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Designing a Low-Cost Location Tracker for Use in IoT Applications

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Abstract

This paper reports on a new low-cost location tracker design, utilizing GPS/BeiDou and 2G rather than the relatively costly, and much more limited coverage, 4G cellular solution. The target retail cost of the tracker is 7 Euro or less. The target market is in IoT asset tracking applications. The tracker has been successfully demonstrated in a pilot test in China for tracking 50,000 auto parts boxes.

1 Introduction

There are many commercially available tracking solutions, e.g. based on satellite navigation (GPS, GLONASS, GALILEO, BeiDou) with supplementary cellular communication (2G/3G/4G/5G), facilitating the provision of location-based services (LBS) [1, 2]. Present day tracker prices start from approximately 20 Euro. This paper reports on a new low-cost location tracker design, utilizing GPS/BeiDou and 2G rather than the relatively costly, and much more limited coverage, 4G cellular solution. The target retail cost is 7 Euro or less. The target market is in IoT asset tracking applications. The tracker has been successfully demonstrated in a pilot test in China for tracking 50,000 auto parts boxes.

2 Tracker Design

The 2G modem/microcontroller selected for the tracker is the ARMv7-based chip MT2503, along with the RDA6625 chip for the power amplifier (PA) and antenna switch. The four-layer tracker printed circuit board (PCB) includes:

- GSM RF and GPS RF antennas;
- A battery power management chip, LTC4054, and a voltage-regulator diode, PZ5D4V2H;
- An auto power on circuit, an opto-sensor, a LED, a USB connector, and a nano-SIM card;
- Besides the modem and PA-Antenna switch, kernel components include a SGM2031 3.3V LDO, a XTAL S3225 26-MHz crystal oscillator for the microcontroller, a Rakon TCXO IT2205me 16.368-MHz crystal oscillator for the GPS; and
- Passives (capacitors, resistors, and inductances);
- An external sensor circuit, including a temperature and humidity sensor AHT10, a digital ambient light sensor (ALS) AP3216A, and X-, Y-, and Z-axis angular rate sensors (gyroscopes) ICM-20608-G.

Figures 1a and 1b depict the developed PCB and hardware of the tracker, whereas Figure 1c depicts the sensor circuit.

The Mediatek's Nucleus real-time operating system (RTOS) was utilized as it only needs 2K memory footprint, with all corresponding APIs for MMU, power management, connectivity (CAN, I2C, SPI, USB, UART), file system, data and networking. With the source code of the kernel, drivers, and libraries provided, intelligent power-saving algorithms of the tracker were successfully developed and used.

The tracker can work in three modes: timing mode, continuous mode, and intelligent mode. After the tracker powers on, it first establishes a socket connection with a corresponding server via 2G and then sends an IMEI-based heart-beat packet to it, followed by another packet, containing the ICCID and IMSI for registration. Then the tracker follows the defined protocols to provide location and/or alarm information to the server. Figure 2a shows the corresponding algorithm's processing sequence, whereas Figure 2b shows a demo data packet. A screen shot of the developed web application is shown in Figure 2c.

3 Conclusion

The developed tracker has been successfully demonstrated in a pilot test in China for tracking 50,000 auto parts boxes. In sleep mode, it consumes 13μA only. With a 4.2V/5000mAh battery, at one profile update daily, whether located indoor or outdoor, a minimum three year life span of the tracker is expected.

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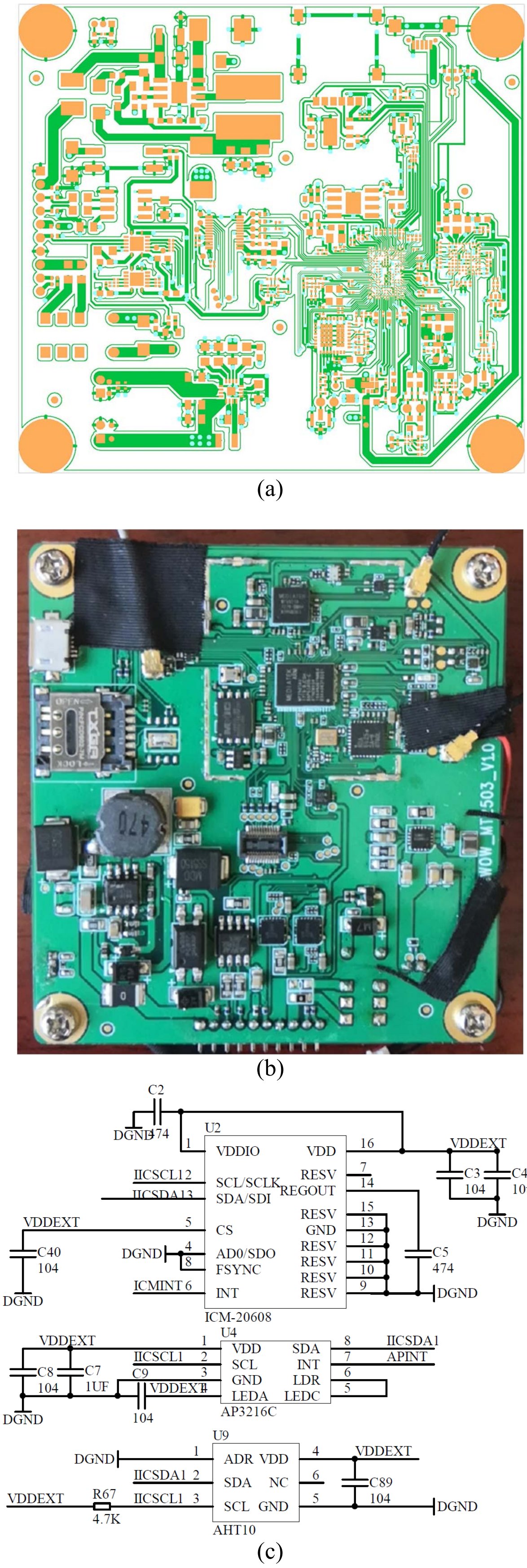

Figure 1. (a) The 4-layer color-coded tracker's PCB layout design; (b) Ready-to-go tracker; (c) Sensor circuit.

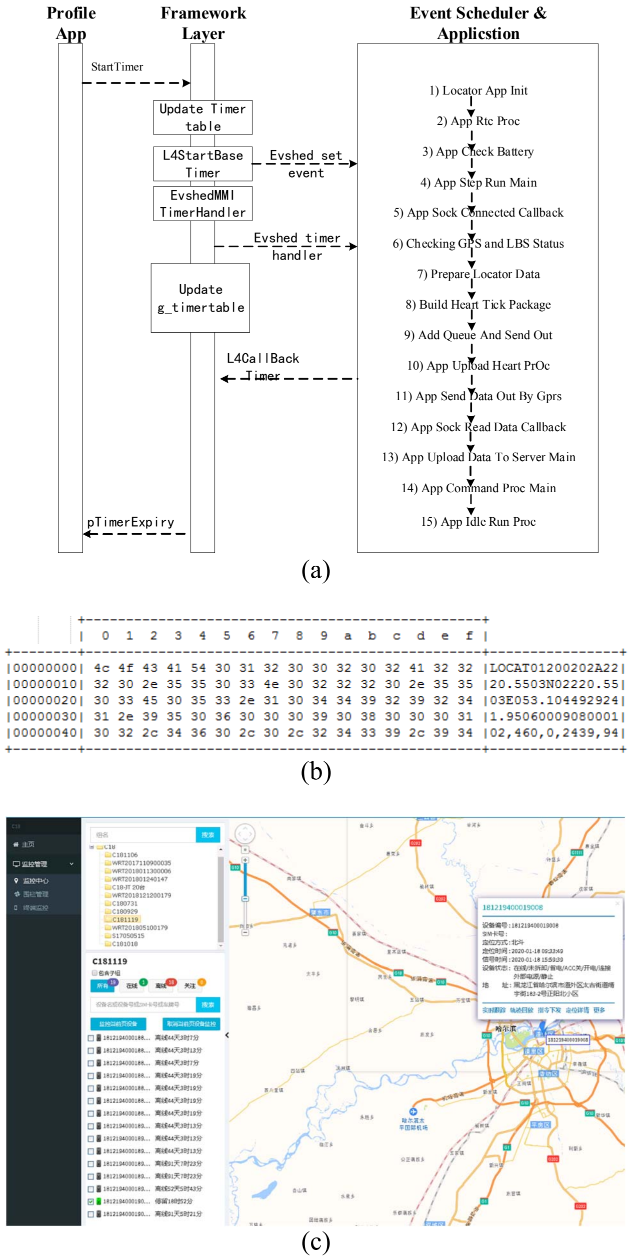

Figure 2. (a) Tracking algorithm's processing sequence; (b) Data packet; (c) Tracker's web application view.

5 References

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