ABSTRACT

This paper evaluates the performance as well as effectiveness of the High Speed Ethernet LAN-Based Distributed Telemetry Data Network Architecture. It also attempts to obtain a feasible solution for the Extension of LAN over High Performance Digital Modem via Routers and Bridges. With the advent of highly efficient broadband TCP/IP network and rapid growth of data traffic demand in the area of Telemetry Data Acquisition and Processing, one has to adopt a high bit rate PCM Telemetry Data Stream with the strategy of distributed task scheduling in multi-processor environment. The proposed Telemetry System Architecture is adopted as a milestone to Modern Telemetry system. It incorporates various value added services for the performance evaluation of various flight vehicles providing authenticated data. This paper shows that by configuring the IP addresses of various nodes and router / bridges with V.35 interfaces, it is possible to extend the Telemetry Data on a local LAN to the remote LAN for display and high speed processing in real time. Necessary comparisons of performance of the existing to the proposed systems are presented.

KEY WORDS

PCM Streams, TCP/IP, Ethernet Standard, V.35 WAN Interface, Router, Bridge.

INTRODUCTION

In a conventional Telemetry System, the inherent limitations are the processing speed and the time driven round robin or priority based task scheduling by the single processor. So, in real time scenario, the processor is really overloaded and unable to take the burden of executing extra tasks within its required time frame. The other factor, which adversely affects the system performance, is the limitation of slow data update rate in the Telemetry Remote terminals. This is mainly due to the fact that Serial Asynchronous links have low baud rate and the terminals are 'dump terminal' in the real sense. The remote terminals are restricted to either VT-340, VT-300 or dump terminal emulators only. These remote terminals are normally extended via 9600 baud Asynchronous serial links with data update rate of the order of 1 sec. These displays were provided only as visual aids to the specialists and are not designed for high data rate applications, which require monitoring of
the fast varying parameters at remote sites. Also, in the modern telemetry systems, dump terminals are rarely used as the very purpose of it has changed into the intelligent display where a user can not only monitor the data but also process and retransmit again to another location. So, in the main telemetry system, system complexity has been greatly reduced due to its distributed task scheduling. The proposed Network architecture configures the local and the remote Routers / Bridges via high speed digital link properly, and achieves an efficient means of transportation of High Speed Serial Telemetry Data in real time to remote location. Now, with this noble idea of LAN extension, the remote terminal becomes an intelligent terminal enabling real time remote data logging as well as real time data processing, re-transmission and off-line data extraction and analysis facilities.

The Ethernet LAN based Telemetry Data Network Architecture under consideration, consists of three numbers of Window-NT based Broadcast Nodes and two numbers of Display Stations. The Broadcast Nodes are mainly dedicated for data acquisition of maximum two numbers of 1 Mbps PCM streams or 2 Mbps single PCM stream and broadcast it to Ethernet LAN. The Local Display Stations acquire all the PCM streams from LAN, merges multiple PCM telemetry streams and transmit real time data over serial synchronous link via modems. Each display station can transmit data over maximum four Asynchronous and two Synchronous links with 9600-baud rate. All these nodes are connected over 8 ports 10/100 Mbps Ethernet HUB with IEEE 802.3 CSMA/CD protocol. The data communication between them is implemented with normal TCP/IP protocol via data gram (Broadcast) approach. The local Ethernet LAN HUB is extended to remote location by CISCO 1700 series Router with V.35 interface which is connected to a high speed (2 Mbps) digital subscriber link (HDSL) modem. The remote site will have the same configuration but in reversed fashion and ultimately multiple remote display stations can be connected over remote Ethernet HUB. Another approach towards LAN extension is to use the Bridge instead of Router. If the local and remote LAN are of same network protocol then bridge is sufficient as it simply broadcasts all data packets it receives. The router is required to be used if one needs a security feature to be enabled and both local and remote networks are at different network protocols like Token Ring, Ethernet or FDDI. Also, it can be configured to transmit data packet to the network with specific IP address instead of simply broadcasting to the entire network. Real time Telemetry data acquisition has been achieved satisfactorily using present network configuration with maximum 1 Mbps Telemetry single stream or 500 Kbps dual streams with its own frame overhead. Better performance can be realized by incorporating higher link speed. Once the local LAN is extended to remote site, multiple display stations can be configured putting over another Ethernet HUB. The error detection and correction scheme embedded into router and bridge extends the data link more reliably for providing authenticated data compared to normal asynchronous link. The extracted telemetry data can be transmitted serially over asynchronous and synchronous link again from the remote display station itself, which will increase the effective utilization of the telemetry system resources.

**SYSTEM OVERVIEW**

In a broad sense, the number of nodes, namely broadcast stations for PCM data acquisition and distribution depends on the number of PCM streams to be acquired and processed. In the present system architecture, we have considered three numbers of broadcast stations with two PCM streams for each broadcast station. Hence, a total of six PCM streams with proper connectivity can achieve 100% redundancy in the failsafe system functionalities. These three broadcast stations are connected over 10/100 Mbps Ethernet LAN via 8 ports Ethernet HUB. On the HUB, there are
two Display Stations (ideally any number is possible), which are responsible for merging multiple PCM streams acquired from broadcast stations at local side and displaying the same in graphical as well as in text form. Apart from their own task of Data Acquisition, Distribution and Display, the Broadcast Stations and Display Stations can transmit the extracted data over 9600 baud Asynchronous as well as Synchronous Links with 100 ms (10 Hz) data update rate and the refresh rate of asynchronous terminals is 1Hz only. This may not serve our purpose of monitoring fast varying super-commutated parameters. Another limitation is the number of bytes or frame length that can be transmitted over these links. In this case, theoretically only 120 bytes can be transmitted. However, with a proper study, it is found that due to restriction of protocol overhead and processing speed, the frame length is limited to 72 bytes only. So, efforts were made to use the present networking idea of Routers and Bridges with TCP/IP features. The basic idea of using Router is to interconnect two dissimilar networks with different Network Protocols where it works at 3rd layer of OSI architecture [1]. On the other hand, the Bridge is for two similar networks where it works at level 2 (data link) of OSI. Another advantage of using Router is to inter-connect multiple and different networks in different domains. Also, by properly defining the network and host addresses in the routing table and specifying the hop limit, we can restrict the Telemetry data flow over the entire network. When all the networks are in a same domain and data flow manipulation is not important, it is easier to use a bridge instead of router. The router’s V.35 WAN interface is terminated in turn to high-speed digital modem (HDSL). It supports maximum 2 Mbps rate, single twisted pair cable up to 3 Km and minimum 160 Kbps up to 12 Km. On the other side of the network, this cable is terminated to same HDSL modem and then to remote router through V.35 WAN interface. The router’s LAN interface (Ethernet) is connected to 10/100 Mbps remote Ethernet HUB where we can connect as many display stations as required either by up-linking the HUB itself or via another router and so on. With this present scheme and link speed limit, maximum of two PCM streams of 500 kbps each or 1 Mbps single stream are extended satisfactorily without any data loss.

SYSTEM SPECIFICATIONS

1720 CISCO Router:

The 1 Port Serial Wide Area Network (WAN) Interface Card (WIC) provide EIA/RS-232, EIA-449, V.35, X.21 Data Terminal Equipment / Data Communication Equipment (DTE/DCE) Serial Interfaces. It supports both asynchronous up to 115.2 Kbps and synchronous up to 2.048 Mbps data rates. Its 10/100 Mbps fast Ethernet interface port connects the router to local Ethernet LAN (IEEE 802.3 standard). This port auto-senses the speed (10 Mbps or 100 Mbps) and mode (Full duplex or Half duplex) of the device to which it is connected and then operates at the same speed and in same mode. The major tasks while configuring the Routers are to configure the global parameters, security, fast Ethernet interface, serial WAN interface and dynamic routing parameters [2, 3, 4].

Remote Bridge – H Connect RS (BANYAN Networks)

The H-Connect RS is a High bit rate Digital Subscriber Line (HDSL) desktop unit to extend the communication range on a physical copper wire reducing the need for repeaters to connect two isolated Ethernet LANs. This unit is compatible with IEEE 802.3 Ethernet standard with IEEE 802.1d Spanning Tree Bridging Protocol and ETSI RTR/TM-3036 and ANSI T1, E1 standards
It operates at full duplex on 2 wire at a bit rate in the range of 144 Kbps to 2320 Kbps with operating range of 1.0 Km over 0.4 mm copper wire or 1.2 Km over 0.5 mm copper wire with 6 dB noise margin over near end cross talk with a $10^{-7}$ BER @ 2.32 Mbps [5].

SYSTEM ARCHITECTURE

The basic architecture of the entire LAN based Telemetry Network and its extension via Router or Bridge is shown in Fig.1.0. The actual network and its extension via Router/Bridges are shown in Fig.2.0. We have configured the local network / host addresses of Broadcast Stations 1, 2 and 3 as 190.0.0.1, 190.0.0.2 and 190.0.0.3 and two Display Stations 1 and 2 as 190.0.0.4 and 190.0.0.5 respectively. The local router LAN port is configured to address 190.0.0.254. All the Broadcast Stations are programmed to distribute the acquired Telemetry Data over the entire network by a broadcast address of 255.255.255.255 i.e. all the host of all the networks. The remote LAN is configured to be of Class-A type with network address 10.1.1.0 with remote display station 1 as 10.1.1.1 and so on. The remote router Ethernet LAN port is configured as 10.1.1.254. Both the routers’ routing tables are configured to have access to each other (No deny).

If there are more than two such LANs in different IP domain, these can be interconnected by separate sets of Routers and HUB and the routing tables of each router have to be modified accordingly. In the case of a bridge, the IP packets received will be broadcasted over the remote LANs whereas the router will route IP packets only to those remote networks, which are specified in its IP forwarding table. Presently three display stations are configured at the remote LAN which is almost 3 Km away from actual telemetry station. The remote display stations are pre-configured with required telemetry parameters to be monitored real time for critical decision-making. We can use any serial synchronous or asynchronous card for further communication / retransmission to various other locations if required. In this case, actual telemetry acquisition node may be responsible for only data acquisition whereas other major tasks like display, analysis, transmission can be off-loaded to various nodes in local as well as remote LAN. Using the above distributed architecture, telemetry resources are effectively managed in better way with enhanced level of satisfaction. With the remote bridge configuration, the pair of local and remote routers is simply replaced by a pair of remote bridges.

Fig.1.0. The basic Network Architecture
SYSTEM PERFORMANCE AND RESULTS

The restrictions as discussed earlier for the conventional Telemetry systems can be removed easily by using the above concept of LAN extension. In such case, entire local network traffic is available at the remote site for immediate analysis. As the remote LAN display stations are PC based, extracted Telemetry data can be logged in real time on the local hard disk and also on-line re-configuration for new graphs or text displays is possible. After acquisition of PCM frames, it is tagged with IRIG-B time at the broadcasters at a minimum of one msec update rate. As far as the data update rate is concerned, it is basically the frame update rate of the incoming PCM frame, which is floated over the LAN by the broadcast stations after acquisition and time stamping. With the router or remote bridge with data bandwidth of 2.048 Mbps, the LAN extension scheme is found to be steady up to one PCM stream with 1 Mbps rate each or two PCM streams at 500 Kbps each.
SUMMARY AND CONCLUSION

In this paper, it has been observed that for a given data traffic, a LAN based distributed architecture gives a better performance in real time in terms of network throughput and data updating rate compared to the conventional Telemetry system. For the remote stations, at distances more than the above specified distances, the fiber optic interfaces can be adopted. With router and bridge with 2.048 Mbps link, PCM stream up to 1 Mbps (single stream) or 500 Kbps (dual stream) has been achieved. So it is concluded that the router / bridge inter-connectivity of different remote telemetry networks is a natural cost-effective and efficient solution for the telemetry data transfer over intra-net or inter-net. It is observed that telemetry resource sharing and distributed resource management in LAN based telemetry and its extension via router bridge leads to highly efficient data network compared to conventional telemetry systems.

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