Optimization of Design and Application of Micro-grid Energy Management System Data Acquisition System

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***Abstract*-- In a Micro-grid research platform by studying distributed generation with distributed power, the reliability and data real-time of Data Acquisition System, directly affect the validity and accuracy of Control System Operation. In the process of design Data acquisition system, we put forward the optimization communication model by the combination between completion port and the thread pool, the model of the communication pipeline maintenance with the hierarchical management of data collection objects' contexts. Firstly, Data Acquisition System established the network hardware platform which ensures real-time data and scalability system. Secondly, the internal structure of DAS is designed by three aspects of the structure model, data model and information model, describing the optimization structure. Lastly, based on the above software system design ideas, DAS was realized in the physical platform, reached the performance testing by professional testing software and union-test experiment with each functional module of platform.**

Index Terms: **Micro-grid; Data Acquisition System; IOCP; Two-step Contexts**

I. INTRODUCTION

Micro-grid with DER, as compared with the traditional power grid, is very different whether it is from the system capacity and the size of the collection points, and control methods[1-3]. As an important part of the basic platform for Micro-grid management control system, Data acquisition system is responsible for completing data exchange with the remote IED devices and distributed power controller, while providing the reliable data source for the advanced applications of Micro-grid energy management system. Data Acquisition System not only has a strong hardware environmental constraints, it also requires a high stability and real-time data. The network load will increase instantaneously for periodic Data Total Calls and Checking Time. These requests Data Acquisition System to be able to deal with these important data with a high accuracy, reliability, and flexibility, have a strong scalable processing capability with the instability data stream.

II. HARDWARE ARCHITECTURE

Good connection of communication network is the material basis for real-time data[4]. As the RS485 serial communication interface constraining by the number of nodes on the network and considering the full and effective use of hardware resources, using Ethernet-supported network layer is an economic and practical choice. Based on the thought of the current network system generally followed —the horizontal distribution, vertical stratification[5], hardware platform of networks should give priority to establish a standard and open distributed system. Platform structure shown in Figure 1:

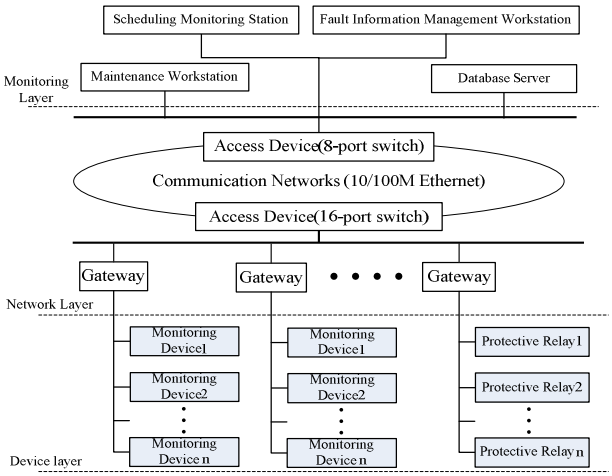

Figure 1 Network Architecture of Hardware device

III. SOFTWARE SYSTEM DESIGN

The software design of Data Acquisition System should take into account the characteristics of the network physical environments. Method used to form the Ethernet data acquisition system, need to consider the TCP/IP protocol and operating system co-ordination and to consider the acquisition system as a client and the monitoring and control unit or power supply controller link stability and the reliability of data exchange[6].

A. Structural model

The choice of software particle size determines the size of each functional module. Since the Statute Analytic and packaged function module is a high reusability of modules, software, and the coupling degree of each module is reduced by modular programming. At the same time, it will be very convenient for the expansion of other statute in the future. The software framework of Data Acquisition System shown in Figure 2 can be divided into Interface layer, Statute layer, Communication layer.

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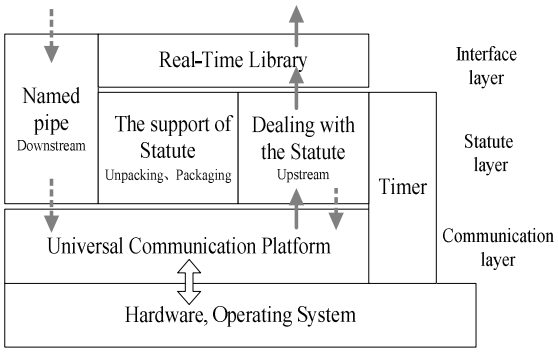

Figure 2 Software Architecture

B. Data Flow Model

The dynamic data information of Data Acquisition System exchanged by thread pool[7] and its related technologies. If threads which send and receive data packets were established as a unit of gateway, a large number of redundant context switch handling of threads would be produced, taking up a large number of system resources. It is difficult to ensure that data in real time, completeness and accuracy. Universal communication platform based on I/O completion port (IOCP), to achieve efficient data transceiver, is a mature communication mechanism which handle asynchronous I/O request using the thread pool[8]. I/O completion port is an optimized multi-threaded concurrency model, through effective thread management, reducing threads context switching, avoiding multi-threaded competition for resources, for occasions where are a large number of socket I/O requests. After system starting, the main thread will initialize the other threads from the database server firstly, downloading configuration information parameter table of Data Acquisition System, and creating a memory real-time database. The relationship between the various threads is shown in Figure 3. I/O Port Monitoring thread will carry upstream packet pointer into the Work Queue waiting for the treatment of Logical Worker threads. Work Queue will minimize the coupling between Statute layer and Communication layer, without affecting real-time transmission of data. The Logical Worker threads in the Statute layers use the same technology of thread-pool. In order to avoid bottlenecks in data stream, the two thread pools situated in the different level of the software structure, which share the system load, thereby ensuring a smooth transition of data stream. The important control data of downstream, directly through the sending interface provided by the communication platform, is sanded individually which ensure that interactive control commands and data frame of the Statute issued without delay, while the upstream and downstream did not affect each other.

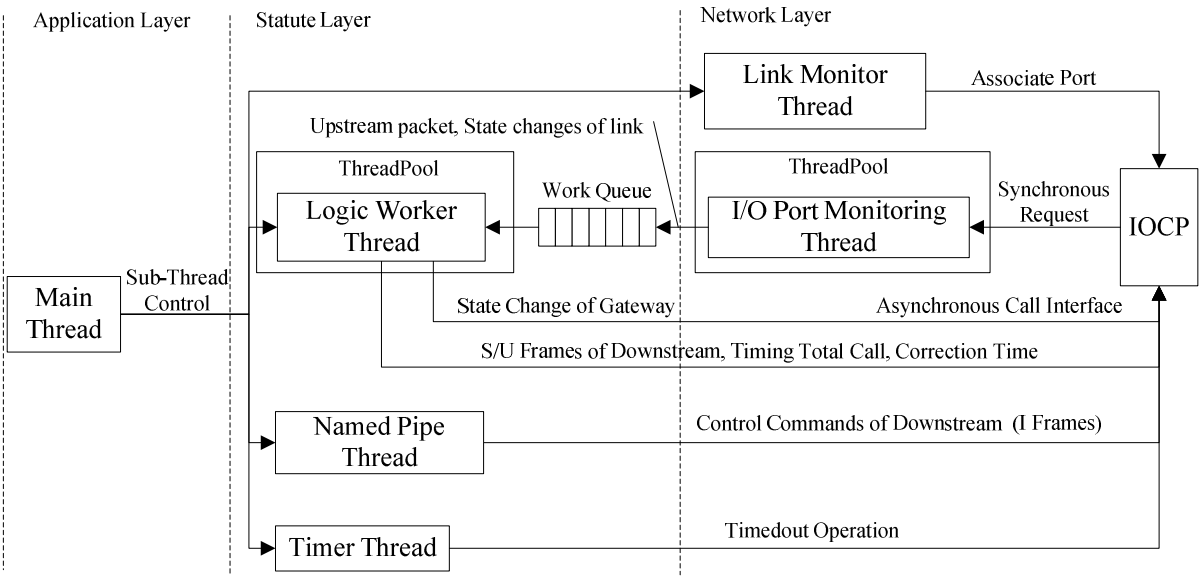

Figure 3 The relationship among the core threads

C. *Information Model*

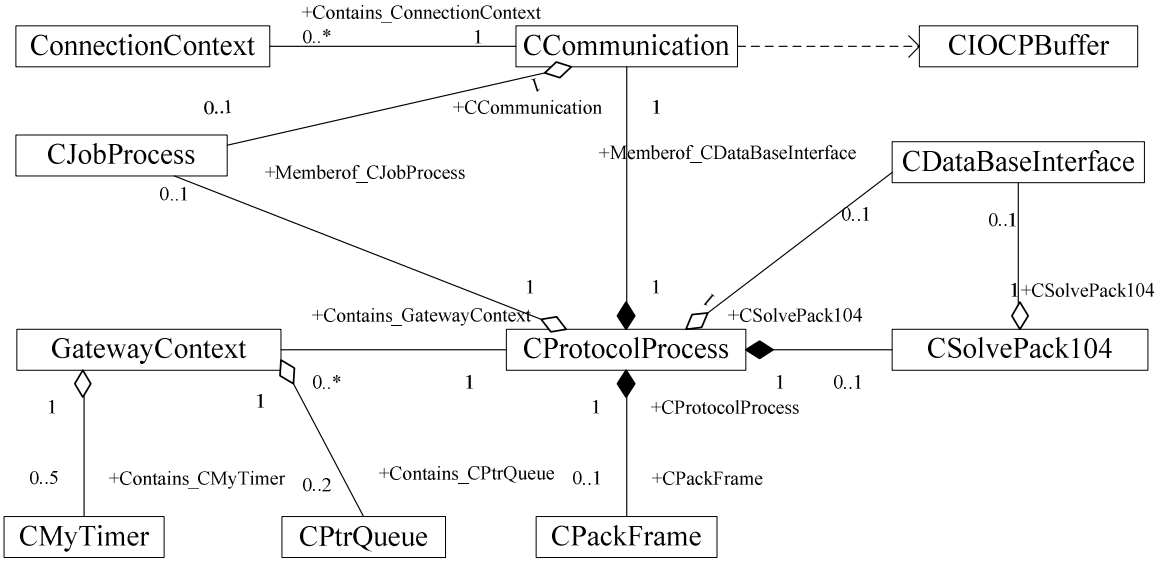

Figure 4 System Static Objects

IV. Application of Data Acquisition System

The Micro-grid test platform of Hefei University of Technology based on the ideas of building network hardware platform, adopt special measurement and control devices and digital gateways.

According to the software system design ideas described in Section 2, the system main program DAS_MGEMS is coded. According to the test principle provided by the literature [9-10], after the pressure test, configuration parameters test, and application functional test with the professional test software, the software has pass through union-test experiment with each functional module in Hefei University of Technology Micro-grid experimental platform. At present, the system runs normal, stable and reliable and meets the design requirements.. Based on the performance test software LoadRunner of HP, the contrast between the DAS_MGEMS CPU usage changes and the amount of TCP data packet transmission request changes is shown in Figure 10. The instantaneous fluctuations of net data traffic resulting from the system cycle incident, impact the computer system resources load inconspicuously. The screen of DAS_MGEMS running is shown in Figure 11.

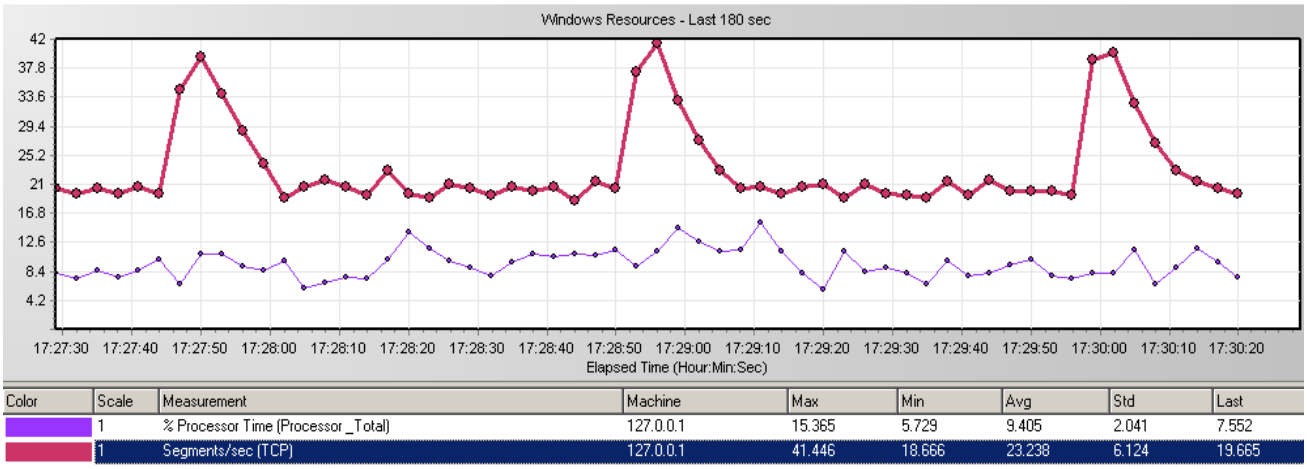

Figure 5 Comparative of DAS_MGEMS operating parameters

V. Conclusions

1) The efficient communication mechanisms based on the thread pool technology have been very mature, but the combination with IOCP and using the workload of the task within the system to achieve self-management system, can further improve the system's flexibility and real-time.

2) The maintenance of the communication channel with two-step context mechanisms facilitates effective management and ensures the accuracy of communication.

3) System resources are saved significantly by the application of synchronization multiple threads in various locations, the reasonable context maintenance and the introduction I/O completion ports.

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