Exp 14：TCP 综合实作

目的：让学生了解如何传输控制协议(TCP，Transmission Control Protocol)是如何工作的。

摘要：前几个实验分别抽出TCP协议里几个重要的功能与机制作分析讨论，本实验则借着MDDL 语言描述并完整仿真TCP协议的工作原理。

时间：9 hrs

一、网络拓扑

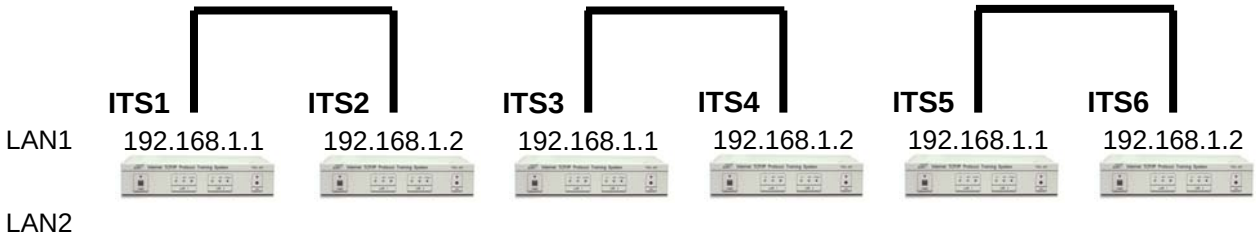

图14.1

二、技术背景

在TCP 通讯协议下，传输的报文我们称为段。透过TCP segment 在双方计算机间的交换，TCP得以建立连结、交换数据、传送acknowledgements、通报Sliding Window 空间大小和结束链接…等等，部份相关性技术在我们先前的实验已经讨论过。此外，由于TCP协议提供的是以联机为导向(Connection Oriented)的可靠传输，在联机建立之初会产生三次握手(Three Way Handshake)的机制，确定双方沟通无误，再开始传送数据。表14.1为整个TCP segment 的字段格式：

0	4	10	16	24	31
SOURCE PORT			DESTINATION PORT		
SEQUENCE NUMBER					
ACKNOWLEDGEMENT NUMBER					
HLEN	RESERVED	CODE BITS	WINDOW		
CHECKSUM			URGENT POINTER		
OPTIONS(IF ANY)				PADDING	
DATA					
…					

表14.1

SOURCE PORT and DESTINATION PORT (各16 bits)：发送端及目的端连接端口号。

SEQUENCE NUMBER (32 bits)：记录此封包在TCP 数据传输管道中，发送端发送资料的编号。

ACKNOWLEDGEMENT NUMBER (32 bits)：记录此封包在TCP 数据传输管道中，已经被目的端确认收到的数据编号。

CODE BITS (6 bits)：用来表明此segment的功用及内容，下表中分别解释6个bit代表的意义：

Bit (left to right)	Meaning if bit set to 1
URG	Urgent pointer field is valid
ACK	Acknowledgement filed is valid
PSH	This segment requests a push
RST	Reset the connection
SYN	Synchronize sequence numbers
FIN	Sender has reached end if its byte stream

表14.2

WINDOW (16 bits)：用以告知发送端每次传送可允许接收量 (即Windoiw Size)。

附带一提，TCP 是遵循以下的有限状态机 (FSM，Finite State Machine)：

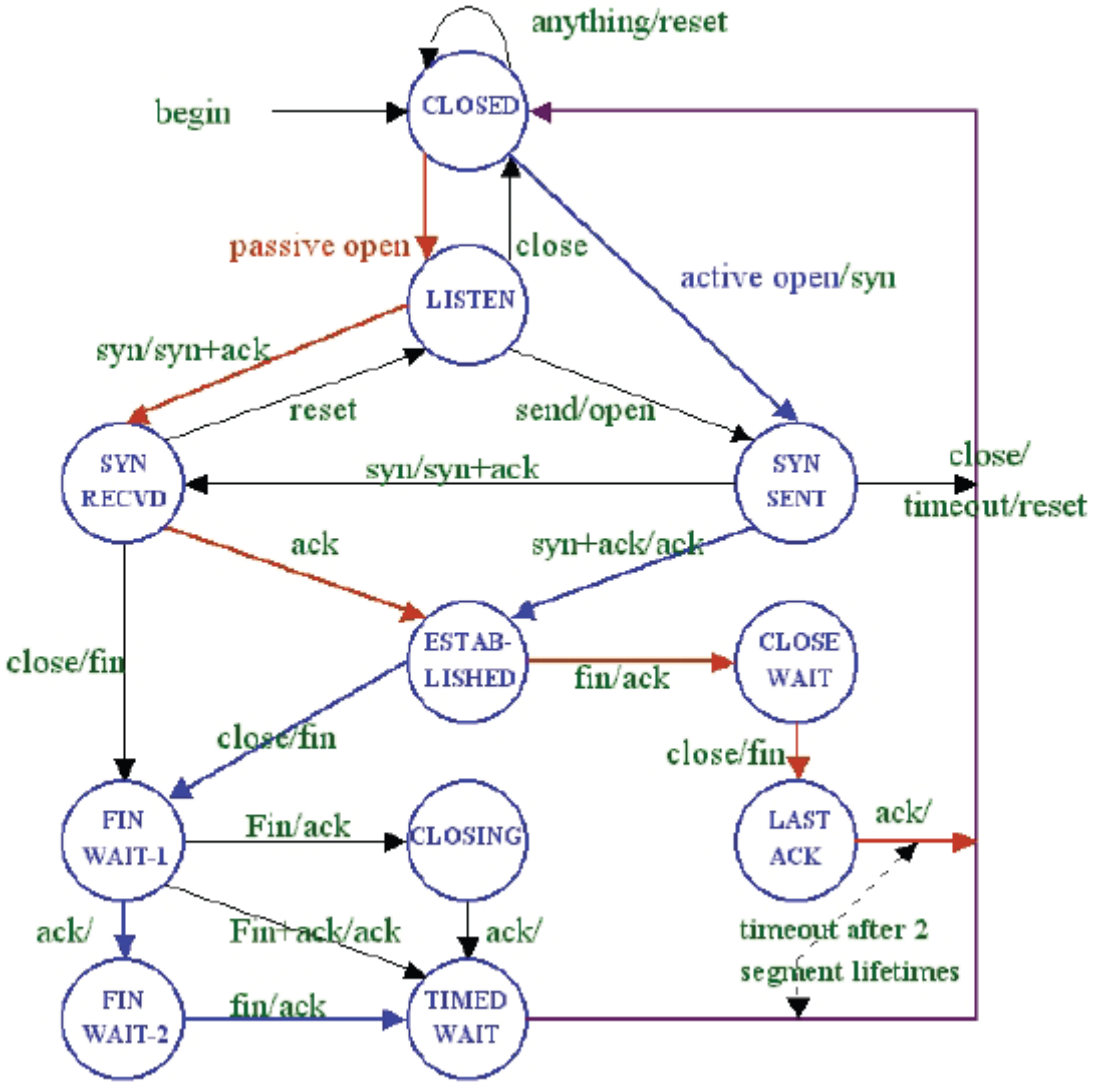

图14.2

遵循以上FSM, TCP 方能完成以下工作：

1）建立TCP联机

2）关闭TCP联机

3）重置TCP联机

三、实验步骤

1、网络拓扑

1）在Hubox上将网络连接如图14.3所示。

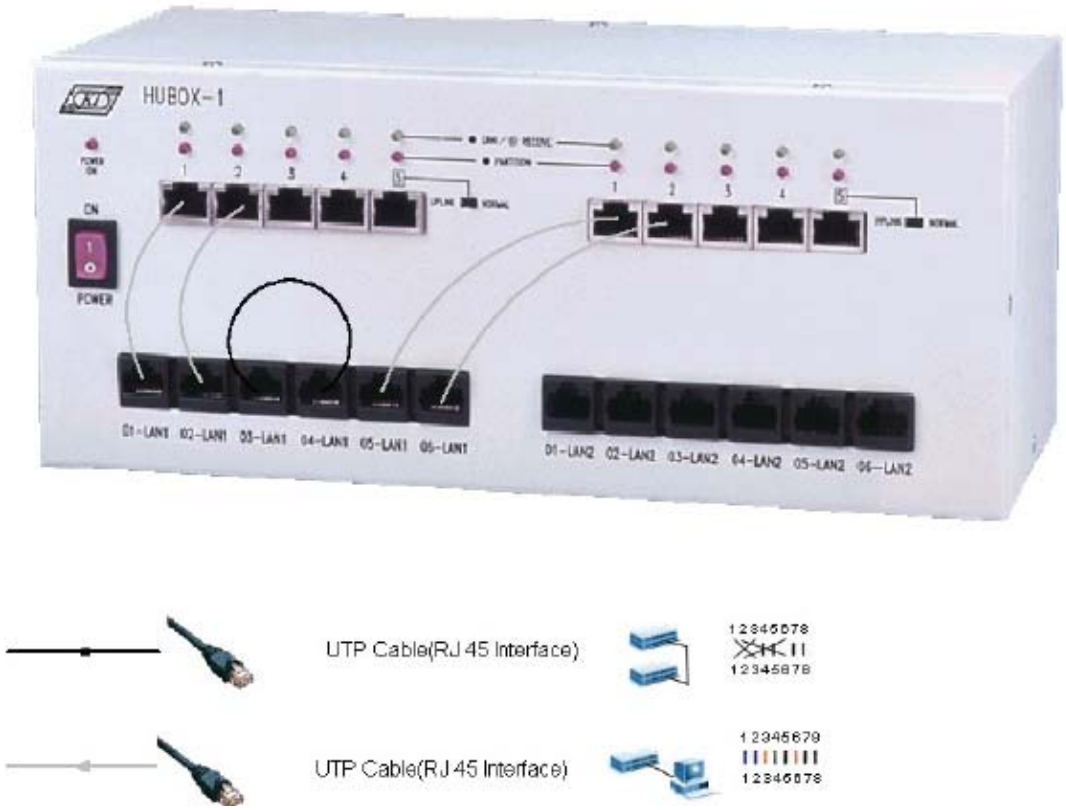

图 14.3

2、设置 Host 方法

ITS1 and ITS2

2）执行 **XCLIENT.BAT**，打开 ITS 软件界面。

3）在主菜单上选择 Tool 菜单，再选择 **Network Configuration** ，打开该界面。

ITS1 设置如下：

4）根据网络拓扑图，定义 Interface 1 的 IP 地址为 “**192.168.1.1**” 见图 14.4。

5）模式设定为“ **Host** ”，然后点击“**Set & Close”**按钮。

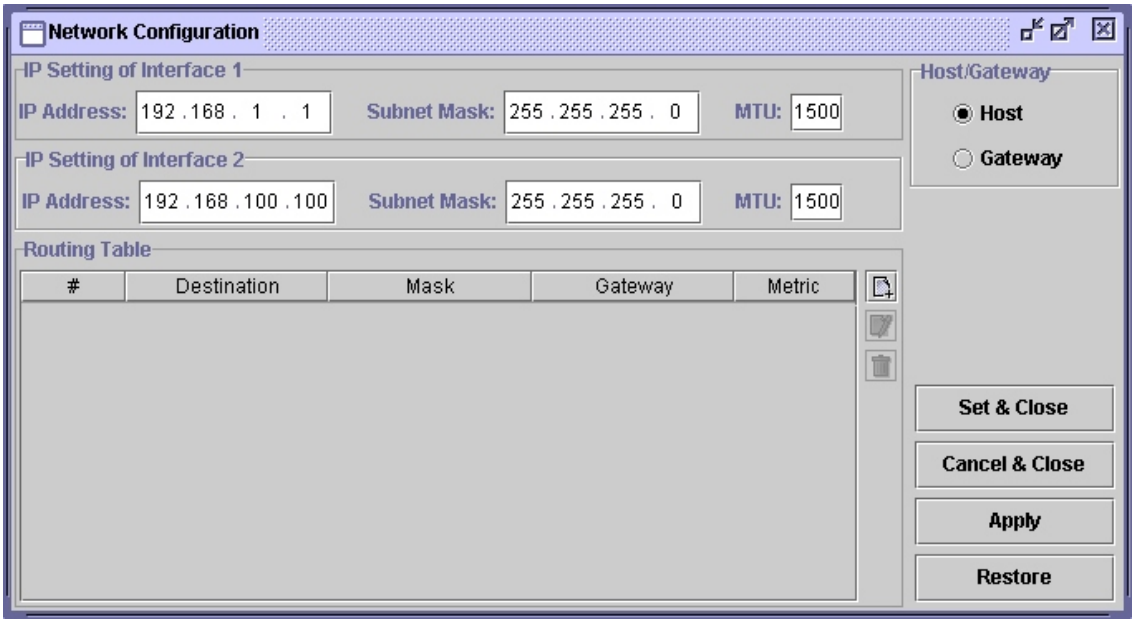

图 14.4

ITS2

6）定义 Interface 1 的 IP 地址为 “**192.168.1.2**”。

7）模式设定为“ **Host** ”，然后点击“**Set & Close”**按钮。

3、TCP Session

ITS1 操作如下：

8）打开网络封包浏览器（Network Message Browser）界面，同时主意是否打开了监听状态。（**Listening On**）

9）从 TCP 菜单上，打开“New TCP Session ”对话框。

10）选择“ **System Default TCP** ”项。“**Source IP Address** ”处输入 “**192.168.1.1**” ，“**Source Port**”处选择“ **HTTP (80)** ”。 (见图 14.5)

11）点击 **Listen** 按钮。

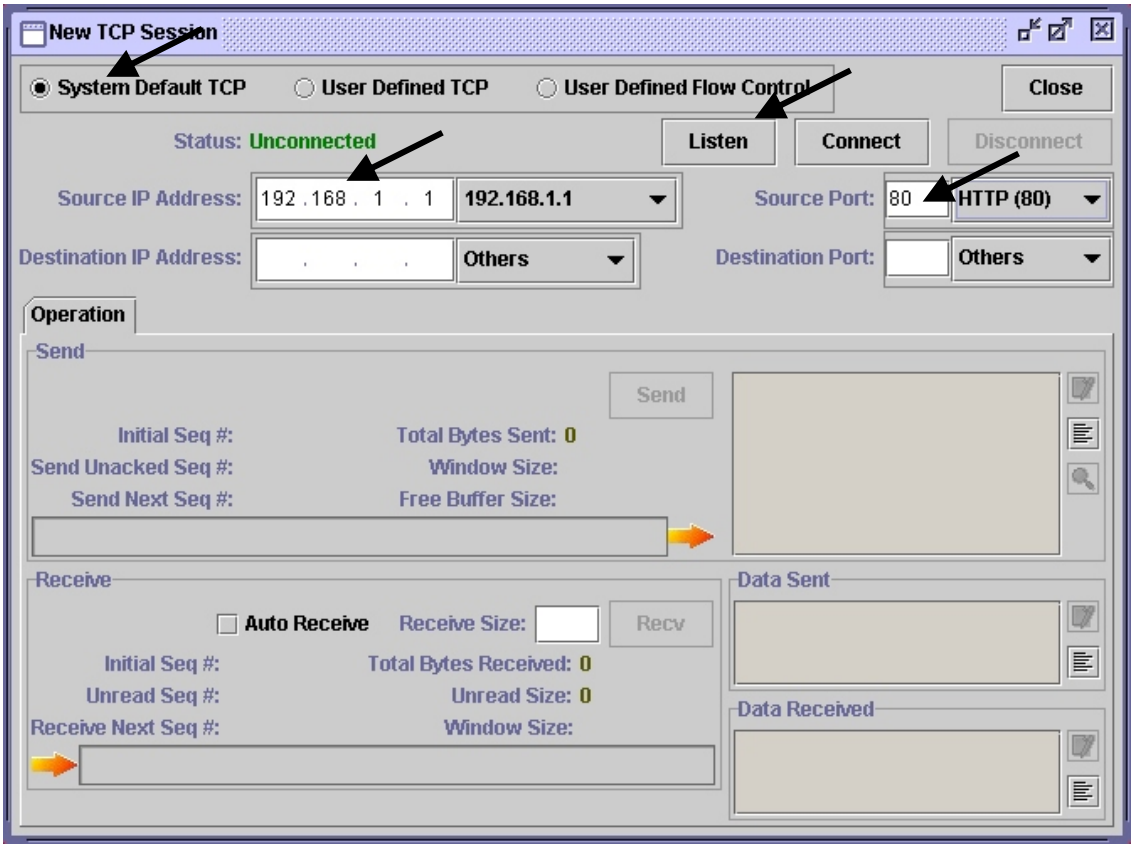

图 14.5New TCP Session dialog

ITS2 操作如下：

12）打开网络封包浏览器（Network Message Browser）界面，同时主意是否打开了监听状态。（**Listening On**）

13）从 TCP 菜单上，打开“New TCP Session ”对话框。

14）选择“ **System Default TCP** ”项．“**Destination IP Address** ”处输入“**192.168.1.1**”，“**Destination Port**”处选择“ **HTTP (80)** ”。 (见图 14.6)

15）点击 **Connect** 按钮．现在我们就已经在 ITS1 和 ITS2 之间通过 TCP 建立了连接，可以在网络封包浏览器中看到三次握手的过程。（见图 14.7）

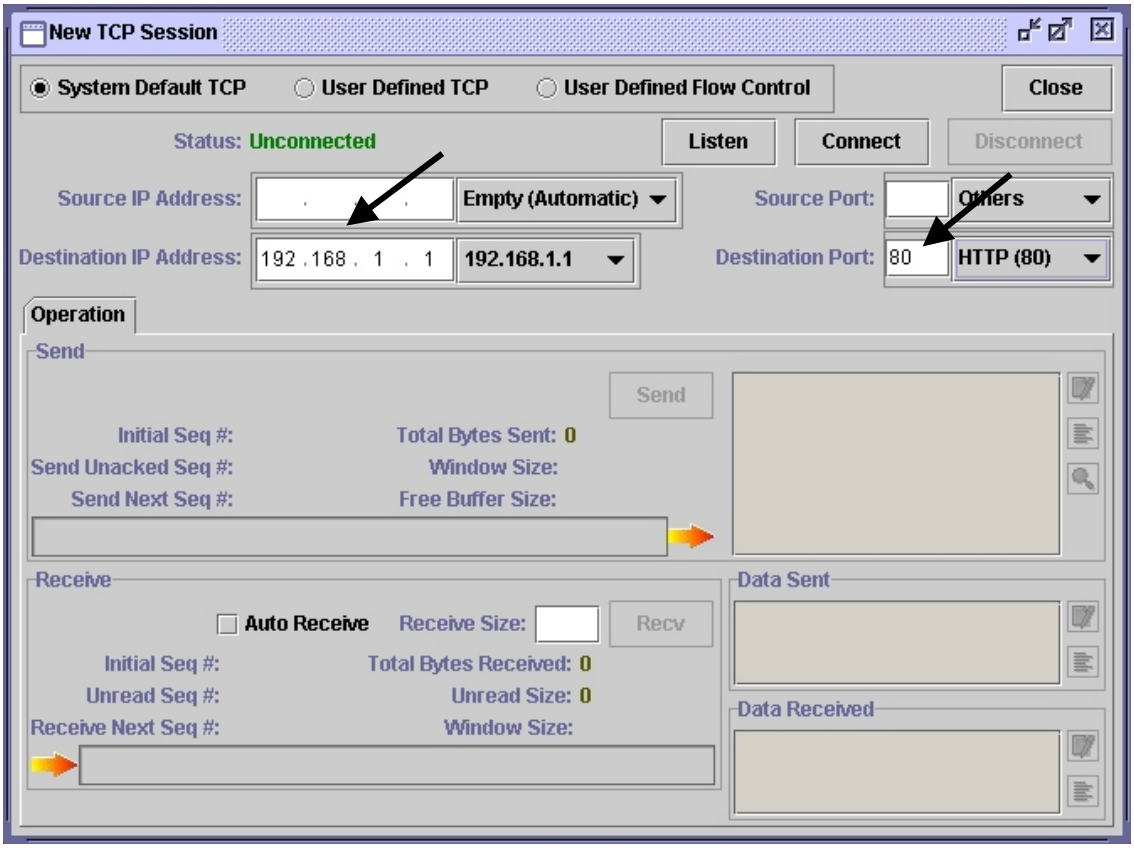

图 14.6

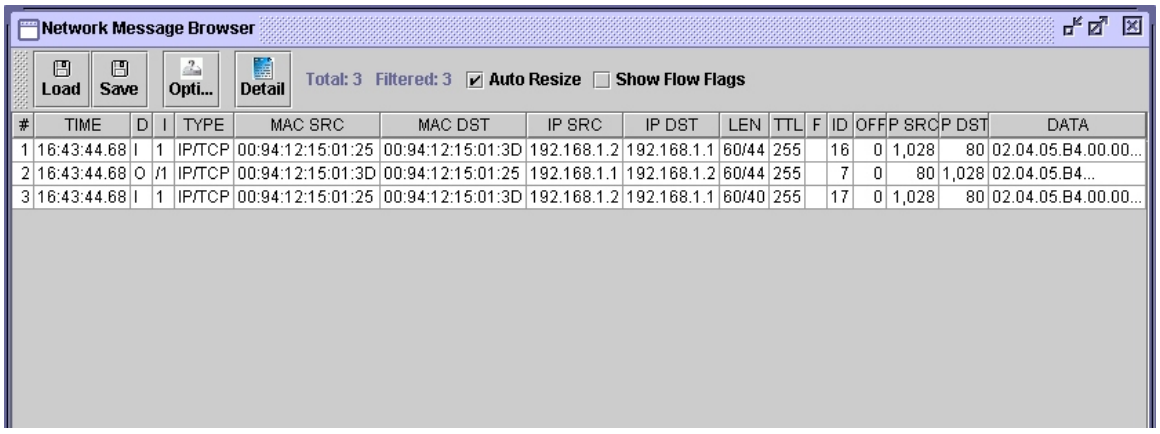

图 14.7

4、User Defined TCP 实验

我们也可以通过 MDDL 程序定义 TCP 协议。首先，需要复位您的 ITS 实验箱，并且按照下面的操作进行实验：

ITS1 and ITS2 操作如下：

16）打开网络封包浏览器（Network Message Browser）界面，同时主意是否打开了监听状态。（**Listening On**）

17）打开 MDDL 平台（MDDL Editor）。

18）点击 **Load** 按钮，调用 C: \XClient \Data \Mddl \Tutorial \Ex14 \TCP.mddl 最后点击 **Upld** 按钮。

ITS1 操作如下：

19）打开“ New TCP Session”对话框. 模式选择 “**User Defined TCP”**, “**Source IP Address** ”处输入 “**192.168.1.1**” ，“**Source Port**”处选择“ **HTTP (80)** ”。最后，点击 **Listen** 按钮。

ITS2 操作如下：

20）打开“ New TCP Session”对话框. 模式选择 “**User Defined TCP”**, “**Destination IP Address** ”处输入 “**192.168.1.1**” ，“**Destination Port**”处选择“ **HTTP (80)** ”。最后，点击 **Connect** 按钮. 现在我们就已经在 ITS1 和 ITS2 之间通过用户自定义 TCP 的方式建立了连接。

5、Sending Data by User Defined TCP 实验：

ITS2 操作如下：

21）在“ New TCP Session”界面下，Send 端的可编辑窗口下输入 “**test**” 。然后，点击 **Send** 按钮。(见图 14.8)

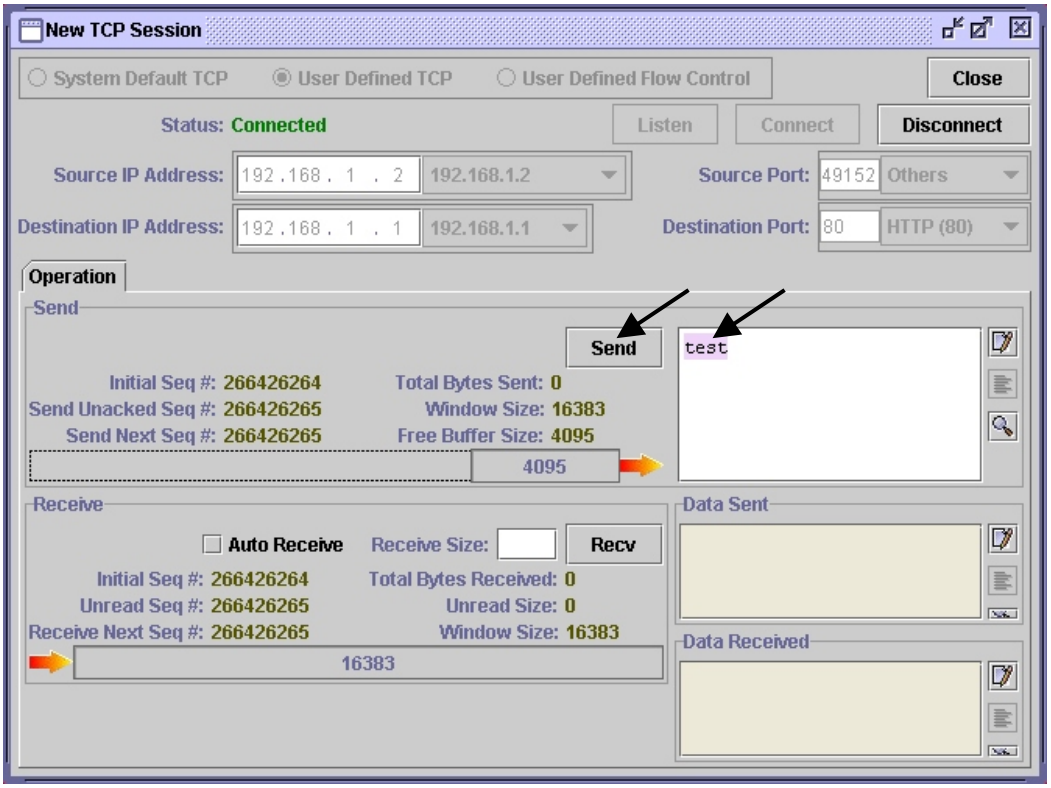

图 14.8

ITS1 操作如下：

22）一旦 ITS2 发送了数据，你就会在 Receive 端看见数据内容，并将数据保存在 buffer 内。（见图 14.9）

23）点击 **Recv** 按钮，您会发现在 Receive 端接收到数据。（见图 14.10）

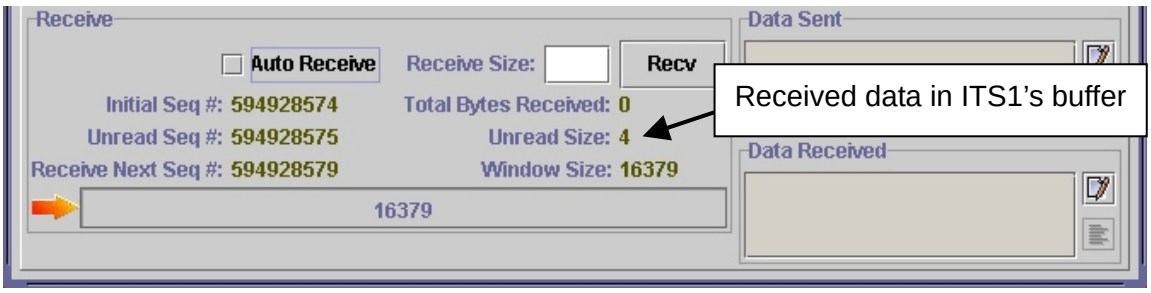

图 14.9

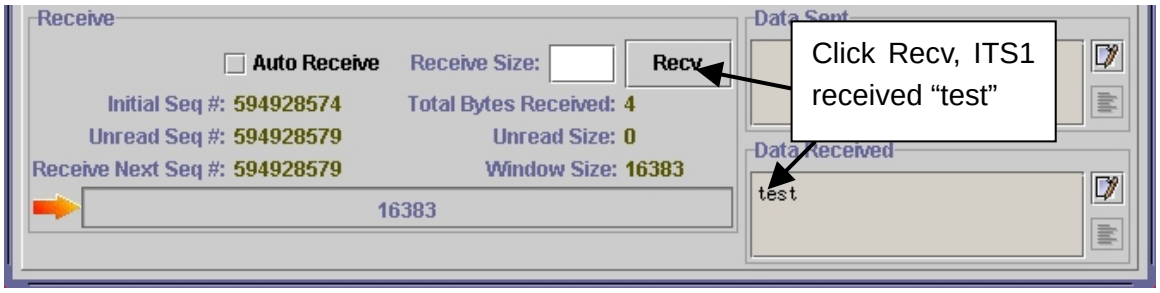

图 14.10

四、实验讨论

1、如果在联机已建立后，我们单击New TCP Session联机接口工具里的Disconnect钮，会发生什么样的状况？试着从网络信息浏览器观察看看。

2、如果在ITS 1尚未listen的情形下，我们就从ITS 2要联机到ITS 1，会发生什么状况？

REACTOR PROGRAM

1、TCP.mddl

```
VAR6.TCB                    =0                          ;
VAR6.TCB_SOCKET_ID          = 5                         ;
VAR6.TCB_STATE              = CNST_TCB_STATE_CLOSED     ;

VAR6.TCB_SND_BUF_SEM        = 15                        ;
VAR6.TCB_SND_BUF_SIZE       = 4096W                     ;

VAR6.TCB_RCV_BUF_SEM        = 25                        ;
```

```
VAR6.TCB_RCV_BUF_SIZE                    = 16384W                    ;

VAR6.TCB_WAS_LISTENING                   = FALSE                     ;
VAR6.TCB_POOL_RETRANSMISSION             = 15                        ;
VAR6.TCB_POOL_REASSEMBLY                 = 25                        ;

SERVICE_TCP_OPEN
{
    IF( VAR6.TCB_STATE != CNST_TCB_STATE_CLOSED )
    {
        GENERATE_USER_MSG WITH_DATA
        {
            TARGET = "TCP STATE IS NOT CLOSED!"
        }
        GENERATE_USER_MSG WITH_DATA
        {
            TARGET = VAR6.TCB_STATE
        }
        RETURN;
    }

    VAR6.TCB_SND_BUF_L                   = 0W                        ;
    VAR6.TCB_SND_BUF_H                   = 0W                        ;
    VAR6.TCB_RCV_BUF_L                   = 0W                        ;
    VAR6.TCB_RCV_BUF_H                   = 0W                        ;
    VAR6.TCB_RCV_WND = ( VAR6.TCB_RCV_BUF_L +   VAR6.TCB_RCV_BUF_SIZE -
    1 - VAR6.TCB_RCV_BUF_H ) % VAR6.TCB_RCV_BUF_SIZE;
    VAR6.TCB_TIMER_2MSL                  = 0W                        ;

    VAR6.TCB_STATE                   = CNST_TCB_STATE_SYN_SENT       ;
```

```
IF(PARA_IPADDR_SRC() == CNST_IP_ADDR_BROADCAST)
    VAR6.TCB_IP_ADDRSRC                = MYIP(1)                    ;
ELSE
    VAR6.TCB_IP_ADDRSRC            = PARA_IPADDR_SRC()              ;

VAR6.TCB_IP_ADDRDST                = PARA_IPADDR_DST()              ;

IF(PARA_PORT_SRC() == 0W)
    VAR6.TCB_PORTSRC                = 49152W                        ;
ELSE
    VAR6.TCB_PORTSRC            = PARA_PORT_SRC()                   ;

VAR6.TCB_PORTDST                = PARA_PORT_DST()                   ;
VAR6.TCB_ISS                    = RANDOM()                          ;
VAR6.TCB_SND_UNA                = VAR6.TCB_ISS                      ;
VAR6.TCB_SND_NXT                = VAR6.TCB_SND_UNA                  ;

VAR7.TCP_PSEUDO_IP_ADDRSRC      = VAR6.TCB_IP_ADDRSRC               ;
VAR7.TCP_PSEUDO_IP_ADDRDST      = VAR6.TCB_IP_ADDRDST               ;
VAR7.TCP_PSEUDO_ZERO            = 0                                 ;
VAR7.TCP_PSEUDO_PROT            = CNST_IP_PROT_TCP                  ;
VAR7.TCP_PSEUDO_LEN             = 24W                               ;

VAR7.TCP_PSEUDO_DATA.TCP_PORTSRC        = VAR6.TCB_PORTSRC          ;
VAR7.TCP_PSEUDO_DATA.TCP_PORTDST        = VAR6.TCB_PORTDST          ;
VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM        = VAR6.TCB_SND_NXT          ;
VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM        = 0L                        ;
VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET    = VAR7.TCP_PSEUDO_LEN << 2  ;
VAR7.TCP_PSEUDO_DATA.TCP_FLAGS          = CNST_TCP_FLAG_SYN         ;
```

```
        VAR7.TCP_PSEUDO_DATA.TCP_WINDOW          = VAR6.TCB_RCV_WND      ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM          = 0W                    ;
        VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR         = 0W                    ;
        VAR7.TCP_PSEUDO_DATA.TCP_OPTION          = {0X02, 0X04, 0X01, 0XCC}  ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM          = CHECKSUM(VAR7[0,
                                                       VAR7.TCP_PSEUDO_LEN +
                                                       11])    ;

        VAR6.TCB_SND_NXT                    += 1                         ;
        SEND_OUT_IP WITH_DATA
        {
            T.IP_PROT                        = CNST_IP_PROT_TCP          ,
            T.IP_ADDRDST                     = VAR6.TCB_IP_ADDRDST       ,
            T.IP_DATA                        =
    VAR7.TCP_PSEUDO_DATA.TCP_HEADER
        }

        WAIT_SIGNAL VAR6.TCB_SOCKET_ID;

        IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED )
        {
            VAR7.TCP_PSEUDO_LEN              = 20W                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM         = VAR6.TCB_SND_NXT  ;
            VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM         = VAR6.TCB_RCV_NXT  ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET     = VAR7.TCP_PSEUDO_LEN << 2  ;
            VAR7.TCP_PSEUDO_DATA.TCP_FLAGS           = CNST_TCP_FLAG_ACK ;
            VAR7.TCP_PSEUDO_DATA.TCP_WINDOW          = VAR6.TCB_RCV_WND  ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM          = 0W                ;
            VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR         = 0W                ;
```

```
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM          = CHECKSUM(VAR7[0,
                                                        VAR7.TCP_PSEUDO_LE
                                                        N + 11])   ;

        SEND_OUT_IP WITH_DATA
        {
            T.IP_PROT                       = CNST_IP_PROT_TCP                  ,
            T.IP_ADDRDST                    = VAR6.TCB_IP_ADDRDST               ,
            T.IP_DATA                       = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
        }

        RETVAL_ID_SEND_INI                  = VAR6.TCB_ISS                      ;
        RETVAL_ID_RECV_INIT                 =VAR6.TCB_IRS                       ;
        RETVAL_SEND_BUFFER_SIZE             = ( VAR6.TCB_SND_BUF_L +
                                                VAR6.TCB_SND_BUF_SIZE - 1 -
                                                VAR6.TCB_SND_BUF_H ) %
                                                VAR6.TCB_SND_BUF_SIZE;
        RETVAL_WIN_SIZE_SEND_INIT           = VAR6.TCB_SND_WND                  ;
        RETVAL_WIN_SIZE_RECV_INIT           = ( VAR6.TCB_RCV_BUF_L +
                                                VAR6.TCB_RCV_BUF_SIZE - 1 -
                                                VAR6.TCB_RCV_BUF_H ) %
                                                VAR6.TCB_RCV_BUF_SIZE;
        RETVAL_SOCKET_ID                    = VAR6.TCB_SOCKET_ID                ;
        RETVAL_IPADDR_SRC                   = VAR6.TCB_IP_ADDRSRC               ;
        RETVAL_PORT_SRC                     = VAR6.TCB_PORTSRC                  ;
        RETVAL_ERRORCODE                    = CNST_TCP_NO_ERROR                 ;
    }
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_SYN_RECEIVED )
    {
        VAR7.TCP_PSEUDO_LEN                 = 20W                               ;
```

```
            VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM       = VAR6.TCB_ISS                  ;
            VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM       = VAR6.TCB_RCV_NXT              ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET   = VAR7.TCP_PSEUDO_LEN << 2      ;
            VAR7.TCP_PSEUDO_DATA.TCP_FLAGS             = CNST_TCP_FLAG_ACK |
                                                         CNST_TCP_FLAG_S ;
            VAR7.TCP_PSEUDO_DATA.TCP_WINDOW        = VAR6.TCB_RCV_WND          ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM        = 0W                        ;
            VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR       = 0W                        ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM        = CHECKSUM(VAR7[0,
                                                         VAR7.TCP_PSEUDO_LEN +
                                                         11])     ;

            SEND_OUT_IP WITH_DATA
            {
                T.IP_PROT                  = CNST_IP_PROT_TCP                  ,
                T.IP_ADDRDST               = VAR6.TCB_IP_ADDRDST               ,
                T.IP_DATA                  = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
            }
        }
        ELSE
            RETVAL_ERRORCODE           = CNST_TCP_ERROR_OPEN                   ;
    }

    SERVICE_TCP_LISTEN
    {
        IF( VAR6.TCB_STATE != CNST_TCB_STATE_CLOSED )
        {
            GENERATE_USER_MSG WITH_DATA
            {
                TARGET = "TCP STATE IS NOT CLOSED!"
```

```
    }
    GENERATE_USER_MSG WITH_DATA
    {
        TARGET = VAR6.TCB_STATE
    }
    RETURN;
}

VAR6.TCB_SND_BUF_L                  = 0W                                    ;
VAR6.TCB_SND_BUF_H                  = 0W                                    ;
VAR6.TCB_RCV_BUF_L                  = 0W                                    ;
VAR6.TCB_RCV_BUF_H                  = 0W                                    ;
VAR6.TCB_RCV_WND = ( VAR6.TCB_RCV_BUF_L +   VAR6.TCB_RCV_BUF_SIZE -
                        1 - VAR6.TCB_RCV_BUF_H ) %
                        VAR6.TCB_RCV_BUF_SIZE;
VAR6.TCB_TIMER_2MSL                  = 0W                                   ;

VAR6.TCB_STATE                       = CNST_TCB_STATE_LISTEN                ;
VAR6.TCB_IP_ADDRSRC                  = PARA_IPADDR_SRC()                    ;
VAR6.TCB_IP_ADDRDST                  = PARA_IPADDR_DST()                    ;
VAR6.TCB_PORTSRC                     = PARA_PORT_SRC()                      ;
VAR6.TCB_PORTDST                     = PARA_PORT_DST()                      ;
VAR6.TCB_WAS_LISTENING               = TRUE                                 ;

WAIT_SIGNAL VAR6.TCB_SOCKET_ID;

IF(VAR6.TCB_STATE != CNST_TCB_STATE_SYN_RECEIVED)
{
    VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
    RETURN;
```

```
}

VAR6.TCB_ISS                        = RANDOM()                          ;
VAR6.TCB_SND_UNA                    = VAR6.TCB_ISS                      ;
VAR6.TCB_SND_NXT                    = R6.TCB_SND_UNA                    ;

VAR7.TCP_PSEUDO_IP_ADDRSRC      = VAR6.TCB_IP_ADDRSRC                   ;
VAR7.TCP_PSEUDO_IP_ADDRDST      = VAR6.TCB_IP_ADDRDST                   ;
VAR7.TCP_PSEUDO_ZERO            = 0                                     ;
VAR7.TCP_PSEUDO_PROT            = CNST_IP_PROT_TCP                      ;
VAR7.TCP_PSEUDO_LEN             = 24W                                   ;

VAR7.TCP_PSEUDO_DATA.TCP_PORTSRC      = VAR6.TCB_PORTSRC                ;
VAR7.TCP_PSEUDO_DATA.TCP_PORTDST      = VAR6.TCB_PORTDST                ;
VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM      = VAR6.TCB_SND_NXT                ;
VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM      = VAR6.TCB_RCV_NXT                ;
VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET  = VAR7.TCP_PSEUDO_LEN << 2 ;
VAR7.TCP_PSEUDO_DATA.TCP_FLAGS        = CNST_TCP_FLAG_SYN |
                                        CNST_TCP_FLAG_ACK           ;
VAR7.TCP_PSEUDO_DATA.TCP_WINDOW       = VAR6.TCB_RCV_WND            ;
VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM       = 0W                          ;
VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR      = 0W                          ;
VAR7.TCP_PSEUDO_DATA.TCP_OPTION       = {0X02, 0X04, 0X05, 0XB4}    ;
VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM       = CHECKSUM(VAR7[0,
                                        VAR7.TCP_PSEUDO_LEN +
                                        11])  ;

VAR6.TCB_SND_NXT += 1;
SEND_OUT_IP WITH_DATA
{
```

```
        T.IP_PROT                   = CNST_IP_PROT_TCP                  ,
        T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST               ,
        T.IP_DATA                   = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
    }

    WAIT_SIGNAL VAR6.TCB_SOCKET_ID;

    IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED )
    {
        RETVAL_ID_SEND_INIT         = VAR6.TCB_ISS                      ;
        RETVAL_ID_RECV_INIT         = VAR6.TCB_IRS                      ;
        RETVAL_SEND_BUFFER_SIZE     = ( VAR6.TCB_SND_BUF_L +
                                        VAR6.TCB_SND_BUF_SIZE - 1 -
                                        VAR6.TCB_SND_BUF_H ) %
                                        VAR6.TCB_SND_BUF_SIZE;;
        RETVAL_WIN_SIZE_SEND_INIT   = VAR6.TCB_SND_WND                  ;
        RETVAL_WIN_SIZE_RECV_INIT   = ( VAR6.TCB_RCV_BUF_L +
                                        VAR6.TCB_RCV_BUF_SIZE - 1 -
                                        VAR6.TCB_RCV_BUF_H ) %
                                        VAR6.TCB_RCV_BUF_SIZE;
        RETVAL_SOCKET_ID            = VAR6.TCB_SOCKET_ID                ;
        RETVAL_IPADDR_SRC           = VAR6.TCB_IP_ADDRSRC               ;
        RETVAL_IPADDR_DST           = VAR6.TCB_IP_ADDRDST               ;
        RETVAL_PORT_DST             = VAR6.TCB_PORTDST                  ;
        RETVAL_ERRORCODE            = CNST_TCP_NO_ERROR                 ;
    }
    ELSE
        RETVAL_ERRORCODE            = CNST_TCP_ERROR_OPEN               ;
}
```

```
SERVICE_TCP_CLOSE
{
    IF( VAR6.TCB_SOCKET_ID != PARA_SOCKET_ID() )
        RETURN;

    IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED )
    {
        VAR6.TCB_STATE                      = CNST_TCB_STATE_FIN_WAIT_1          ;

        VAR7.TCP_PSEUDO_LEN             = 20W                                    ;
        VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM    = VAR6.TCB_SND_NXT           ;
        VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM    = VAR6.TCB_RCV_NXT           ;
        VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET  = VAR7.TCP_PSEUDO_LEN << 2  ;
        VAR7.TCP_PSEUDO_DATA.TCP_FLAGS      = CNST_TCP_FLAG_FIN |
                                                CNST_TCP_FLAG_ACK    ;
        VAR7.TCP_PSEUDO_DATA.TCP_WINDOW     = VAR6.TCB_RCV_WND           ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                                 ;
        VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                                 ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = CHECKSUM(VAR7[0,
                                                VAR7.TCP_PSEUDO_LEN +
                                                11])     ;

        VAR6.TCB_SND_NXT                    += 1                                 ;
        SEND_OUT_IP WITH_DATA
        {
            T.IP_PROT                       = CNST_IP_PROT_TCP               ,
            T.IP_ADDRDST                    = VAR6.TCB_IP_ADDRDST            ,
            T.IP_DATA                   = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
        }
    }
```

```
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_CLOSE_WAIT )
    {
        VAR6.TCB_STATE                              = CNST_TCB_STATE_CLOSING      ;

        VAR7.TCP_PSEUDO_LEN                         = 20W                         ;
        VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM            = VAR6.TCB_SND_NXT    ;
        VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM            = VAR6.TCB_RCV_NXT    ;
        VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET    = VAR7.TCP_PSEUDO_LEN << 2    ;
        VAR7.TCP_PSEUDO_DATA.TCP_FLAGS              = CNST_TCP_FLAG_FIN |
                                                      CNST_TCP_FLAG_AC ;
        VAR7.TCP_PSEUDO_DATA.TCP_WINDOW     = VAR6.TCB_RCV_WND            ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                          ;
        VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                          ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = CHECKSUM(VAR7[0,
                                                  VAR7.TCP_PSEUDO_LEN +
                                                  11])     ;

        VAR6.TCB_SND_NXT                    += 1                          ;
        SEND_OUT_IP WITH_DATA
        {
            T.IP_PROT                           = CNST_IP_PROT_TCP            ,
            T.IP_ADDRDST                        = VAR6.TCB_IP_ADDRDST         ,
            T.IP_DATA                       = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
        }
    }
    ELSE
        RETURN;
}

SERVICE_TCP_SEND
```

```
{
    IF( PARA_SOCKET_BUFFER_LEN() == 0 || VAR6.TCB_SOCKET_ID !=
        PARA_SOCKET_ID() || (VAR6.TCB_STATE != CNST_TCB_STATE_ESTABLISHED
        && VAR6.TCB_STATE != CNST_TCB_STATE_CLOSE_WAIT))
    {
        RETVAL_DATA_LEN = 0;
        RETURN;
    }

    VAR7.TCP_PSEUDO_LEN             = 20W + PARA_SOCKET_BUFFER_LEN()        ;
    VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM        = VAR6.TCB_SND_NXT              ;
    VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM        = VAR6.TCB_RCV_NXT              ;
    VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET        = 80                        ;
    VAR7.TCP_PSEUDO_DATA.TCP_FLAGS      = CNST_TCP_FLAG_ACK |
                                              CNST_TCP_FLAG_PSH             ;
    VAR7.TCP_PSEUDO_DATA.TCP_WINDOW     = VAR6.TCB_RCV_WND                  ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                                ;
    VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                                ;

    VAR7.TCP_PSEUDO_DATA.TCP_DATA       = PARA_DATA()                       ;

    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = CHECKSUM(VAR7[0, 11 +
                                              VAR7.TCP_PSEUDO_LEN]);

    ADD_TO_POOL VAR6.TCB_POOL_RETRANSMISSION WITH_DATA
    {
        T[  0,  3]                  = 6                                     ,
        T[  4,  7]                  = 5                                     ,
        T[  8, 11]                  = VAR6.TCB_SND_NXT                      ,
        T[ 12, 15]          = VAR6.TCB_SND_NXT + PARA_SOCKET_BUFFER_LEN() ,
```

```
            T[ 16,     ]          = VAR7.TCP_PSEUDO_DATA.[0, VAR7.TCP_PSEUDO_LEN - 1]
        }

        VAR6.TCB_SND_NXT            += PARA_SOCKET_BUFFER_LEN()                    ;
        IF( VAR6.TCB_SND_MAX - VAR6.TCB_SND_NXT >= 0X80000000L )
            VAR6.TCB_SND_MAX                = VAR6.TCB_SND_NXT                    ;

        GENERATE_SEND_BUFFER_PARAMETERS_CHANGED( VAR6.TCB_SOCKET_ID,
        VAR6.TCB_SND_UNA, VAR6.TCB_SND_NXT, VAR6.TCB_SND_WND,
        ( VAR6.TCB_SND_BUF_L +    VAR6.TCB_SND_BUF_SIZE - 1 -
        VAR6.TCB_SND_BUF_H ) % VAR6.TCB_SND_BUF_SIZE );

        SEND_OUT_IP WITH_DATA
        {
            T.IP_PROT                   = CNST_IP_PROT_TCP                    ,
            T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST                 ,
            T.IP_DATA          = VAR7.TCP_PSEUDO_DATA.[0, VAR7.TCP_PSEUDO_LEN - 1]
        }

        RETVAL_DATA_LEN = PARA_SOCKET_BUFFER_LEN();
        RETVAL_DATA = PARA_DATA();
    }

    SERVICE_TCP_RECEIVE
    {
        IF(VAR6.TCB_RCV_BUF_L == VAR6.TCB_RCV_BUF_H ||
    PARA_SOCKET_BUFFER_LEN() == 0)
            RETURN;
```

```
IF(VAR6.TCB_SOCKET_ID == PARA_SOCKET_ID() && (VAR6.TCB_STATE ==
  CNST_TCB_STATE_ESTABLISHED ||VAR6.TCB_STATE ==
  CNST_TCB_STATE_CLOSE_WAIT ||VAR6.TCB_STATE ==
  CNST_TCB_STATE_FIN_WAIT_1 ||VAR6.TCB_STATE ==
  CNST_TCB_STATE_FIN_WAIT_2 ))
{
    IF(PARA_SOCKET_BUFFER_LEN() > (VAR6.TCB_RCV_BUF_H +
       VAR6.TCB_RCV_BUF_SIZE - VAR6.TCB_RCV_BUF_L ) %
       VAR6.TCB_RCV_BUF_SIZE)
    {
        IF(VAR6.TCB_RCV_BUF_L < VAR6.TCB_RCV_BUF_H)
        {
            RETVAL_DATA.[0, ] = VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_L,
            VAR6.TCB_RCV_BUF_H - 1];
        }
        ELSE
        {
            RETVAL_DATA.[0, ] =    VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_L,
            VAR6.TCB_RCV_BUF_SIZE - 1];
            RETVAL_DATA.[VAR6.TCB_RCV_BUF_SIZE -
            VAR6.TCB_RCV_BUF_L, ] =    VAR6.TCB_RCV_BUF.[0,
            VAR6.TCB_RCV_BUF_H - 1];
        }

        RETVAL_DATA_LEN = (VAR6.TCB_RCV_BUF_H +
        VAR6.TCB_RCV_BUF_SIZE - VAR6.TCB_RCV_BUF_L ) %
        VAR6.TCB_RCV_BUF_SIZE;

        VAR6.TCB_RCV_BUF_L = VAR6.TCB_RCV_BUF_H;
    }
```

```
ELSE
{
    IF(VAR6.TCB_RCV_BUF_L < VAR6.TCB_RCV_BUF_H)
    {
        RETVAL_DATA.[0, ] = VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_L,
        VAR6.TCB_RCV_BUF_L + PARA_SOCKET_BUFFER_LEN()- 1];
    }
    ELSE
    {
        IF(PARA_SOCKET_BUFFER_LEN() <= VAR6.TCB_RCV_BUF_SIZE -
        VAR6.TCB_RCV_BUF_L)
        {
            RETVAL_DATA.[0, ] =
            VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_L,
            VAR6.TCB_RCV_BUF_L + PARA_SOCKET_BUFFER_LEN()- 1];
        }
        ELSE
        {
            RETVAL_DATA.[0, ] =
            VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_L,
            VAR6.TCB_RCV_BUF_SIZE - 1];
            RETVAL_DATA.[VAR6.TCB_RCV_BUF_SIZE -
            VAR6.TCB_RCV_BUF_L, ] =    VAR6.TCB_RCV_BUF.[0,
            PARA_SOCKET_BUFFER_LEN() - (VAR6.TCB_RCV_BUF_SIZE -
            VAR6.TCB_RCV_BUF_L) - 1];
        }
    }

    RETVAL_DATA_LEN = PARA_SOCKET_BUFFER_LEN();
```

```
        VAR6.TCB_RCV_BUF_L = (VAR6.TCB_RCV_BUF_L +
        PARA_SOCKET_BUFFER_LEN()) % VAR6.TCB_RCV_BUF_SIZE;
    }

    VAR6.TCB_RCV_WND = ( VAR6.TCB_RCV_BUF_L +
    VAR6.TCB_RCV_BUF_SIZE - 1 - VAR6.TCB_RCV_BUF_H ) %
    VAR6.TCB_RCV_BUF_SIZE;

    GENERATE_RECEIVE_BUFFER_PARAMETERS_CHANGED(VAR6.TCB_SOCKE
    T_ID, VAR6.TCB_RCV_NXT - ( VAR6.TCB_RCV_BUF_H +
    VAR6.TCB_RCV_BUF_SIZE - VAR6.TCB_RCV_BUF_L ) %
    VAR6.TCB_RCV_BUF_SIZE, VAR6.TCB_RCV_NXT, VAR6.TCB_RCV_WND);

    VAR7.TCP_PSEUDO_LEN                 = 20W                                   ;
    VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM    = VAR6.TCB_SND_NXT          ;
    VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM    = VAR6.TCB_RCV_NXT      ;
    VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET  = VAR7.TCP_PSEUDO_LEN << 2    ;
    VAR7.TCP_PSEUDO_DATA.TCP_FLAGS      = CNST_TCP_FLAG_ACK         ;
    VAR7.TCP_PSEUDO_DATA.TCP_WINDOW     = VAR6.TCB_RCV_WND          ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = CHECKSUM(VAR7[0,
                                                VAR7.TCP_PSEUDO_LEN + 11]) ;

    SEND_OUT_IP WITH_DATA
    {
        T.IP_PROT                   = CNST_IP_PROT_TCP                      ,
        T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST                   ,
        T.IP_DATA                   = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
    }
```

```
    }
    ELSE
    {
        RETVAL_DATA_LEN = 0;
    }
}

IP_IN_HANDLER
{
    IF(S.IP_PROT!=CNST_IP_PROT_TCP)
        RETURN;

    DISCARD_MESSAGE;

    IF( VAR6.TCB_STATE > CNST_TCB_STATE_SYN_SENT &&
        VAR6.TCB_IP_ADDRSRC == S.IP_ADDRDST && VAR6.TCB_IP_ADDRDST ==
        S.IP_ADDRSRC && VAR6.TCB_PORTSRC == S.IP_DATA.TCP_PORTDST &&
        VAR6.TCB_PORTDST == S.IP_DATA.TCP_PORTSRC )
    {
        VAR9[0, 3] = S.IP_LEN - ((S.IP_VERHEADERLEN & 0X0F) << 2) -
        (S.IP_DATA.TCP_DATA_OFFSET >> 2);

        VAR9[4] = FALSE;

        IF      ( VAR9[0, 3] == 0 && VAR6.TCB_RCV_WND == 0 )
        {
            IF( S.IP_DATA.TCP_SEQ_NUM == VAR6.TCB_RCV_NXT )
                VAR9[4] = TRUE;
        }
        ELSE IF( VAR9[0, 3] == 0 && VAR6.TCB_RCV_WND >   0 )
```

```
            {
                IF( ( S.IP_DATA.TCP_SEQ_NUM - VAR6.TCB_RCV_NXT < 0X80000000L )
                  && ( S.IP_DATA.TCP_SEQ_NUM - ( VAR6.TCB_RCV_NXT +
                  VAR6.TCB_RCV_WND ) ) >= 0X80000000L )
                     VAR9[4] = TRUE;
            }
            ELSE IF( VAR9[0, 3] >    0 && VAR6.TCB_RCV_WND == 0 )
            {
                VAR9[4] = FALSE;
            }
            ELSE
            {
                IF( ( ( S.IP_DATA.TCP_SEQ_NUM - VAR6.TCB_RCV_NXT < 0X80000000L)
                  && ( S.IP_DATA.TCP_SEQ_NUM - ( VAR6.TCB_RCV_NXT +
                  VAR6.TCB_RCV_WND ) >= 0X80000000L ) ) ||
                  (    (    ( S.IP_DATA.TCP_SEQ_NUM + VAR9[0, 3] - 1 ) -
                  VAR6.TCB_RCV_NXT < 0X80000000L ) && ( ( S.IP_DATA.TCP_SEQ_NUM
                  + VAR9[0, 3] - 1 ) - ( VAR6.TCB_RCV_NXT + VAR6.TCB_RCV_WND ) >=
                  0X80000000L ) ) )
                     VAR9[4] = TRUE;
            }

            IF(VAR9[4] == FALSE)
            {
                IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) ==
        CNST_TCP_FLAG_RST)
                     RETURN;

                VAR7.TCP_PSEUDO_LEN                 = 20W                          ;
                VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM    = VAR6.TCB_SND_NXT      ;
```

```
            VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM     = VAR6.TCB_RCV_NXT     ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET =VAR7.TCP_PSEUDO_LEN << 2 ;
            VAR7.TCP_PSEUDO_DATA.TCP_FLAGS     = CNST_TCP_FLAG_ACK        ;
            VAR7.TCP_PSEUDO_DATA.TCP_WINDOW        = VAR6.TCB_RCV_WND ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM        = 0W                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR       = 0W                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM        = CHECKSUM(VAR7[0,
                                                          VAR7.TCP_PSEUDO_LE
                                                          N + 11]) ;

            SEND_OUT_IP WITH_DATA
            {
                T.IP_PROT                  = CNST_IP_PROT_TCP                 ,
                T.IP_ADDRDST               = VAR6.TCB_IP_ADDRDST              ,
                T.IP_DATA                  = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
            }

            RETURN;
        }

        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) ==
CNST_TCP_FLAG_RST )
        {
            IF      ( VAR6.TCB_STATE == CNST_TCB_STATE_SYN_RECEIVED )
            {
                IF( VAR6.TCB_WAS_LISTENING == TRUE)
                {
                    VAR6.TCB_STATE = CNST_TCB_STATE_LISTEN;
                    RETURN;
                }
```

```
                ELSE
                {
                    VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
                    RETURN;
                }
            }
            ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED &&
            VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_1 &&
            VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_2 &&
            VAR6.TCB_STATE == CNST_TCB_STATE_CLOSE_WAIT )
            {
                VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
                RETURN;
            }
            ELSE
            {
                VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
                RETURN;
            }
        }

        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_SYN ) ==
CNST_TCP_FLAG_SYN )
        {
            VAR7.TCP_PSEUDO_LEN             = 20W                                ;
            VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM =S.IP_DATA.TCP_ACK_NUM ;
            VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM        = 0L                         ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET    = VAR7.TCP_PSEUDO_LEN << 2 ;
            VAR7.TCP_PSEUDO_DATA.TCP_FLAGS           = NST_TCP_FLAG_RST;
            VAR7.TCP_PSEUDO_DATA.TCP_WINDOW         = VAR6.TCB_RCV_WND;
```

```
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM          = 0W                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR         = 0W                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM          = CHECKSUM(VAR7[0,
                                                    VAR7.TCP_PSEUD
                                                    O_LEN + 11])    ;

    SEND_OUT_IP WITH_DATA
    {
        T.IP_PROT                    = CNST_IP_PROT_TCP              ,
        T.IP_ADDRDST                 = VAR6.TCB_IP_ADDRDST           ,
        T.IP_DATA                    = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
    }

    RETURN;
}

IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_ACK ) == CNST_TCP_FLAG_ACK )
{
    IF      ( VAR6.TCB_STATE == CNST_TCB_STATE_SYN_RECEIVED )
    {
        IF( ( S.IP_DATA.TCP_ACK_NUM - VAR6.TCB_SND_UNA <
          0X80000000L ) && ( VAR6.TCB_SND_NXT -
          S.IP_DATA.TCP_ACK_NUM < 0X80000000L ) )
        {
            VAR6.TCB_STATE = CNST_TCB_STATE_ESTABLISHED;

            WAKEUP_SIGNAL VAR6.TCB_SOCKET_ID;
        }
        ELSE
        {
```

```
            VAR7.TCP_PSEUDO_LEN              = 20W                          ;
            VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM=IP_DATA.TCP_ACK_NUM ;
            VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM      = 0L                      ;
        VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET =VAR7.TCP_PSEUDO_LEN << 2;
        VAR7.TCP_PSEUDO_DATA.TCP_FLAGS = CNST_TCP_FLAG_RST ;
        VAR7.TCP_PSEUDO_DATA.TCP_WINDOW = VAR6.TCB_RCV_WND ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR     = 0W                      ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM =CHECKSUM(VAR7[0,
                                                          VAR7.TCP_PS
                                                          EUDO_LEN +
                                                          11])     ;

            SEND_OUT_IP WITH_DATA
            {
                T.IP_PROT                    = CNST_IP_PROT_TCP            ,
                T.IP_ADDRDST                 = VAR6.TCB_IP_ADDRDST         ,
                T.IP_DATA     = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
            }

            WAKEUP_SIGNAL VAR6.TCB_SOCKET_ID;

            RETURN;
        }
    }
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED ||
    VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_1 || VAR6.TCB_STATE
    == CNST_TCB_STATE_FIN_WAIT_2 || VAR6.TCB_STATE ==
    CNST_TCB_STATE_CLOSE_WAIT || VAR6.TCB_STATE ==
    CNST_TCB_STATE_CLOSING )
```

```
                {
                    IF      ( S.IP_DATA.TCP_ACK_NUM - VAR6.TCB_SND_UNA >=
0X80000000L )
                    {
                        RETURN;
                    }
                    ELSE IF( VAR6.TCB_SND_NXT - S.IP_DATA.TCP_ACK_NUM >=
0X80000000L )
                    {
                        VAR6.TCB_FLAGS |= CNST_TF_DELACK;
                        RETURN;
                    }

                    VAR6.TCB_SND_UNA = S.IP_DATA.TCP_ACK_NUM;

                    FOR_EVERY_ELEMENT_IN_POOL
                    VAR6.TCB_POOL_RETRANSMISSION
                    WITH_CONDITION( VAR6.TCB_SND_UNA - PE[12, 15] < 0X80000000L )
                        REMOVE_CURRENT_POOL_ELEMENT;

                    IF( ( VAR6.TCB_SND_WL1 - S.IP_DATA.TCP_SEQ_NUM >=
                    0X80000000L )|| ( VAR6.TCB_SND_WL1 == S.IP_DATA.TCP_SEQ_NUM
                    && ( S.IP_DATA.TCP_ACK_NUM - VAR6.TCB_SND_WL2 <
                    0X80000000L ) ) )
                    {
                        VAR6.TCB_SND_WND = S.IP_DATA.TCP_WINDOW;
                        VAR6.TCB_SND_WL1 = S.IP_DATA.TCP_SEQ_NUM;
                        VAR6.TCB_SND_WL2 = S.IP_DATA.TCP_ACK_NUM;
                    }
```

```
                GENERATE_SEND_BUFFER_PARAMETERS_CHANGED( VAR6.TCB_S
                OCKET_ID, VAR6.TCB_SND_UNA, VAR6.TCB_SND_NXT,
                VAR6.TCB_SND_WND, ( VAR6.TCB_SND_BUF_L +
                VAR6.TCB_SND_BUF_SIZE - 1 - VAR6.TCB_SND_BUF_H ) %
                VAR6.TCB_SND_BUF_SIZE );

                IF( VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_1 )
                    VAR6.TCB_STATE = CNST_TCB_STATE_FIN_WAIT_2;

                IF( VAR6.TCB_STATE == CNST_TCB_STATE_CLOSING )
                {
                    VAR6.TCB_STATE = CNST_TCB_STATE_TIME_WAIT;
                    VAR6.TCB_TIMER_2MSL = 10;
                }
            }
            ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_LAST_ACK )
            {
                VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
                RETURN;
            }
            ELSE
            {
                VAR6.TCB_FLAGS |= CNST_TF_DELACK;
                RETURN;
            }
        }
        ELSE
            RETURN;
```

```
IF( VAR9[0, 3] > 0 )
{
    IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED ||
      VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_1 ||
      VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_2 )
    {
        ADD_TO_POOL VAR6.TCB_POOL_REASSEMBLY WITH_CONDITION
        ( ( S.IP_DATA.TCP_SEQ_NUM - PE[0, 3] >= 0X80000000L ) || ( PE[0, 3] ==
        S.IP_DATA.TCP_SEQ_NUM && ( ( S.IP_DATA.TCP_SEQ_NUM +
        VAR9[0, 3] - PE[4, 7] >= 0X80000000L ) ) ) ) WITH_DATA
        {
            T[0, 3] = S.IP_DATA.TCP_SEQ_NUM                    ,
            T[4, 7] = S.IP_DATA.TCP_SEQ_NUM + VAR9[0, 3]      ,
            T[8,    ] = S.IP_DATA.TCP_DATA
        }

        VAR9[4, 7] = VAR6.TCB_RCV_NXT;

        FOR_EVERY_ELEMENT_IN_POOL VAR6.TCB_POOL_REASSEMBLY
        {
            IF( ( VAR9[4, 7] - PE[0, 3] < 0X80000000L ) && ( PE[4, 7] -
              VAR6.TCB_RCV_NXT <= ( VAR6.TCB_RCV_BUF_L +
              VAR6.TCB_RCV_BUF_SIZE - 1 - VAR6.TCB_RCV_BUF_H ) %
              VAR6.TCB_RCV_BUF_SIZE ) )
            {
                IF( PE[4, 7] - VAR9[4, 7] < 0X80000000L )
                    VAR9[4, 7] = PE[4, 7];
            }
            ELSE
            {
```

```
            BREAK;
        }
    }

    FOR_EVERY_ELEMENT_IN_POOL VAR6.TCB_POOL_REASSEMBLY
    WITH_CONDITION( VAR9[4, 7] - PE[4, 7] < 0X80000000L )
    {
        IF((PE[4, 7] - VAR6.TCB_RCV_NXT) > ( VAR6.TCB_RCV_BUF_L +
        VAR6.TCB_RCV_BUF_SIZE - 1 - VAR6.TCB_RCV_BUF_H ) %
        VAR6.TCB_RCV_BUF_SIZE)
        {
            BREAK;
        }

        IF((VAR6.TCB_RCV_BUF_SIZE - VAR6.TCB_RCV_BUF_H) >=
        (PE[4, 7] - VAR6.TCB_RCV_NXT))
        {
            VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_H, ] =
            PE.[8, ].[VAR6.TCB_RCV_NXT - PE[0, 3], PE[4, 7] - PE[0, 3] - 1];
        }
        ELSE
        {
            VAR6.TCB_RCV_BUF.[VAR6.TCB_RCV_BUF_H, ] =
            PE.[8, ].[VAR6.TCB_RCV_NXT - PE[0, 3],
            VAR6.TCB_RCV_NXT - PE[0, 3] + (VAR6.TCB_RCV_BUF_SIZE
            - VAR6.TCB_RCV_BUF_H) - 1];

            VAR6.TCB_RCV_BUF.[0, ] = PE.[8, ].[VAR6.TCB_RCV_NXT -
            PE[0, 3] + (VAR6.TCB_RCV_BUF_SIZE -
            VAR6.TCB_RCV_BUF_H), PE[4, 7] - PE[0, 3] - 1];
```

```
                    }

                    VAR6.TCB_RCV_BUF_H += PE[4, 7] - VAR6.TCB_RCV_NXT;

                    VAR6.TCB_RCV_BUF_H %= VAR6.TCB_RCV_BUF_SIZE;

                    VAR6.TCB_RCV_NXT = PE[4, 7];

                    REMOVE_CURRENT_POOL_ELEMENT;
                }

                VAR6.TCB_RCV_WND = ( VAR6.TCB_RCV_BUF_L +
                VAR6.TCB_RCV_BUF_SIZE - 1 - VAR6.TCB_RCV_BUF_H ) %
                VAR6.TCB_RCV_BUF_SIZE;


GENERATE_RECEIVE_BUFFER_PARAMETERS_CHANGED(VAR6.TCB_SOCKET_ID,
VAR6.TCB_RCV_NXT - ( VAR6.TCB_RCV_BUF_H + VAR6.TCB_RCV_BUF_SIZE -
VAR6.TCB_RCV_BUF_L ) % VAR6.TCB_RCV_BUF_SIZE, VAR6.TCB_RCV_NXT,
VAR6.TCB_RCV_WND);

                    VAR6.TCB_FLAGS |= CNST_TF_DELACK;
                }
            }

            IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_FIN ) ==
CNST_TCP_FLAG_FIN )
            {
                VAR6.TCB_RCV_NXT += 1L;
```

```
IF      ( VAR6.TCB_STATE == CNST_TCB_STATE_SYN_RECEIVED )
{
    VAR6.TCB_STATE = CNST_TCB_STATE_CLOSE_WAIT;
}
ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_ESTABLISHED )
{
    VAR6.TCB_STATE = CNST_TCB_STATE_CLOSE_WAIT;

    VAR7.TCP_PSEUDO_LEN          = 20W                                  ;
    VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM   = VAR6.TCB_SND_NXT ;
    VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM   = VAR6.TCB_RCV_NXT ;
    VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET = VAR7.TCP_PSEUDO_LEN << 2;
    VAR7.TCP_PSEUDO_DATA.TCP_FLAGS   = CNST_TCP_FLAG_ACK   ;
    VAR7.TCP_PSEUDO_DATA.TCP_WINDOW   = VAR6.TCB_RCV_WND ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM    = 0W                          ;
    VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR   = 0W                          ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM   = CHECKSUM(VAR7[0,
                                                  VAR7.TCP_PS
                                                  EUDO_LEN +
                                                  11])   ;

    SEND_OUT_IP WITH_DATA
    {
        T.IP_PROT              = CNST_IP_PROT_TCP                    ,
        T.IP_ADDRDS            = VAR6.TCB_IP_ADDRDST                 ,
        T.IP_DATA              =VAR7.TCP_PSEUDO_DATA.TCP_HEADER
    }

    VAR6.TCB_FLAGS &= ~(CNST_TF_DELACK);
```

```
        GENERATE_REMOTE_CLOSED(0, VAR6.TCB_SOCKET_ID);
    }
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_1 )
    {
        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_ACK ) ==
        CNST_TCP_FLAG_ACK )
        {
            VAR6.TCB_STATE = CNST_TCB_STATE_TIME_WAIT;
            VAR6.TCB_TIMER_2MSL = 10;
        }
        ELSE
            VAR6.TCB_STATE = CNST_TCB_STATE_CLOSING;
    }
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_FIN_WAIT_2 )
    {
        VAR6.TCB_STATE = CNST_TCB_STATE_TIME_WAIT;
        VAR6.TCB_TIMER_2MSL = 10;

        VAR7.TCP_PSEUDO_LEN                 = 20W                                   ;
        VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM = VAR6.TCB_SND_NXT    ;
        VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM = VAR6.TCB_RCV_NXT    ;
        VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET = VAR7.TCP_PSEUDO_LEN << 2;
        VAR7.TCP_PSEUDO_DATA.TCP_FLAGS = CNST_TCP_FLAG_ACK    ;
        VAR7.TCP_PSEUDO_DATA.TCP_WINDOW    =VAR6.TCB_RCV_WND ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                                   ;
        VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                                   ;
        VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = CHECKSUM(VAR7[0,
                                                    VAR7.TCP_PSEUDO_
                                                    LEN + 11])     ;
```

```
                SEND_OUT_IP WITH_DATA
                {
                    T.IP_PROT               = CNST_IP_PROT_TCP                  ,
                    T.IP_ADDRDST            = VAR6.TCB_IP_ADDRDST               ,
                    T.IP_DATA               = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
                }

                GENERATE_DISCONNECTED(0, VAR6.TCB_SOCKET_ID);
            }
            ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_CLOSE_WAIT )
            {

            }
            ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_CLOSING )
            {

            }
            ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_LAST_ACK )
            {

            }
            ELSE
            {

            }
        }
    }
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_SYN_SENT &&
    VAR6.TCB_IP_ADDRSRC == S.IP_ADDRDST && VAR6.TCB_IP_ADDRDST ==
```

```
S.IP_ADDRSRC && VAR6.TCB_PORTSRC == S.IP_DATA.TCP_PORTDST &&
VAR6.TCB_PORTDST == S.IP_DATA.TCP_PORTSRC )
{
    IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_ACK ) == CNST_TCP_FLAG_ACK )
    {
        IF(S.IP_DATA.TCP_ACK_NUM!=VAR6.TCB_SND_NXT)
        {
            IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) == CNST_TCP_FLAG_RST )
                RETURN;
            ELSE
            {
                VAR7.TCP_PSEUDO_LEN                 = 20W                       ;
                VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM=S.IP_DATA.TCP_ACK_NUM ;
                VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM        = 0L                ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET = VAR7.TCP_PSEUDO_LEN << 2 ;
                VAR7.TCP_PSEUDO_DATA.TCP_FLAGS = CNST_TCP_FLAG_RST;
                VAR7.TCP_PSEUDO_DATA.TCP_WINDOW = VAR6.TCB_RCV_WND        ;
                VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM      = 0W               ;
                VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR     = 0W               ;
                VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM      =
                CHECKSUM(VAR7[0, VAR7.TCP_PSEUDO_LEN + 11])    ;

                SEND_OUT_IP WITH_DATA
                {
                    T.IP_PROT            = CNST_IP_PROT_TCP                 ,
                    T.IP_ADDRDST      = VAR6.TCB_IP_ADDRDST                 ,
                    T.IP_DATA          =VAR7.TCP_PSEUDO_DATA.TCP_HEADER
                }

                RETURN;
```

```
                    }
                }
                ELSE
                {
                    IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) ==
                    CNST_TCP_FLAG_RST )
                    {
                        VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
                        RETURN;
                    }

                    IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_SYN ) ==
                    CNST_TCP_FLAG_SYN )
                    {
                        VAR6.TCB_STATE          = CNST_TCB_STATE_ESTABLISHED ;
                        VAR6.TCB_SND_UNA        = S.IP_DATA.TCP_ACK_NUM      ;
                        VAR6.TCB_IRS            = S.IP_DATA.TCP_SEQ_NUM      ;
                        VAR6.TCB_RCV_NXT        = S.IP_DATA.TCP_SEQ_NUM + 1L ;
                        VAR6.TCB_SND_WND        = S.IP_DATA.TCP_WINDOW       ;

                        WAKEUP_SIGNAL VAR6.TCB_SOCKET_ID;
                    }
                }
            }
            ELSE
            {
                IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) ==
CNST_TCP_FLAG_RST )
                    RETURN;

                IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_SYN ) == CNST_TCP_FLAG_SYN )
                {
```

```
                VAR6.TCB_STATE              = CNST_TCB_STATE_SYN_RECEIVED    ;
                VAR6.TCB_IRS                = S.IP_DATA.TCP_SEQ_NUM          ;
                VAR6.TCB_RCV_NXT            = S.IP_DATA.TCP_SEQ_NUM   + 1L   ;
                VAR6.TCB_SND_WND            = S.IP_DATA.TCP_WINDOW           ;

                WAKEUP_SIGNAL VAR6.TCB_SOCKET_ID;
            }
        }
    }
    ELSE IF( VAR6.TCB_STATE == CNST_TCB_STATE_LISTEN &&
    ( VAR6.TCB_IP_ADDRSRC == CNST_IP_ADDR_BROADCAST ||
    VAR6.TCB_IP_ADDRSRC == S.IP_ADDRDST ) && ( VAR6.TCB_PORTSRC ==
    S.IP_DATA.TCP_PORTDST ) )
    {
        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) == CNST_TCP_FLAG_RST )
            RETURN;

        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_ACK ) == CNST_TCP_FLAG_ACK )
        {
            VAR7.TCP_PSEUDO_LEN             = 20W                            ;
            VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM = S.IP_DATA.TCP_ACK_NUM ;
            VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM      = 0L                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET  =
VAR7.TCP_PSEUDO_LEN << 2   ;
            VAR7.TCP_PSEUDO_DATA.TCP_FLAGS        = CNST_TCP_FLAG_RST ;
            VAR7.TCP_PSEUDO_DATA.TCP_WINDOW       = VAR6.TCB_RCV_WND ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM       = 0W                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR      = 0W                       ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM       = CHECKSUM(VAR7[0,
                                                    VAR7.TCP_PSEUDO_L
                                                    EN + 11]) ;
```

```
            SEND_OUT_IP WITH_DATA
            {
                T.IP_PROT                   = CNST_IP_PROT_TCP                  ,
                T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST               ,
                T.IP_DATA                   = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
            }

            RETURN;
        }

        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_SYN ) == CNST_TCP_FLAG_SYN )
        {
            VAR6.TCB_STATE              = CNST_TCB_STATE_SYN_RECEIVED   ;
            VAR6.TCB_IRS                = S.IP_DATA.TCP_SEQ_NUM         ;
            VAR6.TCB_RCV_NXT            = S.IP_DATA.TCP_SEQ_NUM  + 1L   ;

            IF(VAR6.TCB_IP_ADDRSRC == CNST_IP_ADDR_BROADCAST)
                VAR6.TCB_IP_ADDRSRC             = S.IP_ADDRDST;

            VAR6.TCB_IP_ADDRDST                 = S.IP_ADDRSRC;

            VAR6.TCB_PORTDST                    = S.IP_DATA.TCP_PORTSRC;

            WAKEUP_SIGNAL VAR6.TCB_SOCKET_ID;
        }

    }
    ELSE
    {
        IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_RST ) == CNST_TCP_FLAG_RST )
            RETURN;
```

```
IF( ( S.IP_DATA.TCP_FLAGS & CNST_TCP_FLAG_ACK ) == CNST_TCP_FLAG_ACK )
{
    VAR7.TCP_PSEUDO_LEN             = 20W                                   ;
    VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM=S.IP_DATA.TCP_ACK_NUM   ;
    VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM        = 0L                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET = VAR7.TCP_PSEUDO_LEN << 2 ;
    VAR7.TCP_PSEUDO_DATA.TCP_FLAGS      = CNST_TCP_FLAG_RST     ;
    VAR7.TCP_PSEUDO_DATA.TCP_WINDOW    = VAR6.TCB_RCV_WND       ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM    = 0W                     ;
    VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = CHECKSUM(VAR7[0,
                                                VAR7.TCP_PSEUDO_LE
                                                N + 11])    ;

    SEND_OUT_IP WITH_DATA
    {
        T.IP_PROT                   = CNST_IP_PROT_TCP              ,
        T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST           ,
        T.IP_DATA                   = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
    }

    RETURN;
}
ELSE
{
    VAR7.TCP_PSEUDO_LEN             = 20W                                   ;
    VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM        = 0L;                   ;
    VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM            =
                                                S.IP_DATA.TCP_S
                                                EQ_NUM +
                                                S.IP_LEN -
                                                (S.IP_VERHEADE
```

```
                                                    RLEN & 0X0F) <<
                                                    2 -
                                                    S.IP_DATA.TCP_D
                                                    ATA_OFFSET >>
                                                    2 ;
            VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET =
VAR7.TCP_PSEUDO_LEN << 2   ;
            VAR7.TCP_PSEUDO_DATA.TCP_FLAGS          =
                                                    CNST_TCP_FLAG_
                                                    RST |
                                                    CNST_TCP_FLAG_
                                                    ACK          ;
            VAR7.TCP_PSEUDO_DATA.TCP_WINDOW      = VAR6.TCB_RCV_WND ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM      = 0W                ;
            VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR     = 0W                ;
            VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM      = CHECKSUM(VAR7[0,
                                                      VAR7.TCP_PSEUDO_L
                                                      EN + 11]) ;
            SEND_OUT_IP WITH_DATA
            {
                T.IP_PROT                 = CNST_IP_PROT_TCP              ,
                T.IP_ADDRDST              = VAR6.TCB_IP_ADDRDST           ,
                T.IP_DATA                 = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
            }

            RETURN;
        }
    }
}

TIMER_WITH_PERIOD 200
{
```

```
    IF( ( VAR6.TCB_FLAGS & CNST_TF_DELACK ) != CNST_TF_DELACK )
        RETURN;

    VAR7.TCP_PSEUDO_LEN                 = 20W                                   ;
    VAR7.TCP_PSEUDO_DATA.TCP_SEQ_NUM    = VAR6.TCB_SND_NXT                      ;
    VAR7.TCP_PSEUDO_DATA.TCP_ACK_NUM    = VAR6.TCB_RCV_NXT                      ;
    VAR7.TCP_PSEUDO_DATA.TCP_DATA_OFFSET = VAR7.TCP_PSEUDO_LEN << 2 ;
    VAR7.TCP_PSEUDO_DATA.TCP_FLAGS      = CNST_TCP_FLAG_ACK                     ;
    VAR7.TCP_PSEUDO_DATA.TCP_WINDOW     = VAR6.TCB_RCV_WND                      ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM     = 0W                                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_URG_PTR    = 0W                                    ;
    VAR7.TCP_PSEUDO_DATA.TCP_CHKSUM         = CHECKSUM(VAR7[0, 11 +
                                                VAR7.TCP_PSEUDO_LEN];

    SEND_OUT_IP WITH_DATA
    {
        T.IP_PROT                   = CNST_IP_PROT_TCP                          ,
        T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST                       ,
        T.IP_DATA                   = VAR7.TCP_PSEUDO_DATA.TCP_HEADER
    }

    VAR6.TCB_FLAGS &= ~(CNST_TF_DELACK);
}

TIMER_WITH_PERIOD 500
{
    FOR_EVERY_ELEMENT_IN_POOL VAR6.TCB_POOL_RETRANSMISSION
    {
        PE[0, 3] -= 1;
        IF( PE[0, 3] > 0 )
            CONTINUE;
```

```
            PE[4, 7] -= 1;
            IF( PE[4, 7] == 0 )
            {
                VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
                RETURN;
            }

            PE[0, 3] = 6;

            SEND_OUT_IP WITH_DATA
            {
                T.IP_PROT                   = CNST_IP_PROT_TCP          ,
                T.IP_ADDRDST                = VAR6.TCB_IP_ADDRDST       ,
                T.IP_DATA                   = PE.[16, ]
            }
        }

        IF(VAR6.TCB_TIMER_2MSL > 0)
        {
            VAR6.TCB_TIMER_2MSL -= 1;
            IF(VAR6.TCB_TIMER_2MSL==0)
                VAR6.TCB_STATE = CNST_TCB_STATE_CLOSED;
        }
    }
```