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**TD :3Discussion Smart sensors ( M1-ESE module: CSM)**

**To read and discuss the subject.**

Smart sensors are the result of the integration of sensitive components combined with microprocessors. Smart sensors integrate sensor detection information functions andmicroprocessor data processing functions. Compared with general sensors, smart sensorshave the following advantages: they can achieve high-precision information acquisitionand fast data processing; they are low cost; they have the ability to transmit informationfor data interaction; they have diversified functions; they are intelligent and have low

power consumption, etc. Therefore, smart sensors have gradually been used in variousfields, such as aerospace, aviation, national defense, science and technology, as well asindustrial and agricultural production [1–5]. For example, there is an instance in the fieldof robotics [6] where smart sensors enable robots to have human-like functions of thefive senses and the brain to sense various phenomena and perform various actions.

Hardware Architecture Smart sensors are mainly composed of conventional sensors, multiplex switches, amplifiers, A/D converters, microprocessors (or microcomputers) and related circuits. Traditional sensors will be measured by the physical quantities into the corresponding electrical signals, which will be sent to the signal conditioning circuit, filtering, amplification, analogue-to-digital conversion and sent to the microprocessor (or microcomputer). Amicroprocessor (or microcomputer) is the core of smart sensors; it can not only calculate the sensor measurement data, storage, and data processing but also through the feedback loop to adjust the sensor. As the microprocessor (or microcomputer) effectively performs a variety of software functions, it can complete tasks that are difficult to complete with hardware. As a result, the manufacturing difficulty of the smart sensor is greatly reduced, the performance of the smart sensor is improved and the cost is reduced. The 5G-BSS structure designed in this paper is shown in Figure 1.



**Hardware Selection**

Open-source hardware is a hardware artefact that can be manufactured, modified,distributed and used by anyone. Commonly used open-source hardware are Arduino,Raspberry Pi (RPi), vvBoard and Mirco: bit, etc. A comparison of these open-sourcehardware parameters is shown in Table 2. The choice of open-source hardware in thehardware design of 5G-BSS will enable the rapid construction of a hardware prototype

of the blockchain smart sensor. Three main software tasks need to be run by 5G-BSS.

Task 1: to receive data on physical variables from the surrounding environment froman acquisition module consisting of inductive sensors.

Task 2: processing of incomingphysical variable data, including integrity processing and confidentiality processing.

Task3: using the network of deployed blockchain nodes and the already installed blockchainclient, call the smart contract interface for data transfer and quickly upload the processeddata to the blockchain via 5G network communication technology. For the analysis ofthese three running tasks and the comparison with the results in Table 2, we found thatthe Raspberry Pi 4B—a RAM-based microcomputer motherboard with the advantages ofhigh performance, large memory and rich interface—can perform these three tasks well.

Therefore, the Raspberry Pi 4B is chosen as the hardware platform for the blockchain smart

sensor in this paper.

The network adapter module for smart sensors has been selected for 5G communication,which will enable fast transmission of data collected by the sensors. At present, 5Gcommunication mobile phones have gradually become popular in China, Beijing, Shanghai,Shenzhen and Chengdu, and 17 other cities have achieved the use of 5G mobile phonesby civilians. The current mainstream 5G mobile chips are: Kirin 990 with integrated 5Gbaseband, Qualcomm Snapdragon 855/865 with external X55 baseband, Qualcomm Snapdragon888 with integrated X60 baseband, Tiangui 1000 with integrated Helio M70, etc.

**Theperformance goals of 5G communications** are to increase data rates( 100Mb/s), reduce latency(1 ms), saveenergy, reduce costs, increase system capacity and support large-scale device connectivity.

With the rapid advancement of 5G infrastructure and the continued commercializationof 5G communications, 5G base stations are dense, providing realistic conditions for theapplication of 5G communications to the Internet of Things (IoT) and the Industrial Internetof Things (IIoT). 5G modules are based on 5G chips, with external circuitry added accordingto actual demand and then packaged. There are only two types of mainstream 5G industrialcommunication modules currently available on the market. One is the Baron MH5000 modulewith integrated Huawei 5G baseband and the other is the SIM8200EA-M2 module based

on the Qualcomm Snapdragon X55 baseband. A partial comparison of their parameters isshown in Table 3. By comparing the parameters of the two 5G communication modules, itcan be seen that Huawei’s Baron 5000 module has three major advantages. First, it offershigh data rate, low latency, energy saving, low cost and support for large-scale deviceconnectivity. Second, Baron 5000’s 5G module supports Huawei’s self-developed interfaces,including Modem, PCUI, Diag, GPS and GPS Control, etc. Third, it can perfectly dock

with Ubuntu/Linux system to quickly build a communication environment. Therefore,the Huawei MH5000-31 5G module is chosen as the network adapter for the blockchainsmart sensor.

**Table 2.** Comparison table of the four open-source hardware parameters

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**Functional Verification**

Firstly, for 5G communication, the hardware connection to the Raspberry Pi 4B wascompleted using the Huawei MH5000-31 industrial module via a USB 3.0 interface in thesmart sensor Linux(OpenWrt) system to modify the Linux kernel driver and configure theUSB serial port-driver related configuration items and the dial-up Internet access. This waythe blockchain smart sensors use 5G communication to achieve network data transmissionof the system. In the experimental platform Ubuntu 18.04.4 LTS system, the Fisco-Bcosblockchain network was set up according to the official Fisco-Bcos documentation [50].

The blockchain smart sensor calls the blockchain client program to initialize and the smartsensor node joins the Fisco-Bcosblockchain network. The transmission of transactiondata is completed in the smart contract through the system network link (5G networkcommunication). The smart contract is invoked in the blockchain smart sensor, where thedata on the environmental variables of the smart sensor is automatically uploaded to theFisco-Bcosblockchain storage. The blockchain smart sensor solution was experimentally

proven to be feasible. As follows, Table 6 evaluates the validation results of the various

functions that can be achieved by the blockchain smart sensor.

Reference: Article

**“5G-BSS: 5G-Based Universal Blockchain Smart Sensors”,Zhengyi Yao 1, Liang Tan 1,2,\* and Kun She 3**

Link :Blockchain Smart Sensors. Sensors**2022**, 22, 4607. <https://doi.org/10.3390/s22124607>