Research of ADR mechanism in low mobility scenario

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Abstract

As one of promising and valuable low-power Wide Area Network (WAN) technologies, LoRaWAN has been in the limelight among the scholars at home and abroad. Adaptive Data Rate (ADR) has been introduced in LoRaWAN, because it can adjust Spreading Factor (SF) and Transmission Power (TP) according to the changes of network topology and changes of network topology and channel conditions. The ADR mechanism can enable LoRa nodes to maintain a certain network performance while trying not to lose the reliability of network topology. LoRaWAN is widely used not only on fixed devices, but also on mobile devices.

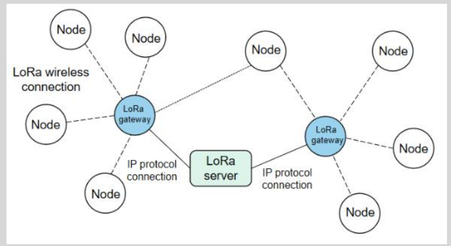
In this paper, the flexibility of ADR mechanism in low mobility environment was studied by means of the FLora framework of OMNet++ simulation software. We first optimized the parameters of ADR mechanism in low mobility environment, and then changed the moving speed of LoRa node to observe its relationship with the effect of ADR mechanism. We found that the network performance will be improved by 12 % when the node moves at a specific speed compared with the case of static nodes. In addition, we also compared the convergence speeds of ADR algorithm at node (Node-ADR) and ADR algorithm at network server (Net-ADR). The simulation results show that the convergence speed of Net-ADR algorithm is about 6 % faster than Node-ADR algorithm.

Introduction

LoRaWAN is a network protocol designed for LoRa communication, which has the advantages of long distance, low power consumption and low cost. The network topology of LoRaWAN is star-shaped and has a flexible ADR mechanism. This mechanism has recently been updated in the LoRaWAN specification v1.1 and gradually entered commercial deployment. In theory, LoRaWAN only consumes very low energy to connect devices and gateways tens of kilometers away. Therefore, LoRaWAN is gradually sought after by academia and widely used in building Internet of Things facilities. Moreover, with the support of ADR mechanism, LoRaWAN has good reliability and extensibility.

Adaptive Data Rate

The ADR mechanism is defined by LoRaWAN, which can control the values of the uplink transmission parameters of LoRa devices, such as SF and TP , to maintain good network performance and make LoRaWAN achieve a balance between reliability and network performance.



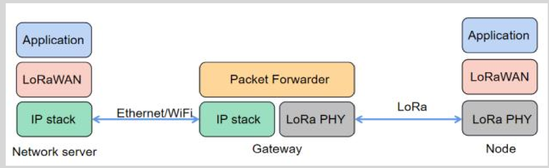
MODEL DESCRIPTION

In order to evaluate the flexibility of ADR mechanism in the low-speed mobile node environment, we simulate the network composed of one gateway and 10 mobile nodes. The trajectories of these mobile nodes are randomly generated, and an average packet is sent every 10 seconds. This paper assumes that the operation of LoRaWAN in Europe where TP and duty cycle are limited to 14 dBm and 1 % respectively for the default frequency channel.The SF can be varied from 7 to 12 to adapt both the communication range and data rate.Each simulation time is 86400 seconds. Each group of experiments was repeated 15 times and the average results were taken as the basis for the conclusion. The key parameters of simulation are shown in TABLE 1.

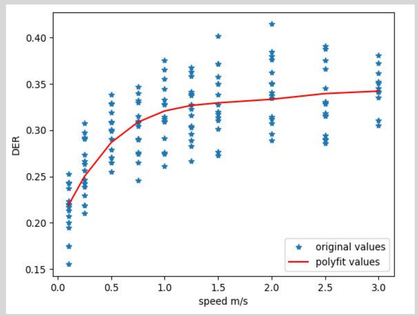
Parameter	Value
Average message rate	60 seconds per message
Carrier frequency	g1 sub-band(868.1,868.3,868.5 MHz)
Bandwidth	125kHz
Code rate	4/5
Spreading factor	7 to 12
Transmission power	{2,5,8,11,14}dBm
Path loss values[11]	d0 = 40m,γ=2.08,PL(d0)= 127.41dB
Channel variation level	σ = 3.57

PERFORMANCE EVALUATION

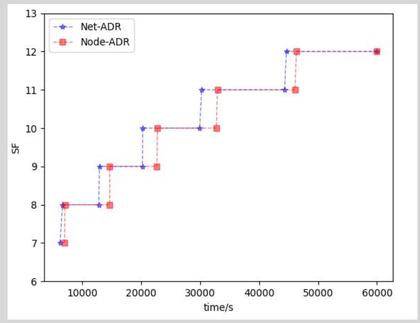
We mainly pay attention to the flexibility of ADR mechanism in the environment of low-speed mobile nodes. For the purpose of quantitative measurement, the Data Extraction Rate (DER) was adopted evaluate the network performance. We define the DER as the ratio of received messages to transmitted messages over a period of time.



In addition, we defined the ADR convergence time as the duration from the change of network link quality to the network receiving a sufficient number of packets for calculating the new SF and TP values and reaching the stable SF and TP values. Now, we evaluate the influence of moving speed on the effect of ADR mechanism in low mobility environment, and then compare the relationship between Node-ADR and Net-ADR convergence speeds.



First of all, we focus on the moving speed of nodes. In this simulation experiment, the mobile speed of all nodes in the network remained the same, and then we gradually increased the moving speed from 0m/s to 3m/s and recorded the average DER values of all the nodes every time. After repeating the simulation for 15 times, Fig. 4 can be obtained as follows:irstly, we focus on the speed of node movement. In this simulation experiment, the speed of all nodes in the network is consistent, and gradually increases the speed of node movement from 0m / s to 3m / s, and records the average DER value of all nodes in each network.



CONCLUSION

This paper is mainly aimed at evaluating and optimizing the performance of the official ADR mechanism proposed by the LoRaWAN Alliance in the LoRaWAN Specification v1.1. Firstly, in order to adapt to the changing network topology and channel quality in low mobility scenarios, we optimize the key parameters of ADR mechanism. Second ,Unlike other previous studies, we pay more attention to the flexibility of ADR in low mobility scenarios. In this research process, we try to answer several questions, such as the influence of the moving speed on the ADR mechanism, and the relationship between the convergence speeds of Node-ADR and Net-ADR. We provide useful insights for improving the algorithm:

- ADR mechanism can improve network performance in low mobility environment. In the network simulation, when the node moves at 1.25 m / s, the DER value increases by about 12 % compared with the fixed node, and the network performance has been significantly improved. But the effect of ADR mechanism will be greatly weakened if the speed reaches a certain threshold.
- The convergence speed of Net-ADR algorithm is about 6 % faster than Node-ADR algorithm in low mobility environment.

We believe that LoRaWAN can be widely used in low mobility scenarios, but the current ADR algorithm needs to constantly adapt to the actual environmental changes, so that we provide a good trend for proposing the next generation of ADR algorithm. In addition to being flexible and adaptive in the fixed node scenario, it is necessary for this algorithm to be optimized in the mobile node scenario..