LoRaWAN Technology for Internet of Things

[1] Dae-Young Kim, [*2] Seokhoon Kim
[1,2]*Dept. of Software Engineering, Changshin University,*
{kimdy, shkim}@cs.ac.kr

Abstract.

LoRaWAN as base technology for the Internet of Things is recently treated as one of the standard technology of the global industry. LoRa Alliance with its focus on global representative corporations defines the needs of communications technology for Internet of Things and is in the process of standard development. LoRaWAN is a communications technology with a low data rate based on low-power technology, and provides a wide communication radius. Thus, LoRaWAN can be utilized in a variety of things through internet application. In June 2015, The LoRaWAN R1.0 was released, and the data transmission technology was introduced through many of LoRaWAN alliances. In this thesis, we summarized the data transmission technology standards that are expected of LoRaWAN, and the higher utilization from Internet of things applications by studying the applications of LoRaWAN.

Keywords: *Long Range Wide Area Network, Internet of Things, Wireless Network, communications technology, wide communication radius*

1. Introduction

The network has expanded by recent advances in communications technology. Connections between devices have changed from wired network to wireless network, as communication devices get smaller with more various functions. Therefore, a new information technology service called "internet of things" has become possible. Internet of things can be seen as a kind of infrastructure for enabling intelligent services through the connection between objects (devices). Objects must always be connected to a network to transmit information [1-3]. Thus, the sensing information collected through the device via internet of things is analyzed by the cloud system generating new services or it is provided to expand or enhance existing services [4-6].

The devices of internet of things are usually battery-powered and transmit the sensing information collected by the access network of the cloud object. Therefore, communication in the access network of the Internet of Things is for low-power and based on the wireless technology to be applied, Figure 1 information collected by the access network, such as the network must have a structure that can be delivered to the cloud. In the access network for data transmission using wireless communication technology for object Internet and is connected to the gateway of the cloud is to use an existing IP network.

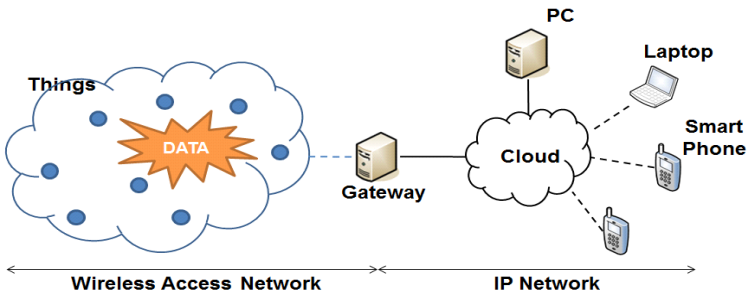

Figure1. Network Architecture of Internet of Things

[*] Corresponding Author
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Objects of the Internet access network to the IEEE 802.15.4 LR-WPAN [7, 8]. The most common technique is considered, but, IEEE 802.15.4 is a radius of tens of meters to a data transmission standard is limited and the POS (Personal Operating Space) for a 10m Since the target object to implement a wide range of applications of the Internet it has a pharmaceutical component. Therefore, long range wide area network to note the (LoRaWAN) which has broader communications with a radius of branch network technology are being noted. LoRaWAN provide wide range of network communications technology as an industry standard for communication and semiconductor global companies associated with the object oriented implementation of the Internet and supports low-cost, low-power battery-based communication for the object [9]. Standard Release v1.0 for LoRaWAN was announced by the LoRa Alliance in June 2015, it has been providing services for the Internet of Things and M2M developers. In this article, we have investigated to look for a standard communication technology communication LoRaWAN, network requirements and issues information is based on Release v1.0 of this LoRaWAN.

2. LoRaWAN

LoRaWAN is a wireless technology, characterized of long-range, low-power, low data rate and composed of end-devices, gateways, and central network server. An end-device is applicable to things that can collect and deliver sensed information and sensed information is delivered to the end-device via the gateway network server. Therefore, the gateway should relay the sensed information to the network server in the backend. The information transfer between the gateway and the end-device with the use of a single hop LoRaWAN wireless communication technology, communication between the gateway and the network server is to use a standard IP network [10, 11]. The LoRaWAN network architecture is a typical star-of-stars topology. The end-device and the gateway are connected by the star topology, because many gateways are connected to one single network server to form a star topology.

As you can see in Figure 2, the internet of things and structure is similar to Figure 1. The sections LoRaWAN's transmission technology are used can be seen as the access network and the gateways connected to the network server can be seen as a cloud server. LoRaWAN's master, the network server controls the end-device, the slave node which operates integrated management of the information collected from the end-device. It also results of the analysis can provide information to the intelligence services. LoRaWAN standards mainly deal with the wireless communication technology of the access network for data transmission end-device. LoRaWAN is in communication with the frequency of the ISM band of 800 MHz or 900 MHz, in the urban environment is the single-hop communication range to Mile 2 and the open area has a large communication range, so that a single-hop communication range correspond to a 10 mile. Also, LoRaWAN data rates range from 0.3 kbps to 50 kbps. adaptive data transfer rates and data transmission rate of (adaptive : adr data rate) communications can adjust the scope of control. And increasing the transmission efficiency by supporting multiple radio channels (Multiple channels). Do Listen Before Talk (LBT) process to determine the status of a radio channel before data transmission to a radio channel selected, and, if the channel to be used lies in the Busy state end-device is to change the radio channel for data transmission LBT again perform the procedure [10].

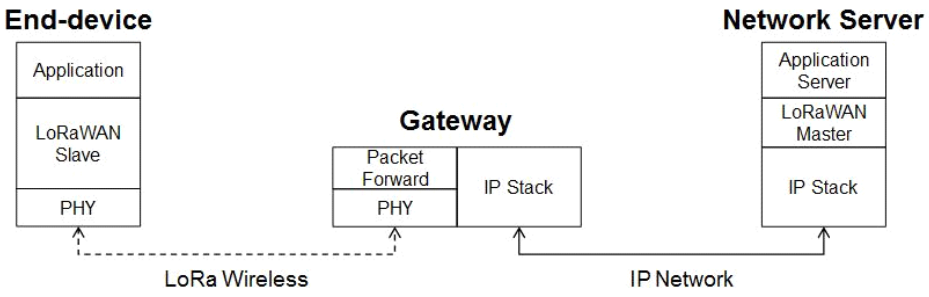

Figure 2. LoRaWAN network

2.1. Gateway movement

In LoRaWAN, a number of gateways exist and these gateways relay data of the end-device to a network server. Gateway broadcasts the message to a periodic beacon. At this point, a beacon message propagates information of time synchronized beacon and available channels. Receiving the beacon message, the end-device can perform the synchronized operation using the time synchronized information and channel information of the gateway to use the available radio channel selections.

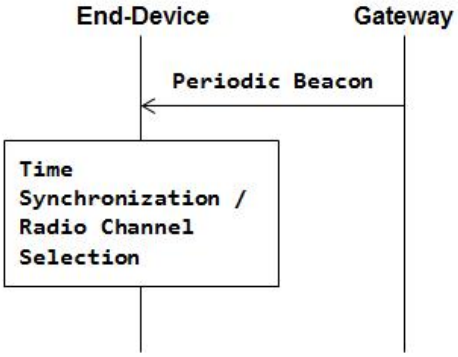

Figure 3. Beacon procedure of LoRaWAN

2.2. End-device Movement

End-device has a global 64-bit application identifier (globally unique application ID) and global device identifier (globally unique device ID). Also it has the AppKey imparted from the application service provider. end-device may send encrypted data via a session key derived from the AppKey. End-device uses two ways to join the LoRaWAN. One contains a procedure to Join Over-the-Air Activation method. Join the end-device procedure is as follows: When the End-device sends a Join Request message, including AppEUI, DevEUI, gateway relaies this message to the network server to listen. If the Network server accepts the end-device Involve the end-device by responding to Join Accept message to LoRaWAN. Another way is activation by personalization way, in a private network, network do not do the necessary information for participation procedures used and join end - deviceA better way to simplify the procedures of security by allocating in advance.

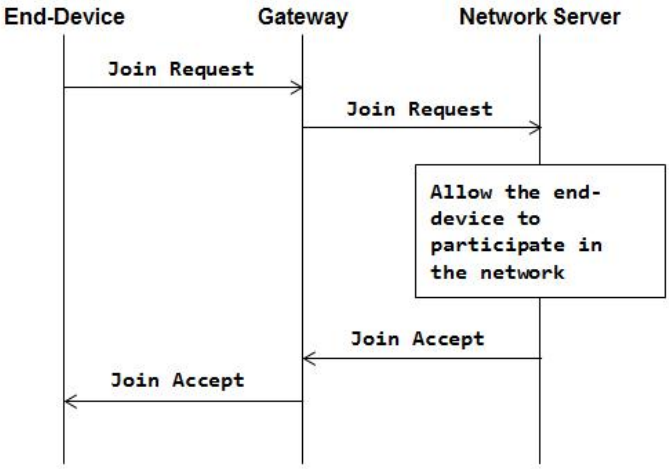

Figure 4. Join procedure of LoRaWAN

Data transfer in LoRaWAN is divided into uplink and downlink. All the end-device and the uplink transmission is completed, it has two reception window. Through the reception window to receive a response to uplink transmission. The first receiving window is located after the time point of the RECEIVE DELAY 1 in the uplink transmission is completed, the second receiving window is positioned at the point of time after RECEIVE_DELAY2 uplink transmission is completed has a longer time than the time of RECEIVE_DELAY1. When reception is completed, if the answer in the first receive window without waiting for an end-device is a second receiving window to attempt the next data transfer.

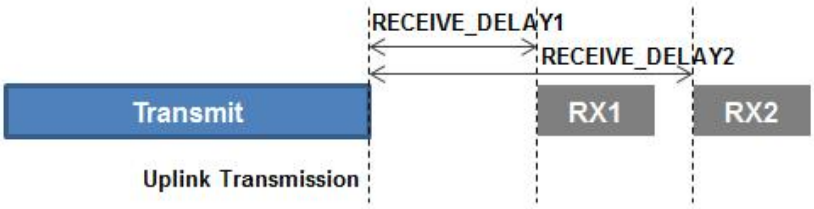

Figure 5. Data Transmission at the end-device of LoRaWAN

2.3. Adaptive data rate control

MAC payload of LoRaWAN (payload) is composed of a frame header (FHDR) and a frame payload (FRMPayload), may use a specific bit (bits ADR) of FHDR use an adaptive data rate. If that bit is set, the network can control the transmission rate of the end-device. Adaptive data rate control when the end-device is used as the data transmission rate over the main data transfer rate (default data rate), end-device has to periodically verify whether a successful data transfer. End-device increments the counter (ADR_ACK_CNT) every time the transmission of each frame, and upon receipt of the counter without a response has reached the threshold value (ADR_ACK_LIMIT) by setting the ADR response request (ADRACKReq) bit in the frame header gateway a given time (ADR_ACK_DELAY) to respond to requests within. If the gateway does not receive any response from the end-device extends, the transmission range reduces the data transfer rate. The End-device is transmitting a frame after the counter value is reset if the response was received. Doing so will use an adaptive data rate control to extend the range of the network, reducing the unnecessary use of the battery end-device can increase the network lifetime.

2.4. The main MAC Command message

MAC command frame payload messages or piggybacked, the frame may be transmitted in a single MAC command in the payload.

2.4.1. Link Check

An end-device is used to verify the network connectivity and transmits a LinkCheckReq message to the network server. And via the Network server, the gateway receives the LinkCheckReq message and responds with a LinkCheckAns message. The LinkCheckAns message network signal strength measured at the gateway (link margin) It is sent to the end-device, including the number of the gateway having received the information LinkCheckReq.

2.4.2. Link ADR

The Network Server LINKED RREQ message is indicated using end-device, the data rate, transmission power, to change the radio channel. The end-device receives a response to a message

LinkADRReq LinkADRAns message, and a measured signal strength information at LinkADRReq Message.

2.4.3. Duty Cycle

Network server using the DutyCycleReq message sets the maximum duty cycle of the transmission and end-device and the end-device responds with the DutyCycleAns message.

2.4.4. End-device Status

The network server requests the status information from an end-device using a DevStatusReq message. The end-device responds with a DevStatusAns message including information about the battery level, signal strength and network connection.

2.4.5. New Channel

The network server defines the data rate range and the new radio channels, or transmits the NewChannelReq message to correct the information for a radio channel to the end-device. The end-device acknowledges the reception of a NewsChannelReq by responding with a NewChannelAns command.

2.5. Beaconing

All LoRaWAN the gateway provide a starter (time-synchronization) mechanism to the end-device by transmitting a beacon at regular intervals. Beacon message has a gateway information including a network identifier, the radio channel information, GPS time, and the gateway location. Gateway is broadcast periodically by allowing end-device is located within the network can take advantage of receiving the beacon message.

3. Applications

LoRaWAN the Internet of Things, for low-power smart city, industrial applications, was developed as a low-cost two-way communication technology. WiFi, Bluetooth, ZigBee as the wide transmission range than conventional communication technologies for the Internet of things It is characterized with. Therefore, logistics, manufacturing, building automation, connected home, smart city, etc. may be used for the purposes of remote monitoring.

By sending the information end-device is collected in a smart factory scenario applied in the manufacturing process as a network server enables data analysis from the network server, and Based on this, identify the status of the plant status of my machines, production lines and adjust the appropriate output it is possible. National Park of the information in the environmental monitoring scenarios using LoRaWAN collection of local ecosystems, and effective monitoring and management through the actuator and the machinery located in the remote control is possible. Smart City scenario in the end-device to reduce data loss in a wireless environment due to a multi-hop transmission data to be delivered to the network server via the gateway to the single-hop transmission.

4. Conclusion

With the focus on things at home and abroad has focused on internet-based technology for the internet of things service implementation. While wireless technologies are limited to be narrower by the service data transmission range is limited for objects existing Internet LoRaWAN been able to provide a wide data transmission range and a low-power, low-cost wireless communication. IBM, SEMTECH, Microchip, such as those focusing on established global companies Through the Alliance, the wireless communication standard was published, the SKT Telecom in Korea has been actively participating as LoRaWAN alliance in research of internet of things technology. In this paper, as the

Internet of Things wireless technology wondered about the application look at the specifications for the transfer of data LoRaWAN. LoRaWAN uses the ISM frequency band, and an adaptive data rate The utilization for a control object and the future Internet services by supporting multiple radio channel is expected to be high and communication technology. In particular, it is expected in military and industrial objects Internet service that Internet service object remote monitoring is required to be a key of the wireless technology.

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