A Long-Range Low-Power Wireless Sensor Network Based on U-LoRa Technology for Tactical Troops Tracking Systems

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***Abstract*—this paper presents the deployment of a LoRaWAN implemented by Thai people called Universal and Ubiquitous (U-LoRa) for an application of Internet-of-Things in tactical troop tracking systems. The proposed long-range communication system comprises only the implemented gateway using Raspberry-Pi but also an end-device using microcontroller with GPS and other sensors for geological and physical tracking. The proposed system employs four gateways with bridge-to-bridge WIFI connection for communication to the server. The end node can be integrated more than ten types of sensors such as GPS, temperature, humidity, and water sensors. All data can be visualized real-time via monitor station. The proposed system provides not only an emerging long-range communication but also low-power operation in a military campsite within 0.5 kilometers using a transmission power of 4dBi.**

Keywords—U-LoRa; LoRaWAN; Long-range communication.

I. Introduction

Internet of Things (IoT) has been initiated from enabling connectivity on edge devices, and providing new services which have not been available with reasonable cost. Key challenges in the realization of IoT systems and applications are to minimize edge nodes deployment cost and maintenance cost. It is because the number of required edge nodes is much higher than that of hand-held devices. Wireless communication protocols, which are specially designed for IoT applications, can minimize the hardware complexity and power consumption of edge nodes. Furthermore, cloud technology providing the common service frameworks can reduce maintenance cost of IoT systems. Fig.1 shows the place of LPWAN in IoT wireless connectivity ecosystem whilst Fig. 2 demonstrates the block diagram of a low-power long-range transceiver module SX1276/77/78/79, operating at 137 MHz to 1020 MHz [1]. In accordance to possible communication ranges, two wireless communication protocols can be classified into two categories, i.e. (i) short-range and (ii) long-range communication protocols. On the one hand, WiFi, Zigbee, and Bluetooth represent the short-range communication protocols, which are suitable for indoor environments. On the other hand, long-range communication protocols can be deployed using LoRa communications [2-4]. Typically, LoRaWAN has three classes of end-point devices to address different needs reflected in wide range of applications as follows;

	Local Area Network Short-Range Communications	Low Power Wide Area (LPWAN) Internet-of-Tings	Cellular Network Traditional Machine-to-Machine
Ratio Use	40%	45%	15%
Advantages	Well Established Standard	Low Power Consumption Low Cost	Existing Coverage High Data Rate
Disadvantages	Battery Live, Cost	Emerging Standard	Autonomv. High Cost
Examples	Bluetooth Wi-Fi	LoRa	3G 4G

Fig. 1. The place of LPWAN in IoT wireless connectivity ecosystem.

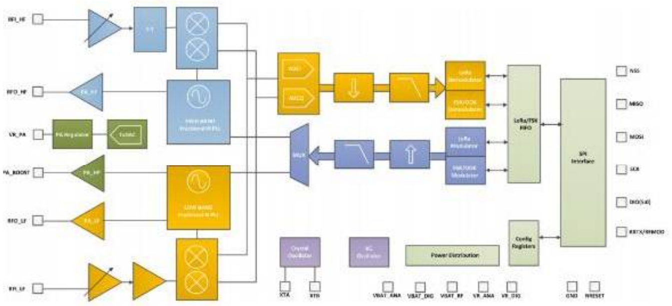

Fig. 2. The block diagram of a low-power long-range tranciever module SX1276/77/78/79, operating at 137 MHz to 1020 MHz [1].

First, class *A* or a bi-directional end-device in which end-devices allow for bi-directional communications whereby each end-device uplink transmission is followed by two-short downlink receives windows. This class *A* operation is the lowest power end-device system for applications that require downlink communication from the server shortly after the end-device has sent an uplink transmission. Second, class *B* or a bi-directional end-device with scheduled receive slots. Such a class *B* device opens extra receive windows at scheduled times. In order for the end-device to open receive window at the scheduled time it receives a time synchronized Beacon from the gateway. This allows the server to know when the end-device is listening. Last, class *C* or a bi-directional end-device with maximal receive slots in which end-devices have nearly continuously open receive windows, only closed when transmitting [5].