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Data Recovery by Fountain Codes in IoT Networks

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Abstract

The internet of Things (IoT) is an increasing number of existences for smart applications. A long range wide area network (LoRaWAN) is a Long-range low-power communications which is used to supply excellent connectivity for the Iot devices. Information can be lost when it passes from sender to receiver due to the collision of the nodes. In this paper, we discussed about the LoRaWAN technology which is used to communicate with low bit rate. To minimize the information losses when passing from sender to receiver in LoRaWAN, a data recovery method is proposed for the process of encoding and decoding using convolution and fountain codings.

Keywords: - Long range wide area network, internet of things, data recovery, fountain code, convolution code

INTRODUCTION

The Internet of things (IoT) connects human things to the Internet. This allows smarter and comfortable human living space. With the rise and projected scale of applications in IoT, many technological solutions are proposed for short range communication. However, recent advances have enabled a simpler technological solution called Low Power Wide Area Networks (LPWAN) that covers low energy communication over distances of multiple kilometers, making devices to send data to the Internet backbone over only one hop. LoRaWAN is one of the several competing LPWAN technologies. LoRaWAN is specifically developed for smart applications with tiny end-devices that have to send tiny amount of data over massive time intervals at low cost.

In [1] the authors proposed about LoRa in which it uses chirp spread spectrum modulation technique which causes collision due to confines on duty cycle. The stochastic geometry frame-work used for modeling the performance of single way Lo-Ra network. The drawback is high in data loss. In [3] the author analyzed about the components of LoRa. The collision and traffic are high. In [4] the author proposed about the real-life measurements of LPWAN technology. The limitation is retransmissions with less output. In [5] the author analyzed about the LoRa low power wide area network (LPWAN) technology under European frequency regulations. The implementation is implausibly high worth. In [6] the author proposed about the scaling laws which explain about the properties of delimited wireless networks. The drawback is packet loss.

In this paper to reduce data loss in LoRaWAN, a novel coding scheme of data recovery is recommended. The frame loss leads to data loss in the network that is characterized in terms of spatial and temporal properties based on data set. The data loss in LoRaWAN is reduced by the data recovery using application layer coding. Data recovery uses convolution code which calculates the redundant information and output of the convolution is decoded by fountain code. The performance of the parameters is analyzed with the uncoded and coded method using network simulator. The rest of the paper is as follows. In the next section, we present the concept of LoRaWAN and in section III introduces the proposed methodology. Section IV introduces about the simulation results and discussions.

LONG RANGE WIDE AREA NETWORK

LoRaWAN is a wireless communication providing long range at a small bit rate. LoRaWAN operates in different spreading factors from seven to 12.

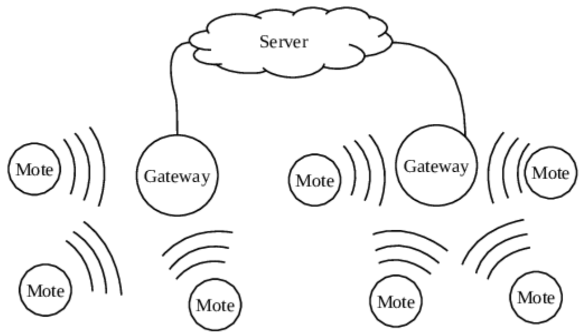

Figure.1. Topology of LoRaWAN

The topology described in figure 1 is a star to star topolgy. LoRaWAN aims to exchange information between low-power devices and a network server, through gateways over long distances. The components of a LoRaWAN Network are follows:

- **End-device**: The end device communicates through gateways.
- **Gateway:** The end devices send packets to a network server which allows a good larger turnout.
- **Network server:** It is mainly used for de-duplicating and cryptography the packets.

PROPOSED METHODOLOGY

A. Data Recovery in LoRaWAN

End-device transmits its sensor data to destination. This data is at the heart of the IoT applications. ALOHA protocol leads to collision which causes frame loss that leads to data loss. The frames transmitted over LoRaWAN can experience significant frame loss. The data loss in LoRaWAN is reduced by the data recovery based on fountain code and convolution code which is implemented in application layer. Furthermore, we show that the solution has less overhead compared to other low-complexity solutions. Below given are the methods followed in data recovery process.

B. Convolution Code

Convolution code is used in data recovery technique for retrieving the data. Here, the convolution code is used as encoding process. Convolution code is used to transmit data to other node. The convolution code sequentially convolves the sequence of information bits. The encoding are mapped by each code bit sequence uniquely which corresponds to an information bit sequence. In convolution code, the information bits are spread along the sequence. The encoding is performed by different shift registers which rolls the information from one side to other side. A convolution code can be defined by using a generator matrix that describes the encoding function.

C. Fountain Code

Fountain codes are used in data recovery technique for performing the decoding process. The decoding method is performed by collecting the output of the encoded method. A fountain code took encoded data and transforms into an effectively unlimited number of encoded chunks, such that we can reassemble the original file given by any subset of those chunks.

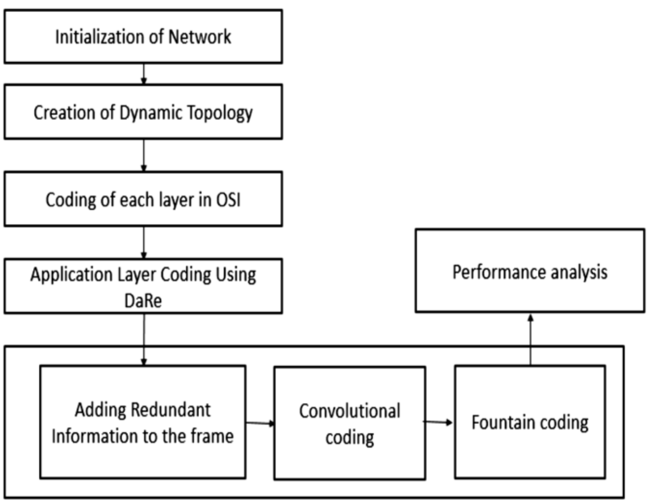

Figure 3. Flowchart of working process

The working process is described in figure 3 which is described briefly below in following steps.

STEP 1: Initialization of Network Basic configuration.

The location of variable data processed in network configuration.

STEP 2: Creation of nodes and deployment in dynamic topology.

The nodes are created once a flow is deployed that send and receive some messages. Dynamic topology will be created with variety of nodes in X & Y direction.

STEP 3: Each layer in OSI layer will be coded

The seven layers in OSI model are coded where the physical layer implements the lora and establishes the connection. In the data link layer, the lpwan is implemented and in and MAC layer, the LoRaWAN is implemented. In network layer establishes the network connection. The transport layer transports the data from source to destination. In application layer, the data recovery technique is implemented.

STEP 4: Data Recovery implemented in Application Layer

The data recovery is applied in application layer of OSI model which is coded by fountain code and convolution code which reduces data loss in LoRaWAN.

STEP 5: Adding Redundant Information to the frame for recovery

The existing data sets are collected which is added to the redundant information to the frame for recovering the original data which is send to the convolution process.

STEP 6: **Frame has been applied using convolution coding**

Convolution code is used in data recovery technique for retrieving the data. Here, the convolution code is used as encoding process. Convolution code used to reliably transmit data to system. The convolution code maps the information to code bits but sequentially convolve the sequence of information bits.

STEP 7: Output of the convolution has been coded by fountain coding

Fountain codes are used in data recovery technique for performing the decoding process. The decoding method is performed by collecting the output of the encoded method. A fountain code took the convoluted data and transforms into decoded data, such that we can get back the original file.

STEP 8: PERFORMANCE ANALYSIS

The output of the fountain codes are analyzed for the performance of the network using the parameters such as accuracy, energy consumption, data recovery rate and packet delay.

SIMULATION RESULTS AND DISCUSSIONS

Network Simulator-2 is widely used tool to simulate the behavior wireless networks. Network simulation software permits us to anticipate the performance of an extensive scale and complicated network system such as internet at low cost under different contour of interest and over long duration. The tabular I discussed about the parameters of network simulation.

Table 1. PARAMETERS OF NETWORK SIMULATION

PARAMETERS	VALUE
NO. OF NODES	47
MAXIMUM ENERGY OF SENSOR NODE	0.85J
DATA AGGERATION ENERGY	3
SIZE OF THE NETWORK	47×47
LOCATION OF SOURCE	10×10

The below given graphical representation are the comparison of the packet delay, packet delivery, energy consumption and data recovery rate.

Packet Delay

The delay is caused between selected packets when it sends information from one node to other node due to the packets being collide or ignored.

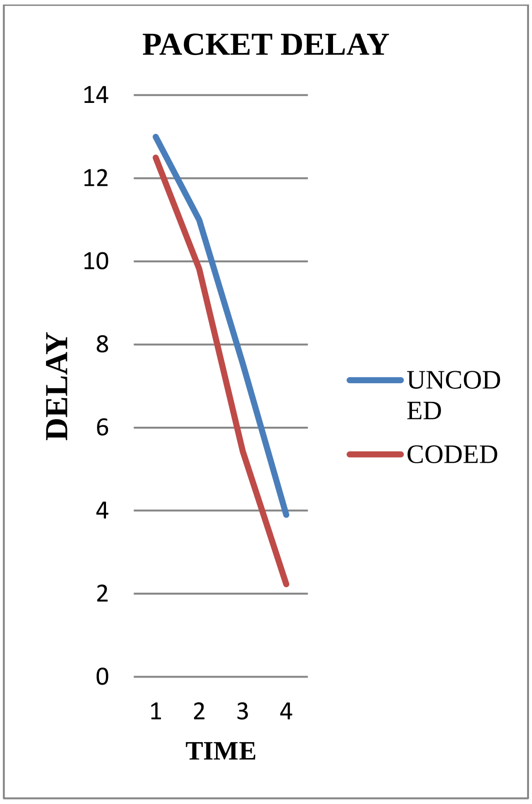

Figure 4. Graph describing packet delay

The figure 4 shows the values which are compared between the coded and uncoded method. The packets get delayed when it passes from sender to receiver due to collision of nodes which are reduced in coded method with ALOHA protocol.

Data Recovery Rate

The amount of data which is retrieved from the node and the rate is defined as the ratio of amount of data recovered by the maximum amount of data which is send in the network.

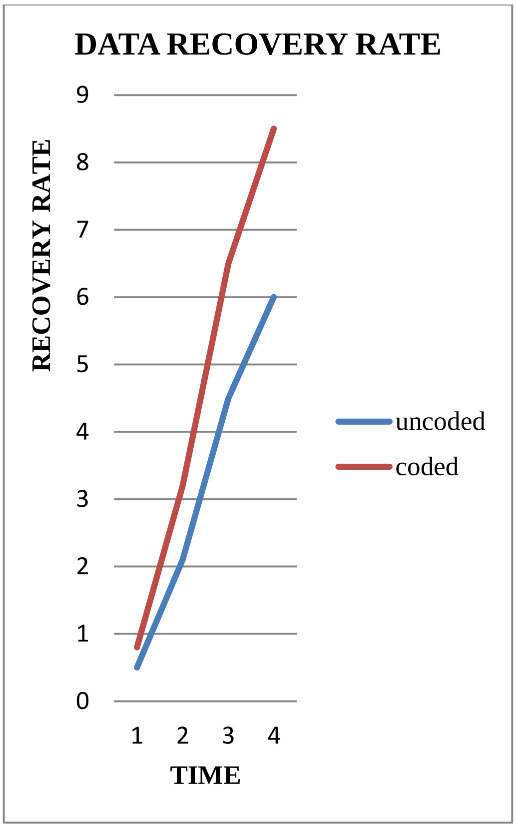

Figure 5. Graph describing data recovery rate

The figure 5 shows the values which are compared between the coded and uncoded method. The data gets recovered from the losses which are recovered highly in coded method by using convolution code and fountain code.

Throughput

The amount of data moved successfully from one place to another in a given time period is defined as throughput.

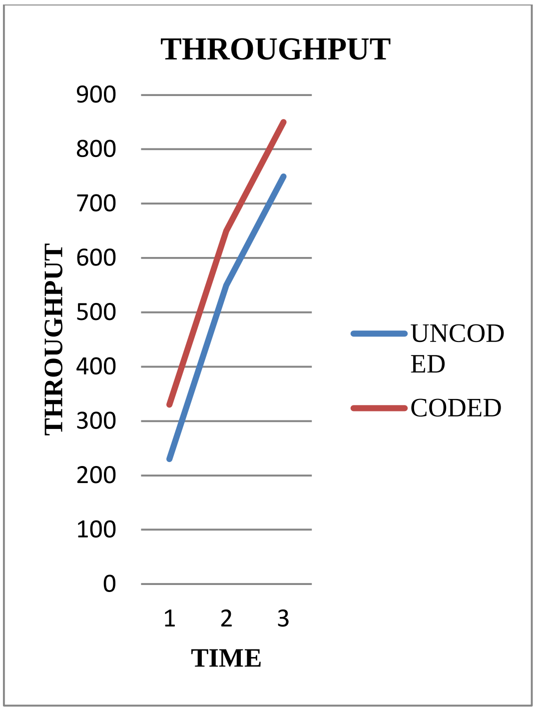

Figure 6. Graph describing throughput

The figure 6 shows about the values which are compared between the coded and uncoded method. The amount of data moved to destination is high when compared with the uncoded method.

Packet Delivery Ratio

Packet delivery ratio is defined as the ratio of data packets collected by the destinations which was generated by the sources.

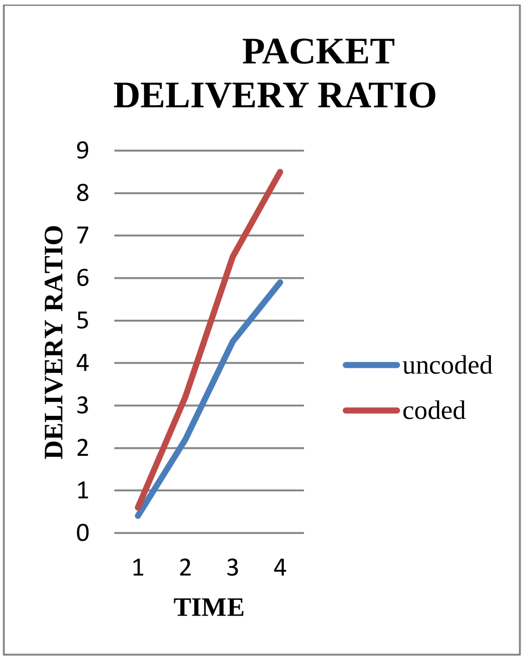

Figure 7. Graph describing packet delivery ratio

The figure 7 shows about the values which are compared between the coded and uncoded method. The amount of packet which is moved to destination successfully is high when compared with the uncoded method.

CONCLUSION

In this paper, we tend to specify about the adopted modus of LoRaWAN. To collect data from IoT devices, a new architectures called LoRaWAN, a Low Power Wide Area Network (LPWAN) technology is proposed.

By the simulation and execution of the proposed system, it is clear that the performance level in case of delay, throughput and packet loss is reduced in coded method using fountain code and convolution code. The performance measure for packetdelay, packet transfer, throughput, energy consumption and accuracy are represented graphically comparing the uncoded and coded method in LoRaWAN. According to the result, it is clear that the data recovery in LoRaWAN has much more efficient way of data packets transfer without any loss.

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