in (Kumari et al., 2019; Rogier and Mohamudally, 2019; Yudho, 2020; Kodali et al., 2019; Wibisono et al., 2018). However, the open possibilities research in LoRa transmission is still interesting topics. LoRa transmission were affected by Spread factor (SF) as a consequences of Chirp Spread Spectrum (CSS) transmission technique, the value of SF is set from 7 to 12 which differs in Bit rate transfer ability in a second measurements (Widianto et al., 2019).

Table 1: LoRa Spread Factor and Bit

Spread Factor (SF)	Bit rate [bit/s]	Range recomendation
7	5469	1 to 100 meters
8	3125	1 to 500 meters
9	1758	1 to 500 meters
10	977	1 to 500 meters
11	537	Over 500 meters
12	293	Over 500 meters

Quick Response Code	Access this article online	
	Website: www.actaelectronicamalaysia.com	DOI: 10.26480/aem.02.2020.51.55

Cite the Article: Satrio Yudho (2020). Construction of Lora Data Power Sensor from Giot and Acsip Using Sql Technique. *Acta Electronica Malaysia, 4(2): 51-55.*

LoRa Spread Factor value determine the range ability coverage from Gateway to End Node, the bit rate capacity was adjusted by the SF. Received Signal Strength Indicators (RSSI) also considered as a parameter in LoRa transmission system, the measurement of RSSI define quality of transmit and receive from Gate to end Node. The formulation of RSSI is showing below:

$$RSSI = P_{tx} + G_{tx} + G_{rx} - P_l$$

P_{tx} define the power transmitted in dBm (decibel milliwatt), and G_{tx} and G_{rx} are the gains of antenna in te manner of isotropic antenna (dBi) and P_l presents as the Path loss model. considering the fit implementation for LoRa devices which consists of Gateway and end Node ought to analyse operating environment and adjust the sensor operation to gain the best performance.

Acsip S76s is one of LoRa communication shield developed by Acsip technology corporation, its work as communication interface to deliver the data from end Node to Gateway (Acsip, 2017). Below is short of technical specification of S76s:

Table 2: Acsip S76s Technical Specification

Parameter	Value
Spreading Factor	12
Frequency Bands	915
Payload Length	64 Bytes
Error Correction Code	4/6
Workng temperature	25 Celcius
Output Power	13 dBm

Payload capacities determine the length of data transmitted from end Node to gateway, with 64 Bytes length of data, S76s suitable to applied in major usage in small sensor data width in a wireless sensors network. As mentioned above in RSSI formulation, G_{tx} refers to value of receiving packet from end Node in LoRa Network Scheme, researcher engage GioT Gemtek Gateway as a Receiver unit to catch the data from every end Node. The technical specifications from GioT shown below:

Table 3: GioT Technical Specification

Parameter	Value
Frequency Bands	EU 862~870 MHz / US 902~928 MHz / India 865~867 MHz / AS 923 MHz / CN 470~510 MHz
Concurrent Channels	Up To 8 channels
Transmit RF Power	0.5W (up to 27 dBm)
Wireless LAN Protocol	802.11 b/g/n 2.4G
Working Temperature	-10ºC ~ 55ºC

Concurrent channel feature from GioT Gateway is optimization feature to manage huge amount of end Node in a single gateway, it works as traffic handler between gateway and end Node, every channel provides status information to avoid unexpected queue in sensor network, this ability is making significant results in Low cost LoRa development. Data collection taken from sensors is the main objectives in smart system, inadequacy of data leads more problems to analyse and justified behaviour of elements in a system. Database Management System still an interesting topics conducted in internet of things majorly in data processing technique called as Structured Query Language, dealing with real time data collection in Internet of Things NoSQL method applicable for highly connected cloud system but the problem was coined at force major condition which cannot always connected to the cloud system (Fatima and Wasnik, 2016; Georgiev and Marinov, 2019). The findings of this research are construct the Database Format for Real Time data storing in a lack internet connectivity area using SQL technique as a comparative result besides NoSQL.

3. Research Methodology

To aim the objectives in research, we designed three distinctive activities descripted below:

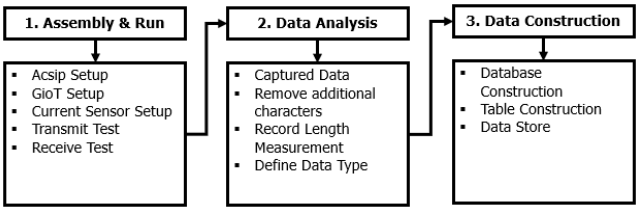

Figure 1: Research Methodology

First activity is assuring the LoRa system able to operate, in this step Acsip Shield were assembled with Current sensor. And the end Node LoRa gateway called GiOT were calibrated to receive and deliver all data sent by end Node over protocol MQTT (Spinsante et al., 2017). after data captured by MQTT, Internet Protocol works as data delivery through computer using IEEE 802 standard, most of devices like smartphone, laptop, personal computer, and computer server are integrated using WiFi or Wired network.

Second step is analysing all data captured from end Node in Gateway, enabling data capture can be done using parameters of MQTT and IP address through wireless or wired network from devices mentioned in step one, additional code using Node.js is needed to accomplish communication between those protocols, code placed inside server connected to GioT gateway system. the form of data necessary to be cleaned as well, the process involved a set of activities from removing additional characters like {", //, '} using Standard Query Language command and calculate the record length and define data type for every record. This process was intersected with last step in methodology.

4. Finding and Discussion

Third step is finalizing construction of data storage using Database Management System role, there are two main tasks involved first is Data Definition Language required to create Database structure which consist of Database Name, Table Name, User Privileges, and Scheme, and second Data Manipulation language to retrieve record from the table. The form of Database System in this research is following Object Relational Form, since recently research in most of sensor's data are stored in no Relational model regarding of programming language to process the data. The purpose of database construction in Relational Model is to scale of the services onto smart system in an organization or community which complex problem came along from activities and energies

Exctracted from methodology above, systematic approach designed to accomplish experiments. Three major steps categorized as layer consists of several small activities. We depicted it in a figure below:

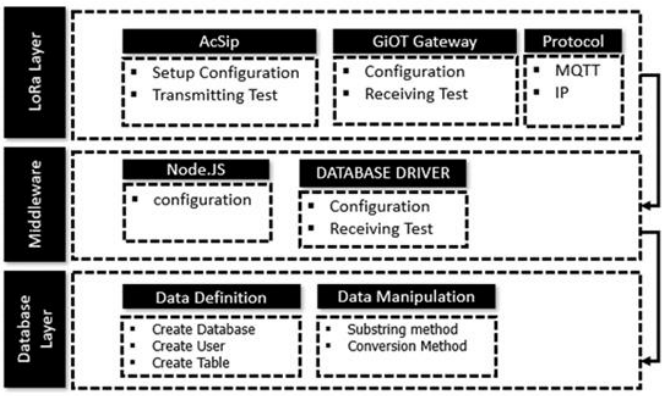

Figure 2: Schema of LoRa data construction

Three sequential steps designed to achieve result of data construction, first layer dealt with LoRa network setup, begin with Acsip configuration using base command setup to define channels, frequency, data components and end Node Activation, GioT activation to detect and pairing end Node, engage protocol MQTT to determine data from end Node and Internet Protocol to communicate with devices (computer, smartphone and others). Second Layer, Node.Js programming to bridging communication between protocols mentioned, it placed inside a computer

act as a server to manage connection from gateway and other devices, database driver included to define service accessibility and authority of resources (Disk and Privileges) inside codes, Structured Query Language (SQL) is in use to access temporary data storage. Third layer conduct with major Database System activities, defining metadata and physical data storage using Data Defition Syntax for creating Database, Table, and User, and completing activities for data refinement and extraction using built in syntax, these steps conduct with data definition which critical for the experiment.

Table 4: LoRa Layer Setup

Type of Action	Instruction	description
Acsip Transmision Set	mac tx <Type> <PortNum> <Data> sf value	Set the confirmed data to the port available and define the 4 bytes hexadecimal data format eg. 0x00 Set the SF range to operate
GioT and MQTT /IP Connection Test	mosquitto_pub -d -h 192.168.55.131 -t GIOT-GW/DL/00080029601Db5	Ensure the Gateway connected to end Node (Acsip) using the instruction set of MQTT role

Proving successful connection from end Node to Gateway in transmitting data can be seen using MQTT service command using proper parameter (subscribe) as showing in Table 4, after all services in a system run succesfully, a set of information able to catch and displayed as shown in figure 3:

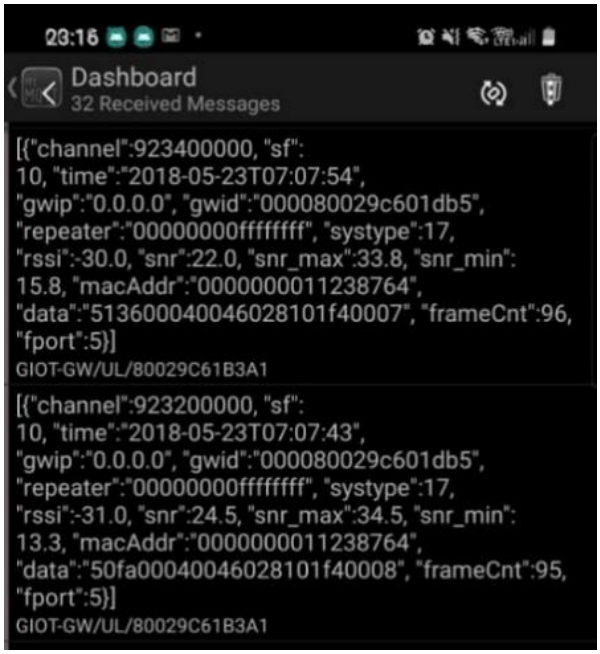

Figure 3: MQTT and IP connection

Ensuring data passed through MQTT protocol, required a set of parameters to connect into servers, this parameter should follow the identity of Gateway (MAC Address) and the Internet Protocol Address from computer server, IP protocol should refer to computer server connected to GioT system, otherwise there are fault of receiving messages from end Node. Acsip were programmed to send data as defined in Figure 4. a set of information displayed contains data which transmitted from end Node in each time, our findings is focused on a field known as "data", Data components and formation to be delivered consists of 4 bytes length of record in every field. Totally there were 24 bytes data length transmitted in a time.

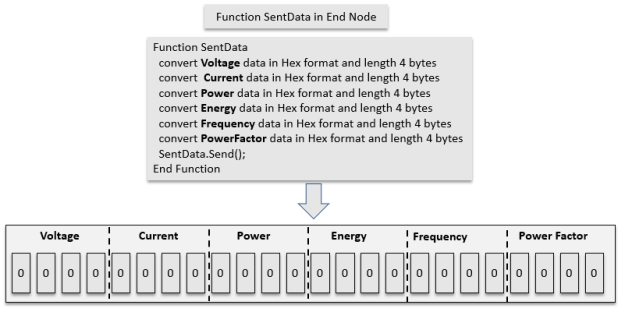

Figure 4: Data Structure from end Node

Each data components constrained to Hexadecimal format, in figure 3. recognition of data structure is "50fa00040046028101f40008", to have the data stored in Database Management System, the middleware engagement is necessary to set along with database driver. Programming language in middleware using Node.Js built to accommodate data capturing activities when end Node and Gateway have connected each other. The script involves MQTT protocol and IP address so it can establish the two-way communication mode, structure of Node.Js code are below:

Table 5: Node.Js MQTT IP Function setup

Type of Action	Instruction	description
Function Connect MQTT ()	Connect (Broker, Topic)	Set the Broker (IP address of Machine) and Topic (Parameter of MQTT subscribe-Table 4.)
Function Receive Message	function mqtt_messsageReceived (topic, message, packet)	Gathering data sent from end Node, the variable of data is packet
Function Insert Message	function insert_message (topic, message_str, packet) {	Store the data in packet variable onto database temporary field

After the second step or middleware layer completed, the data has been stored in a table in which set as temporary data collection area. Ensuring data capture in table 5. at Function insert message need Structured Query Language syntax, its statement using "insert into table" is a predecessor process before data refinement activities taken. Before statements of adding data named "insert into" syntax successfully executed, dispatching data from one form string type of variable named message_str is important. A set of data inside message_str, is kept on one size length formats, disassembled it into several components of variable can be done by create an array variable. Captured data stored in temporary table from sensors still in a single field. Splitting data to separate name of field require specific SQL syntax. every field in temporary table filled with a semi proper value, after splitting action completed. Captured data from temporary table previewed as below:

	data
)029C61B3A1	"data":"507800190b2c029901f40036"
)029C61B3A1	"data":"5046001a0b90029901f40037"
)029C61B3A1	"data":"503c001a0b86029901f40036"
)029C61B3A1	"data":"4ff6001a0bc2029a01f40037"
)029C61B3A1	"data":"504600190b0e029a01f40036"
)029C61B3A1	"data":"505000190b18029a01f40036"
)029C61B3A1	"data":"506e00190b0e029a01f40036"
)029C61B3A1	"data":"505a00190afa029a01f40036"

Figure 5: Temporary Table

Special characters wrapped data value are inserted within "data", these circumstances lead to refine and recreate the formation of data using SQL syntax. In the last stage, constructing sensor data in proper format inside

database management system is distintive activity which focused on the refinement and extraction of data and grouped them into fields in a clearly defined table. The SQL syntax required to accomplish activity are categorized and detailed in table 6 below:

Tabel 6: SQL Syntax Data Definition and Data Manipulation

Category	Type of Action	Instruction	description
Data Definition	Create Database	Create Database_name	Constructing Database object
	Create Table	Create Table_name	Creating table within Database
Data Manipulation	Remove Additional Characters	Substr (field, start range, end range)	Selecting set of data within a set value format
	Data Conversion	Convert(field)	Converting selected data to from hexadecimal to decimal value
	Data Conversion	Cast(filed) as data type	Converting selected data from unsigned to signed data type

As mentioned above, to construct data power from sensors in a single-phase residential load, data manipulation needs to be carefully executed to avoid inconsistencies and disintegrity. As a result of data manipulation from single format data in hexadecimal in figure 5, there were seven variables created to store the data in a table. Table structure for clean data storage is set to seven fields, field naming adjusted from single-phase residential power data:

Table 7: Database table structure of data power

Field name	Data type	format
dwaktu	Timestamp	yyyy-mm-dd hh:mm: ss
nvoltase	Integer	99,99
narus	Integer	99
npower	Integer	99,999
nenergy	Integer	999
nfrekwensi	Integer	999
npowerfactor	Integer	99,999

Field dwaktu referred as date and time occurs of data transmitted from end Node, nvoltase field is the voltage value, narus refers to current value, npower refers to power value, nenergy refers to energy value, nfrekwensi refers to Frequency value and the last is npowerfactor refers to power factor value. The meaning of "n" in field naming referes to number data type and the "d" refers to datetime data type, since the ethical database programming rule suggest for field naming should be understoodable and meaningful to the data type. Results of succeed execution using data definition in database system is a well-structured table formation which ready to filled with data, every data captured from Node.js were inserted to each table field as shown in figure 6, data stored sequently in the norm of "insert" statements of Structured Query Language.

dwaktu	nvoltase	narus	npower	nenergy	nfrekwensi	npowerfactor
2020-10-28 07:20:14	20,600	25	45,760	665	500	16,387
2020-10-28 07:20:24	20,550	26	47,360	665	500	16,387
2020-10-28 07:20:34	20,540	26	47,200	665	500	16,387

Figure 6: Construction of LoRa Data Power

In executing data extraction, creating data in figure 6 using SQL syntax usages in selecting data with combination of cast and substring command is: **cast(SUBSTRING(Database.tabel.data,time,21,8) AS TIME)** and combination of conversion and substring command is: **conv(SUBSTRING(Database.table.data,19,4),16,10).**

Both syntax formats contain similar function to work using difference type of parameter of database, table and field where temporary data stored, completing execution of data filled with parameter Database name=Temporarydb, Table name=Temporarytable, and data= Temporarytable.data. number parameter is the mandatory parameter in substring syntax. Significant value of parameters showing in last parameters of cast () or conv (), term "as" in cast () refers to datatype for the final value and two digits in conv () refer to decimal value set for final value.

Cast () method provides the value enhance from data type, changing value allowed from cast is date value "yyyy-mm-dd", datetime "yyyy-mm-dd hh:mm: ss" time "hh:mm: ss", char to fixed length in string, signed integer 64-bit format, unsigned 64-bit format a binary. Convert () function has the same purpose as Cast () the difference of those is in syntax format. In this experiment both of function were tested to handle the variety of data type came from sensors. In further implementation using various database management system, both functions needed to evaluate to ensure compabilities problem.

In figure 6, dwaktu field is filled with time format, end Node were set to transmitting data in every 10 seconds, frequency of data transmission has a flexibility in millisecond measurements. More frequents data sent from sensors define storage capacity should provide, at least prediction of data capacity formulated with totalcapacity= record length (in bytes) x frequency (times). In addition, Received Signal Strength Indicator (RSSI) field and Spread Factor (SF) also added in table, it contains changing value of sending data from end Node to Gateway regarding distance and obstacles, record length for RSSI is set to 2 bytes and Spreading Factor is 2 bytes length.

nsf	nrssi
10	-10.0
10	-11.0
10	-12.0

Nsf refers to numeric value of Spread Factor, and nrssi refers to RSSI numeric value, those value is automatically coming along as the data power received in GioT system. calculation of range using RSSI formulation mentioned above is necessary to do every time. Spreading Factor refers range of receiving and transmitting mechanism form end Node, it will affect of the data length carried and the power consumption to broadcast data. RSSI and SF collected in this experiment gathered from residential home power consumer, difference value from both depends on location of end Node and the GioT system, in first step on activating end Node, Acsip has been enable to choose range of spreading factor by writing it inside the memory system. For best results in positioning measurement, signal obstacles -wall, temperature, humidity - are necessary to be considered as improvement of Quality Assurance process in data and signal quality.

5. Conclusion

This paper present steps in constructing LoRa data power from single-phase residential load to Database Management System, there are two main activities, first is implement LoRa wireless sensor network and create a code to catch data from communication protocols MQTT and IP, second is Data Construction using SQL command to define data structure and refining data format. Our experiment using data taken from sensors can be managed in Local Area Network Scheme, to aim comprehensive evaluation from wireless sensor network data, a low-cost data storage mechanism should be considered. Limitations in this finding is to ensure the quality from power using more accurate sensors, measuring power from alternate current and direct current in a home or building in microgrid, improving information for monitoring and control power consumption, and analyse the prediction for data space storage.

Future works in this research is scaling up data storage and improving performance of huge amount LoRa sensors in a wireless sensor network

which differs in data eg. Temperature, Luminance, Humidity, Geo-Location, and others to operate in microgrid and consumer within grid, there are two type of network operation of LoRa sensor network, first is Local Area type which is not always connected to the internet and Wide area network called LPWAN is typical on connect with internet. The objectives in Local Network Mode works as LoRa performance test in an urban area with differs topology (hills, valley, or mountain). Final objectives of this research are to develop smart system based on real time data regarding conditions of various network connection.

REFEENCES

Acsip, 2017. Acsip S76s Product Specification'. Taiwan: Acsip Technology Corporation, Pp. 0–20.

Afisiadis, O., Cotting, M., Burg, A., Balatsoukas-Stimming, A., 2020. On the Error Rate of the LoRa Modulation with Interference. IEEE Transactions on Wireless Communications, 19 (2), Pp. 1292–1304.

Ahuja, K., Khosla, A., 2019. A novel framework for data acquisition and ubiquitous communication provisioning in smart cities', Future Generation Computer Systems. Elsevier B.V., 101, Pp. 785–803.

Fatima, H., Wasnik, K., 2016. Comparison of SQL, NoSQL and NewSQL databases for internet of things', IEEE Bombay Section Symposium 2016: Frontiers of Technology: Fuelling Prosperity of Planet and People, IBSS 2016. doi: 10.1109/IBSS.2016.7940198

Georgiev, G., Marinov, M., 2019. An approach to storing real-time sensor readings based on NoSQL database systems', 2019 16th Conference on Electrical Machines, Drives and Power Systems, ELMA 2019 - Proceedings. IEEE, Pp. 1–5. doi: 10.1109/ELMA.2019.8771666.

Kodali, R.K., Borra, K.Y., Sharan, S.G.N., Domma, H.J., 2019. An IoT Based Smart Parking System Using LoRa', Proceedings - 2018 International Conference on Cyber-Enabled Distributed Computing and Knowledge Discovery, CyberC 2018. IEEE, Pp. 151–154. doi: 10.1109/CyberC.2018.00039.

Krishna, P.N., and Prasanna, V.D., 2018. Machine Learning Based Residential Energy Management System. 2017 IEEE International Conference on Computational Intelligence and Computing Research, ICCIC 2017. IEEE, Pp. 1–4. doi: 10.1109/ICCIC.2017.8524383.

Kumari, P., Gupta, H.P. and Dutta, T., 2019. An Adaptive Power level Allocation Model in LoRa for Internet of Things. Annual IEEE Communications Society Conference on Sensor, Mesh and Ad Hoc Communications and Networks workshops. IEEE, Pp. 1–2.

Ma, K., Yao, T., Yang, J., Guan, X., 2016. Residential power scheduling for demand response in smart grid. International Journal of Electrical Power and Energy Systems. Elsevier Ltd, 78, Pp. 320–325.

Petäjäjärvi, J., Mikhaylov, K., Pettissalo, M., Janhunen, J., Iinatti, J., 2017. Performance of a low-power wide-area network based on lora technology: Doppler robustness, scalability, and coverage. International Journal of Distributed Sensor Networks, 13 (3). doi: 10.1177/1550147717699412.

Pinzon, J.A., Vergara, P.P., da Silva, L.C.P., Rider, M.J., 2019. Optimal Management of Energy Consumption and Comfort for Smart Buildings Operating in a Microgrid. IEEE Transactions on Smart Grid, 10 (3), Pp. 3236–3247. doi: 10.1109/TSG.2018.2822276.

Rogier, J.K., Mohamudally, N., 2019. Forecasting Photovoltaic Power Generation via an IoT Network Using Nonlinear Autoregressive Neural Network. Procedia Computer Science. Elsevier B.V., 151 (2018), Pp. 643–650. doi: 10.1016/j.procs.2019.04.086.

Spinsante, S., Ciattaglia, G., Campo, A.D., Perla, D., Pigini, D., Cancellieri, G., Gambi, E., 2017. A LoRa enabled building automation architecture based on MQTT', 2017 AEIT International Annual Conference: Infrastructures for Energy and ICT: Opportunities for Fostering Innovation, AEIT 2017, 2017-Janua, Pp. 1–5. doi: 10.23919/AEIT.2017.8240560.

Wibisono, G., Permata, S.G., Awaludin, A., Suhasfan, P., 2018. Development of advanced metering infrastructure based on LoRa WAN in PLN Bali toward Bali Eco smart grid', 2017 Saudi Arabia Smart Grid Conference, SASG 2017, Pp. 1–4. doi: 10.1109/SASG.2017.8356496.

Widianto, E.D., Pakpahan, M.S.M., Faizal, A.A., Septiana, R., 2019. LoRa QoS Performance Analysis on Various Spreading Factor in Indonesia. ISESD 2018 - International Symposium on Electronics and Smart Devices: Smart Devices for Big Data Analytic and Machine Learning. doi: 10.1109/ISESD.2018.8605471.

Yudho, S., 2020. Conceptual Design of Battery Energy Storage Monitoring System using LoRa', in 2020 International Seminar on Application for Technology of Information and Communication (iSemantic). IEEE, Pp. 374–377. doi: 10.1109/iSemantic50169.2020.9234217.

Zhou, Q., Zheng, K., Hou, L., Xing, J., Xu, R., 2019. Design and Implementation of Open LoRa for IoT. IEEE Access. IEEE, 7, Pp. 100649–100657. doi: 10.1109/access.2019.2930243