# MULTIDRIVE CONTROL NETWORK LINK


Alojz Slutej

ABB Industrial Systems AB

S-721 67 Västerås, Sweden

Fetah Kolonić

Faculty of Electrical Engineering and Computing

HR-10000 Zagreb, Croatia



***Abstract*** - This paper summarizes the most important features of the Control network link as a part of the distributed multidrive system. The used control network link provides real-time communication link between various clients or controllers in a complex system. This network is designed as a local communication network in accordance with ISO's seven-layer model for Opens System Interconnection). It is used for the time critical, real-time communication within the distributed control system. Complex Multidrive System as distributed multicontroller systems with several application controllers interconnected by fast local communication link is presented. Some basic features of the new communication module demonstrate a usefulness of proposed access to the control link.


## I. INTRODUCTION

Within the framework of industrial modernization, increasingly powerful and more flexible distributed control systems in industrial multidrive application are needed. Application controller together with drive sub-controllers as a part of distributed control system is capable of fulfilling these requirements. These include control network based on open and standardized communication capabilities to enable their complete integration into complex factory production sequences. The basic concept of open system is to enable an exchange of information between application functions implemented on all distributed field devices. That include defined application functions as a standard user interfaces for communications and a standard transmission medium. Functional specification for the communication protocol based on an open protocol, supports multivendor interoperability and interchangeability. The complex drive system applications based on the control network facilities are capable of fulfilling above mentioned requirements.

## II. CONTROL NETWORK LINK

The control network provides real-time communication link between various clients or controllers in a complex control system. These networks are local to the respective clients and can only communicate with clients connected to the same bus. The communication link may be of varying types, and do not necessarily provide direct physical connections between clients. Thus, control network is designed as a local communication network (LAN) in accordance with ISO's seven-layer model for Opens System Interconnection (OSI) (Fig.1). It is used for the time critical, real-time communication within the distributed control system [1].

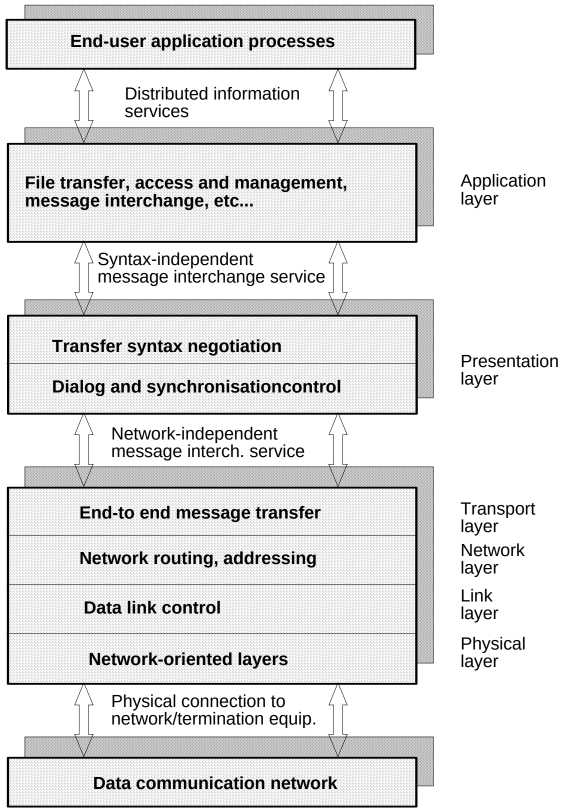


Fig. 1. ISO's Seven-layer model

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 Medium Access Control (MAC) standard together with associated physical media specification (according to IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD) standard's document) are implemented in connection-oriented transport protocol ensuring flow control and reliability with multiple priorities [7], [8].

### II.A. Implementation based on TCP/IP protocol support

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.2).

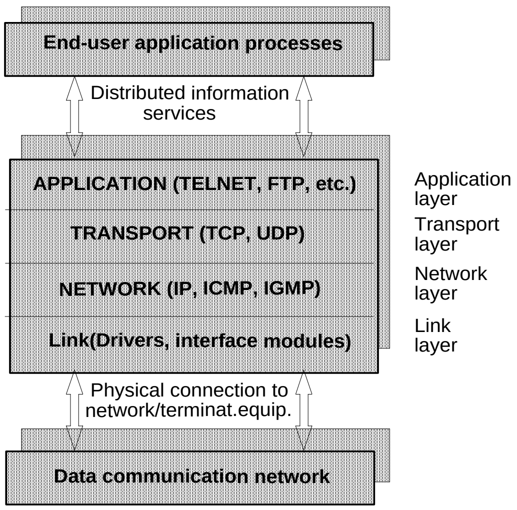


Fig. 2. TCP/IP protocol

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 (IP), Internet Control Message Protocol (ICMP) together with Internet Group Menagement Protocol (IGMP) 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 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. TCP/IP protocols called sockets and TLI (Transport Layer Interface) for API (Application programming interface) are used. A socket is end-point for communications that get bounds to the UDP or TCP port within the node. The used TCP/IP protocol provides a connection oriented byte 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. This application using a stream socket that uses TCP and bind it to a particular port number. Another host device in the network 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.

### II.B. Distributed multidrive systems

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 control system could be a multidrive system 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 control network and fieldbuses brings about a number of advantages, such as simplified connections, consistent operator supervision or control and improved application program legibility. In distributed multidrive systems, several application controllers are interconnected by fast sub-local communication link where each drive is used as separate node. Common control functions are distributed to separate nodes by the use of digital communication. The application controller 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. Principally, drive controller is not locally programmable and operation modes and other functions are selected by fixed set of parameters. These parameters are "visible" by overriding system. The drive controller is normally equipped with speed measurement facilities, and could be defined as controller with either torque or speed controlled outer loop (torque or speed control mode). Torque reference is used when speed control is located in the application controller or when the drive controller is used in the torque control mode. Communication to the overriding systems is possible through the use of optional communication boards [3]. To ensure the high performance, reliability, and availability required for mentioned drive control, a suitable fast control network should be used.

### II.C. Access to Control Network Link

Communication module is supported by MC68EN360 Quad Integrated Communication Controller [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. This combination simplifies interfacing a microcomputer base system to a packet network by providing the link-layer services of sequencing, flow control, error control and multiplexing of logical links. Communication module (Fig.3) is based on glueless system design. That means, QUICC interfaces gluelessly to an EPROM or flash EEPROM, DRAM SIMM module and Dual Port RAM as an interface to the control system. 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 Ethernet formats. The EEST provides a glueless interface to the QUICC. The QUICC supports the Ethernet/IEEE 802.3 protocol, widely used as LAN and it is predominant form of Local Area Network technology used with TCP/IP. It uses an access method based on CSMA/CD approach. It operates at 10 Mbit/sec and is based on the frame structure. The 48-bit destination or source address is used.

### II.D. Basic Software Support

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. The network facilities allow "transparent" access to other compatible sockets, remote command execution, remote login, etc. VxWorks currently supports network connections (IEEE 802.3) and serial lines (SLIP or CSLIP). Internet protocol as implemented in BSD4.3 for network communication is used. Universal communication module supports access to the Ethernet/IEEE 802.3 control network, HDLC/SDLC local LAN and UART used as service channel.

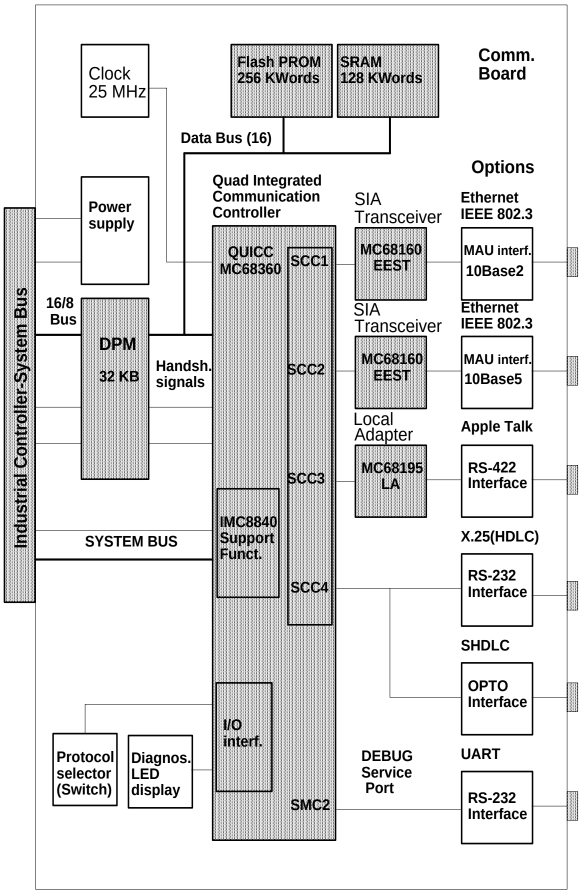


Fig. 3. Communication module

### II.E. Communication Protocols Support

The direct logical interface to the control network protocol suite is via different sockets (Fig.4). A socket is end-point for particular protocol that gets bound to a TCP (optionally UDP) port within the node and holds or points to all the informations associated with the link. TCP maintains its own control block for each connection, containing all the variables and state informations for the particular connection. State transition diagrams summarize all TCP's actions, in response to different types of segments arriving on a connection, disconnection or exceptional and define the TCP finite state machine. One application layer creates a TCP stream socket and bind it to a particular well known port number. Another application layer creates another stream socket. 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.

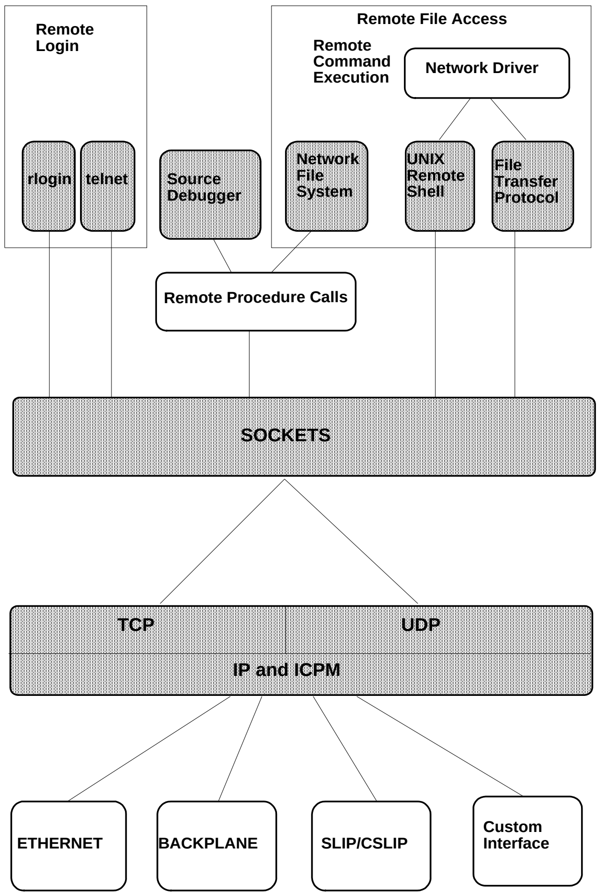


Fig. 4. Network Support

## III. CONCLUSION

The control network provides time critical, real-time communication link between various clients or controllers in a distributed control system. These networks are local to the respective clients and they are used in the complex drive system to integrate a variable speed drives into overall process control system application. The control network 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. Universal communication board supports access to the control network and creates a direct logical interface to the control network protocol suite is 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. Distributed control system, access to the control network and some hardware capabilities of the new communication module are shortly presented.

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