

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

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Presentation Outline

- **Introduction**
- Hardware Components
- Software Components
- Results
- Conclusions



Introduction

- 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).
- Present day prices start from 20 Euro.
- This paper reports on a new low-cost location tracker design, utilizing GPS/BeiDou and 2G rather than the relatively costly, and with 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.



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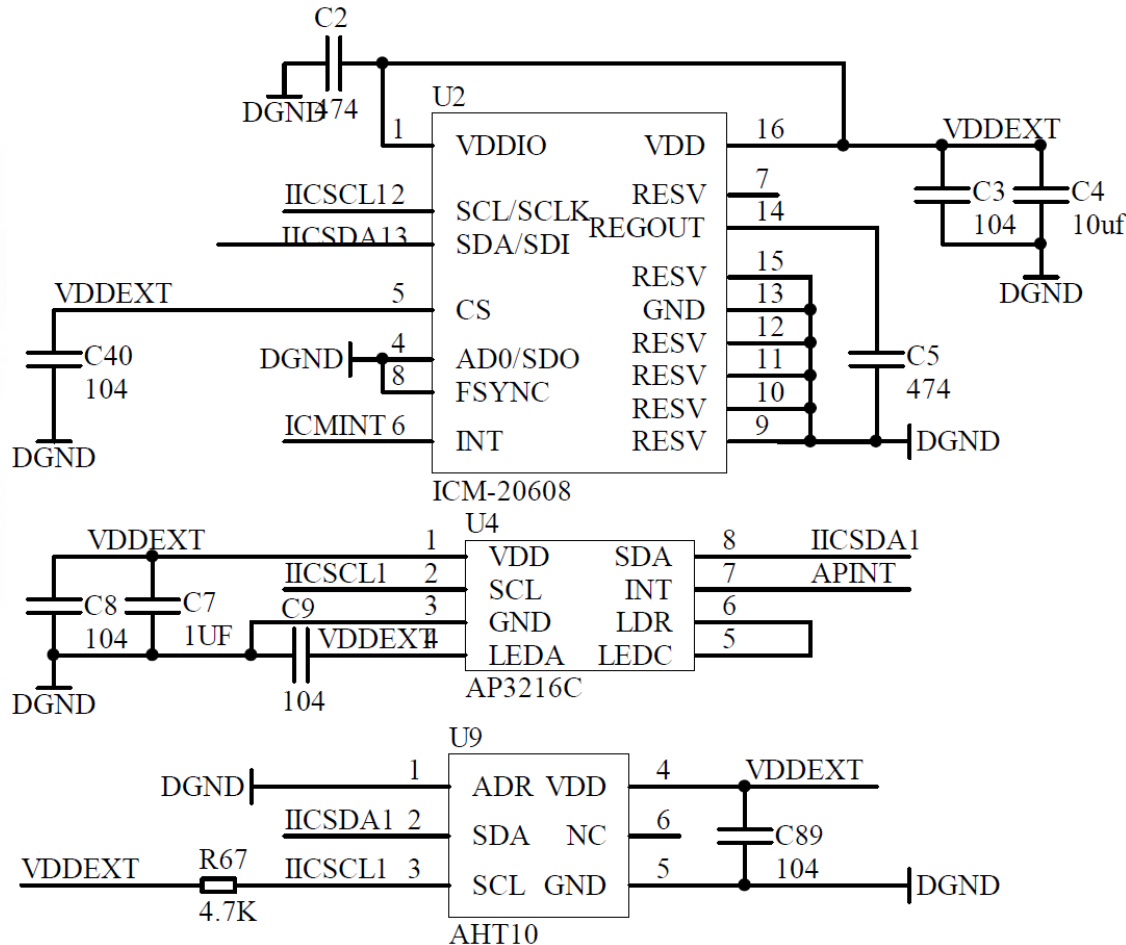


Tracker: Hardware Components

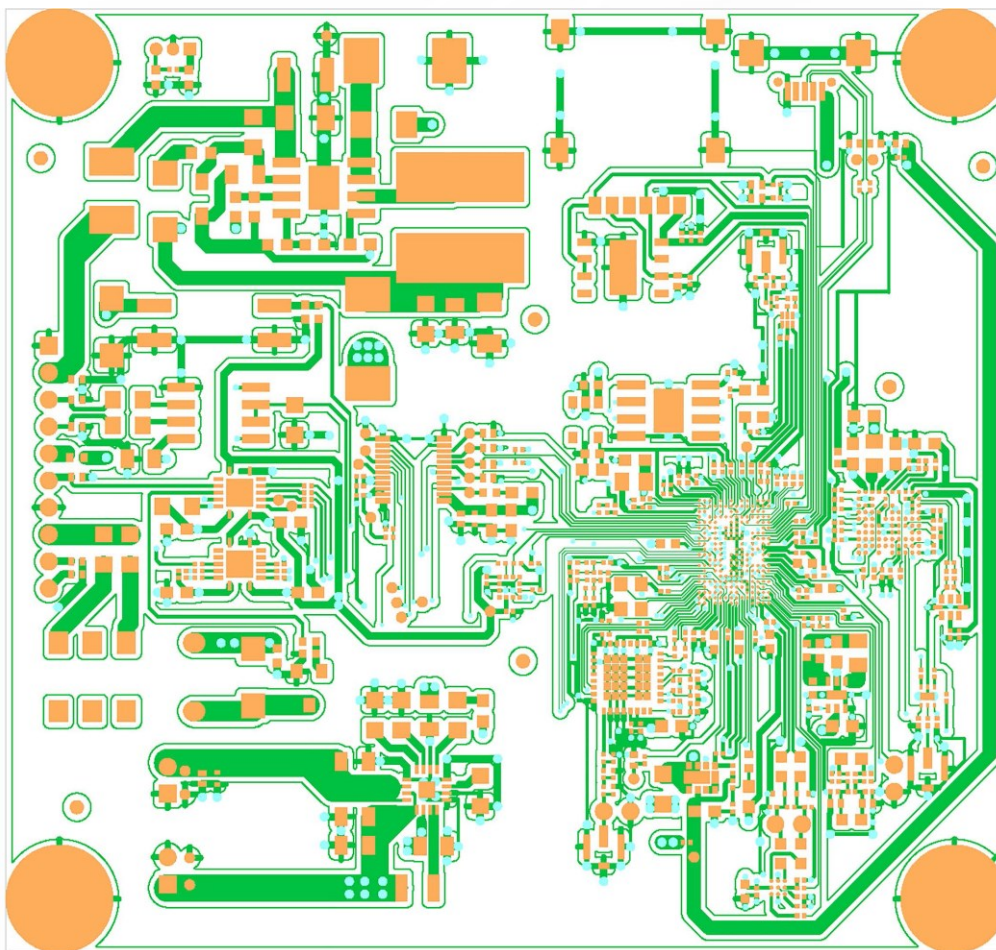
- ARMv7-based chip MT2503 (for the 2G modem/microcontroller)
- RDA6625 chip (for the power amplifier)
- GSM RF and GPS RF antennas
- Antenna switch
- Battery power management chip, LTC4054, and a voltage-regulator diode, PZ5D4V2H
- Auto power on circuit, opto-sensor, LED, USB connector, and nano-SIM card
- SGM2031 3.3V LDO
- XTAL S3225 26-MHz crystal oscillator (for the microcontroller)
- Rakon TCXO IT2205me 16.368-MHz crystal oscillator (for the GPS)
- Passives (capacitors, resistors, inductances)
- External sensor circuit, including a temperature and humidity sensor AHT10, digital ambient light sensor AP3216A, and X-, Y-, and Z-axis angular rate sensors (gyroscopes) ICM-20608-G



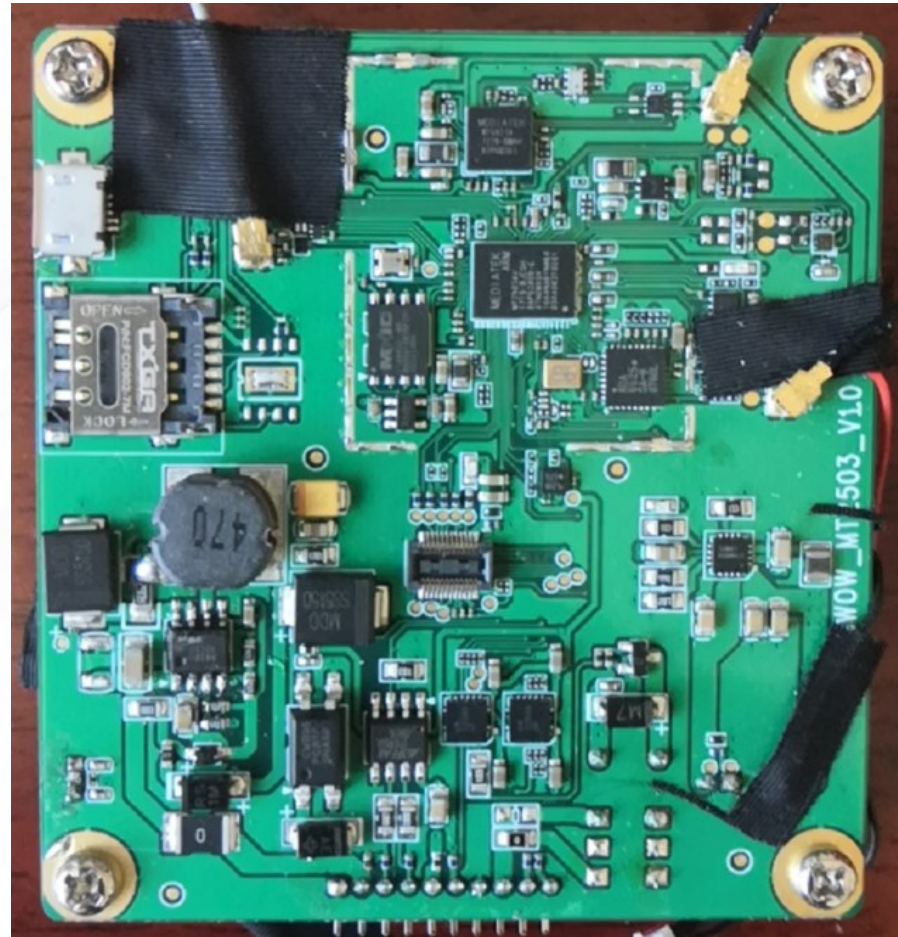
Tracker: Sensor Circuit



Tracker: 4-layer PCB Layout



Ready-to-Go Tracker



Prof. Ivan GANCHEV @ XXXIII URSI General Assembly and Scientific Symposium (URSI GASS 2020). Rome, Italy. 29 August – 5 September 2020.



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Tracker: **Software Components**

- Mediatek's Nucleus real-time operating system (RTOS)
 - 2K memory footprint,
 - 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, tested, and used.

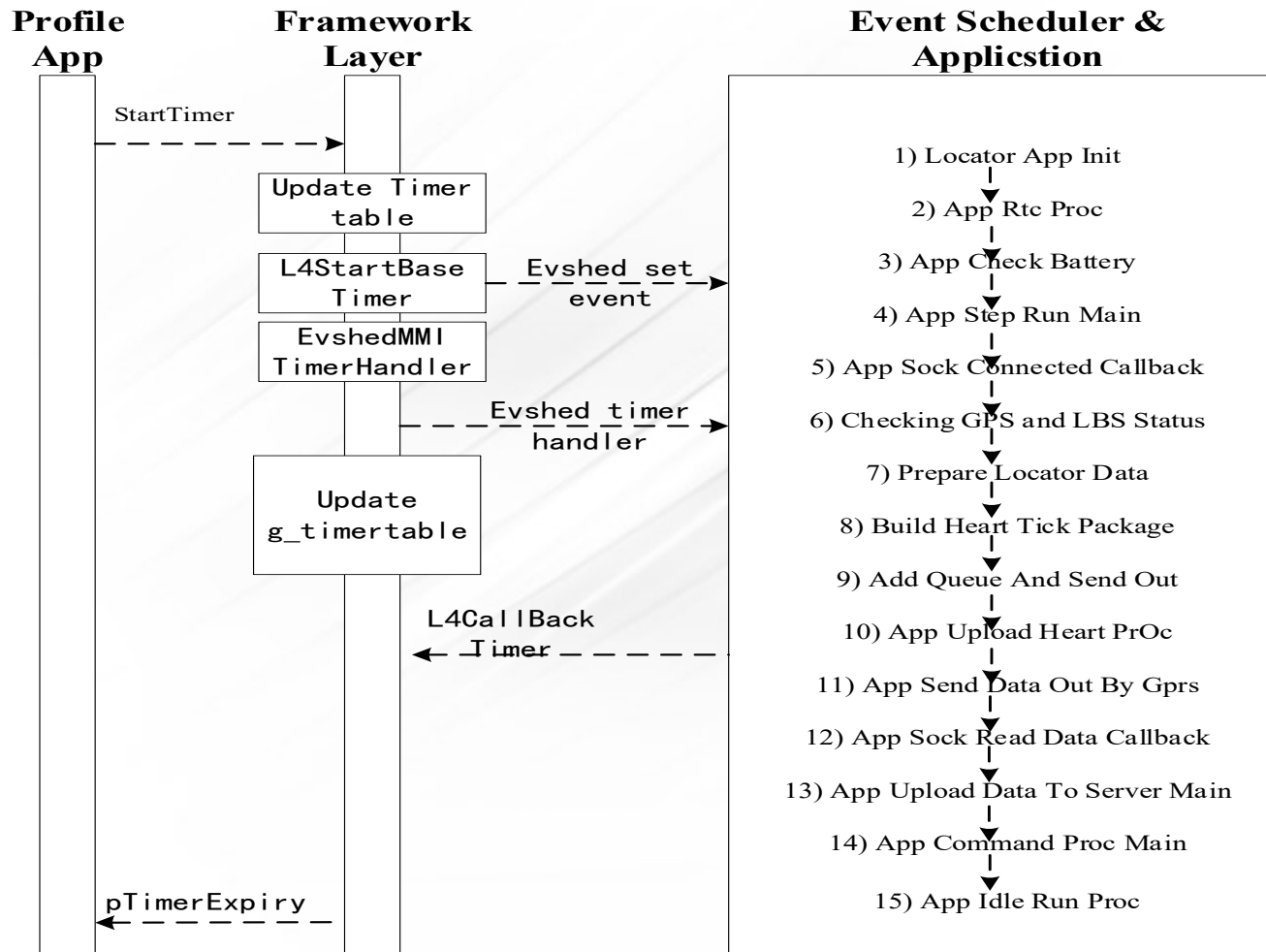


Tracker: Modes of Operation

- The tracker can work in three modes:
 - *Timing* mode
 - *Continuous* mode
 - *Intelligent* mode
- After powering on, it first establishes a socket connection with the corresponding server via 2G
- Then it sends an IMEI-based heart-beat packet to it, followed by another packet, containing the ICCID and IMSI for registration.
- After that, the tracker follows the defined protocols to provide location and/or alarm information to the server.



Tracking Algorithm: Processing Sequence



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Data Packet: Example

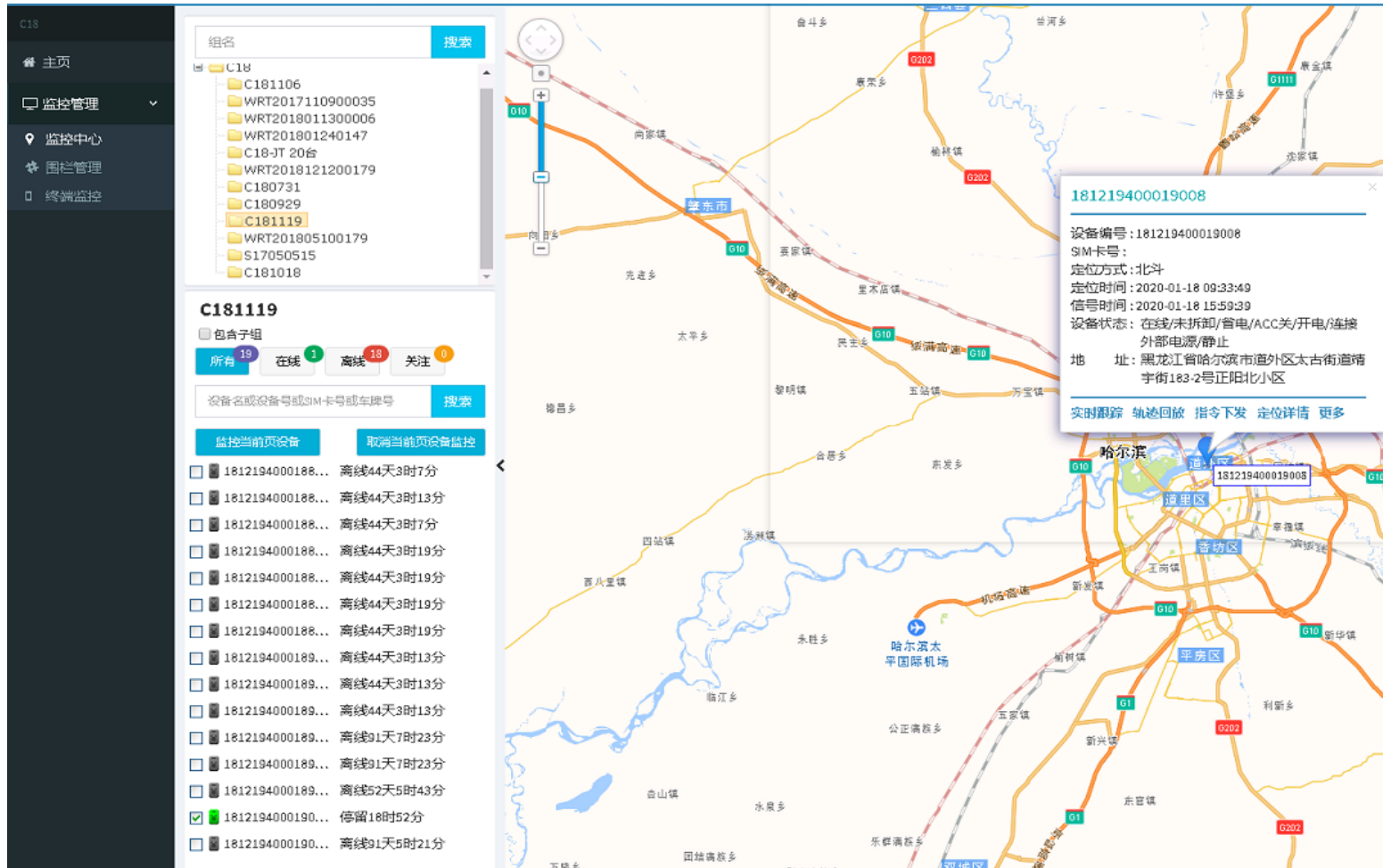
```

+-----+
| 0 1 2 3 4 5 6 7 8 9 a b c d e f |
+-----+
|00000000| 4c 4f 43 41 54 30 31 32 30 30 32 30 32 41 32 32 |LOCAT01200202A22|
|00000010| 32 30 2e 35 35 30 33 4e 30 32 32 32 30 2e 35 35 |20.5503N02220.55|
|00000020| 30 33 45 30 35 33 2e 31 30 34 34 39 32 39 32 34 |03E053.104492924|
|00000030| 31 2e 39 35 30 36 30 30 30 39 30 38 30 30 30 31 |1.95060009080001|
|00000040| 30 32 2c 34 36 30 2c 30 2c 32 34 33 39 2c 39 34 |02,460,0,2439,94|
+-----+

```



Web Application: Screenshot



181219400019008

设备编号: 181219400019008
SIM卡号:
定位方式: 北斗
定位时间: 2020-01-18 09:33:49
信号时间: 2020-01-18 15:59:39
设备状态: 在线/未拆卸/省电/ACC关/开电/连接
外部电源/静止
地址: 黑龙江省哈尔滨市道外区太古街道晴宇街183-2号正阳北小区

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C181119

包含子组

所有 19 在线 3 离线 18 关注 0

设备名或设备号或SIM卡号或车牌号 搜索

监控当前页设备 取消当前页设备监控

- 1812194000188... 离线44天3时7分
- 1812194000188... 离线44天3时13分
- 1812194000188... 离线44天3时7分
- 1812194000188... 离线44天3时19分
- 1812194000188... 离线44天3时19分
- 1812194000188... 离线44天3时19分
- 1812194000188... 离线44天3时19分
- 1812194000189... 离线44天3时13分
- 1812194000189... 离线44天3时13分
- 1812194000189... 离线44天3时13分
- 1812194000189... 离线91天7时23分
- 1812194000189... 离线91天7时23分
- 1812194000189... 离线52天5时43分
- 1812194000190... 停留18时52分
- 1812194000190... 离线91天5时21分



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Conclusions

- 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 $13\mu\text{A}$ only.
- With a 4.2V/5000mAh battery, at one profile update daily, whether located indoor or outdoor, a minimum 3 year life span of the tracker is expected.



Thank you for attention! Questions & comments?

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