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Land-state Network Congestion Location System based on Embedded TCP/IP Stack

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Abstract: At present, with the rapid development of science and technology and computer field, great changes have taken place in the traditional way of production and life, and it has a very big influence in the network mapping technology. Now the state has conducted in-depth research in satellite navigation, space mapping and other aspects. Of which, rapid positioning system of CMONOC congestion based on embedded TCP/IP protocol stack has made great contributions to geology, measurement, satellite navigation and other aspects, and it has also helped China build an observation network with high precision, high spatial and temporal resolution and precise positioning on the Chinese mainland. This paper focuses on the key role of embedded TCP/IP protocol stack in the positioning system. Combined with the characteristics of the system, learn the control mechanism of CMONOC positioning, and the research results in this field in China. This paper makes a preliminary discussion and application analysis of the system.

Keywords: TCP/IP protocol stack; CMONOC; Congestion location; Observation

1. Introduction

In the information age with the rapid development of network technology, network congestion has become an innegligible problem, especially in the case of high precision requirements. When time is urgent, it becomes a key problem to quickly locate network congestion and respond appropriately to clear the network, especially in CMONOC. Therefore, the researchers believe that the embedded system can be well applied in the existing CMONOC. Using the special processing function of this network can process the data more quickly and conveniently. With the addition of embedded system, the network coverage is wider and we can carry out remote control better, meeting the requirements of remote control. In order to make the embedded system networked, it is necessary to realize TCP/IP protocol stack in it, and carry out positioning control in combination with the CMONOC system. TCP/IP protocol stack is the key of the whole system, and it can help remote location to a new level.

As for the system study, internationally, some large companies abroad have developed some smaller TCP/IP protocol stacks, it is mainly lightweight protocol stack with strong compatibility and portability. In addition, we also use the embedded protocol stack software lwip, compared with traditional protocol stack, lwip is original, and it makes use of the proxy technology and routing connectivity, so that the technology can implement outside the protocol stack unlike the traditional technology, on the contrary it improves the efficient and the performance of the whole system.

2. TCP/IP Protocol Stack Features

The TCP/IP stack is a group of many protocols. There are five major protocols for the introduction of embedded systems into the internet, namely: Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), IP address, Internet Control Message Protocol (ICMP) and Transmission Control Protocol (TCP). Its functions are to provide network address with interpretation and analysis, network diagnosis, and network transmission and network connection. At the network interface layer, the system needs to implement ARP response protocol, the protocol performs address translation between IP addresses and MAC addresses of Ethernet. In the network layer, the IP protocol is implemented to reduce the fault tolerance rate. IP message contains the part of message correctness detection, which can ensure the correctness of the transmission process. In addition, in order to ensure the network and the application system connectivity, it needs to achieve Ping protocol of the network control message.

Embedded systems are generally added to meet a part of the requirements, the main features are: the first is that the protocol's standards need to be made public so that different networks know the rules and it can operate flexibly across different networks; the second is the standardization of high-level protocols. Due to the unified network address allocation scheme, each network has a unique address corresponding to each other, thus reducing the service error rate; the third is simple code, occuping small memory space and saving system space resources; the last is that it is easy to cut and extend, the protocol should be simplified or extended according to the characteristics of embedded system for different applications.

3. The Overview of CMONOC Congestion Control

In CMONOC, congestion happens so many times, timely network congestion positioning is conducive to reducing transmission delay and dredging flow at the location where congestion occurs, and it is helpful for real-time monitoring and accuracy of measurement [1]. Scales used to describe the degree of congestion is different, and each scale measures the degree of network congestion, such as waiting delay, data processing rate, network transmission efficiency, etc., which makes it more difficult to solve network congestion. The degree of user satisfaction varies from point of view. The reason why CMONOC congestion generates is that users cannot share resources in an optimal order, when multiple users request the same network resources, and it is easy to cause information congestion and network congestion. The direct reason is that the storage space is small, the processing speed and capacity during processing is limited and inconsistent, and the bandwidth capacity is too small.

As for the control mechanism of CMONOC congestion, the system adopts TCP congestion control [2]. TCP is a widely used transport layer protocol, and it has four processes: Firstly, carry out slow start stage, the idea of sliding windows is used. Starting from 1, improve multiply to ensure that the initial amount of flow to the network is not too large; secondly, access to congestion avoidance stage. The main function of this stage is to make the flow of CMONOC exceeding the limit of the processing capacity increase slowly and ascends one by one. In this way, network congestion can be avoided to some extent; thirdly, fast retransmission, when the data has not received the feedback within a certain time range, this measure will be adopted to transmit the information without error, and the lost packets will be retransmitted with this strategy. Finally, fast recovery; restore the network in a state of congestion.

4. Orientation Control Algorithm of CMONOC Congestion based on TCP/IP

As for orientation control algorithm, there are Reno algorithm, improved NewReno algorithm and Sack algorithm [3]. Next, we mainly introduce these three algorithms, and they play a key role in the location and processing of real network congestion.

The first is Reno algorithm, which was improved based on Tahou research in the 19th century. Tahoe algorithm is the ancestor of the TCP algorithm, appearing at the earliest time, but most TCP implementations still adopted it. The main concept is that the sender mainly maintains a dynamic value -- congestion window. The size of data sent by the sender is affected by the congestion window and the amount of data changes according to the size of the congestion window. The size of the congestion window depends on the actual situation of the network, conducting real-time update and adjustment according to the current flow condition. At the beginning, the flow of the sending window of the sender is equal to that of the congestion window. Under normal circumstances, the size of the sending window is definitely smaller than that of the congestion window. In this way, the change of the whole flow will have certain elasticity and flow processing space. Slow start algorithm generally means to transfer data slowly, slowly increase the value of the congestion window from small to large. Reno algorithm improves the original algorithm in two aspects. The first is to receive three consecutive ACK, and the algorithm goes straight into congestion avoidance rather than into slow start. The second is to add two methods, fast retransmission and fast recovery. The specific process is as follows: firstly, receive three confirmations entering the transmission state, and three confirmations are needed resulting from three handshake of message delivery, and this is to make the size of the sliding window equal to half the size of the congested window, then resend the lost packet, then according to the actual situation, change the size of the sliding window, and then the size of the sliding window is generally increased, it is the number of repeated ACK. Finally, when the minimum values of the congestion window and the sliding window are large enough, a new packet is sent. When a non-repeated ACK is received, the size of the sliding window changes to the size of the congestion window, and finally it moves to the stage of congestion avoidance. It can be seen that when Reno receives the three confirmations, it enters into the state of rapid recovery. If the data is not transmitted successfully and the delay is too long, Reno algorithm and Tahoe algorithm reopen the slow start stage.

The next are NewReno and Sack algorithms, and the NewReno algorithm is an improvement of Reno algorithm from the name. NewReno adds a lot of humanized design to the original Reno algorithm. Due to many unnecessary retransmission operations of Reno, time and space are wasted. NewReno, on the other hand, can maximize the likelihood of not performing many retransmissions during the rapid recovery phase. The size of the send window is represented here as an ACK, which transfers the data immediately and improves network performance. Although NewReno is widely recognized, and it is also widely used, however, it has the disadvantage that the university cannot utilize the bandwidth in the rapid recovery stage. To make up for this, the researchers introduced Sack algorithm, what distinguishes the Sack algorithm from NewReno is that it does not retransmit all the wrong data packets. Instead, it analyzes the existing confirmation number and selectively retransmits the missing parts, so that the previous ones that arrive on time do not need repeated operations. This improvement makes it faster, more efficient and more accurate. Of course, Sack algorithm has its own disadvantages. It modifies TCP at the receiving end, which is often troublesome and also brings some space overhead.

5. CMONOC IP Congestion Control Mechanism

With the rapid development of network, single congestion control mechanism cannot satisfy the problem of role positioning in CMONOC, and in addition, not every internet user can fully follow the end-to-end congestion control mechanism, the ideal situation cannot meet the actual conditions, it requires CMONOC itself to have the ability to manage and control resources. Under this concept, the CMONOC IP congestion control mechanism is proposed.

The main algorithms are: Random early detection algorithm (RED), explicit congestion notification algorithm (ECN) and Weighted fair queuing algorithm (WFQ) [4]. RED is to calculate the length of waiting queue randomly, the sending port is notified to reduce the size of the congestion window if it is found that the data transmission is slow, or the time delay and the flow exceeds the maximum. The algorithm consists of two parts: How to calculate the monitor queue length and the specific moment to abandon the data. Firstly, RED uses length to calculate the average queue length, the formula is: $queue=(1-length)\times queue+length\times S\_queue$. Of which, $0<length<1$, S_queue stands for the queue length at the time of sampling measurement. Generally speaking, the average length can be used to calculate the degree of congestion more accurately. The probability of data retransmission is linearly related to the bandwidth of the router, the larger the bandwidth is, and the greater the probability of dropping packets will be. We also need to classify the flow into an appropriate bandwidth. The rationality of bandwidth is a very important factor.

Secondly, it is ECN algorithm, and the algorithm inserts ECN into the data at the sending end, according to the specific situation of the network, set CE (Congestion Experienced) bit, through internet, the data received back by the sending end is required to be CE set, and then continue to send the data, and use it as the data that does not need to be saved. The congestion feedback algorithm can adjust the size of the congestion window, correct the connection error with delay, and improve the fairness of the shared bandwidth. Finally, it is weighted fair queuing algorithm, and it is an improved algorithm of fair queuing (FQ). The WFC algorithm allocates a number to measure the carrying capacity of each waiting queue and each flow road. This weight determines the number of bits per queue forwarded by the router, thus controlling the data flow to obtain the bandwidth [5]. The algorithm allocates data flow weights according to different priorities, and the specific method is to allocate according to the emergency degree, the waiting time of different data and the size of the cache resource. The algorithm itself is more complex, considering more comprehensively, and it has strong application adaptability, meanwhile it is a common processing algorithm.

In short, the rapid positioning system of CMONOC congestion based on embedded TCP/IP protocol stack has played an important role in measurement and mapping, spatial orientation and other aspects, and it make network delay small and data processing accuracy high, and the remote monitoring and measurement technology more skilled. The rapid positioning system of CMONOC congestion based on embedded TCP/IP protocol stack plays an important role in military, mapping and people's life, and the study will continue, and this also requires developers to master more technology under the condition of learning knowledge of embedded product design, in order to make a good system similar to the rapid positioning system of CMONOC congestion based on embedded TCP/IP protocol stack.

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