ETHERNET Gateway Implementation for a High-speed Multiservice LAN

J. Koutsonikos, T. Antonakopoulos, V. Pallios and V. Makios

The 2nd International Conference on Software Engineering for Real Time Systems

CIRENCESTER, UK, SEPTEMBER 1989

ETHERNET GATEWAY IMPLEMENTATION FOR A HIGH-SPEED MULTISERVICE LAN (LION)

J. Koutsonikos, T. Antonakopoulos, V. Pallios and V. Makios

University of Patras, Greece

Abstract : In the local area environment, the near future user-needs show an increasing demand for voice, data and image services. In a Multiservice Local Area Network (MLAN), the growing penetration of wideband services and the considerable amount of real-time voice and interactive data require simultaneously handling of stream and bursty type communications. Besides high-speed and service integration features, such a system has to provide powerful interconnection with both public networks and other, well diffused in the market, LANs. Therefore, the implementation of Gateways becomes an important part of the network design. This paper addresses the Gateway design and implementation for the Local Integrated Optical Network (LION) and ETHERNET.

INTRODUCTION

Recent advances in network technology and the wide diffusion of public and private communication systems and services are introducing new communication systems with the ambitious goal of fulfilling all the communication requirements of the near future enterprises (1). These systems, refered as Multiservice Local Area Networks (MLANs), connect usually a few hundred of nodes, supporting thousands of individual users and integrate different kinds of traffic, encompassing data, voice and images. The interconnection needs between these systems become essential and the requirement of economic and flexible access to external homogeneous networks through Bridges (BRG) and heterogeneous networks through Gateways (GTW) becomes critical, as far as the network performance is concerned (2).

Local Integrated Optical Network (LION) is a Multiservice LAN connecting three hundred nodes, supporting both stream and bursty types of traffic using a bus topology at a transmission rate of 500 Mb/s through fiber cable. The stream traffic is supported through a transparent "bearer" service at the MAC sublayer of the International Standards Organization (ISO) model for Open Systems Interconnection (OSI) and the I.450, I.451 ISDN protocols. The packet traffic is supported by an OSI protocol profile, as following: the 2a OSI sublayer (MAC) is provided through a specially developed Access Protocol and hardware based on the Hybrid Switching concept (3), (4), due to the integration of stream and packet traffic and the expected workload; the 2b OSI sublayer follows the LLC1 protocol; the Network Layer is based on the inactive Internet Protocol (IP) for the LION users and the active IP for the external users; finally, the Transport Layer follows the Transport Class 4 Protocol (TR4). The impact of the internetworking problems is mirrored on the protocol profile choice since the network is considered as a "distributed end system" resulting to a connectionless approach up to layer 3 (network layer).The implemented ETHERNET to LION Gateway (ELGTW) provides access to the network layer and supports the required address transformation and relay functions. The hardware used is an off-the-self ETHERNET controller and a specially developed Interface Board (IB) for speed compensation, buffering allocation and special control purposes imposed by the network node and the ETHERNET controller architecture. The ELGTW software consists of four parts, namely:

1. The Communication Protocols Software (CPS).
2. A Real-Time Multitasking Operating System (RMOS).
3. A specially developed Low-Level Software (LLS), and
4. A specially developed software, providing the interface between RMOS and CPS, called Environment (ENV).

The Gateway Architecture

The internetworking problems in a MLAN, as far as the packet traffic is concerned, require a careful choice between a protocol profile matching that of the external network -providing a simple Gateway - and a protocol profile conceived to support efficiently the internal communications, giving rise to a more complex Gateway. The mentioned problems become more complex when the required Gateway architecture must at the same time satisfy several different external networks and protocol profiles. A critical parameter for the GTW architecture is the traffic requirements, especially in view of the huge workload of a MLAN. In Table I (2), the workload analysis of the GTW is shown. In Fig.1 the throughput-delay characteristics of the ELGTW are shown, based on a network processing time requirement of 750 µsec. The ELGTW architecture is shown in Fig.2, based on the network multiprocessing architecture and the protocol profile described in the introduction. The GTW is basically made up of two parts, the LION part and the external network part, following the so-called "half-Gateway" architecture (2). This structure offers several benefits in terms of modularity, flexibility and capability to adapt to the specific characteristics of the interconnected network. The ETHERNET-LION interconnection takes advantage of the adopted communication protocol profile, based on ISO 8474/AD1 Internet Protocol, carried out as it is shown in Fig.3. End systems exchange data units in a connectionless mode. The crossed subnetworks are only requested to provide a data pipe on which data are routed independently. The convergence between ISO IP and the underlying LLC1 is a simple one-to-one primitive mapping. "Source routing" with address information for ETHERNET is a simple mapping function also since LION adopts the IEEE 48 bit address format. In this interconnection

	TRAFFIC CHARACTERISTICS				PERCENTAGE OF TERMINALS	GATEWAY WORKLOAD (kbit/s)
	Typical Services	**Reference data rate (kbit/s)**	**Busy-hour utilization**	**Busy-hour workload (kbit/s)**		
CLASS I kilo-stream	- digital voice - facsimile - freeze frame video	64	0.25	16	60	2900
CLASS II mega-stream	- videoconference - videotelephony - high resolution graphics	2048	0.15	300	5	4500
CLASS III kilo-bursty	- interactive data - remote control - videotext	9.6	0.15	1.6	34	160
CLASS IV mega-bursty	- file transfer - software downloading - high volume printing	512	0.3	150	1	450

TABLE I - Terminals, Gateways and Workload in **ELGTW** system

scheme, the GTW is not burdened, but it has only to perform encapsulation-decapsulation functions, buffering and CPU allocation only on an "as-needed" basis.

The ELGTW Implementation

The hardware implementation of ELGTW is based on an off-the-self ETHERNET controller VME330, which includes a 68000 CPU at 10 MHz, dynamic RAM of 512 Kbytes, ROM of 64 Kbytes where the Kernel and the communication protocol software are loaded and a hardware implementation for the CSMA/CD access protocol for ETHERNET.

A special Interface Board (IB) has been developed to accommodate:

i) Additional ROM requirements for the ELGTW software.

ii) The needed control mechanisms (special interrupt handling for the ELGTW and the network node communications).

iii) A dual port RAM for the implementation of a mailbox intercommunication system between the ELGTW and the network node, for increased performance purposes.

iv) A FIFO memory (receive and transmit) which provides fully independent operation of the ELGTW CPU and the network node CPU, thus permitting parallel processing functions to be implemented.

v) A timer required by the RMOS operation.

In Fig. 4 the detailed software structure loaded on the ELGTW is shown. The ELGTW follows the same protocol profile as the LION network node up to the network layer, namely CPS, which is a portable communication protocols software developed by ALCATEL / TITN, France (5), based on the OSI model. The RMOS is a modified version of RMS68K Kernel of VERSADOS, Motorola (6), suitable for the specific ELGTW requirements.

LLS is a software module, specially developed for the ELGTW, with the following responsibil ities:

i) Initialization of the ELGTW hardware and software modules.

ii) Control of the data packets between the ELGTW and the network node.

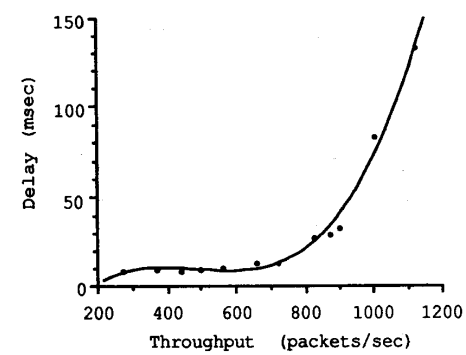

Figure 1 ELGTW througput-delay characteristics

iii) Management of the implemented dual port and FIFO buffers of the IB.

ENV is also a specially developed software, which includes after adaptation the AXI, GTIM and GBUF software modules, developed by ALCATEL/TITN. The GBUF module is responsible for the CPS memory resources management under the RMOS procedures and functionalities. GTIM is responsible for the timing resources of the system and the RMOS task execution scheduler. AXI has the responsibility to initialize the system tasks with the specified parameters and to provide the required system resources and resource management to the rest of the system tasks. The RMOS communication to the system tasks is carried out through the Environment module in the form of primitives exchanged between each task and RMOS. The responsibilities of the ENV are:

i) Interface for subsystem access by user entities and entity access by the subsystems.

ii) Isolation of the Operating System and hardware environment, providing the required format transformation, drivers, utilities and monitoring interfaces.

iii) Management and allocation of the system resources, especially buffers, queues and timers.

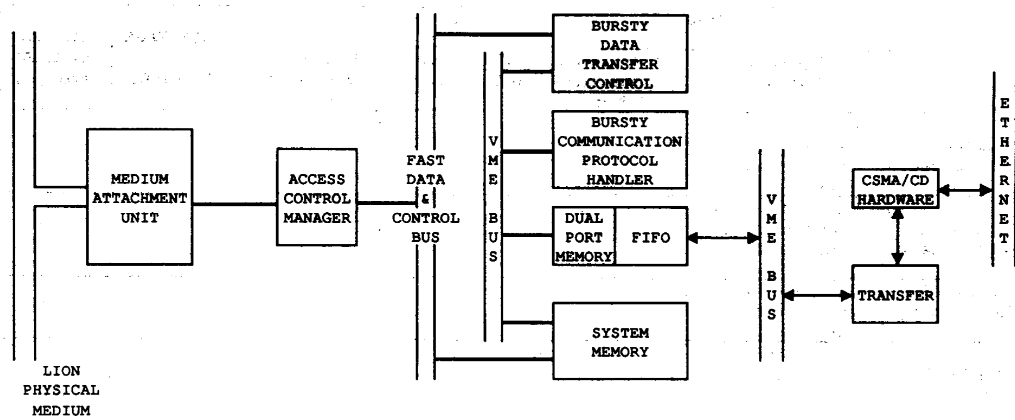

Figure 2 The ELGTW architecture

iv) Intercommunication between the various system tasks, and

v) User interface in the form of C language functions for transmitting and receiving the primitives of the various subsystems and the Real-time Multitasking Operating System.

The developed drivers have on one hand the role of data format transformation between the various parts of ENV software, which provides more efficient operation and on the other hand they provide the required communication primitive and data format transformation with the external world (the LION node), during initialization for identity, quality of service and various procedural functions, required by the ELGTW and the LION global software architecture.

The ETHERNET interface is handled and managed by a developed Kernel function, integrated in the RMOS module, in order to provide modular and efficient handling. The responsibilities of the Kernel are:

i) Initialization and testing of the ETHERNET interface,

ii) Local resources management, related to the ETHERNET interface,

iii) Interface to the ENV software at the level of LLC1 sublayer, implementing the required primitives, and

iv) Monitoring of the ETHERNET activity and reporting to the higher layer protocols.

The ELGTW software has the advantage of a modular and largely independent from the Operating System implementation, since the porting requirements are relied only in implementing a new Environment module and drivers, since the rest of ENV, CPS and LLS software can directly be reused. The ELGTW system is tested and integrated on the LION node system and will be available for demonstration purposes at the end of May, 1989.

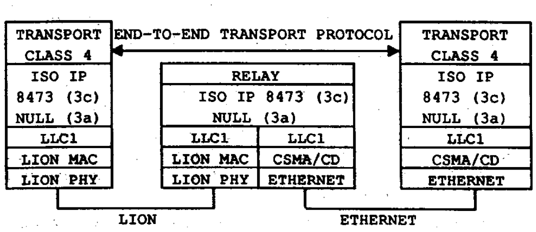

Figure 3 LION-ETHERNET internetworking

CONCLUSION

The implementation of a Gateway between a high-speed Multiservice LAN and ETHERNET is presented, based on the concept of a generalized and closely universal approach, both for the hardware and the software parts of the implementation. The hardware architecture, based on a "half-Gateway" technique, provides implementation means for any LION-LAN Gateway and even more provides hardware independence from the actual LION node architecture. The software implementation is based on the concept of providing two means of interface, one for the operating system and the other for the LION node interface, which are system dependent, while the rest of the software is system independent and portable.

ACKNOWLEDGEMENTS

This work was carried out under the financial support of the European Community through the ESPRIT program as a subcontract to ALCATEL/TITN in the project LION 169.

REFERENCES

1. Special Issue on User's Views of Telecommunications Needs, IEEE Communications Magazine, vol.24, July 1984.

2. D.Roffinella, C.Trinchero, G.Freschi, "Interworking Solutions for a Two-Level Integrated Services Local Area Network", IEEE Journal on Selected Areas in Commun., vol.SAC-5, no.9, pp. 1444-1453, Dec. 1987.

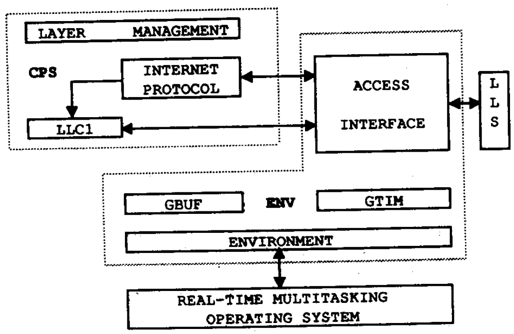

Figure 4 The ELGTW protocol profile structure

3. V.Pallios,T.Antonakopoulos,V.Makios, "Architecture and Implementation of the Access Mechanism for a Bus-Structured Multiservice LAN",the 8th International Conference on Distributed Computing Systems, IEEE ,San Jose California,June 1988.
4. V.Pallios,T.Antonakopoulos,V.Makios, "Access Control Module for Local Integrated Optical Network", Electronics Letters, vol. 25, no.3, pp. 183-185, 1989.
5. TITN, "General Specifications IP and TR4 Products",ESPRIT project 169, Internal Report, March 1988.
6. Motorola: "VERSADOS Overview",M68KOVER/D7, 1986.