

Research and Application of Remote Centralized Reading Technology of Electric Power Metering Based on Beidou Space-Time Quantity

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Abstract

Under the background that Beidou satellite communication system in China has been networked and commercialized, A remote centralized reading system of electric power metering based on Beidou space-time quantity is proposed in this article, with the establishment of the software and hardware platform of the system. The remote centralized reading system of power metering based on Beidou space-time quantity researched and developed by this research and development, combining Beidou satellite system with intelligent distribution network automatic operation management, and putting forward the research and development technical route and specific implementation scheme which focuses on the key function points of Beidou positioning. The test results show that the data transmission of the system is fast, stable and reliable, and remote real-time monitoring and data acquisition can be achieved.

Keywords: *Remote concentrated meter-reading of electricity quantity, Beidou satellite communication, Acquisition terminal*

I . Introduction

Beidou satellite communication system is a national science and technology development strategy, which has been listed the application of this system in smart grid in thirteen top-level strategic plans by the State Grid Corporation. Beidou system has the unique advantage of no need of building private network base stations or laying special optical cables, and its unparalleled information security, together with unique “short message two-way communication” function, combines Beidou satellite communication system with intelligent distribution network automatic operation management organically, thus a Beidou power metering remote concentrated meter-reading system suitable for the whole power system is designed and implemented based on the hardware scheme, with its software scheme meeting the requirements of national grid standards, which is applied to power terminal equipment

The products of this project can effectively meet the needs of typical application scenarios of the current and future development direction of power grid, and has broad prospects for popularization to the whole power grid, forming practical technical achievements in the field of intelligent distribution network, bringing considerable economic benefits to the company, and providing practical and effective technical support and product support for the company's collaborative research and development of Beidou Power Integrated Platform

The power remote concentrated meter-reading system based on Beidou space-time quantity researched and developed in this project organically combines Beidou satellite system with intelligent distribution network automatic operation management, and puts forward the research and development technical route and specific implementation plan focusing on the key function points of Beidou positioning.

With the achievement of the centralized reading of Beidou Electric Power in this project, Beidou space-time technology has been fully utilized in power metering equipment, to measure the location and time of the power metering terminal, which can provide important technical support for metering power asset management and metering local time service rate settlement, truly realizing the landing of ubiquitous Internet of Things in the field of power metering. The main research contents are as follows: Development of Beidou RDSS Micro-power Embedded Standard Module Corresponding to Underlying Software Access to Current Marketing Power Collection and Test System Expansion of Existing Terminal Communication Protocol of Metrology Automation Master Station

II. Overall System Architecture

The remote concentrated meter-reading system of power metering based on Beidou space-time quantity includes the communication layer of acquisition terminal and the master station layer. The overall structure of the system is shown in Fig. 1. The work flow is as follows: Re-design the structure in the 4G module of the existing acquisition terminal. On the basis of its original functions, Beidou acquisition and communication module is added, to acquire the position information of the acquisition terminal through Beidou antenna, and the acquisition terminal is responsible for collecting the electric energy data and Beidou position information of the remote field acquisition terminal, then transmit it to the communication management machine (analysis server and front server) through the communication layer (4G network). The system master station is accessed through the safe access area, to store the electric energy data in a large-capacity database. The display interface is constructed at the Beidou master station layer to realize the monitoring and management of position information to upload the electric energy data to the metering automation master station system through the mobile communication module

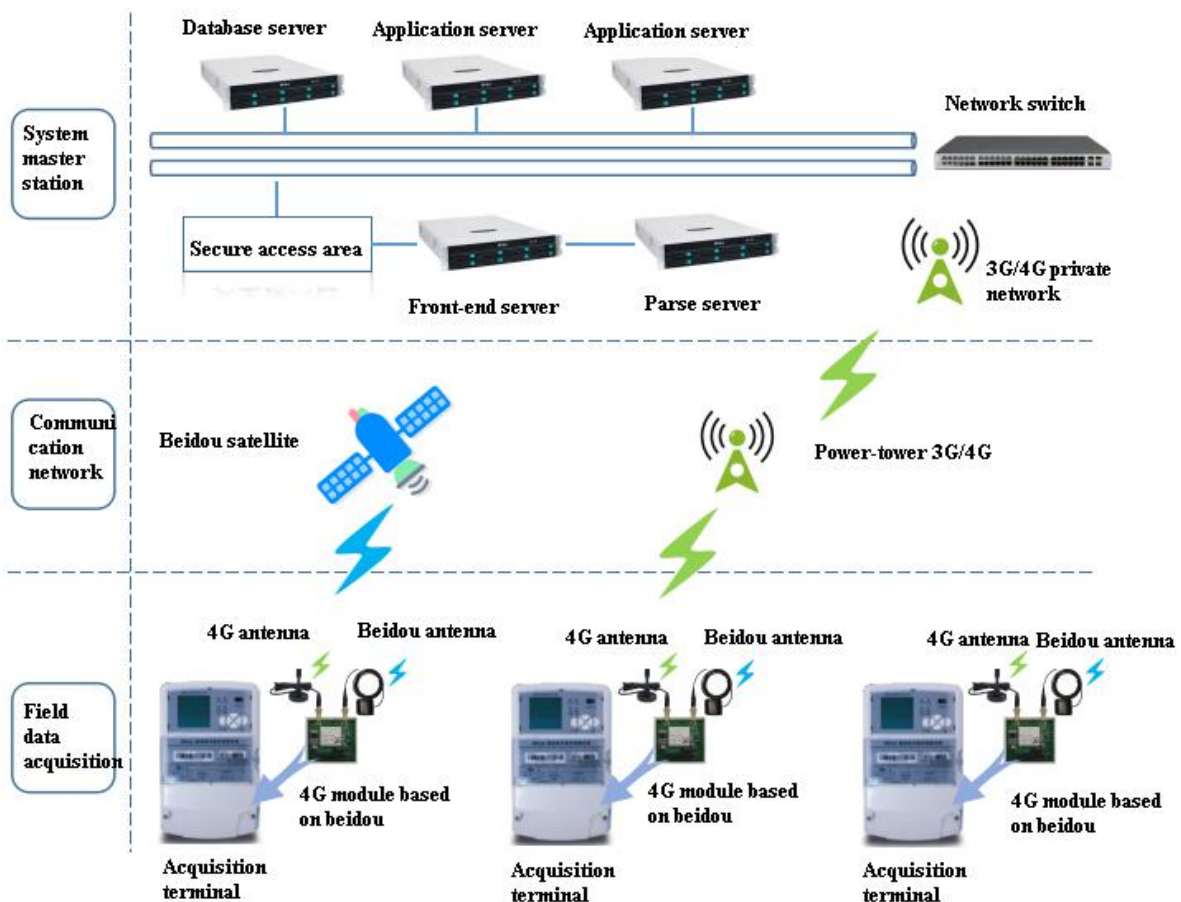


Fig.1 The Metering Remote Centralized Reading Master Station Layer Construction Based on Beidou

The remote concentrated meter-reading master station system integrates Beidou communication software, metering automation negative control software database and client display software on a high-performance commercial server. Beidou communication software sets up large-capacity buffer and reusable timer, which is used to receive and analyze Beidou messages and send instruction messages for broadcast or designated user machines; The database system adopts vertical cutting and horizontal cutting technology to solve the problems of mutual exclusion and high concurrent response speed; Integrate several mobile data communication modules, which uploads data of 100 acquisition terminals through a SIM card; The negative control software analyzes the Beidou protocol message into the uplink protocol message of the metering automation terminal, to set the delay time for sending, and the large-capacity buffer queue for receiving, with the purpose to maintain the stability of message analysis and uploading

(II) Hardware structure design of electric energy acquisition terminal based on Beidou

The research and development of Beidou power metering remote centralized reading system involves the study of many key technologies from scheme design to implementation test. With such perfect hardware scheme design, the requirements of reliable communication protocol conversion, low power consumption, simple structure and low cost can be met at the same time.

1). Positioning standard module Develop a positioning 4G micro-power embedded positioning standard module that can directly replace the existing wireless communication modules on typical metering automation terminals such as low-voltage concentrator negative control terminals and integrate 4G uplink technology Beidou RNSS positioning technology

2). The application of Beidou RDSS communication module in terminal equipment is limited by the size structure and power supply requirements of the original GPRS module. On the basis of meeting the original functions, Beidou RDSS communication module needs to integrate microprocessor, Beidou RDSS RF transceiver chip baseband circuit and power amplifier chip, Beidou RNSS positioning chip with timing function chip added separately. The selection of all devices should be considered from the perspectives of size, power supply and performance.

3). Structure and information optimization are based on market and technical requirements, Carry out demand analysis on products, through analysis, the processing speed requirements and the interface requirements of MCU are determined, such as demanding numbers of SPI or Uart interfaces, or requirements towards storage. On that basis of the existing terminal uplink module size structure, Optimization of its structure, and increase of Beidou RDSS positioning chip has been done, as well as adding Beidou communication antenna on the basis of the original 4G communication, obtaining Beidou positioning information, and transmitting electric energy data and Beidou information to the system master station through the original 4G network. The preliminary hardware design of this product is shown in Fig. 2.

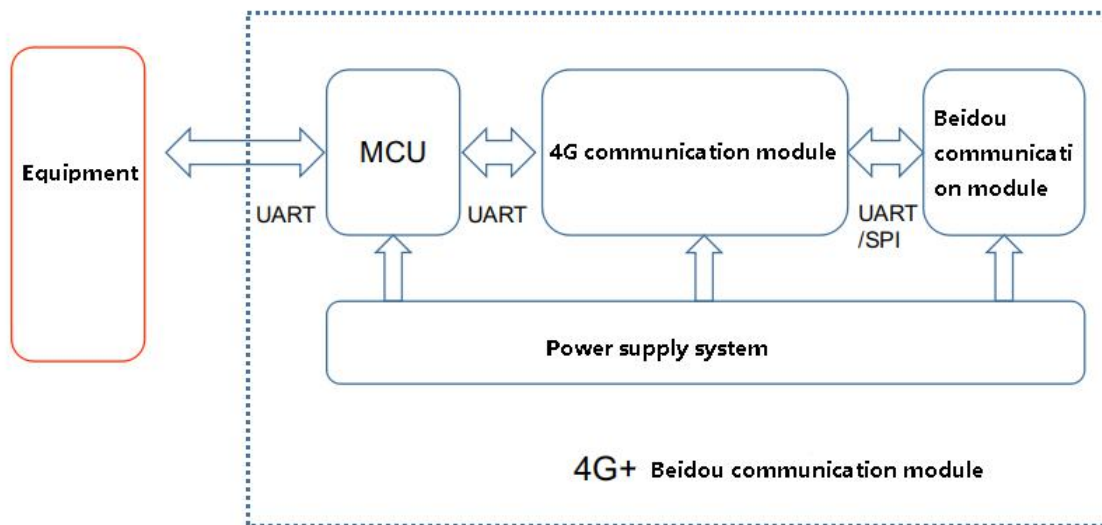


Fig.2 The Principle Block Diagram of Communication Module Based on Beidou

4). Hardware Circuit Module

(1) Main control unit: The MGU with ARM7 core which is selected, has the highest working frequency of 55MHz and the working temperature of $-40(85\text{ }^{\circ}\text{C})$, with rich peripheral interfaces and easy to expand.

(2) Beidou communication module: Its functions include positioning, time service, position report, etc.. Positioning allows to share position information of data acquisition terminals, and time service can provide high-precision time information and realize network time synchronization

(3) Power supply part: Support AC and DC wide voltage input, that is, $220(1 \pm 20\%) \text{ V}$ or $110(1 \pm 20\%) \text{ V AC}$ (frequency 47(63Hz) $220(1 \pm 20\%) \text{ V}$ or $110(1 \pm 20\%) \text{ V DC}$, and output 24V DC voltage to supply power to the control unit and Beidou communication module.

(4) Other peripheral circuits: Realize the communication between the terminal and the meter, as well as the date display of the meter. Upgrade the prompt of debugging and alarming, etc.

III. Handling of Communication Protocols

A. Login Heartbeat Protocol

After establishing TCP connection, Beidou module sends login frame. Then confirming the reply of master station, next sending heartbeat frame regularly, and finally the master station replies with confirmation to show that the link operates well.

The login heartbeat protocol entries are as follows(Fig.3):

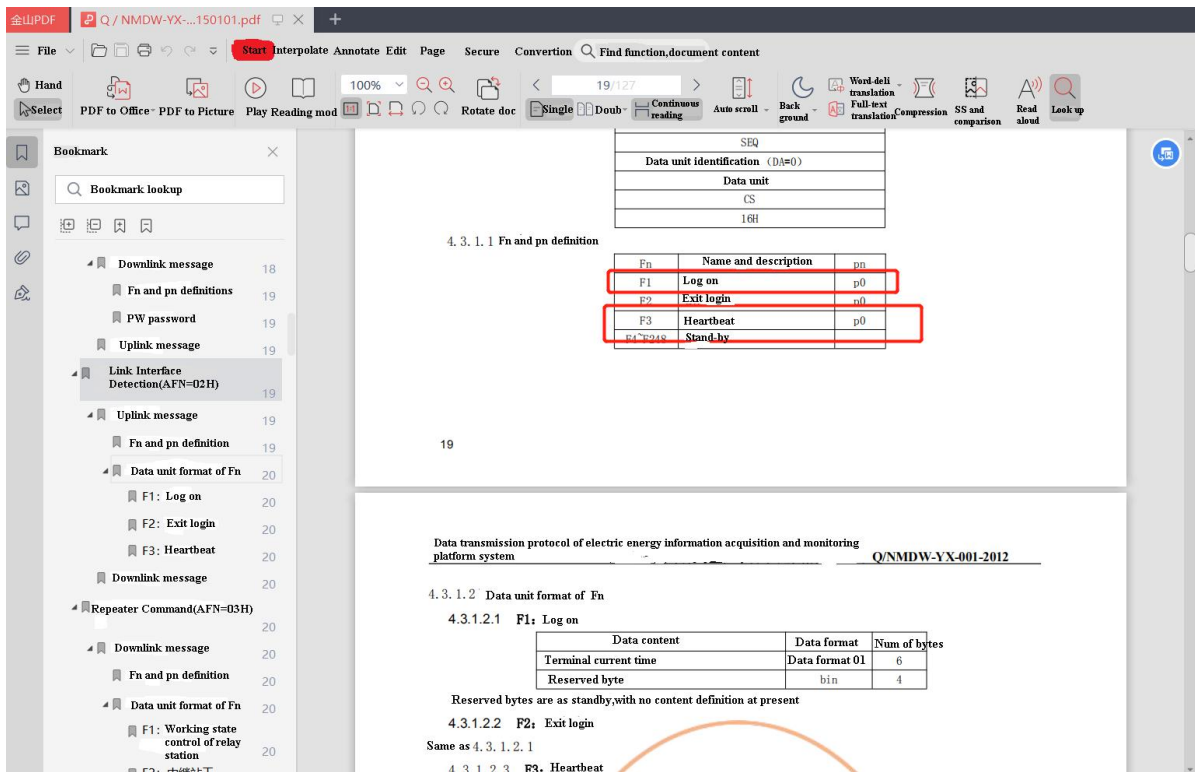


Fig.3 The Login Heartbeat Protocol Entries

The confirmation/denial frame protocol entries are as follows(Fig.4):

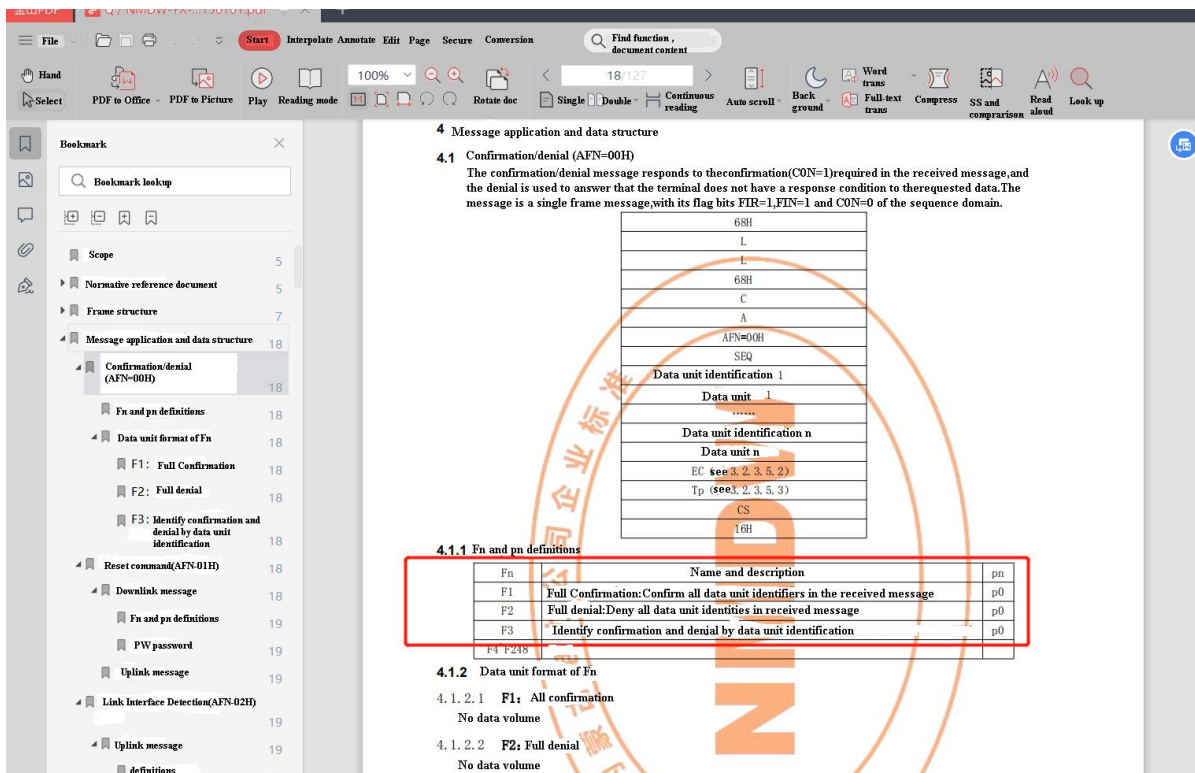


Fig.4 The Confirmation/Denial Frame Protocol Entries

B. Terminal Geographic Location Information Protocol

Beidou module can actively report geographic location information, with the values of msa 0; The master station can call and measure the geographical position information, and the msa of position information replied by Beidou should be consistent with the msa in the downlink message.

The protocols of Beidou location information protocol are as follows(Fig.5):

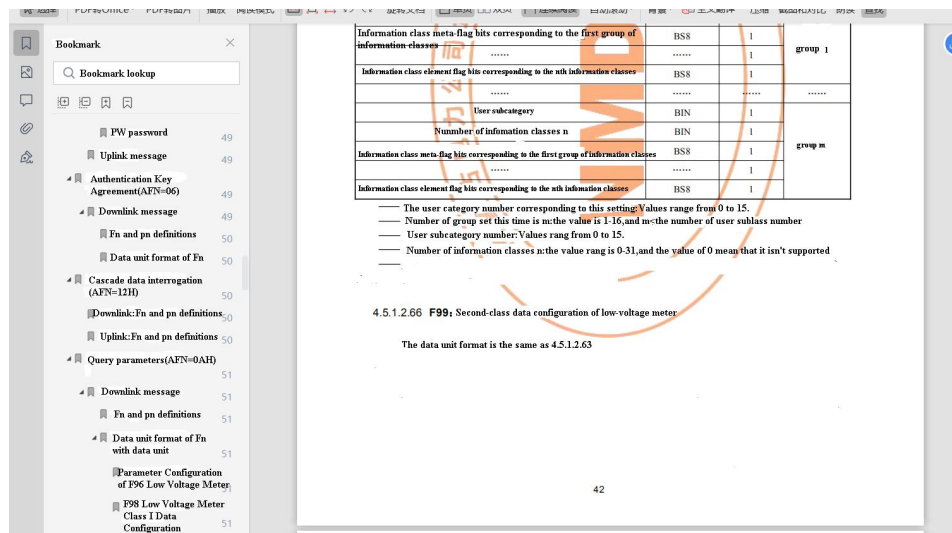


Fig.5 The Protocols of Beidou Location Information Protocol

IV. Position Information Transmission Process of Beidou

information transmission process of Beidou shows in Fig.6

A. Operation principle

An MCU is added to the communication module, aiming at actively collecting equipment information, automatically connecting with the server, and sending Beidou address information to the background server

B. Work flow

- 1). Located between the electric meter and the communication module, the MCU is responsible for transmitting and monitoring the communication data between these two
- 2). MCU parses the following information out from the AT message of the electric meter:
 - (1) Server IP Address
 - (2) Address of electricity meter
- 3). The MCU read that NEMA message of the Beidou module and parse out the current position information

- 4). According to 376.1 standard, MCU packages the address and location information of the meter and reports it to the server
- 5). MCU monitors the server port and queries the information accordingly
- 6). MCU sends heartbeat message to the server regularly

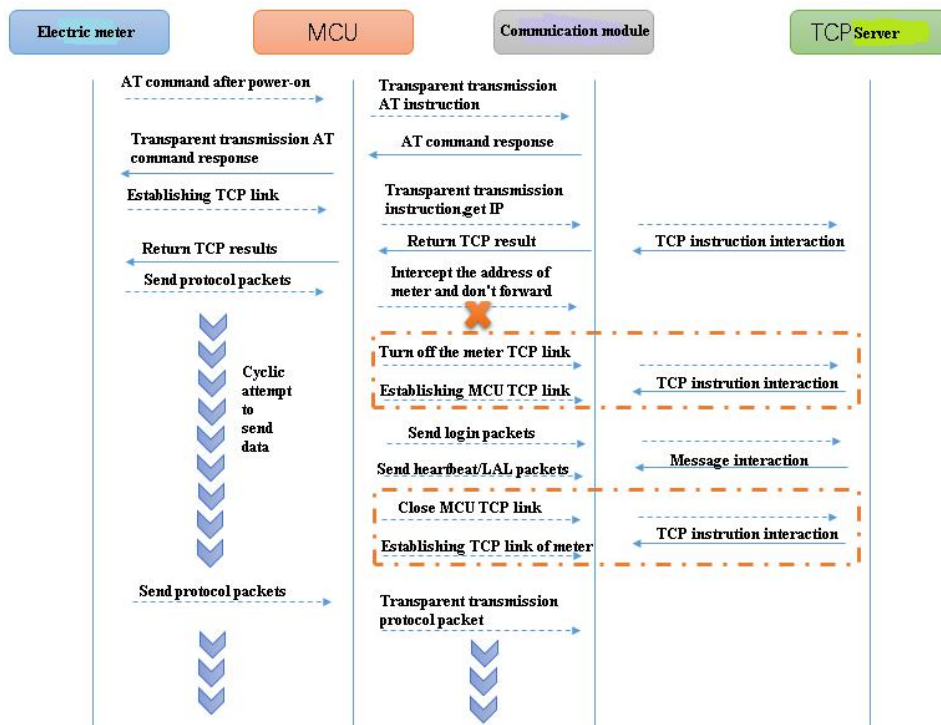


Fig.6 Information Transmission Process of Beidou

V. Practical Application of Measurement Remote Concentrated Meter-Reading Based on Beidou

The electric energy acquisition terminal based on Beidou was actually tested and operated in Qingshan District, Baotou City, Inner Mongolia Province, collecting information such as electric energy and Beidou position from 100 metering points. In the test system of metering marketing, the monitoring screen with switching function realizes the collection and monitoring of electric energy data through client-end software, And it is reliably transmitted to the metering master station through the data transmitter DTU. After a period of stable operation, the system data acquisition stays complete and reliable, with the online rate of the metering centralized reading terminal based on Beidou over 99%, the online data integrity rate is 100% and the automatic reading model is 100%. The data transmission latency is very low. The software client display is shown in Fig. 7.



Terminal number	User information	Location information	Electric energy acquisition and control
BT001	Second Affiliated Hospital		
BT002	District 12 of Huhehot		
BT003	District 18 of Huhehot		
BT004	District 12		
BT005	District 18 of Huhehot		

Fig.7 Presentation of Remote Centralized Reading Client of Power Metering Based on Beidou

VI. Conclusion

With the construction and application of remote concentrated meter-reading system for electric power based on Beidou space-time quantity, not only can the automatic meter-reading and real-time monitoring of various electric data be realized, but also the longitude and latitude information (Beidou position information) of 100 metering and acquisition terminals can be obtained, which provides a good solution for the marketing and production system of Baotou and even Inner Mongolia Power Grid, and enable power supply enterprises to monitor and control user terminals more comprehensively, provide effective real-time power data for power grid system analysis and prediction, and provide more comprehensive and reliable basic data for power grid economic and security analysis. all these are of strong practical significance and popularization value

VII. Acknowledgment

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