# CONTROL NETWORK AND FAST MULTIDRIVE FIELD BUS LINK

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***Summary:** This paper summarizes the most important features of the Control Network Link (CNL) and Fast Multidrive Field bus Link (FMFL) as a part of the Distributed Multidrive System (DMS). The proposed links provide a real-time communication link between various clients or controllers in a complex DMS. CNL is configured as a local overriding communication network and includes FMFL as subnet. CNL and FMFL are designed in accordance with ISO's seven-layer model for Opens System Interconnection (OSI). Both links are used for the time critical, real-time communication within the DMS. DMS, access to the CNL and basic features of the FMFL's protocol are shortly presented.*

## 1. INTRODUCTION

The complex distributed applications based on the control network facilities should be capable to fulfill all requirements for framework of industrial modernization. The majority of open distributed applications are based on the client-server communication model. This means that client or application process accessing and using server as remote file system. A single server process supports access requests from a distributed community of clients concurrently. Part of the distributed application could be DMS as a basic concept with the number of different possibilities to solve particular engineering problems. Direct integration of variable speed drives into the overall process control system by way of CNL and FMFL, brings about a number of advantages, such as simplified connections, consistent operator supervision or control and improved application program legibility. In DMS, several application controllers (APC) are interconnected by FMFL where each drive is used as separate node. Common control functions are distributed to separate nodes by the use of digital communication. The APC takes care of the specific control functions a basically, it could be a single board controller with all software and hardware facilities needed for a single or multidrive systems. The functions of the drive controller are independent whether a DC or AC drive applications are used. The drive controller (DRC) is normally equipped with speed measurement facilities, and could be either in torque or speed control mode. When the DRC is in torgue control mode, torque reference is generating from APC For communication to the common overriding control system CNL is used. Mentioned link ensures high performance, reliability, and availability required for DMS application.

## 2. CONTROL NETWORK LINK

The CNL provides real-time communication link between various clients or controllers in a complex DMS. These links are local to the respective clients and can only communicate with clients connected to the same bus. CNL is designed in accordance with ISO's seven-layer model for Opens System Interconnection (OSI). It is used for the time critical, real-time communication within the distributed control system [1]. When two or more networks are involved in an application, the mode of working is normally refereed to as internetworking [1], [2]. The term internetwork or internet is used to refer to the composite network. Each constituent network is referred to as a subnet. It is assumed that each network is of a different type and hence that the router will have a different set of network protocols associated with each network part. Control network based on internet is assumed as a subnet. The CNL's Medium Access Control (MAC) standard together with associated physical media specification (contained in the IEEE 802.3 Carrier Sense Multiple Access with Collision

Detection (CSMA/CD) standard's document) are implemented [7], [8].

## 2.1. CNL based on TCP/IP protocol

The internet protocol is one protocol associated with the complete protocol stack and it is known as TCP/IP protocol (Transmission Control Protocol/Internet Protocol). Protocol is now widely used in many commercial and research internets and includes transport and application layers. Networking protocols layers are responsible for a different facet of the communication. A protocol suite for used TCP/IP protocol is the combination of different protocols at various layers and is considered to be a minimized 4-layer system (Fig.1).

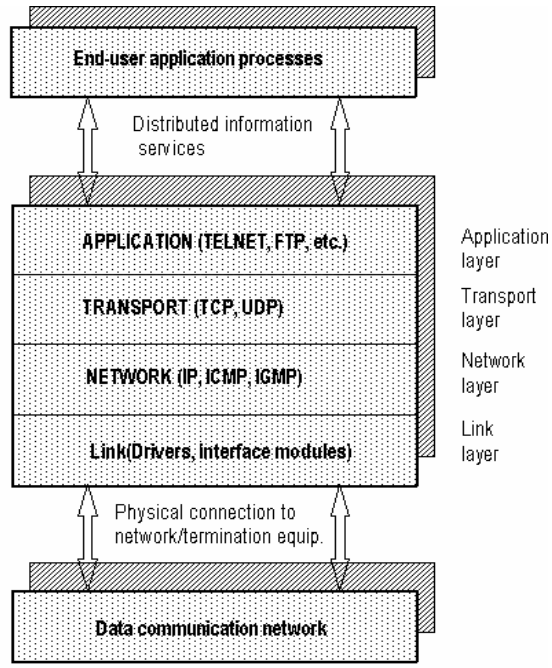


Fig. 1. TCP/IP protocol

The data link layer or network interface layer, includes the device driver in the operating system and corresponding network interface module. This module handle all the hardware components of physically interfacing to the network Media. Network layer or internet layer supports the movement of packets around the network as well as routing of packets. Internet Protocol, Internet Control Message Protocol together with Internet Group Management Protocol provide the network layer in the TCP/IP protocol suite. Transport layer supports a flow of data between two hosts. TCP/IP protocol includes two different transport protocols: TCP (Transmission Control Protocol) and UDP (User Datagram Protocol). TCP and UDP are two predominant transport layer protocols and both use IP as the network layer [4], [5]. TCP provides a reliable transport layer, UDP sends and receive datagrams for applications. The application layer is direct interface to the user application program and could include: Telnet, FTP (File Transfer Protocol), SNMP (Simple Network Management Protocol), SMTP (Simple Mail Transfer Protocol). Telnet provides services to enable a user application program to log on to the operating system of remote device. User can communicate interactively with another application process as if the user terminal was connected directly to it. FTP enables user application program to access and interact with remote file system. Access to a remote file server is a basic requirement in many distributed control applications. SMTP manages the transfer of mail from one system mail to another. SNMP is concerned with management of all the communication protocols and supports the total network environment. API (Application programming interface) for application using the TCP/IP protocols called sockets and TLI (Transport Layer Interface). A socket is end-point for communications that get bounds to the UDP or TCP port within the node. One application layer creates a TCP stream socket and bind it to a particular well known port number. Next application layer in the host device creates another stream socket which one will request connection to the previous socket by specifying its host Internet address and port number. Once the two TCP sockets have been thus connected, there is a virtual circuit set up between them. Up to five different protocols or sockets could be created. The socket layer contains a certain number of paired "calls" and these routines protect code that accesses data structures shared between the socket layer and the protocol-processing layer. The board communication software support package uses a client-server communication model. The main server reads requests and, if requested, sends a reply back to the client. The client builds the request according to the specific application layer, sends message and waits for a reply to be sent back .

# 3. FAST MULTIDRIVE FIELD BUS LINK

APCs are interconnected by FMFL where each drive is connected as separate node. High Level Data Link Control (HDLC) protocol is an international standard (defined by ISO for use on both point-point and multidrop data links) and is used in this application. It supports Layer 2 of the

seven-layer OSI model and is called data link layer. HDLC uses a bit-stuffing process to ensure that bit pattern of the delimiter flag does not occur in the fields between flags. The HDLC frame is synchronous and physical layer provides a method of clocking and synchronizing the transmitter/receiver. It uses both data and control messages carried in a standard format frame (Fig.2).

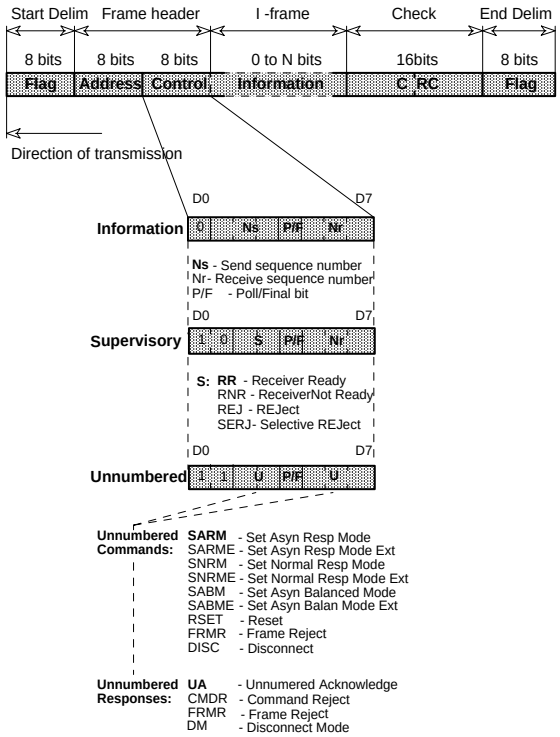


Fig.2. Frame format

Address field carry the frame's destination address. The length of this field is commonly 0 or 8 bits, depending on the data link layer protocol. The content of the address field depend on the mode of operation. The 8 or 16-bit control field provides a flow control and defines the frame type. Data is transmitted in the data field, which can vary in length. Error control is implemented by appending a Cyclic Redundancy Check (CRC) to the frame. For this application 16-bits long CRC is used. Three classes of frame are used in HDLC protocol: Unnumbered, Information and Supervisory frames. Unnumbered frames are used for Link Management (LM) for example to establish a logical connection between APCs and any DRC. All data (packed in information frame) is transfered under the control of the master station (application controller). In a multidrop application LM procedure for Normal Response Mode (NRM) and Asynchronous Balanced Mode (ABM) are used (Fig.3), [1].

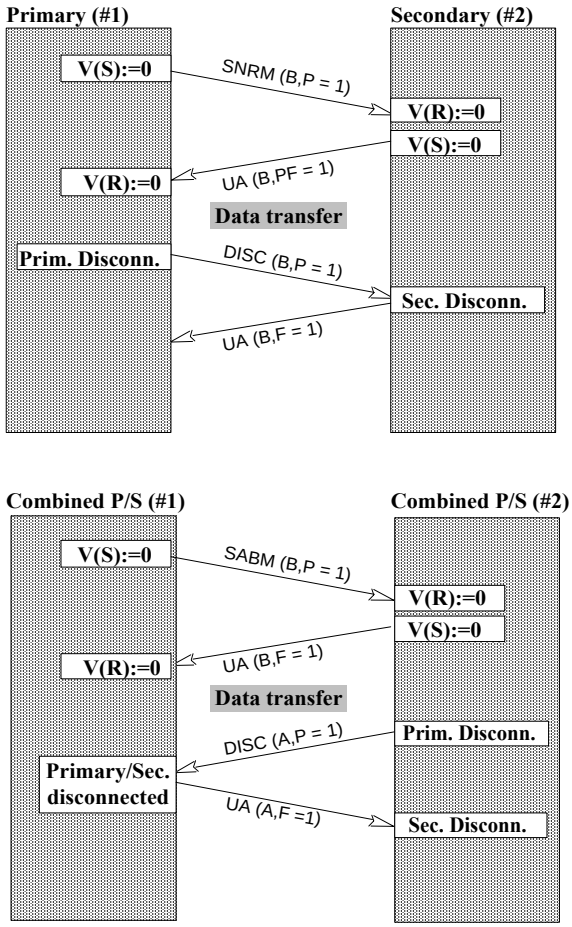


Fig.3. HDLC Link Management

## 4. ACCESS TO CNL AND FMFL

Communication module is supported by MC68EN360 Quad Integrated Communication Controller (QUIC), [10]. The QUICC is a versatile one chip integrated microprocessor with peripheral combination. It is the logical extension of MC68302 design and includes communication processor, two IDMA controllers and four general purpose timers. Communication module (Fig. 4) is based on glueless system design. For the Ethernet LAN capability of the QUICC, additional SIA transceiver is required. Ethernet serial MC68160 EEST supports connections to the attachment unit interface or twisted-pair. The QUICC supports the Ethernet/IEEE 802.3 protocol. High-performance real-time operating system (VxWorks developed by Wind River Systems) is adapted for this communication board [9]. VxWorks includes a fast, scaleable run-time system, testing and debugging facilities, and a UNIX cross-development package.

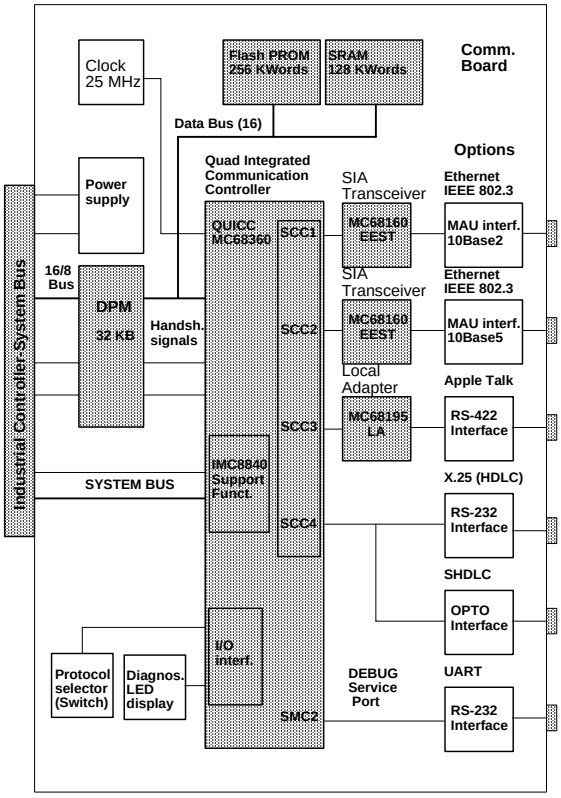


Fig.4. Communication module

Universal communication module supports access to the Ethernet/IEEE 802.3 control network, HDLC/SDLC local LAN and UART used as service channel.

## 5. CONCLUSION

The CNL provides real-time communication link between various clients or controllers in a DMS application. These networks are local to the respective clients and they are used in the complex DMS to integrate a variable speed drives into overall process control system application. The CNL is based on the Ethernet/IEEE 802.3 (TCP/IP) protocol and provides a connection oriented data stream service between the two end points of user application process. The term stream is used since it treats all the user data associated with a sequence of request and response messages. Communication module supports access to the CNL and creates a direct logical interface to the CNL protocol suite via different sockets. The stream socket layer maps protocol-independent requests from application layer to the protocol-specific implementation. Up to five different protocols or sockets could be selected and serviced within less then 20 ms. The FMFL is based on the HDLC protocol and is used in multidrop configuration. It supports Layer 2 of the seven-layer OSI model and is called data link layer. Guaranteed data exchange between different clients should be less then 2 ms. DMS, access to the CNL and FMFL then some hardware capabilities of the new communication module are shortly presented.

## 6. REFERENCES


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