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Audio/Video Bridging (AVB) Protocol for Industrial Application

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Abstract

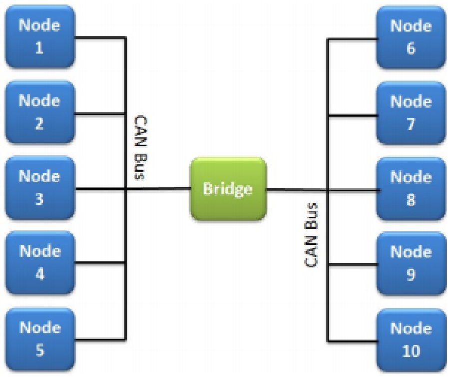
In Industrial Real-Time Systems, data rate and latency are important factors. Many researchers discuss the industrial protocols to robust Industrial network performances. CAN Bus is one of protocol which is used in industrial application. CAN Bus is develop for Industrial Automation Systems interest. It designed to al low MCU (Micro-Control Unit) and other devices to communicate each other without host computer. Nowadays CAN Bus also be used as fieldbus in automation environment. In CAN Bus network, if the main cable is damaged t hen the networks will fail or be split into two networks. The other protocol which is suitable for Industrial Automation Systems is Audio/Video Bridging (AVB) protocol. IEEE 802.1BA is the Audio/Video Bridging (AVB) standard for transporting audio, video, or the other real-time data through ethernet. AVB network can reserved bandwidth for critical information. One aspect of this standardization effort is to adapt AVB stream reservation mechanisms to operate with industrial-standard. This thesis proposed the AVB mechanism to achieve low latency in industrial network and compared with CAN Bus protocol.

Keywords : *Audio/Video Bridging, Industrial Application, Real-Time Systems*

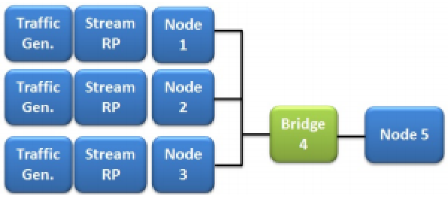
1 INTRODUCTION

In industrial application (Quang, 2012) real-time delivery is important. It contains of the number of sensors, actuators, and I/Os. (Choi, 2008), (Nhon, 2015) The time-sensitive traffic requires three main functions. First, precise timing and synchronization is needed so that individual traffic streams will meet their respective jitter, and time synchronization requirements.

The Audio/Video Bridging (AVB) (Szurman, 2014) is one of proto col which is used for time-sensitive traffic over IEEE 802 bridged networks. It can reserve the source bandwidth for the real-time data such as Audio, Video, or the others. Ethernet AVB is a set of standards, providing quality of service (QoS) mechanisms for low latency communication. Several IEEE standard was adding to achieve the QoS requirements for low latency streaming in Ethernet network. With AVB, Industrial Real-Time Ethernet will be able to leverage all of the advantages. These functions (Geyer, 2013, Garner, 2011) are provided by three AVB standard: IEEE 802.1AS (precise timing and synchronization), IEEE 802.1Qat (Stream Reservation Proto col (SRP)), and IEEE 802.1Qav (Forwarding and Queueing Enhancements for Time-Sensitive Streams). All of these standards will be used to make AVB network in this paper work. This work describes a configuration mechanism to achieve low latency in industrial network. The CAN Bus proto col is used as comparison with AVB protocol.



(a) CAN Bus Network



(b) Audio/Video Bridging Network

Figure 1: System Model

2 SYSTEM MODEL

2.1 CAN Bus Network Model

A simple CAN network contains of source no de, CAN Bus, Bridge, and destination node. 10 no des is used in this simulation model, as shown in figure 1a. CAN Bus arbitrates for each sensor based on ID (IDENTIFIER) of message, where lower can win. If CAN Bus is busy, then p ort will buffer sensor data, else process.

2.2 Audio/Video Bridging Network Model

The AVB system can include the talkers and listeners such as video cameras, radars, broadcast systems, etc. The network can include AVB interfaces, bridges, switches, and gateways. System model for this simulation can be seen in figure 1b.

Each node consist of one Traffic Generator, StreamRP, and Node Block. The bridges the AVB Bridge block. A node 5 is listener, the output of this block is connected to the AVB

Stats to measure the latency. Figure 2 is the process how the AVB networks reserve d the bandwidth and transmit the stream. Talker sends TalkerAdvertise message to the bridges. The bridges which is receiving the TalkerAdvertise message check for bandwidth availability. The required bandwidth of the streaming data (StreamBW) at each node of intermediates bridges is calculated by using equation 1.

$$StreamBW = \frac{(MSF + OH).MIF}{IntervalTime} \tag{1}$$

MaxFrameSize (MFS) indicates the maximum payload size of each frame transporting the stream while MaxIntervalFrames (MIF) in each interval time (Kim, 2008, Choi, 2010). The OverHead (OH) is 42 bytes and includes the Ethernet header, preamble, and CRC. After the streamBW is calculated and the output port of switch has enough resource, the frame is forwarded without any modifications to the port. In the other case, when no sufficient resources are available, the frame is modified to talker failed frame with failure information. When the bridge has got sufficient resources available on that port, then the TalkerAdvertise is propagated to the next bridge/node. If the resource is not available, the bridge will sends a TalkerFailed message. This message contains of failure code and bridge identification to provide error checking or notification.

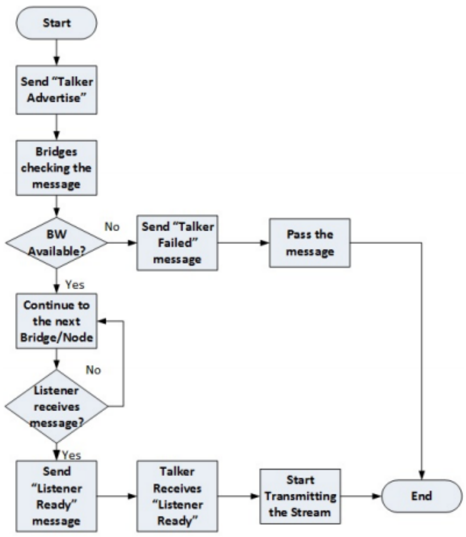


Figure 2: AVB Bandwidth Reservation Flowchart

The bridges which is receiving TalkerFailed message, will drop the message. When the listeners receives a Talker Advertise message, it will respond with ListenerReady message that is forwarded back towards the talker. The bridges use the ListenerReady message to lock down the resources needed by the stream. When the talker receives a ListenerReady message, it can start transmitting the stream. The talker can de-registering the stream by sending the de-registration message through the network in the same manner as the registration stream.

3 RESULTS AND ANALYSIS

This work is focused on designing an Audio/Video Bridging Protocol in Industrial Application environment and compared it with CAN protocol. In industrial application the end-to-end delay must be small to get good network performance.

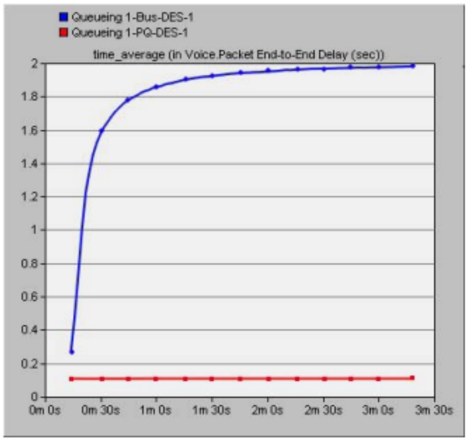


Figure 3: End-to-End Delay

Figure 3 shows the time average for end-to-end delay to transmit voice stream. AVB protocol end-to-end delay is smaller than CAN Bus protocol. It is because in AVB network, the bandwidth has been reserved for voice stream, so the average time is stable around 0.1 second.

One of the metric which is used in this paper is Queuing Delay. Queuing delay in AVB (Red line) network is smaller than CAN (Blue line) network. AVB network need around 2.7 ms and 3.0 ms for CAN network for queuing the packets as shown on the figure 4. It happen because in the AVB network used Priority Queuing Scheduler. The queuing delay in the AVB network can be small by reduce the reservation bandwidth for audio or video stream.

4 CONCLUSION

This paper designed the Audio/Video Bridging (AVB) to enhanced the industrial network performances. The AVB using Reserved Streaming Proto col (RSP) to reserved the bandwidth for real-time content in the network. CAN protocol is standard which is used for industrial application. Because of that reason, CAN network has been simulated as comparison with AVB network.

The AVB network is suitable is industrial application on the other real-time applications such as automotive. The performances using AVB protocol are better than CAN protocol. These are happened because in AVB proto col need to reserved bandwidth/resource before start the transmission. Simulation result shows that AVB has smaller end-to-end delay, and queuing delay.

For further research, this study will be implemented the AVB proto col in wireless application. Because nowadays , the AVB support for ethernet only.

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