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Networking And Communications Technology Laboratory: Design/development Progress Report Submission #2

Jack Thompson

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INSTITUTE FOR SIMULATION AND TRAINING

Contract N61339-89-C-0044
January 15, 1990

Networking and Communications Technology Laboratory

Design/Development Progress Report Submission 2

IST

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University of Central Florida
Division of Sponsored Research

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NETWORKING AND COMMUNICATIONS TECHNOLOGY LABORATORY

DESIGN/DEVELOPMENT PROGRESS REPORT

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1. INTRODUCTION

This memo presents a summary of the progress made to date involving the design and development of the Institute for Simulation and Training's **Network and Communications Technology Laboratory**. Within this laboratory there are two functional testbeds which house the equipment and capabilities required for carrying out the specific research activities of this project. These functional testbeds are the **Simulation Network Prototyping Testbed** and the **SIMNET World Access Testbed**.

2. SIMULATION NETWORK PROTOTYPING TESTBED

This testbed supports research in several areas pertaining to the use of Local Area Network (LAN) technology for interconnecting Simulation Training Devices. These research areas include: Carrier Sense Multiple Access with Collision Detection protocol networks (i.e., ETHERNET), Token-Ring Networks, Fiber Distributed Data Interface (FDDI) Technology, Simultaneous Voice and Data Transmission, and Non-Homogeneous Simulator Network Interfacing.

2.1 Testbed Overall Design Approach

A flexible design approach has been developed and adopted for the establishment of the IST Simulation Network Prototyping and Assessment Testbed. The main goal of this approach is to facilitate the investigation and evaluation of alternate network protocols using PC-based platforms. The PC's will provide each SIMNET node with a quasi-contentionless ETHERNET interface. When equipped with appropriate network controller boards, the PC platforms readily provide a gateway capability between networks of different topologies, such as ETHERNET and token-ring. Each PC will also be capable of operating as a controller/protocol translator providing the necessary services for routing SIMNET packets to the alternate network prototypes.

2.2 Testbed Implementation

The Hewlett-Packard Vectra 386 PC/AT Tower System will be used as a data logger, network traffic generator and protocol translator for the Testbed. Our initial tests and evaluation of the intelligent Excelan 205E ETHERNET controller boards have revealed that such intelligent boards would not be able to capture all the broadcast data packets generated in the SIMNET real-time environment. Our data capture prototyping effort will be based, therefore, on dumb ETHERNET controller boards that are optimized for speed of the low-level transmit/receive operations. The high-level TCP/IP processing capability of the intelligent boards, however, will still be used to provide file transfer services for data analysis, software development, and other applications requiring PC-to-PC ETHERNET communications.

Because of the many features of token-ring protocols, coupled with the commercial availability of token-ring boards for the PC, our alternate network prototyping effort will focus on building a token-ring network configuration for the SIMNET environment. Packets captured off the SIMNET ETHERNET by the PC-platforms will be used to drive the token-ring LAN. Various performance tests to evaluate the token-ring scheme will then be conducted.

2.2.1 Ongoing Activities

The following is a summary of the main activities that have been carried out during the first phase of building the Alternate Network Testbed.

- We have gained considerable experience on using the 3-Com ETHERLINK II dumb ETHERNET boards. With these boards installed in the HP Vectra 20MHz PC's, we are able to transmit packets with data passed from the HP Vectra to the 3-Com board, of length 64,128 and 256 bytes at rates of 1.8, 2.1 and 2.3 Mbits/sec., respectively. Furthermore, we are able to transmit packets without data passed from the HP Vectra to the 3-Com board, of length 64,128 and 256 bytes at rates of 3.6, 4.9 and 6.4 Mbits/sec., respectively. . The data capture capability of the boards using a single receive buffer is approximately one half of the transmit capability or 1Mbits/sec. These measurements were made over Thin-Net ETHERNET under light traffic loads with minimal collisions.

- We have begun preliminary efforts towards using the HP Vectra's to perform data logging (i.e., to read broadcast packets off the SIMNET ETHERNET, time-stamp and store them to a disk or tape file). These early activities include experimentation with various techniques for time stamping, assessing the impact of missed packets on playback performance, experimentation with optimum precision of time reference used for timestamping.

- We have written a program to generate EHTERNET packets and transmit them out onto the network. Currently, we are working on techniques to provide programmable delay to packet transmissions, as well as generating packets with fixed and jittering interarrival times. Software used to generate simulated packet inter-arrival times in the network simulation software models will be reused to generate actual network traffic. This will allow us to perform more accurate validation experiments on the software models against actual hardware.

- We have written C-language programs to extract and manipulate different fields within a SIMNET protocol data unit (PDU). These programs consist of several header files along with compilable C-routines and have been used in several applications including capturing, manipulating and retransmitting SIMNET M1 data packets, as well as capturing ETHERNET data packets from non-SIMNET simulators and translating them into SIMNET compatible packets.

- We are currently able to pass data packets across the 4Mbits/sec 3-Com TOKENLINK token-ring network boards between two of the HP Vectra's. Experiments are underway to determine the maximum load of SIMNET packets that can be communicated over the ring.

- We are currently performing tests using Concurrent-C simulation models to compare the performance of the **early token release** protocol of token-ring LAN's with that of the **late token release** version. These tests will give us an insight into the significance of the improvement in throughput attained through the early release protocol, as well as the amount of network overhead required to support prioritized tokens.

- We are currently building a predictive model to investigate the **greedy node** problem in Ethernet simulation networks. In our preliminary model, the impact of a greedy node on the transmission of a single non-greedy node is considered and the corresponding channel probabilities are tabulated. It is hoped that this type of modeling will help us evaluate the magnitude of the **greedy node** problem and its impact on network packet delay and packet loss.

- We are in the process of completing experiments which will allow us to implement ETHERNET-like protocols via the 3-Com Etherlink II boards. Tests have indicated that it may be possible to discard old state update messages from the 3-Com board's transmit buffer and substitute them with new (more recent) update messages. This will allow us to improve the delay performance of the standard ETHERNET protocol.

NOTE: Listings of all software programs mentioned above are included as an attachment.

2.2.2 Planned Activities

The following activities are planned the next phase of the project:

- Improve the data capture capabilities of the 3-Com Etherlink II ETHERNET controller board by implementing a scheme utilizing multiple receive buffers. This will allow us to determine the safe operating range of traffic load for which minimal data loss occurs.

- Design and build C-language software libraries for transmitting and receiving both ETHERNET and token-ring data packets.

- Design and build C-language software programs for performing data logging and artificial packet generation for both the ETHERNET and token-ring LAN's.

- Examine the token-ring priority scheme and evaluate its suitability and potential benefits to optimize packet management in the SIMNET environment.

- Begin using the DURRA software analysis tool developed by Carnegie Mellon University's - Software Engineering Institute. This application is written in ADA and will be implemented on a SUN Workstation. Plans are to use DURRA as part of a research task involving the use of intelligent filtering techniques applied at Gateways which interconnect multiple SIMNET type networks via high capacity local area or long haul networks.

- Continue activities involving the use of the 3-Com Etherlink II board to implement ETHERNET-like protocols and investigate the capability of changing some parameters of the standard ETHERNET protocol in an effort to produce priorities on the network. Such parameters include the packet **slot-time** which directly affects the calculation of the **retransmission back-off algorithm**, as well as the back-off algorithm itself. We will also focus on the implementation of a modification of the standard ETHERNET protocol that reduces packet transmission delays, only at times when the channel is sensed idle. The final thrust in this effort will be to implement the GBRAM protocol by utilizing the 3-Com ETHERNET board. GBRAM is superior to the ETHERNET protocol for medium to high traffic loads.

2.3 Data Analysis

Data Analysis capabilities in the laboratory will consits of hard and software which will be used to manage and analyze the large amounts of data generated by networked simulators. A variety of test experiments will be conducted in order to evaluate the performance of the vairous LAN configurations. Different performance measures (e.g., packet transmission delay, distribution of packet inter-arrival times, utilization of transmission medium, LAN throughput, etc.) will be collected and analyzed (using statistical inference) for both ETHERNET and token-ring LAN's. Some of the statistical tests which will be applied include confidence intervals, analysis of variance, goodness-of-fit tests (e.g., the Kolmogorov-Smirnov test), and regression analysis. A VAX 3100 workstation has been procured and will be used for the performance of the required statistical tests and data analysis services.

2.4.1 Ongoing Activities

The following is a summary of the main activities that have been carried out during the first phase of this research.

- We have gained considerable experience on using the VAX 3100 workstation in both the system administration and user areas.

- Graphics software, the ULTRIX (UNIX for VAX) operating system and some software development tools for the VAX 3100 workstation have been received.

- Chris Pinon has attended the VMS System Management Class I to aid her in administering the VAX 3100 (see Memo for Record from Chris Pinon dated Nov. 20, 1989).

- Local Software and Hardware support has been established through Dingital Equipment Computer Users Society (DECUS). Membership has been obtained and a Local User Group meeting was attended (see Memo for Record from Chris Pinon dated Nov. 29, 1989).

- Procurement has begun for statistical packages and data analysis tools.

2.3.2 Planned Activities

The following activities are planned the next phase of the project:

- Develop a list and a detailed description of the performance measures, statistical experiments and data analysis tests that will be used for evaluating the performance of the ETHERNET interface, as well as the prototype networks to be implemented.

- Procure any statistical software packages found to be suitable for this project.

- Write any necessary software interfaces needed for the invocation of the statistical packages mentioned above.

- Interface VAX DECNET to existing laboratory ETHERNET.

2.4 Simultaneous Voice and Data Transmission Research

Research involving the simultaneous transmission of digital voice and data will be conducted utilizing Digital Signal Processing (DSP) modules interfaced to a networked HP Vectra PC platform. The Ariel DSP56001 DSP modules were chosen and two of the boards were procured for this effort.

2.4.1 Ongoing Activities

The following is a summary of the main activities that have been carried out during the first phase of this research.

- We have received the DSP56001 boards and are gaining experience on using them to manipulate voice data under real-time constraints.

- We have nearly completed the program to packetize the digital voice data that are stored in the memory of DSP56001 Board.

- We are in the process of writing a program to transfer the packetized data from the DSP56001 board to the 3-Com ETHERNET board, and visa versa, for transmission to and reception from the ETHERNET network.

- We are in the process of writing a program to reassemble the packetized data located in the memory of the DSP56001 board into a continuous stream of digital data for subsequent conversion to analog information (voice).

2.4.2 Planned Activities
The following are planned activities which will be performed during the next phase of the project:

- Utilize the aforementioned C-language programs to extract and manipulate different fields within a protocol data unit (PDU) in order to send the voice data over the network in a form that is consistent with the SIMNET communication protocol standard.

- Utilize the capabilities of the DSP56001 board to distort the digitized voice information in a manner that corresponds to the degradation of the analog voice signal in the actual battle environment (RF phenomena).

- Show experimentally, by using the DSP56001 board, the percentage of lost voice packets that we can accommodate without affecting the clarity of the voice signal. This will allow us to find the number of concurrent voice conversations that the network can support in the ETHERNET protocol environment.

- Use the DSP56001 boards to show the effect of certain signal processing techniques on the digitized speech signals (i.e., data compression, coding, voice listener tests). By doing so we will expect to accommodate more simultaneous voice conversations on the network.

- Examine the ETHERNET boards carefully to determine the possibility of implementing an alternative protocol (other than ETHERNET) that can support simultaneous voice and data transmission over the network.

2.5 Non-Homogeneous Simulator Network Interfacing
The goal of this research is to provide a proof-of-principle demonstration of interconnecting non-homogeneous simulators via a common network, and provide the means for them to interact with one another.

This activity is on-going in nature and centers on the interconnection of non-SIMNET devices (such as the ASAT's, the Silicon Graphics' Networkable Flight Simulator, the SUN Microsystems' AVIATOR Networkable Simulator, and others) with the existing IST SIMNET devices. Protocol translation/transformation, intelligent filtering techniques for gateways used to interconnect LAN's of differing topologies, and techniques for handling inconsistencies in data protocol formats between dissimilar simulations are some of the research areas being investigated under this task.

3. SIMNET WORLD ACCESS TESTBED
Providing access to the SIMNET World is one of the major capabilities IST is developing in the Network and Communications Technology Laboratory. Additional SIMNET modules are being acquired to enhance the existing suite of SIMNET equipment. These new modules include a Stealth Vehicle, a Plan View Display, a Data Logger/Playback System and a Long Haul Communications Gateway. The addition of this equipment will provide a wide

range of SIMNET capabilities to support ongoing research efforts in the areas of alternate network implementations, digital voice transmission, network benchmarking, and Long Haul Networking.

3.1 IST SIMNET Network Configuration

As mentioned earlier, the current SIMNET configuration uses an ETHERNET network to provide data communications between simulators. The SIMNET-T site at Ft. Knox uses an interconnect scheme which connects up to eight SIMNET modules together via a multi-port transceiver box, which in turn is attached to the ETHERNET coaxial cable. In the IST Lab, the SIMNET modules are interconnceted via a THIN-NET ETHERNET network. THIN-NET uses 50 ohm coaxial cable similar to RG58 to interconnect the nodes on the network. Each node has a small transceiver attached directly to it which provides the required interface to the coaxial cable. This THIN-NET implementation provides a flexible interconnect scheme, without any loss in performance and is more suited to laboratory requirements.

Currently in the IST Laboratory, there are several clusters of computers which are being used for various research activities. By running a series of coaxial cables around the lab we are able to provide a variety of interconncetions between the clusters. For example, the SIMNET modules are linked together in one cluster and the networking research equipment (HP LAN Analyzer and PC's with ETHERNET cards) are linked in another. These two clusters can be tied together whenever desired by simply removing two cable termination devices and hooking the two cables together. This scheme allows for the sharing of resources, no matter where they may be physically located in the lab.

3.2 SIMNET Compatible Interconnect Capabilities

This capability in the lab refers specifically to the concept of providing gateways into the SIMNET World. The first gateway to be procured will be a BBN SIMNET Gateway. This gateway is based on the BBN Butterfly computer and most probably will be a closed system, meaning that we will have no way to alter its software and/or hardware to experiment with it. The SIMNET Gateway is being procured, and is expected to be delivered to IST within the next two months.

Commercially available long haul networking hardware is currently being evaluated to determine its suitability for the SIMNET application. Details of this evaluation can be found in the attached memo, **Notes on IST Long-haul Interconnectivity**, dated 11/29/89. To achieve interconnectivity, we will procure several ETHERNET bridges which will allow for limited dial-up access to the IST SIMNET world, as well as support research being performed in the area of Long Haul Networking.

We have initiated conversations with personnel at Human Engineering Labs (HEL) in Aberdeen Proving Grounds, MD. Preliminary plans are to establish a long haul link between the IST SIMNET Laboratory and HEL's laboratories. There are tentative travel plans for two IST researchers to visit HEL (Aberdeen, MD) during the month of January 1990 to further discuss this project.

3.3 Simulation Network Performance Benchmarks

The functional requirements for a set of benchmarks to be used to evaluate training device network performance and interfacing capabilities will be established. These benchmarks will aid in the validation of interfacing methods between non-homogeneous simulators and compatibility with the current SIMNET communications protocol standard. The benchmarks will consist of a set of software programs which will perform automated analysis of incoming network data, either in real-time or off-line, and will provide an orderly method of evaluating a networked training device's network performance.

Initial benchmark development efforts will employ the use of the VAX 3100 workstation for software development and data analysis. This benchmark work depends highly on the simulation network protocol standards currently under development. Therefore, these activities will be closely monitored and attended to ensure benchmark analysis techniques are valid meaningful measures of performance.

Our initial evaluations indicate a software system called DURRA might be a useful tool to aid in benchmark development. DURRA was developed by the Software Engineering Institute (SEI) at Carnegie Mellon University. IST is the first site to receive DURRA. DURRA is essentially a system for predicting the preformance networked computing nodes. DURRA provides a flexible environment for specifying the interconnection of these nodes (i.e. network topology), as well as predicting the system performance under varying loades and usages. DURRA programs can be written which can perform network assessments off-line. On-line assessments will require enhancements which will be pursued by IST and SEI.

4. CONCLUSIONS

This report has presented a summary of the procurements, activities and progress made towards the development of the IST Network and Communications Technology Laboratory. Comments and/or suggestions are encouraged and should be directed to:

Jack Thompson
Institute for Simulation and Training
University of Central Florida
12124 Research Parkway
Orlando, FL 32826

MEMORANDUM FOR RECORD

To: Jack Thompson

From: Chris Pinon

Subject: VMS System Management I Class
November 13-17
DEC Education Center
Maitland, Florida

Date: November 20, 1989

Purpose:
The purpose of taking this class was to become more familiar with the VAXstation's operating system and to learn skills and commands associated with managing the system. The VAXstation 3100 is an integral part of the Networking laboratory. The training was necessary to aid in the integration of the VAX onto the network.

Key Topics:
The class provided an overview of the VMS operating system and the role of the system manager in maintaining the system. Topics discussed include:

- Understanding the User Environment
- Managing System Users
- Managing Queues
- Managing Disk and Tape Volumes
- Customizing the System
- Starting Up and Shutting Down the System
- Maintaining System Integrity
- Monitoring System Performance
- Installing and Updating System Software

Conclusion:
The class provided an excellent overview of the VMS operating system and gave the student many valuable tools that can be implemented immediately. The class fulfilled the purpose detailed above.

Copy to:
B. Goldiez, S. Smith, J. Cadiz, R. Ouyang, M. Georgiopoulos, M. Bassiounni

Memorandum

To: Jack Thompson
From: Chris Pinon
Subject: Central Florida DECUS LUG
November Meeting
Merritt Island Public Library
Date: November 29, 1989

Purpose:
The purpose of the meeting was to meet with members of the Central Florida DECUS LUG (DEC users Local Users Group). This group is a valuable resource for help concerning the VAXstation. This is the first meeting attended since joining DECUS. I also sought contacts to help with the transfer of data from one type of tape media to another, an activity essential for the statistical study of the SIMNET data packets and for examining the program from Carnegie-Mellon University.

Key Topics:
The meeting took place at the Merritt Island Public Library and began at 9:00 am. The meeting proceeded as follows:

1) DECUS business
2) DIGITAL update - an overview of new products on the market
3) "Leveraging PC Applications on the VAX" - a presentation by RECITAL Corporation

LUNCH BREAK

4) "PCSA and 386WARE" - a presentation by Bob Thomson, Computer Operations Supervisor for Martin Marietta Aerospace, KSC
5) General Question and Answer session - A chance for all to discuss problems and solutions. Also a chance to share tips and shortcuts.

The meeting ended at 3:30 pm. I spent some time talking to Mr. Christopher Korson, Software Engineer for Level Five Research, Inc. in Indialantic. He has the means to transfer 8mm, 9mm and TK70 tapes to the TK50 format our computer requires. All IST has to do is provide the tape.

Conclusion:
This meeting provided some valuable information concerning VAX computers in general and some SW products available on the market at this time. It also provided some business contacts that may be valuable in the near future.

Copy to: B. Goldiez, G. Winkler, M. Bassiouni

To: Jack Thompson

From: Jorge Cadiz

Date: 11/29/89

Subject: Notes on IST Long-haul Interconnectivity

- It seems that we have the choice to make as far as what type of interface device we would like to use in the Long-haul environment. The three devices that we can use are Bridges, Routers, and Gateways. Following are definitions for these devices. These definitions were extracted from TRW's Unified LAN I Components Guide (July, 1989).

  Bridge: A router that connects two or more networks and forwards packets among them. Usually, bridges operate at the physical network level. For example, an ETHERNET bridge connects two physical ETHERNET cables and forwards from one cable to the other exactly those packets that are not local. Bridges differ from repeaters because bridges store and forward complete packets while repeaters forward electrical signals.

  Router: Any machine responsible for making decisions about which of several paths network (or Internet) traffic will follow. At the lowest level, a physical network bridge is a router because it chooses whether to pass packets from one physical wire to another. Within a long haul network, each individual packet switch is a router because it chooses routes for individual packets. In the Internet, each IP gateway is a router because it uses IP destination addresses to choose routes.

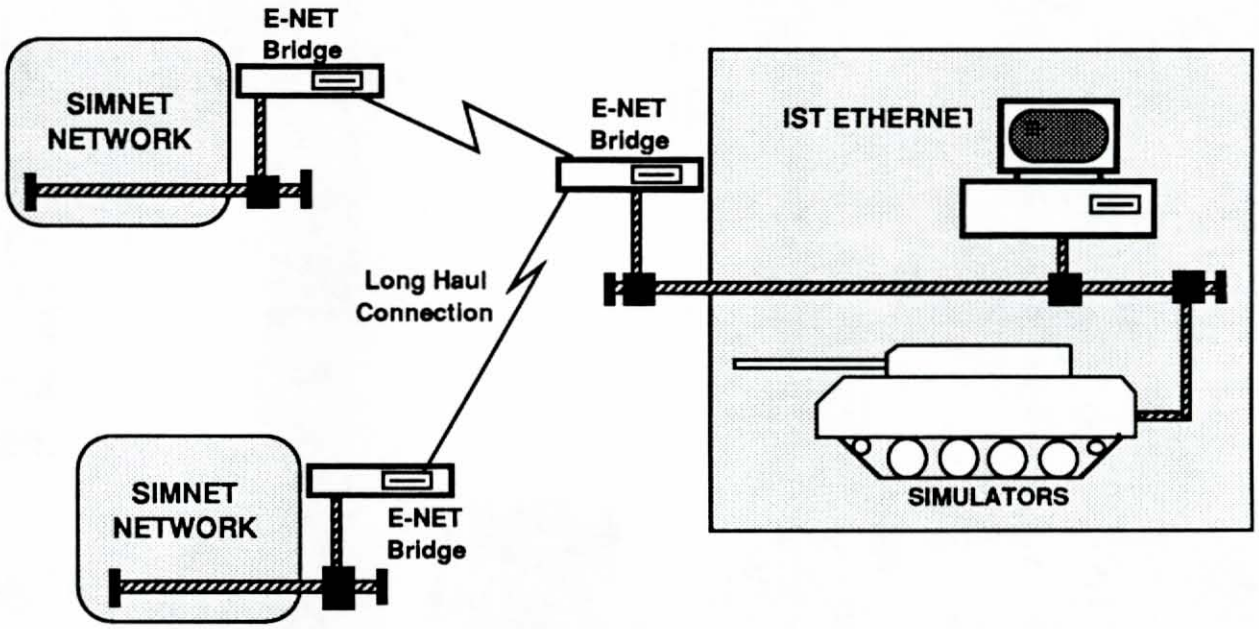
  Gateway: A special purpose, dedicated computer that attaches two or more networks and routes packets from one to the other. In particular, an Internet gateway routes IP datagrams among the networks to which it connects. Gateways route packets to other gateways until they can be delivered to the final destination directly across one physical network. The term is loosely applied to any machine that transfers information from one network to another, as in *mail gateway*.

- After looking at some literature on the three devices, it seems that a bridge may be the type of device that we may want to procure. Bridges are generally faster than routers, and they perform packet filtering in order to prevent some of the "local" traffic from getting onto the long-haul medium.

- Routers seem like they may provide more functions than are necessary for our application. In the SIMNET environment a large percentage of the traffic has a broadcast destination address. This means that most of the traffic generated at the different nodes will be looking to be transmitted over the network. This will require a "dumb" interface which simply passes the traffic to the remote location.

- A gateway will provide a connection between two segments of network that are driven by a different type of protocol. These "protocol translators" are not what we need since the SIMNET units communicate with the same protocols.

- Following is a diagram which is my perception of the long-haul network that will be established by IST



- I have gathered some product information on some Bridges, Routers, Brouters, etc. Here is a table which summarizes the pricing information.

Company	Device	Price
Advanced Computer Communications	ACS 4110 Remote ETHERNET Bridge	$7,500
Advanced Computer Communications	ACS 4030 Remote ETHERNET Bridge	$4,975-$5,575
Halley Systems	ConnectLAN 100 Local and Remote Brouter	$?
Blackbox Corporation	Remote Bridge 56Kbps	$6,600
Blackbox Corporation	Remote Bridge T1	≈$12k

```
/**************************************************************************/
/*                                                                        */
/*   CTO3LC.C                                                             */
/*                                                                        */
/*   Description: This file contains the code which calls the funtions    */
/*                provide by the CTO3L.ASM to receive/transmit packets    */
/*                through 3COM EtherLinkii board.                         */
/*                                                                        */
/**************************************************************************/

#include <stdio.h>
extern cInitAdapters();
extern cInitParameters();
extern cResetAdapter();
extern cWhoAmI();
extern cRdRxFilter();
extern cWrRxFilter();
extern cPutTxData();
extern cGetRxData();
extern cSetLookAhead();
extern cXmit1();

extern cRcvSome();

main()

    int i, j;
    struct ini_hdr {
        char len;
        char non1;
        char non2;
        char non3[2];
        char non4[4];
        char non5[4];
        char non6;
        char cdend[4];
        char *argo;
        short args;
        char non7;
    };

    struct WhoStruct {
        unsigned char addr[6];
        char ver_major;
        char ver_minor;
        char sub_ver;
        char type_ds;
        char type_adapter;
        char init_status;
        char reserved;
        char num_tran_buf;
        short size_tran_buf;
        long  ttl_tran_cnt;
        long  ttl_tran_err_cnt;
        long  ttl_tran_timeout_cnt;
        long  ttl_recp_cnt;
        long  ttl_recv_bdr_cnt;
        long  ttl_recv_err_cnt;
        long  ttl_retry_cnt;
        char  xfr_mode;
    char  wait_mode;
    char  hdr_spec_data;
};

struct PktStr {
    char inp[1500];
};

struct WhoStruct far *Who;
struct PktStr far *Pkt;
struct ini_hdr *parmsdr;

int ttlpl, nb, flags, reqid, nreqid;
char far *paddr = "This is a test only";

int rc, rxf=0x000c, rrxf, Adapters=0;
int rs = 0, icnt = 0;
parmsdr->len=0x17;
parmsdr->non1=0x00;
parmsdr->non2=0x00;
parmsdr->non3[0]=0x00;
parmsdr->non3[1]=0x00;
parmsdr->non4[0]=0x00;
parmsdr->non4[1]=0x00;
parmsdr->non4[2]=0x00;
parmsdr->non4[3]=0x00;
parmsdr->non5[0]=0x00;
parmsdr->non5[1]=0x00;
parmsdr->non5[2]=0x00;
parmsdr->non5[3]=0x00;
parmsdr->non6=0x00;
parmsdr->cdend[0]=0x00;
parmsdr->cdend[1]=0x00;
parmsdr->cdend[2]=0x00;
parmsdr->cdend[3]=0x00;
/* parmsdr->argo = "c:\3com\ether503.sys /a:2e0/m:4/t:1/d:1/i:3\n"; */
parmsdr->argo = "c:\\3com\\ether503.sys /A:2e0 /D:1 /I:3\0x0a";
parmsdr->args=getds();
parmsdr->non7=0x00;

rc=getds();
printf("getds 0x%x\n",rc);

rc=cInitParameters(parmsdr);
printf("cInitParameters returns %d\n",rc);
rc=cInitAdapters(&Adapters);
printf("cInitAdapters returns %d, Adp=%d\n",rc, Adapters);

rc=cSetLookAhead(32);
printf("cSetLookAhead returns %d\n",rc);

rc=cWhoAmI(&Who);
printf("cWhoAmI returns %d\n",rc);
printf("addr = %02x %02x %02x", Who->addr[0],
          Who->addr[1], Who->addr[2]);
printf(" %02x %02x %02x\n", Who->addr[3],
          Who->addr[4], Who->addr[5]);
printf("ver major %02x ver minor %02x\n", Who->ver_major, Who->ver_minor);
printf("transfer mode %x wait mode %x\n", Who->xfr_mode, Who->wait_mode);
printf("ttl recp cnt %d (0x%4x)\n", Who->ttl_recp_cnt, Who->ttl_recp_cnt);
```

```
    rc=cWrRxFilter(rxf);
    printf("cWrRxFilter returns %d\n",rc);
    rc=cRdRxFilter(&rrxf);
    printf("cRdRxFilter returns %d, filter=%x\n",rc,rrxf);

    rs = ' ';
    printf("Receiver or Sender ? (r/s)\n");
    while ( ((rs = getchar()) != 'r') && (rs != 's') ) {
        printf("Receiver or Sender ? (r/s)\n");
    };
    if  (rs == 'r') {
        while ( !kbhit() ) {
            rc=cRcvSome(&Pkt);
            if  (rc > 0) {
                icnt++;
/*
                printf("cRcvSome returns %d\n",rc);
                for (i=0; i<rc; i++)
                    printf("%02x",Pkt->inp[i]);
*/
            }
        }
        printf("Total input count %d\n",icnt);
    }
    else {
        ttlpl = 0x64;
        nb    = 0x64;
        flags = 0x0060;
        reqid = 0x0001;
        nreqid = 0x0011;
        for (i=0; i<10; i++) {
            rc=cXmit1(ttlpl, nb, flags, reqid, paddr, &nreqid);
        }
    }

    rc=cResetAdapter();
    printf("cResetAdapter returns %d\n",rc);
    exit (0);
}
void myRxProcess(Status, PacketSize, RequestID, PacketHeader)
int Status, PacketSize, RequestID;
char far *PacketHeader;
{
    /* fprintf(stderr,"Called by ASM - myRxProcess\nNot implement yet\n");
    fprintf(stderr,"Status=%d, PacketSize=%d, RequestID=%d\n",Status,PacketSize,
            RequestID); */
}

void myTxProcess(Status, RequestID)
int Status, RequestID;
{
    /* printf("Called by ASM - myTxProcess\nNot implement yet\n");
    printf("Status=%d, RequestID=%d\n",Status, RequestID); */
}

void myExitRcvInt()
{
    /* printf("Called by ASM - myExitRcvInt\nNot implement yet\n"); */
```

```
title cto3l.asm

;*************************************************************************
;
;File: CTO3L.ASM
;
;Description:  This file contains subroutines which provide a
;              C program with an interface to the 3L 1.0 routines.
;
;*************************************************************************

; Functions called by C
PUBLIC  _getds

PUBLIC  _cInitParameters
PUBLIC  _cInitAdapters
PUBLIC  _cResetAdapter
PUBLIC  _cWhoAmI
PUBLIC  _cRdRxFilter
PUBLIC  _cWrRxFilter
PUBLIC  _cPutTxData
PUBLIC  _cGetRxData
PUBLIC  _cSetLookAhead
PUBLIC  _etext

PUBLIC  _cRcvSome
PUBLIC  _cXmit1

;Need to be written in C
extrn   _myExitRcvInt     :near
extrn   _myRxProcess      :near
extrn   _myTxProcess      :near

;Functions provide by this file
PUBLIC  ExitRcvInt
PUBLIC  RxProcess
PUBLIC  TxProcess

;3L functions
extrn   InitParameters    :near
extrn   InitAdapters      :near
extrn   WhoAmI            :near
extrn   ResetAdapter      :near
extrn   RdRxFilter        :near
extrn   WrRxFilter        :near
extrn   GetRxData         :near
extrn   SetLookAhead      :near
extrn   PutTxData         :near

lf      equ     0ah
cr      equ     0dh

@print  macro   strloc          ;print string at strloc
        local   strloc
        push    ax
        push    cx
        push    ds
        push    dx
        mov     dx,seg strloc
        mov     ds,dx
        mov     dx,offset strloc
        mov     ah,09h
        int     21h
        pop     dx
        pop     ds
        pop     cx
        pop     ax
        endm

@kbdin  macro                           ;get kbd char in al
        mov     ah,8
        int     21h                     ;wait for key
        endm

@kbdchk macro                           ;check for kbd char
        mov     ah,0bh
        int     21h                     ;returns al: 0-nokey, ff-keyhit
        endm

CODE    GROUP   _TEXT, DATA, ICODE

_TEXT   segment byte public 'CODE'
DGROUP  group   _DATA, _BSS
        assume  cs:_TEXT, ds:DGROUP, ss:DGROUP
_TEXT   ends

DATA    segment word public 'CODE'
DATA    ends

ICODE   segment word public 'CODE'
ICODE ends

DATA    segment
his_ds  dw      ?
_etext  db      ?

vectsv  dd      22h dup (0)     ;save all vectors so we can cleanup
retsav  dw      ?
crlf    db      cr,lf,'$'

pklock  db       0
pklen   dw       0
pkerr   dw       0
pkcnt   dw       0
pkcount dw       0
pkthd   db       32 dup(0)
pktdat  db       1500 dup(0)

DATA    ends

_DATA   segment word public 'DATA'
_d@     label   byte
_DATA   ends
_BSS    segment word public 'BSS'
_b@     label   byte
_BSS    ends
_DATA   segment word public 'DATA'
_s@     label   byte
_DATA   ends
```

```
_TEXT   SEGMENT
        ASSUME  CS:_TEXT, DS:DGROUP, SS:DGROUP

_getds  proc    near
        mov     ax,ds
        mov     cs:his_ds,ax
        ret
_getds  endp

;------------------------------------------------------------------------------
;
;_cInitAdapters:     This procedure provides the glue between a C
;                    program and the 3L 1.0 InitAdapters function.
;
;Calling Sequence:
;    int cInitAdapters(&nAdapters)
;
;Input Parameters:
;    None
;
;Output Parameters:
;    int nAdapters
;
;Returns:
;    The return value of the InitAdapters function
;
;------------------------------------------------------------------------------
_cInitAdapters proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,cs
        mov     ds,ax
        mov     di,offset CODE:RxProcess

        call    InitAdapters

        pop     ds
        mov     di,word ptr[bp+4]
        mov     word ptr[di],cx

        pop     di
        pop     si
        pop     bp
        ret
_cInitAdapters endp

;------------------------------------------------------------------------------
;
;_cInitParameters:   This procedure provides the glue between a C
;                    program and the 3L 1.0 InitAdapters function.
;
;Calling Sequence:
;    int cInitParameters(Parms)
;
;Input Parameters:
;    char *Parms - Pointer to a structure with overrides of default
;                   parameters.
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the InitParameters function
;
;-----------------------------------------------------------------------------
_cInitParameters proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     bx,[bp+4]
        mov     ax,ds
        mov     es,ax
        mov     ax,cs
        mov     ds,ax

        call    savvecs
        call    InitParameters

        pop     ds
        pop     di
        pop     si
        pop     bp
        ret
_cInitParameters endp

;-----------------------------------------------------------------------------
;
;_cResetAdapter:  This procedure provides the glue between a C
;                 program and the 3L 1.0 ResetAdapters function.
;
;Calling Sequence:
;    int cResetAdapter()
;
;Input Parameters:
;    None
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the ResetAdapter function
;
;-----------------------------------------------------------------------------
_cResetAdapter proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     dx,0
        mov     ax,cs
        mov     ds,ax
        mov     dl,0
        call    ResetAdapter
        call    fixvecs

        pop     ds
        pop     di
        pop     si
        pop     bp

        ret
_cResetAdapter endp

;-----------------------------------------------------------------------------
;
;_cWhoAmI:  This procedure provides the glue between a C
;           program and the 3L 1.0 WhoAmI function.
;
;Calling Sequence:
;    int cWhoAmI(&WhoPtr)
;
;Input Parameters:
;    None
;
;Output Parameters:
;    struct WhoStruct far *WhoPtr - Far pointer to the WhoAmI structure
;
;Returns:
;    The return value of the WhoAmI function
;
;-----------------------------------------------------------------------------
_cWhoAmI proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     dx,0
        mov     ax,cs
        mov     ds,ax

        call    WhoAmI

        pop     ds
        mov     si,[bp+4]
        mov     Word ptr [si],di
        mov     Word ptr [si+2],es

        pop     di
        pop     si
        pop     bp
        ret
_cWhoAmI endp

;-----------------------------------------------------------------------------
;
;_cRdRxFilter:    This procedure provides the glue between a C
;                 program and the 3L 1.0 RdRxFilter function.
;
```

```
;Calling Sequence:
;     int cRdRxFilter(&RxFilter)
;
;Input Parameters:
;     None
;
;Output Parameters:
;     int RxFilter - The receive filter value
;
;Returns:
;     The return value of the RdRxFilter function
;
;-----------------------------------------------------------------------------
_cRdRxFilter proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,cs
        mov     ds,ax

        mov     dx,0
        call    RdRxFilter

        pop     ds
        mov     di,[bp+4]
        mov     [di],bx

        pop     di
        pop     si
        pop     bp
        ret
_cRdRxFilter endp

;-----------------------------------------------------------------------------
;
;_cWrRxFilter:   This procedure provides the glue between a C
;                program and the 3L 1.0 WrRxFilter function.
;
;Calling Sequence:
;     int cWrRxFilter(RxFilter)
;
;Input Parameters:
;     int RxFilter - The new receive filter value
;
;Output Parameters:
;     None
;
;Returns:
;     The return value of the WrRxFilter function
;
;-----------------------------------------------------------------------------
_cWrRxFilter proc near
        push    bp
        mov     bp,sp
        push    ds
        push    si
        push    di
        mov     ax,cs
        mov     ds,ax

        mov     dx,0
        mov     ax,[bp+4]
        call    WrRxFilter

        pop     di
        pop     si
        pop     ds
        pop     bp
        ret
_cWrRxFilter endp

;-----------------------------------------------------------------------
;
;_cSetLookAhead:   This procedure provides the glue between a C
;                  program and the 3L 1.0 SetLookAhead function.
;
;Calling Sequence:
;    int cSetLookAhead(NumBytes)
;
;Input Parameters:
;    int NumBytes - The nnumber of bytes of look ahead data
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the SetLookAhead function
;
;-----------------------------------------------------------------------
_cSetLookAhead proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,cs
        mov     ds,ax

        mov     dx,0
        mov     ax,[bp+4]
        call    SetLookAhead

        pop     ds
        pop     di
        pop     si
        pop     bp
        ret
_cSetLookAhead endp

;-----------------------------------------------------------------------
;
;_cPutTxData:   This procedure provides the glue between a C
;               program and the 3L 1.0 PutTxData function.
;
;Calling Sequence:
```

```
;     int cPutTxData(TotalPacketLen, NumBytes, Flags, RequestID,
;                    PacketAddr, &NewRequestID)
;
;Input Parameters:
;     int TotalPacketLen - The total packet length (first call only)
;     int NumBytes - The nnumber of bytes to transfer this call
;     int Flags - The DL flags
;     int RequestID - Used if not the first call
;     char far * PacketAddr - A far pointer to the packet
;
;Output Parameters:
;     int NewRequestID - Returned after first call
;
;Returns:
;     The return value of the PutTxData function
;
;-------------------------------------------------------------------------------
_cPutTxDAta proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,ds
        mov     es,ax

        mov     bx,[bp+4]
        mov     cx,[bp+6]

        mov     dl,byte ptr[bp+8]
        mov     dh,byte ptr[bp+10]
        mov     si,[bp+12]
;        mov     di,offset CODE:TxProcess
        mov     di,0ffffh ; no TxProcess

        call    PutTxData

        pop     ds
        xchg    dh,dl
        xor     dh,dh
        mov     di,[bp+16]
        mov     [di],dx

        pop     di
        pop     si
        pop     bp
        ret
_cPutTxData endp
;
;-------------------------------------------------------------------------------
;
;_cGetRxData:    This procedure provides the glue between a C
;                program and the 3L 1.0 GetRxData function.
;
;Calling Sequence:
;     int cGetRxData(&NumBytes, Flags, RequestID, PacketAddr)
;
;Input Parameters:
;     int NumBytes - The nnumber of bytes to transfer this call
;    int Flags - The DL flags
;    int RequestID - The request identifier
;    char far * PacketAddr - A far pointer to the packet to copy the data
;
;Output Parameters:
;    int NumBytes - The actual number of bytes transferred
;
;Returns:
;    The return value of the GetRxData function
;
;-------------------------------------------------------------------------------
_cGetRxData proc near
        push   bp
        mov    bp,sp
        push   si
        push   di
        push   ds

        mov    di,[bp+4]
        mov    cx,ss:[di]
        mov    dl,byte ptr[bp+6]
        mov    dh,byte ptr[bp+8]
        mov    di,[bp+10]
        mov    es,[bp+12]
        call   GetRxData

        pop    ds
        mov    di,[bp+4]
        mov    ss:[di],cx

        pop    di
        pop    si
        pop    bp
        ret
_cGetRxData endp
;-------------------------------------------------------------------------------
;
;TxProcess:  This procedure is the protocol-side routine which is called
;            when a packet has finished transmitting (see _cInitAdapters).  It
;            provides the glue between the 3L 1.0 routines and C routine called
;            myTxProcess.
;
;myTxProcess Calling Sequence:
;    void myTxProcess(Status, RequestID)
;
;myTxProcess Input Parameters:
;    int Status - Receive status
;    int RequestID - The request identifier
;
;myTxProcess Returns:
;    Nothing
;
;-------------------------------------------------------------------------------
TxProcess proc near
        push   bp
        push   si
        push   di
        push   ds
        push   es
        push    ax
        mov     ax,cs:his_ds
        mov     ds,ax
        mov     es,ax
        pop     ax

        xor     cx,cx
        mov     cl,dh
        xor     dh,dh

        push    cx
        push    ax
        call    _myTxProcess

        add     sp,4

        pop     es
        pop     ds
        pop     di
        pop     si
        pop     bp
        ret
TxProcess endp

;-----------------------------------------------------------------------------
;
;ExitRcvInt: This procedure is the protocol-side routine which is called
;            when the 3L has completed a receive interrupt.  It provides
;            the glue between the 3L 1.0 routines and C routine called
;            myExitRcvInt.
;
myExitRcvInt Calling Sequence:
;    void myExitRcvInt()
;
myExitRcvInt Input Parameters:
;    None
;
myExitRcvInt Returns:
;    Nothing
;
;-----------------------------------------------------------------------------
xitRcvInt proc near
;         push    bp
;         push    ds
          push    es
          push    si
;         push    di

          push    ax
;         mov     ax,cs:his_ds
          mov     ds,ax
          mov     es,ax
;         pop     ax
;
          call    _myExitRcvInt

;         pop     di
          pop     si
          pop     es
```

```
;        pop    ds
;        pop    bp
        iret
ExitRcvInt endp

;-----------------------------------------------------------------------------
;
;RxProcess:   This procedure is the protocol-side routine which is called
;             when a packet has been received (see _cInitAdapters).  It provides
;             the glue between the 3L 1.0 routines and C routine called
;             myRxProcess.
;
;myRxProcess Calling Sequence:
;    void myRxProcess(Status, PacketSize, RequestID, PacketHeader)
;
;myRxProcess Input Parameters:
;    int Status - Receive status
;    int PacketSize - Size of the received packet
;    int RequestID - The request identifier
;    char far *PacketHeader - Address of the virtual packet header
;
;myRxProcess Returns:
;    Nothing
;
;-----------------------------------------------------------------------------
RxProcess proc near
comment #
        push   bx
        push   cx
        push   dx
        push   si
        push   di
        push   bp
        push   ds
        push   es
        pushf

        push   es
        push   di

        push   ax
        mov    ax,cs:his_ds
        mov    ds,ax
        mov    es,ax
        pop    ax

        xor    bx,bx
        mov    bl,dh
        xor    dh,dh

        push   bx
        push   cx
        push   ax

        call   _myRxProcess
        add    sp,10

        popf
        pop    es
        pop    ds
        pop     bp
        pop     di
        pop     si
        pop     dx
        pop     cx
        pop     bx
        ret
#
        push     bx
        push     cx

        test     cs:pklock,0ffh
        jz       getp
ontget:
        ;inc      pkcount
        inc      cs:pkcount
        mov      cx,0          ;zero length (just discard)
        jmp      goget
etp:
        ; At this point we could check es:di packet header data
        ; to make some decision on packet disposition

        ; lock our buffer and get packet data into it
        mov      cs:pklock,0ffh ;lock buff
        mov      cs:pkerr,0
oget:
        mov      ax,CODE
        mov      es,ax
        mov      di,offset cs:pkthd      ;buffer
        or       dl,40h        ;release buffer

        call     GetRxData

        jcxz     nolen
        mov      cs:pkerr,ax
        mov      cs:pklen,cx

nolen:
        pop      cx
        pop      bx
        ret

xProcess endp

; -------------------------------------------------------------
  _cXmit1   proc    near
  -------------------------------------------------------------
; transmit one packet
_cXmit1   proc    near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,ds
        mov     es,ax

        ;setup for PutTxData
        mov      bx,[bp+4]          ;set lengths
```

```
       mov     cx,[bp+6]
       mov     dl, byte ptr[bp+8]
       mov     dh, byte ptr[bp+10]
       mov     si,[bp+12]
       mov     di,0ffffh      ;no TxProcess

       call    PutTxData

       pop     ds
       xchg    dh,dl
       xor     dh,dh
       mov     di,[bp+16]
       mov     [di],dx

       pop     di
       pop     si
       pop     bp
       ret
cXmit1   endp

;-------------------------------------------------------------
;_cRcvSome proc    near
; following code to dump received packets for a fixed time
;-------------------------------------------------------------
_cRcvSome proc   near
       push   bp
       mov    bp,sp
       push   si
       push   di
       push   ds

       mov    ax,cs
       mov    ds,ax
hkpk:
       test    cs:pklock,0ffh     ;got a pkt?
       jnz     lstpkt
       mov     cs:pklen, 0    ; No pkt, move 0 to pklen
       jmp     wedone
lstpkt:
       test    cs:pkerr,0ffffh    ;any error
       jz      dmpk
       jmp     wedone
mpk:
       cmp     cs:pklen,0
       jnz     pkok
       jmp     wedone
kok:
       cmp     cs:pklen,256
       jle     wedone
       mov     cs:pklen,256       ;limit dump to 1st 256 bytes
edone:
       mov     cs:pklock,0
       inc     cs:pkcnt
       mov     ax,cs
       pop     ds
       mov     si,[bp+4]
       mov     word ptr [si], offset cs:pkthd
       mov     word ptr [si+2], ax
       mov     ax,cs:pklen
```

```
        pop     di
        pop     si
        pop     bp
        ret

cRcvSome endp

;-----------------------------------------------------------------------
avvecs  proc    near
        push    ds
        push    es
        push    si
        push    di
        push    cx

        mov     ax,ds
        mov     es,ax
        xor     ax,ax
        mov     ds,ax
        mov     cx,22h*2        ;vectors 0 - 21h, 2 wds per
        mov     di,offset CODE:vectsv
        xor     si,si
        cld
        cli
        rep     movsw                   ;save 'em all
        sti

        pop     cx
        pop     di
        pop     si
        pop     es
        pop     ds
        ret
savvecs endp

 -----------------------------------------------------------------------
ixvecs  proc    near
        push    es
        push    si
        push    di
        push    cx
        push    ax

        xor     ax,ax
        mov     es,ax
        mov     cx,22h*2        ;vectors 0 - 21h, 2 wds per
        mov     si,offset CODE:vectsv
        xor     di,di
        cld
        cli
        rep     movsw                   ;restore 'em all
        sti

        pop     ax
        pop     cx
        pop     di
        pop     si
        pop     es
        ret
ixvecs  endp
```

```
_TEXT   ends
        end
```

[illegible]

```
/****************************************************************************/
/*                                                                          */
/*   CTO3LC.C                                                               */
/*                                                                          */
/*   Description: This file contains the code which calls the funtions     */
/*                provide by the CTO3L.ASM to receive/transmit packets      */
/*                through 3COM Token Ring board.                            */
/*                                                                          */
/****************************************************************************/

#include <stdio.h>
extern cInitAdapters();
extern cInitParameters();
extern cResetAdapter();
extern cWhoAmI();
extern cRdRxFilter();
extern cWrRxFilter();
extern cPutTxData();
extern cGetRxData();
extern cSetLookAhead();
extern cXmit1();

extern cRcvSome();

main()
{
    int i;
    struct ini_hdr {
        char len;
        char non1;
        char non2;
        char non3[2];
        char non4[4];
        char non5[4];
        char non6;
        char cdend[4];
        char *argo;
        short args;
        char non7;
    };

    struct WhoStruct {
        unsigned char addr[6];
        char ver_major;
        char ver_minor;
        char sub_ver;
        char type_ds;
        char type_adapter;
        char init_status;
        char reserved;
        char num_tran_buf;
        short size_tran_buf;
        long  ttl_tran_cnt;
        long  ttl_tran_err_cnt;
        long  ttl_tran_timeout_cnt;
        long  ttl_recp_cnt;
        long  ttl_recv_bdr_cnt;
        long  ttl_recv_err_cnt;
        long  ttl_retry_cnt;
        char  xfr_mode;
    char  wait_mode;
    char  hdr_spec_data;
};

struct TokenFrame {
    unsigned char da[6];
    unsigned char sa[6];
    unsigned char info[16];
};

struct PktStr {
    unsigned char inp[1500];
};

struct WhoStruct far *Who;
struct PktStr far *Pkt;
struct ini_hdr ddh;
struct ini_hdr *parmsdr = &ddh;
struct TokenFrame tkbuf;
struct TokenFrame *ptkbuf = &tkbuf;

int ttlpl, nb, flags, reqid, nreqid;

int rc, rxf=0x0005, rrxf, Adapters=0;
int rs = 0, icnt = 0;
parmsdr->len=0x17;
parmsdr->non1=0x00;
parmsdr->non2=0x00;
parmsdr->non3[0]=0x00;
parmsdr->non3[1]=0x00;
parmsdr->non4[0]=0x00;
parmsdr->non4[1]=0x00;
parmsdr->non4[2]=0x00;
parmsdr->non4[3]=0x00;
parmsdr->non5[0]=0x00;
parmsdr->non5[1]=0x00;
parmsdr->non5[2]=0x00;
parmsdr->non5[3]=0x00;
parmsdr->non6=0x00;
parmsdr->cdend[0]=0x00;
parmsdr->cdend[1]=0x00;
parmsdr->cdend[2]=0x00;
parmsdr->cdend[3]=0x00;
parmsdr->argo = "c:\\3com\\tok603.sys 5,300,0,,\0x0a";
parmsdr->args=getds();
parmsdr->non7=0x00;

rc=getds();
printf("getds 0x%x\n",rc);

rc=cInitParameters(parmsdr);
printf("cInitParameters returns %d\n",rc);
rc=cInitAdapters(&Adapters);
printf("cInitAdapters returns %d, Adp=%d\n",rc, Adapters);

rc=cSetLookAhead(32);
printf("cSetLookAhead returns %d\n",rc);

rc=cWhoAmI(&Who);
printf("cWhoAmI returns %d\n",rc);
```

```
    printf("addr = %02x %02x %02x", Who->addr[0],
              Who->addr[1], Who->addr[2]);
    printf(" %02x %02x %02x\n", Who->addr[3],
              Who->addr[4], Who->addr[5]);
    printf("ver major %02x ver minor %02x\n", Who->ver_major, Who->ver_minor);
    printf("adapter type %02x\n", Who->type_adapter);
    printf("transfer mode %x wait mode %x\n", Who->xfr_mode, Who->wait_mode);
    printf("ttl recp cnt %d (0x%4x)\n", Who->ttl_recp_cnt, Who->ttl_recp_cnt);

    for (i=0; i<=5; i++)
        ptkbuf->da[i] =  0xff;
    for (i=0; i<=5; i++)
        ptkbuf->sa[i] =  Who->addr[i];

    rc=cWrRxFilter(rxf);
    printf("cWrRxFilter returns %d\n",rc);
    rc=cRdRxFilter(&rrxf);
    printf("cRdRxFilter returns %d, filter=%x\n",rc,rrxf);

    rs = ' ';
    printf("Receiver or Sender ? (r/s)\n");
    while ( ((rs = getchar()) != 'r') && (rs != 's') ) {
        printf("Receiver or Sender ? (r/s)\n");
    };
    if  (rs == 'r') {
        while ( !kbhit() ) {
            rc=cRcvSome(&Pkt);
            if  (rc > 0) {
/*
                printf(" length = %d\n", rc);
                for (i=0; i<=rc; i++)
                    printf(" %2x", Pkt->inp[i]);
                printf("\n", rc);
*/
                icnt++;
            }
        }
        printf("Total input count %d\n",icnt);
    }
    else {
        ttlpl = 0x1c;
        nb    = 0x1c;
        flags = 0x0060;
        reqid = 0x0001;
        nreqid = 0x0011;
        for (i=0; i<10; i++)
            rc=cXmit1(ttlpl, nb, flags, reqid, ptkbuf, &nreqid);
    };

    rc=cResetAdapter();
    printf("cResetAdapter returns %d\n",rc);
    exit (0);

void myRxProcess(Status, PacketSize, RequestID, PacketHeader)
int Status, PacketSize, RequestID;
char far *PacketHeader;
{
    /* fprintf(stderr,"Called by ASM - myRxProcess\n Not implement yet\n");
    fprintf(stderr,"Status=%d, PacketSize=%d, RequestID=%d\n",Status,PacketSize,
           RequestID); */
}

void myTxProcess(Status, RequestID)
int Status, RequestID;

    /* printf("Called by ASM - myTxProcess\n Not implement yet\n");
    printf("Status=%d, RequestID=%d\n",Status, RequestID); */


void myExitRcvInt()
{
    /* printf("Called by ASM - myExitRcvInt\n Not implement yet\n"); */
}
```

```
title cto3l.asm

;***************************************************************************
;
;File: CTO3L.ASM
;
;Description:  This file contains subroutines which provide a
;              C program with an interface to the 3L 1.0 routines.
;
;***************************************************************************

; Functions called by C
PUBLIC  _getds

PUBLIC  _cInitParameters
PUBLIC  _cInitAdapters
PUBLIC  _cResetAdapter
PUBLIC  _cWhoAmI
PUBLIC  _cRdRxFilter
PUBLIC  _cWrRxFilter
PUBLIC  _cPutTxData
PUBLIC  _cGetRxData
PUBLIC  _cSetLookAhead
PUBLIC  _etext

PUBLIC  _cRcvSome
PUBLIC  _cXmit1

;Need to be written in C
extrn   _myExitRcvInt     :near
extrn   _myRxProcess      :near
extrn   _myTxProcess      :near

;Functions provide by this file
PUBLIC  ExitRcvInt
PUBLIC  RxProcess
PUBLIC  TxProcess

;3L functions
extrn   InitParameters    :near
extrn   InitAdapters      :near
extrn   WhoAmI            :near
extrn   ResetAdapter      :near
extrn   RdRxFilter        :near
extrn   WrRxFilter        :near
extrn   GetRxData         :near
extrn   SetLookAhead      :near
extrn   PutTxData         :near

lf      equ     0ah
cr      equ     0dh

@print  macro   strloc          ;print string at strloc
        local   strloc
        push    ax
        push    cx
        push    ds
        push    dx
        mov     dx,seg strloc
        mov     ds,dx
        mov     dx,offset strloc
        mov     ah,09h
        int     21h
        pop     dx
        pop     ds
        pop     cx
        pop     ax
        endm

@kbdin  macro                   ;get kbd char in al
        mov     ah,8
        int     21h             ;wait for key
        endm

@kbdchk macro                   ;check for kbd char
        mov     ah,0bh
        int     21h             ;returns al: 0-nokey, ff-keyhit
        endm

CODE    GROUP   _TEXT, DATA, ICODE

_TEXT   segment byte public 'CODE'
DGROUP  group   _DATA, _BSS
        assume  cs:_TEXT, ds:DGROUP, ss:DGROUP
_TEXT   ends

DATA    segment word public 'CODE'
DATA    ends

ICODE   segment word public 'CODE'
ICODE ends

DATA    segment
his_ds  dw      ?
_etext  db      ?

vectsv  dd      22h dup (0)     ;save all vectors so we can cleanup
retsav  dw      ?
crlf    db      cr,lf,'$'

pklock  db       0
pklen   dw       0
pkerr   dw       0
pkcnt   dw       0
pkcount dw       0
pkthd   db       32 dup(0)
pktdat  db       1500 dup(0)

DATA    ends

_DATA   segment word public 'DATA'
_d@     label   byte
_DATA   ends
_BSS    segment word public 'BSS'
_b@     label   byte
_BSS    ends
_DATA   segment word public 'DATA'
_s@     label   byte
_DATA   ends
```

```
_TEXT   SEGMENT
        ASSUME  CS:_TEXT, DS:DGROUP, SS:DGROUP

_getds  proc    near
        mov     ax,ds
        mov     cs:his_ds,ax
        ret
_getds  endp

;-----------------------------------------------------------------------------
;
;_cInitAdapters:    This procedure provides the glue between a C
;                   program and the 3L 1.0 InitAdapters function.
;
;Calling Sequence:
;    int cInitAdapters(&nAdapters)
;
;Input Parameters:
;    None
;
;Output Parameters:
;    int nAdapters
;
;Returns:
;    The return value of the InitAdapters function
;
;-----------------------------------------------------------------------------
_cInitAdapters proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,cs
        mov     ds,ax
        mov     di,offset CODE:RxProcess

        call    InitAdapters

        pop     ds
        mov     di,word ptr[bp+4]
        mov     word ptr[di],cx

        pop     di
        pop     si
        pop     bp
        ret
_cInitAdapters endp

;-----------------------------------------------------------------------------
;
;_cInitParameters:  This procedure provides the glue between a C
;                   program and the 3L 1.0 InitAdapters function.
;
;Calling Sequence:
;    int cInitParameters(Parms)
;
;Input Parameters:
;    char *Parms - Pointer to a structure with overrides of default
;                 parameters.
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the InitParameters function
;
;-----------------------------------------------------------------------------
_cInitParameters proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     bx,[bp+4]
        mov     ax,ds
        mov     es,ax
        mov     ax,cs
        mov     ds,ax

        call    savvecs
        call    InitParameters

        pop     ds
        pop     di
        pop     si
        pop     bp
        ret
_cInitParameters endp

;-----------------------------------------------------------------------------
;
;_cResetAdapter:  This procedure provides the glue between a C
;                 program and the 3L 1.0 ResetAdapters function.
;
;Calling Sequence:
;    int cResetAdapter()
;
;Input Parameters:
;    None
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the ResetAdapter function
;
;-----------------------------------------------------------------------------
_cResetAdapter proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     dx,0
        mov     ax,cs
        mov     ds,ax
        mov     dl,0 ; Ruey Ouyang
        call    ResetAdapter
        call    fixvecs

        pop     ds
        pop     di
        pop     si
        pop     bp

        ret
_cResetAdapter endp

;---------------------------------------------------------------------------
;
;_cWhoAmI:  This procedure provides the glue between a C
;           program and the 3L 1.0 WhoAmI function.
;
;Calling Sequence:
;    int cWhoAmI(&WhoPtr)
;
;Input Parameters:
;    None
;
;Output Parameters:
;    struct WhoStruct far *WhoPtr - Far pointer to the WhoAmI structure
;
;Returns:
;    The return value of the WhoAmI function
;
;---------------------------------------------------------------------------
_cWhoAmI proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     dx,0
        mov     ax,cs
        mov     ds,ax

        call    WhoAmI

        pop     ds
        mov     si,[bp+4]
        mov     Word ptr [si],di
        mov     Word ptr [si+2],es

        pop     di
        pop     si
        pop     bp
        ret
_cWhoAmI endp

;---------------------------------------------------------------------------
;
;_cRdRxFilter:   This procedure provides the glue between a C
;                program and the 3L 1.0 RdRxFilter function.
;
```

```
;
;Calling Sequence:
;    int cRdRxFilter(&RxFilter)
;
;Input Parameters:
;    None
;
;Output Parameters:
;    int RxFilter - The receive filter value
;
;Returns:
;    The return value of the RdRxFilter function
;
;-----------------------------------------------------------------------------
_cRdRxFilter proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,cs
        mov     ds,ax

        mov     dx,0
        call    RdRxFilter

        pop     ds
        mov     di,[bp+4]
        mov     [di],bx

        pop     di
        pop     si
        pop     bp
        ret
_cRdRxFilter endp

;-----------------------------------------------------------------------------
;
;_cWrRxFilter:    This procedure provides the glue between a C
;                 program and the 3L 1.0 WrRxFilter function.
;
;Calling Sequence:
;    int cWrRxFilter(RxFilter)
;
;Input Parameters:
;    int RxFilter - The new receive filter value
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the WrRxFilter function
;
;-----------------------------------------------------------------------------
_cWrRxFilter proc near
        push    bp
        mov     bp,sp
        push    ds
        push    si
        push    di
        mov     ax,cs
        mov     ds,ax

        mov     dx,0
        mov     ax,[bp+4]
        call    WrRxFilter

        pop     di
        pop     si
        pop     ds
        pop     bp
        ret
_cWrRxFilter endp

;--------------------------------------------------------------------------
;
;_cSetLookAhead:   This procedure provides the glue between a C
;                  program and the 3L 1.0 SetLookAhead function.
;
;Calling Sequence:
;    int cSetLookAhead(NumBytes)
;
;Input Parameters:
;    int NumBytes - The nnumber of bytes of look ahead data
;
;Output Parameters:
;    None
;
;Returns:
;    The return value of the SetLookAhead function
;
;--------------------------------------------------------------------------
_cSetLookAhead proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,cs
        mov     ds,ax

        mov     dx,0
        mov     ax,[bp+4]
        call    SetLookAhead

        pop     ds
        pop     di
        pop     si
        pop     bp
        ret
_cSetLookAhead endp

;--------------------------------------------------------------------------
;
;_cPutTxData:   This procedure provides the glue between a C
;               program and the 3L 1.0 PutTxData function.
;
;Calling Sequence:
```

```
;     int cPutTxData(TotalPacketLen, NumBytes, Flags, RequestID,
;                    PacketAddr, &NewRequestID)
;
;Input Parameters:
;     int TotalPacketLen - The total packet length (first call only)
;     int NumBytes - The nnumber of bytes to transfer this call
;     int Flags - The DL flags
;     int RequestID - Used if not the first call
;     char far * PacketAddr - A far pointer to the packet
;
;Output Parameters:
;     int NewRequestID - Returned after first call
;
;Returns:
;     The return value of the PutTxData function
;
;-----------------------------------------------------------------------
_cPutTxDAta proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,ds
        mov     es,ax

        mov     bx,[bp+4]
        mov     cx,[bp+6]

        mov     dl,byte ptr[bp+8]
        mov     dh,byte ptr[bp+10]
        mov     si,[bp+12]
;        mov     di,offset CODE:TxProcess
        mov     di,0ffffh ; no TxProcess

        call    PutTxData

        pop     ds
        xchg    dh,dl
        xor     dh,dh
        mov     di,[bp+16]
        mov     [di],dx

        pop     di
        pop     si
        pop     bp
        ret
_cPutTxData endp

;-----------------------------------------------------------------------
;
;_cGetRxData:   This procedure provides the glue between a C
;               program and the 3L 1.0 GetRxData function.
;
;Calling Sequence:
;     int cGetRxData(&NumBytes, Flags, RequestID, PacketAddr)
;
;Input Parameters:
;     int NumBytes - The nnumber of bytes to transfer this call
;     int Flags - The DL flags
;     int RequestID - The request identifier
;     char far * PacketAddr - A far pointer to the packet to copy the data
;
;Output Parameters:
;     int NumBytes - The actual number of bytes transferred
;
;Returns:
;     The return value of the GetRxData function
;
;------------------------------------------------------------------------------
_cGetRxData proc near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     di,[bp+4]
        mov     cx,ss:[di]
        mov     dl,byte ptr[bp+6]
        mov     dh,byte ptr[bp+8]
        mov     di,[bp+10]
        mov     es,[bp+12]
        call    GetRxData

        pop     ds
        mov     di,[bp+4]
        mov     ss:[di],cx

        pop     di
        pop     si
        pop     bp
        ret
_cGetRxData endp

;------------------------------------------------------------------------------
;
;TxProcess:  This procedure is the protocol-side routine which is called
;            when a packet has finished transmitting (see _cInitAdapters).  It
;            provides the glue between the 3L 1.0 routines and C routine called
;            myTxProcess.
;
;myTxProcess Calling Sequence:
;     void myTxProcess(Status, RequestID)
;
;myTxProcess Input Parameters:
;     int Status - Receive status
;     int RequestID - The request identifier
;
;myTxProcess Returns:
;     Nothing
;
;------------------------------------------------------------------------------
TxProcess proc near
        push    bp
        push    si
        push    di
        push    ds
        push    es
        push    ax
        mov     ax,cs:his_ds
        mov     ds,ax
        mov     es,ax
        pop     ax

        xor     cx,cx
        mov     cl,dh
        xor     dh,dh

        push    cx
        push    ax
        call    _myTxProcess

        add     sp,4

        pop     es
        pop     ds
        pop     di
        pop     si
        pop     bp
        ret
xProcess endp

 ------------------------------------------------------------------------

;ExitRcvInt: This procedure is the protocol-side routine which is called
             when the 3L has completed a receive interrupt.  It provides
             the glue between the 3L 1.0 routines and C routine called
;            myExitRcvInt.
;
 myExitRcvInt Calling Sequence:
     void myExitRcvInt()
;
 myExitRcvInt Input Parameters:
     None
;
 myExitRcvInt Returns:
     Nothing
;
;------------------------------------------------------------------------
xitRcvInt proc near
         push    bp
;        push    ds
         push    es
         push    si
;        push    di

         push    ax
         mov     ax,cs:his_ds
;        mov     ds,ax
         mov     es,ax
         pop     ax
;
         call    _myExitRcvInt

;        pop     di
         pop     si
         pop     es
```

```
;        pop    ds
;        pop    bp
        iret
ExitRcvInt endp

;-----------------------------------------------------------------------------

;RxProcess:  This procedure is the protocol-side routine which is called
             when a packet has been received (see _cInitAdapters).  It provides
             the glue between the 3L 1.0 routines and C routine called
;            myRxProcess.
;
 myRxProcess Calling Sequence:
;    void myRxProcess(Status, PacketSize, RequestID, PacketHeader)
;
 myRxProcess Input Parameters:
     int Status - Receive status
;    int PacketSize - Size of the received packet
     int RequestID - The request identifier
     char far *PacketHeader - Address of the virtual packet header
;
;myRxProcess Returns:
     Nothing

;-----------------------------------------------------------------------------
xProcess proc near
omment #
        push   bx
        push   cx
        push   dx
        push   si
        push   di
        push   bp
        push   ds
        push   es
        pushf

        push   es
        push   di

        push   ax
        mov    ax,cs:his_ds
        mov    ds,ax
        mov    es,ax
        pop    ax

        xor    bx,bx
        mov    bl,dh
        xor    dh,dh

        push   bx
        push   cx
        push   ax

        call   _myRxProcess
        add    sp,10

        popf
        pop    es
        pop    ds
        pop     bp
        pop     di
        pop     si
        pop     dx
        pop     cx
        pop     bx
        ret
#
        push     bx
        push     cx

        test     cs:pklock,0ffh
        jz       getp
dontget:
        inc      cs:pkcount
        mov      cx,0          ;zero length (just discard)
        jmp      goget
getp:
        ; At this point we could check es:di packet header data
        ; to make some decision on packet disposition
        ; lock our buffer and get packet data into it
        mov      cs:pklock,0ffh ;lock buff
        mov      cs:pkerr,0
goget:
        mov      ax,CODE
        mov      es,ax
        mov      di,offset cs:pkthd      ;buffer
        or       dl,40h       ;release buffer

        call     GetRxData

        jcxz     nolen
        mov      cs:pkerr,ax
        mov      cs:pklen,cx

nolen:
        pop      cx
        pop      bx
        ret

RxProcess endp

; ------------------------------------------------------------
; _cXmit1   proc    near
; ------------------------------------------------------------
; transmit one packet
_cXmit1   proc    near
        push    bp
        mov     bp,sp
        push    si
        push    di
        push    ds

        mov     ax,ds
        mov     es,ax

        ;setup for PutTxData
        mov      bx,[bp+4]          ;set lengths
        mov      cx,[bp+6]
        mov      dl, byte ptr[bp+8]
        mov     dh, byte ptr[bp+10]
        mov     si,[bp+12]
        mov     di,0ffffh       ;no TxProcess

        call    PutTxData

        pop     ds
        xchg    dh,dl
        xor     dh,dh
        mov     di,[bp+16]
        mov     [di],dx

        pop     di
        pop     si
        pop     bp
        ret
_cXmit1   endp

; --------------------------------------------------------------
;_cRcvSome proc    near
; following code to dump received packets for a fixed time
; --------------------------------------------------------------
_cRcvSome proc    near
        push   bp
        mov    bp,sp
        push   si
        push   di
        push   ds

        mov    ax,cs
        mov    ds,ax
chkpk:
        test    cs:pklock,0ffh      ;got a pkt?
        jnz     lstpkt
        mov     cs:pklen, 0     ; No pkt, move 0 to pklen
        jmp     wedone
lstpkt:
        test    cs:pkerr,0ffffh     ;any error
        jz      dmpk
        jmp     wedone
dmpk:
        cmp     cs:pklen,0
        jnz     pkok
        jmp     wedone
pkok:
        cmp     cs:pklen,256
        jle     wedone
        mov     cs:pklen,256        ;limit dump to 1st 256 bytes
wedone:
        mov     cs:pklock,0
        inc     cs:pkcnt
        mov     ax,cs
        pop     ds
        mov     si,[bp+4]
        mov     word ptr [si], offset cs:pkthd
        mov     word ptr [si+2], ax
        mov     ax,cs:pklen

        pop     di
        pop     si
        pop     bp
        ret
_cRcvSome endp

;------------------------------------------------------------------------
savvecs proc    near
        push    ds
        push    es
        push    si
        push    di
        push    cx

        mov     ax,ds
        mov     es,ax
        xor     ax,ax
        mov     ds,ax
        mov     cx,22h*2        ;vectors 0 - 21h, 2 wds per
        mov     di,offset CODE:vectsv
        xor     si,si
        cld
        cli
        rep     movsw                   ;save 'em all
        sti

        pop     cx
        pop     di
        pop     si
        pop     es
        pop     ds
        ret
savvecs endp

;------------------------------------------------------------------------
fixvecs proc    near
        push    es
        push    si
        push    di
        push    cx
        push    ax

        xor     ax,ax
        mov     es,ax
        mov     cx,22h*2        ;vectors 0 - 21h, 2 wds per
        mov     si,offset CODE:vectsv
        xor     di,di
        cld
        cli
        rep     movsw                   ;restore 'em all
        sti

        pop     ax
        pop     cx
        pop     di
        pop     si
        pop     es
        ret
fixvecs endp
_TEXT   ends
        end
```

```
/******************************************************************
dogdisk.c

This program displays the airplane controled by the SiliconGraphics on
the simnet.

    simnet: Link Level Raw Ethernet Packets / Synchronous Non-blocking

    SiliconGraphics: Synchronous-blocking UDP/IP or
                     (disk file)

******************************************************************/
#include <sys/extypes.h>

#include <stdio.h>
#include <ctype.h>
#include <math.h>
#include <sys/exerrno.h>
#include <sys/socket.h>
#include <netinet/in.h>
#include <fcntl.h>
#include <signal.h>
#include <errno.h>
#include <sys/types.h>
#include <sys/stat.h>
#include <sys/exosopt.h>
#include <sys/exos.h>
#include <ex_ioctl.h>
#include <sys/soioctl.h>
#include <sys/dcb.h>
#include "..\simnet.h\simnet2.h"
#include "..\flight.h\flight.h"

struct sockaddr_link recv_socket = { AF_ETYPEFILTER };
struct sockaddr_link send_socket = { AF_ETYPEFILTER };
struct sockaddr_in recv_socket_sg = { AF_INET };
struct sockaddr_in send_socket_sg = { AF_INET };

#define FILEOFLAG (O_RDONLY | O_BINARY)
#define FILEPMODE (0)

#define PI 3.14159

extern int errno;
extern int break_enabled;
extern int abort_op;

int     diskfd = -1;                /* disk file */
int     netfd = 1;                  /* simnet file */
int     netfdsg = -1;               /* udp/ip file */
int     timelimit = 30;
char    *inputfile;

char    SENDIT;
char    buf[1024];

int  break_handler();

main (argc, argv)
char **argv;
```

```
{
    int an, i, j, pdukind, netcnt;

    signal(SIGINT, break_handler);
    break_enabled = 1;
    inputfile = argv[1];

    sginitin();

    netinit();

    /* Capture a simnet packet first, so we don't have to fill all of the data
         field */
    fprintf(stderr, "wait for simnet\n");
    while(1) {
        /* netcnt=netread(inbuf); */
        netcnt=netread();
        datalength.p_datalength= ntohs (ether_buf.simnet_data.e_datalength);
        netcnt=datalength.i_datalength.length + HEADER_SIZE;
        memcpy (&pdu_buf, &ether_buf.simnet_data, netcnt - HEADER_SIZE);
        pdukind = ntoh_simnet();
        if  (pdukind == vehicleAppearancePDUKind) {
            SENDIT = ' ';
            if  (ether_buf.e_shost [5] == TANKA)
                SENDIT = 'A';
            if  (ether_buf.e_shost [5] == TANKB)
                SENDIT = 'B';
        }
        if  ((SENDIT == 'A') || (SENDIT == 'B')) break;
    }

    fprintf(stderr, "Got a vehicle appearance packet from tank %c\n", SENDIT);
    pdu_buf.VAPDU.VADATA.hdr.vehicleID = MYTANKID;
    pdu_buf.VAPDU.VADATA.appearance.vehKindMask  = A10;
    memcpy (ether_buf.e_shost, my_addr, sizeof(my_addr));

    while (1) {
        netcnt = sgreadin();
        if  (netcnt <= 0) break;
        memcpy(&plane, buf, netcnt);
        ntoh_flight();

        pdu_buf.VAPDU.VADATA.location[0] =
            AIRPORTX + ((plane.x + ADJUSTX)/F2M);
        pdu_buf.VAPDU.VADATA.location[1] =
            AIRPORTZ - ((plane.z + ADJUSTZ)/F2M);
        pdu_buf.VAPDU.VADATA.location[2] = AIRPORTY + (plane.y/F2M);
        calrotation();
        hton_simnet();
        memcpy (&ether_buf.simnet_data, &pdu_buf, netcnt - HEADER_SIZE);
        netwrite();
    }
    fprintf (stderr, "End of input sg packet\n");
    close(diskfd);
    sgfiniin();
    netfini();
}

errexit(errstring)
char *errstring;
```

```
{
        if  (errno) experror(errstring);
        else fprintf(stderr, "%s\nusage: dogdisk filename\n", errstring);
        close(diskfd);
        soclose(netfdsg);
        netfini();
        exit(1);
}

reak_handler()          /* break handler ... control-break or control-c */
{
        static int break_count = 0;

        if  (++break_count == 1) {
            /* first time, just try to stop current network operation */
            abort_op = 1;
            signal(SIGINT, break_handler);       /* reset trap */
            return;
        }
        else {
            /* second time, try to clean up, then quit */
            errexit("user abort");
        }
}

pinfo(optp)
truct exosopt *optp;
{
        /* note that this routine will not return valid results
         * if used with a pre-3.3 driver, which interpreted the
         * board memory address as absolute, rather than relative
         * to the beginning of the data segment
         */
        long    optaddress = 0;          /* location of options */
        int     id;

        if  ((id = brdopen(0, 1)) < 0) {
            experror("brdopen");
            return(-1);
        }
        if  (brdioctl(id, BRDADDR, &optaddress) < 0) {
            experror("brdioctl(,BRDADDR,...)");
            return(-1);
        }
        if  (brdread(id, optp, sizeof(struct exosopt)) < 0) {
            experror("brdread");
            return(-1);
        }
        brdclose(id);
        return 0;
}

#include "..\simnet.h\simnet.ccd"
#include "..\flight.h\flight.ccd"

/*  This subroutine computes the rotation matrix (3x3) for the SIMNET PDU's */
/*  given the pitch, roll and yaw of the vehicle. */

calrotation()
{
```

```
int i,j,k=0;
float R,P,Y;
float RC,RS,PC,PS,YC,YS;
float  A [3] [3];
float  z [3] [3];
float  x [3] [3];
float  y [3] [3];

/* In Silicon Graphics DogFight: Roll=Twist; Pitch=Elevation; Yaw=Azimith */

R=(plane.twist/10*PI)/180;
P=-(plane.elevation/10*PI)/180;
Y=-(plane.azimuth/10*PI)/180;

RC=cos(R);
RS=sin(R);

PC=cos(P);
PS=sin(P);
YC=cos(Y);
YS=sin(Y);

z[0] [0]=YC;
z[0] [1]=-YS;
z[0] [2]=0;
z[1] [0]=YS;
z[1] [1]=YC;
z[1] [2]=0;
z[2] [0]=0;
z[2] [1]=0;
z[2] [2]=1;

x[0] [0]=1;
x[0] [1]=0;
x[0] [2]=0;
x[1] [0]=0;
x[1] [1]=PC;
x[1] [2]=-PS;
x[2] [0]=0;
x[2] [1]=PS;
x[2] [2]=PC;

y[0] [0]=RC;
y[0] [1]=0;
y[0] [2]=RS;
y[1] [0]=0;
y[1] [1]=1;
y[1] [2]=0;
y[2] [0]=-RS;
y[2] [1]=0;
y[2] [2]=RC;

for (i=0; i<=2; i++) {
     for (j=0; j<=2; j++) {
          A [i][j]=0;
          for (k=0; k<=2; k++)
                A[i][j] += x[i][k] * y[k][j];
     }
}
```

```
    for (i=0; i<=2; i++) {
        for (j=0; j<=2; j++){
            pdu_buf.VAPDU.VADATA.rotation[i][j]=0;
            for (k=0; k<=2; k++)
                pdu_buf.VAPDU.VADATA.rotation[i][j] += A[i][k] * z[k][j];
        }
    }
}
```

```
/***************************************************************************
flight.h

   This file is the header file for the airpalne running on
   the SiliconGraphics

***************************************************************************/

#define NAME_LENGTH 15
*
#define MYPLANEID 16
*/
define ADJUSTX -850
#define ADJUSTZ 2050
#define AIRPORTX 40000.0
define AIRPORTY 220.0
define AIRPORTZ 30000.0
/*
#define F2M 3.281
/
#define F2M 5.0

truct plane {
   long planeid;

   char version;                        /* flight version */
   char cmd;                            /* type of packet */
   short type;                          /* plane type */
   short alive;                         /* alive */
   char myname[NAME_LENGTH+1];

   unsigned short status;
   unsigned short won;                  /* for msgs these 2 shorts */
   unsigned short lost;                 /* hold the plane id */

   float x;                             /* plane position */
   float y;
   float z;
   short azimuth;
   short elevation;
   short twist;

   short mstatus;                       /* missile data */
   float mx;
   float my;
   float mz;
   float last_mx;
   float last_my;
   float last_mz;
   long kill;
   float tps;
   int airspeed;
   int thrust;
   short wheels;                        /* wheel position */
   short elevator;                      /* elevator position */
   char mtype;
;

struct plane plane;
hort port=0x140a;                       /* port address for udp/ip connection */
```

```
/*************************************************************************
flight.ccd

    This file contains the c code to handle the airplane flying on the SG

*************************************************************************/

/* Initialize a synchronous/blocking udp/ip connection for input */
sginitin()
{
    /* Check that the driver is loaded, and get our own ethernet MAC
       address from the EXOS board */
    if  (!loaded()) errexit("driver NOT loaded");
    if  (ipinfo(&opt) < 0) errexit("could not get own ethernet MAC address");
    memcpy(my_addr, opt.xo_eaddr, sizeof(my_addr));

    /* Display my address */
    fprintf(stderr, "my addr = %02x-%02x-%02x-%02x-%02x-%02x\n",
                    my_addr[0], my_addr[1], my_addr[2],
                    my_addr[3], my_addr[4], my_addr[5]);

    /* Open input disk file */
    diskfd = open(inputfile, FILEOFLAG, FILEPMODE);
    if  (diskfd < 0) errexit("cannot open diskfile");
    fprintf(stderr, "disk file fd = %d\n", diskfd);

    /* UDP/IP specification */
    send_socket_sg.sin_port = htons(port);
    send_socket_sg.sin_addr.s_addr = 0x00000000;
    recv_socket_sg.sin_port = htons(port);
    recv_socket_sg.sin_addr.s_addr = 0xffffffff;

    /* Make a udp socket call */
    if  ((netfdsg = socket(SOCK_DGRAM, (struct sockproto *) 0,
                           &send_socket_sg, 0)) < 0) {
        fprintf(stderr, "ERRNO %d\n", errno);
        errexit("socket");
    }
    fprintf(stderr, "sg socket fd = %d\n", netfdsg);
    return(0);
}

/* Read synchronous/blocking udp/ip packet */
sgreadin()
{
    int cnt;

    /* if  ((cnt = soreceive(netfdsg, &recv_socket_sg, buf, sizeof(buf))) < 0)
        errexit("soreceive");
    fprintf(stderr, "read %d bytes from sg\n", cnt); */
    if  ((cnt = read(diskfd, buf, 100)) < 0)
        errexit("read");
    /* fprintf(stderr, "read %d bytes from disk\n", cnt); */
    return(cnt);
}

/* Close connection */
sgfiniin()
{
    soclose(netfdsg);
}

* Network order to host order transform */
ntoh_flight ()
{
    int i, j;
    union {
        char  *tmpc;
        float *tmpf;
    } tmp;
    union {
        char  *tmpc;
        short *tmps;
    } tmps;

    tmp.tmpf = &plane.x;
    swap4(tmp.tmpc);
    tmp.tmpf = &plane.y;
    swap4(tmp.tmpc);
    tmp.tmpf = &plane.z;
    swap4(tmp.tmpc);
    tmps.tmps = &plane.azimuth;
    swap2(tmps.tmpc);
    tmps.tmps = &plane.elevation;
    swap2(tmps.tmpc);
    tmps.tmps = &plane.twist;
    swap2(tmps.tmpc);
}

* Host order to network order transform */
hton_flight ()
{
    int i, j;
    union {
        char  *tmpc;
        float *tmpf;
    } tmp;
    union {
        char  *tmpc;
        short *tmps;
    } tmps;

    tmp.tmpf = &plane.x;
    swap4(tmp.tmpc);
    tmp.tmpf = &plane.y;
    swap4(tmp.tmpc);
    tmp.tmpf = &plane.z;
    swap4(tmp.tmpc);
    tmps.tmps = &plane.azimuth;
    swap2(tmps.tmpc);
    tmps.tmps = &plane.elevation;
    swap2(tmps.tmpc);
    tmps.tmps = &plane.twist;
    swap2(tmps.tmpc);
}

* This subroutine is here for documentation, it is on simnet.ccd */
/*
swap4(char *ptr)
```

```
    char tmp;

    tmp = *ptr;
    *ptr = *(ptr+3);
    *(ptr+3) = tmp;
    tmp = *(ptr+1);
    *(ptr+1) = *(ptr+2);
    *(ptr+2) = tmp;

*/

/* This subroutine is here for documentation, it is on simnet.ccd */
/*
swap2(char *ptr)
{
    char tmp;

    tmp = *ptr;
    *ptr = *(ptr+1);
    *(ptr+1) = tmp;
}
*/

display_plane()
{
    fprintf(stderr, "plane id %ld\n", plane.planeid);
    fprintf(stderr, "version %c\t cmd %c\t type %d\t alive %d\t myname %s\n",
                    plane.version, plane.cmd, plane.type, plane.alive,
                    plane.myname);
    fprintf(stderr, "status %ud\t won %ud\t lost %ud\n",plane.x,plane.y,
                    plane.z);
    fprintf(stderr, "x %f\t y %f\t z %f\n",plane.x,plane.y,plane.z);
    fprintf(stderr, "azimuth %d\t elevation %d\t twist %d\n",plane.azimuth,
                    plane.elevation,plane.twist);
    fprintf(stderr, "mstatus %d\t mx %f\t my %f\t mz %f\n",plane.mstatus,
                    plane.mx,plane.my,plane.mz);
    fprintf(stderr, "last_mx %f\t last_my %f\t last_mz %f\n", plane.last_mx,
                    plane.last_my,plane.last_mz);
    fprintf(stderr, "kill %id\t tps %f\n", plane.kill, plane.tps);
    fprintf(stderr, "air speed %d\t thrust %d\n",plane.airspeed,
                    plane.thrust);
    fprintf(stderr, "wheels %d\t elevator %d\t mtype %c\n",plane.wheels,
                    plane.elevator, plane.mtype);
}
```

```
/************************************************************************
simnet2.h

                    SIMNET DATA STRUCTURE DECLARATIONS

************************************************************************/
#define TANKA 0x68                  /* 02-cf-1f-30-27-68 */
#define TANKB 0xff95                /* 02-cf-1f-30-27-95 */
#define MCC   0x09                  /* 02-cf-1f-30-28-09 */
#define ANZR  0x14                  /* 08-00-09-00-ba-14 */

typedef struct {
        unsigned version   :4;      /* version of protocol */
        unsigned length    :12;     /* length of PDU in octets */
        unsigned protocol  :8;      /* protocol PDU belongs to */
        unsigned kind      :8;      /* type of PDU within protocol */
} PDUHeader;

/* version field */
#define protocolVersionFeb87 0      /* the Feb. 1987 version of the protocols */
#define protocolVersionNov87 1      /* the Nov. 1987 version of the protocols */

/* protocol field */
#define protocolNone 0              /* no protocol -- PDU used for padding */
#define protocolMgmt 1              /* the Network Management Protocol */
#define protocolSim  2              /* the Simulation Protocol */
#define protocolData 3              /* the Data Collection Protocol */
#define protocolXfer 4              /* the File Transfer Protocol */
#define protocolDiag 5              /* the Diagnosis Protocol */

/* kind field */
#define activatePDUKind 1           /* Activate PDU */
#define activatingPDUKind 2         /* Activating PDU */
#define deactivatePDUKind 3         /* Deactivate PDU */
#define vehicleAppearancePDUKind 4  /* Vehicle Appearance PDU */
/* #define UNUSED 5                 /* Unused PDU */
#define vehicleImpactPDUKind 6      /* Vehicle Impact PDU */
#define groundImpactPDUKind 7       /* Ground Impact PDU */
#define indirectFirePDUKind 8       /* Indirect Fire PDU */
#define serviceRequestPDUKind 9     /* Service Request PDU */
#define resupplyOfferPDUKind 10     /* Resupply Offer PDU */
#define resupplyReceivedPDUKind 11  /* Resupply Received PDU */
#define repairPDUKind 12            /* Repair PDU */
#define repairedPDUKind 13          /* Repaired PDU */
#define collisionPDUKind 14         /* Collision PDU */
#define firePDUKind 15              /* Fire PDU */
#define radiatePDUKind 16           /* Radiate PDU */
#define resupplyCancelPDUKind 17    /* ResupplyCancel PDU */

/* Vehicle Type Identifier Field */
#define vehMainBattleTank         1  /* M1 or T72 main battle tank */
#define vehPersonnelCarrier       2  /* M2, M3 or BMP */
#define vehCommandPost            3  /* M577 Command Post */
#define vehAmmunitionTruck        4  /* M977 Ammo Truck */
#define vehFuelTruck              5  /* M978 Fuel Truck */
#define vehSupplyTruck            6  /* M35-A2 Truck */
#define vehMortatCarrier          7  /* M106 Carrier */
#define vehSPHowitzer             8  /* M109 Howitzer */
#define vehRecoveryVehicle        9  /* M88 Recovery */
#define vehFISTVehicle            10 /* Fire Support */
```

```
/* Appearance Field Descpritors */

typedef struct {
        PDUHeader pduHdr;             /* version, length, protocol, PDUkind */
        unsigned char exerciseID;     /* exercise identifier */
        unsigned char padding;
        unsigned short vehicleID;     /* vehicle identifier */
} SimPDUHeader;

typedef struct {
        unsigned char role;           /* role of vehicle: ammo truck,
                                                          fuel truck, etc */
        unsigned char batallion;      /* batallion (task force) vehicle belongs
                                         to */
        unsigned char company;        /* company (team) vehicle belongs to */
        unsigned char bumper;         /* bumper number within company */
} VehicleRole;

/* role field */
#define roleSimulator       0         /* a vehicle operated by a full crew,
                                         simulated by a crewed vehicle
                                         simulator */
#define roleOPFOR           1         /* a vehicle simulated by a Semi-automated
                                         Forces system */
#define roleGunneryTarget 2           /* a gunnery target, such as that simulated
                                         by an MCC system */
#define roleAmmoTruck       3         /* an ammunition truck, such as that
                                         simulated by an MCC system */
#define roleFuelTruck       4         /* a fuel truck, such as that simulated by
                                         an MCC system */
#define roleMaintTeam       5         /* a maintenance team , such as that
                                         simulated by an MCC system */
#define roleS2              6         /* a batallion S2's vehicle, such as that
                                         simulated by an MCC system as part of a
                                         tactical operations center (TOC) */
#define roleS3              7         /* a batallion S3's vehicle, such as that
                                         simulated by an MCC system as part of a
                                         TOC */
#define roleFSE             8         /* a batallion fire support officer's
                                         vehicle, such as those simulated by an
                                         MCC system as part of a TOC */
#define roleTACP            9         /* a batallion tactical air control party
                                         vehicle, such as those simulated by an
                                         MCC system as part of a TOC */
#define roleAdminLogCenter 10         /* a batallion admin/log center vehicle,
                                         such as that simulated by an MCC
                                         system */
#define roleOther           99        /* any other vehicle not in one of the above
                                         categories */

/* company field */
#define assignedBattalion  1          /* the vehicle is assigned to no unit in
                                         particular within the batallion */
#define assignedScoutPlt   2          /* the vehicle belongs to the batallion's
                                         scout platoon */
#define assignedTACP       3          /* the vehicle belongs to the batallion's
                                         tactical air control party */
```

```
typedef struct {
        SimPDUHeader hdr;              /* include ID of described number */

        /* Common to all vehicles */
        VehicleRole  role;             /* include ID of described number */
        unsigned char alignment;       /* offense, defense, friend, or foe */
        unsigned char vehicleClass; /* class of vehicle */
        /* unsigned short appearance;  /* type of vehicle and appearance */
        /* struct {
                unsigned vehKindMask : 6;
                unsigned un1             : 1;
                unsigned vehDestroyed    : 1;
                unsigned vehSmokePlume   : 1;
                unsigned vehFlaming      : 1;
                unsigned vehDustCloudMask : 2;
                unsigned un2             : 1;
                unsigned vehTOWLauncherUp : 1;
                unsigned vehEngineSmoke : 1;
                unsigned un3             : 1;
        } appearance; */
        struct {
                unsigned vehSmokePlume   : 1;
                unsigned vehFlaming      : 1;
                unsigned vehDustCloudMask : 2;
                unsigned un2             : 1;
                unsigned vehTOWLauncherUp : 1;
                unsigned vehEngineSmoke : 1;
                unsigned un3             : 1;
                unsigned vehKindMask : 6;
                unsigned un1             : 1;
                unsigned vehDestroyed    : 1;
        } appearance;
        float rotation [3][3];         /* vehicle rotation */
        float location [3];            /* exact vehicle location */
        short grid [2];                /* approximate vehicle location */
        unsigned short engineSpeed; /* engine speed, in RPM */
        /* unsigned short padding; */
        unsigned short sequence;       /* sequence # for vehicleAppearancePDU */

        /* Depending on vehicle class */
        union {

              /* If a simple moving vehicle, without turret ... */
              struct {
                     float velocity [3];    /* velocity (m/sec/15) */
              } simple;

              /* If a tank */
              struct {
                     float velocity [3];    /* velocity (m/sec/15) */
                     unsigned short turretAzimuth;
                                            /* turret/hull orinntation */
                     unsigned short gunElevation;    /* gun/turret elevation */
              } tank;
        } u;
} VehicleAppearancePDU;

/* alignment field */
#define alignedFoe          0          /* the vehicle appears unfriendly to all
                                          participants */
```

```
#define alignedOffense      1          /* the vehicle is on the offense team */
#define alignedDefense      2          /* the vehicle is on the defense team */
#define alignedFriend       3          /* the vehicle appears friendly to all
                                          participants */

/* vehicle class field */
#define vehicleClassStatic 1           /* the vehicle is always stationary when
                                          visible, and it has no independently
                                          movable parts */
#define vehicleClassSimple 2           /* the vehicle can move, but is has no
                                          independently movable parts */
#define vehicleClassTank   3           /* the vehicle can move, and it has a turret
                                          and a gun barrel */

typedef struct {
        unsigned char ammunition;      /* type of ammunition fired */
        unsigned char fuze;            /* type of fuze used */
        unsigned char quantity;        /* number of rounds in burst */
        unsigned char rate;            /* rate of fire, rounds per second */
} BurstDescriptor;

/* ammunition field */
#define ammoHEi25 1                    /* 25 mm high exposive incendiary shell */
#define ammoHEAT105 2                  /* 105 mm high exposive anti-tank shell */
#define ammoAPDS25 3                   /* 25 mm armor piercing discarding sabot
                                          shell */
#define ammoAPDS105 4                  /* 105 mm armor piercing discarding sabot
                                          shell */
#define ammoTP25 5                     /* 25 mm target practice shell */
#define ammoBomb500 6                  /* 500 lb. bomb */
#define ammoHE107 7                    /* 107 mm (4.2in.) high exposive mortar
                                          shell */
#define ammoHE155 8                    /* 155 mm high exposive howitzer shell */
#define ammoMissileTOW 9               /* TOW anti-tank missile */
/* fuze field */
#define fuzePointDetonating 1          /* point detonating fuze */
#define fuzeProximity 2                /* proximity fuze */

typedef struct {
        unsigned char targetType:2;  /* what is known about the target */
        unsigned : 14;
        unsigned short vehicleID;      /* ID of target vehicle, if known */
} TargetDescriptor;

/* targetType field */
#define targetUnknown 0                /* the target vehicle is not known */
#define targetNotVehicle 1             /* the target is known, but it is not a
                                          vehicle */
#define targetVehicle 2                /* the target is known and it is not a
                                          vehicle */

/* */
#define MYTANKID 16
#define MAXBUF              8192
#define HEADER_SIZE 14  /* ethernet header size including our header */

struct  ether { /* first three fields required for any link level packet */
        char  e_dhost[6];          /* 00-05   ethernet destination */
        char  e_shost[6];          /* 06-11   ethernet source */
        short e_type;              /* 12-13   ethernet packet type */
        struct {
            short e_datalength; /* 14-15   user data length */
            char  e_data[1512-HEADER_SIZE]; /* 16-1512 data, max size is 1512 */
        } simnet_data;
};

union {
        struct {
                unsigned length  :12;
                unsigned version :4;
        } i_datalength;
        short p_datalength;
  datalength;

typedef union {
        struct {
                char DATAONLY [1512 - HEADER_SIZE];
        } DATAONLYPDU;
        struct {
                PDUHeader ANYHDR;
                char data [1512 - HEADER_SIZE - 4];
        } ANYPDU;
        struct {
                VehicleAppearancePDU VADATA;
        } VAPDU;
  PDU;

#define MAXPKTSIZE 1514             /* total size of largest possible packet */
/* char send_addr[6];               /* our ethernet MAC address */
/* char recv_addr[6];               /* his ethernet MAC address */
char    my_addr[6];                 /* my ethernet MAC address */
struct  exosopt opt;                /* EXOS board options include own address */
#define ETYPE htons(0x5208)         /* arbitrary unused ethernet type */
#define HELICOPTER11 11
#define HELICOPTER12 12
#define A10 13
PDU     pdu_buf;
struct  ether ether_buf;
```

```
/***************************************************************************
imnet.ccd

        This file contains the c code for the simnet M1 tank simulator.

***************************************************************************/

/* Initialize the synchronous/non-blocking link-level socket connection */
etinit()

    int rc, on=1;

    /* Check that the driver is loaded, and get our own ethernet MAC
       address from the EXOS board */
    if  (!loaded()) errexit("driver NOT loaded");
    if  (ipinfo(&opt) < 0) errexit("could not get own ethernet MAC address");
    memcpy(my_addr, opt.xo_eaddr, sizeof(my_addr));

    /* Display my address */
    fprintf(stderr, "my addr = %02x-%02x-%02x-%02x-%02x-%02x\n",
                     my_addr[0], my_addr[1], my_addr[2],
                     my_addr[3], my_addr[4], my_addr[5]);

    /* Initialize the simnet receiver/sender socket type */
    recv_socket.sl_types[0] = ETYPE;

    /* Make a link level socket call */
    if  ((netfd=socket(SOCK_ETH, (struct sockproto *)0, &recv_socket, 0)) < 0) {
        if  (errno == EACCES)
            errexit ("link-level access must be enabled with -l option on netloa
        else errexit("cannot create socket");
    }
    fprintf(stderr, "socket fd = %d\n", netfd);

    /* Synchronous/non blocking mode */
    soioctl(netfd, SIOCSLINGER, &timelimit);
    rc = soioctl(netfd, FIONBIO, &on);
    if  (rc < 0) {
        experror ("soioctl(...FIONBIO, &on)");
        return(-1);
    }
    return(0);


/* Read synchronous/non blocking mode packet */
* netread (struct ether buf) */
etread ()
{
    int cnt;

    cnt = soreceive(netfd, (struct sockaddr *)0, &ether_buf, MAXPKTSIZE);
    if  ((cnt < 0) && (errno == EWOULDBLOCK))
        ;    /* No network data */
    else
        if  (cnt < 0) experror("soreceive read error"); /* Error condition */
    return (cnt);


/* Write synchronous/non blocking mode packet */
* netwrite (struct ether *buf) */
netwrite ()

    int cnt, netcnt;

    datalength.p_datalength = ntohs (ether_buf.simnet_data.e_datalength);
    cnt = datalength.i_datalength.length;
    netcnt = sosend(netfd, (struct sockaddr *)0, &ether_buf,cnt + HEADER_SIZE);
    if  ((netcnt < 0) && (errno == EWOULDBLOCK)) netcnt = 0;
    if  (netcnt < 0)
        errexit("sosend write error");
    else
        if  ((netcnt >= 0) && (netcnt < cnt))
            fprintf(stderr, "sosend : some data has been lost\n\007\007");
}

* Close synchronous/non blocking socket connection */
etfini ()
{
    int off = 0;

    if  (netfd >= 0) {
        fprintf(stderr, "Please wait up to %d seconds for completion\n",
                        timelimit);
    soioctl(netfd, FIONBIO, &off);
    soclose(netfd);
    netfd = -1;
    }
}

* Network order to host order transform, not all of the data field are included
  yet.  Add more statements if needed and modify the hton_simnet() too */
/* ntoh_simnet (PDU buf) */
toh_simnet ()

    int i, j;
    union {
        char  *tmpc;
        unsigned short *tmpui;
    } tmpui;
    union {
        char  *tmpc;
        float *tmpf;
    } tmp;

    tmp.tmpf = &pdu_buf.VAPDU.VADATA.location[0];
    swap4(tmp.tmpc);
    tmp.tmpf = &pdu_buf.VAPDU.VADATA.location[1];
    swap4(tmp.tmpc);
    tmp.tmpf = &pdu_buf.VAPDU.VADATA.location[2];
    swap4(tmp.tmpc);
    tmpui.tmpui = &pdu_buf.VAPDU.VADATA.hdr.vehicleID;
    swap2(tmpui.tmpc);
    for (i=0; i<=2; i++)
        for (j=0; j<=2; j++) {
            tmp.tmpf = &pdu_buf.VAPDU.VADATA.rotation[i] [j];
            swap4(tmp.tmpc);
    }
    return(pdu_buf.ANYPDU.ANYHDR.kind);
```

```
/* Host order to network order transform, not all of the data field are included
   yet.  Add more statements if needed and modify the ntoh_simnet() too */
 * hton_simnet (struct PDU buf) */
ton_simnet ()
{
    int i, j;
    union {
        char  *tmpc;
        unsigned short *tmpui;
    } tmpui;
    union {
        char  *tmpc;
        float *tmpf;
    } tmp;

    tmp.tmpf = &pdu_buf.VAPDU.VADATA.location[0];
    swap4(tmp.tmpc);
    tmp.tmpf = &pdu_buf.VAPDU.VADATA.location[1];
    swap4(tmp.tmpc);
    tmp.tmpf = &pdu_buf.VAPDU.VADATA.location[2];
    swap4(tmp.tmpc);
    tmpui.tmpui = &pdu_buf.VAPDU.VADATA.hdr.vehicleID;
    swap2(tmpui.tmpc);
    for (i=0; i<=2; i++)
        for (j=0; j<=2; j++) {
            tmp.tmpf = &pdu_buf.VAPDU.VADATA.rotation[i] [j];
            swap4(tmp.tmpc);
    }
    return(0);

/* This subroutine does the same work as ntohl(), htonl(). */
wap4(char *ptr)

    char tmp;

    tmp = *ptr;
    *ptr = *(ptr+3);
    *(ptr+3) = tmp;
    tmp = *(ptr+1);
    *(ptr+1) = *(ptr+2);
    *(ptr+2) = tmp;

/* This subroutine does the same work as ntohs(), htons(). */
wap2(char *ptr)

    char tmp;

    tmp = *ptr;
    *ptr = *(ptr+1);
    *(ptr+1) = tmp;

/* This subroutine is for debugging purpose only, it will DUMP the content of a
   link level packet in hexdecimal*/
 * dump_ether (struct ether ether_buf) */
ump_ether ()
{
    int i, j, netcnt;
    fprintf(stderr,"ETHER content\n");
    datalength.p_datalength = ntohs (ether_buf.simnet_data.e_datalength);
    fprintf(stderr,"Source addr      : %2x-%2x-%2x-%2x-%2x-%2x\n",
        ether_buf.e_shost [0], ether_buf.e_shost [1], ether_buf.e_shost [2],
        ether_buf.e_shost [3], ether_buf.e_shost [4], ether_buf.e_shost [5]);
    fprintf(stderr,"Destination addr : %2x-%2x-%2x-%2x-%2x\n",
        ether_buf.e_dhost [0], ether_buf.e_dhost [1], ether_buf.e_dhost [2],
        ether_buf.e_dhost [3], ether_buf.e_dhost [4], ether_buf.e_dhost [5]);
    fprintf(stderr,"%2x ",datalength.p_datalength);
    netcnt = datalength.i_datalength.length;
    for (i=0, j=3; i<(netcnt-HEADER_SIZE-2); i++, j++) {
        fprintf(stderr,"%2x ", ether_buf.simnet_data.e_data[i]);
        if  (j >= 17) {
            j=0;
            fprintf(stderr,"\n");
        }
    }
    fprintf(stderr,"\n");

/* This subroutine is for debugging purpose only, it will DUMP the content of a
   pdu packet in hexdecimal*/
dump_pdu ()
{
    int i, j, netcnt;

    fprintf(stderr,"PDU content\n");
    datalength.p_datalength = ntohs (ether_buf.simnet_data.e_datalength);
    netcnt = datalength.i_datalength.length;
    for (i=0, j=1; i<(netcnt-HEADER_SIZE-2); i++, j++) {
        fprintf(stderr,"%2x ", pdu_buf.DATAONLYPDU.DATAONLY[i]);
        if  (j >= 17) {
            j=0;
            fprintf(stderr,"\n");
        }
    }
    fprintf(stderr,"\n");

/* This subroutine is for debugging purpose only, it will DISPLAY the content of
   a pdu packet */
isplay_pdu ()
{
    int i, j;
    union {
        char  *tmpc;
        float *tmpf;
    } tmp;

    fprintf(stderr, "Rotation\n");
    for (i=0; i<=2; i++)
        for (j=0; j<=2; j++)
            fprintf(stderr,"%d %d %lf\n",i,j,pdu_buf.VAPDU.VADATA.rotation[i][j]
    fprintf(stderr, "Location\n");
    fprintf(stderr, "%lf\n",pdu_buf.VAPDU.VADATA.location[0]);
    fprintf(stderr, "%lf\n",pdu_buf.VAPDU.VADATA.location[1]);
    fprintf(stderr, "%lf\n",pdu_buf.VAPDU.VADATA.location[2]);
    fprintf(stderr, "%u\n",pdu_buf.VAPDU.VADATA.hdr.vehicleID);
```

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