Programmer’s Guide to the SNP Facility

A Facility for Monitoring TCP/IP-Based Communications

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This document describes usage of a software facility based on the Solaris 2.3 (SunOS 5.3) operating system for monitoring TCP/IP communications on shared media networks. It may be used to monitor DICOM communications based on TCP/IP.

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1 Introduction

The SNP facility provides a means to monitor data communications on shared media networks (e.g. Ethernet) at the TCP level. The monitoring is performed in real-time. The facility was specifically developed for the Sun Solaris 2.3 (Sun OS 5.3) operating system. Only one association (network connection) may be monitored at a time. Parameters of the communication that need to be specified are initiator IP host name/address, acceptor IP host name/address, and acceptor’s TCP port number. Additional parameters include the buffsize, device filename and number, and timeouts. Callback functions also need to be specified to retrieve the parsed TCP data and state information from the facility. In order to monitor communications, the following set of steps / function calls should be implemented in the given order:

SNP_Init

SNP_RegisterCallback (One for data in each direction, and one for state info.)

SNP_Start

SNP_Stop

SNP_Terminate

A coding example entitled “Generic usage of SNP facility” is provided.

For a more complete description of the software architecture, refer to the manual entitled “DICOM Test Tools: A Guide to Programs for Testing DICOM Functionality.”

2 Data Structures

There are instances in which an application using the SNP facility stores the parsed TCP data stream to data files. In such cases, the data is stored in two files (one for data from the initiator, and the other for data from the acceptor) in which case it is necessary to store a header with each of buffer of data. Such a header would be used to signify the ends of associations, sequence the buffers of data between the files, and also provide information about the length of the buffer. The following data structure, found in the header file for the facility (snp.h), describes an example header format for the buffers.

```c
typedef struct {
    u_long type;
    u_long seq;
    u_long len;
} TCP_BUF_HEAD;
```

type represents the type of header and / or its direction. Here are the types and their definitions as per snp.h:
0  ITOA       Data from initiator to acceptor
1  ATOI      Data from acceptor to initiator
2  SNP_EOA   Signifies the End of Association

seq is sequence number of the buffer and may be used to check for the sequence between the files
for data from the initiator to acceptor, and acceptor to initiator. len provides the length of the data
buffer to follow.

3  Include Files

To use the SNP facility, applications need to include these files in the order given below:

```
#include "dicom.h"
#include "lst.h"
#include "condition.h"
#include "snp.h"
```

4  States

The following are the integer state constants as defined in snp.h used to report the status of the
network monitoring. The meaning of each is provided.

NORMAL       All is well
END_ASSOC     End of association
DATA_OVERFLOW Data overflow error
GETMSG_FAIL   getmsg() failure
RESET_ASSOC_INI Association aborted by initiator
RESET_ASSOC_ACC Association aborted by acceptor
NONCONTIGDATA Non contiguous data passed to application
WRITECALLBACKFAIL Failure in callback to write data
LSTINSFAIL    Failure using LST facility Insert()
DROPPEDPACKETS Kernel processing has dropped packets
BAD_END_ASSOC Bad end of association - was not able to capture all data
CON_TIMEOUT  Connection timed out (with segments still to be ack’ed)
STRGETMSG_TIMEOUT  strgetmsg() timed out (in STREAM setup)

5  Return Values

The SNP facility uses the COND facility to form and report conditions. The COND facility is documented in the Programmer’s Guide to the COND facility.

SNP routines return a condition value. These are condition values the SNP facility may return:

- SNP_NORMAL  Normal return from SNP routine
- SNP_MALLOCERROR  Error in performing memory allocation (malloc)
- SNP_CLOSEERROR  Error in closing file
- SNP_OPENERROR  Error in opening file
- SNP_SIGSETEERROR  Error setting up interrupt (signal)
- SNP_STREAMSETUP  Error setting up kernel level streams processing
- SNP_LSTCREATEFAIL  Error creating LST list
- SNP_CALLBACKSMISSING  All callbacks not registered
- SNP_CALLBACKFAIL  Error using callback function
- SNP_ARGERROR  Problem with function argument
- SNP_IOCTLFAIL  ioctl failure
- SNP_UNIMPLEMENTED  Error - unimplemented function
- SNP_PUTMSGFAIL  putmsg failure
- SNP_DLPIFAIL  Failure in DLPI routine
- SNP_DLPIEXPECT  DLPI function strgetmsg received unexpected message
- SNP_ALARMSET  Failure of alarm setting function
- SNP_GETMSGFAIL  getmsg failure in function

6  SNP Routines

This section provides detailed documentation for each SNP facility routine.
SNP_Init

Name

SNP_Init –initializes snooping on a TCP/IP association.

Synopsis

CONDITION SNP_Init()

Description

The routine is called to set up the SNP facility for snooping on a TCP/IP association. It should be called before any other SNP function is called.

Return Values

SNP_NORMAL
**SNP_Terminate**

**Name**

SNP_Terminate – terminate snooping on a TCP/IP association.

**Synopsis**

CONDITION SNP_Terminate()

**Description**

The routine is called to tear down the SNP facility for snooping on a TCP/IP association.

**Return Values**

SNP_NORMAL
SNP_RegisterCallback

Name

SNP_RegisterCallback –to register callback functions to pass TCP parsed data and SNP facility state information to higher software layers

Synopsis

CONDITION SNP_RegisterCallback(CONDITION(*callback) (), int callbackType, void *ctx)

callback
the name of the function to be used to pass parsed TCP data or SNP facility state information back to the application

callbackType
specifies that the callback function being register should be used for data in a particular direction or on state information. The forms of the callback functions are provided:

SNP_CALLBACK_ITOA on data from Initiator to Acceptor with callback function of the form:

CONDITION callback_func_name(char *buffer, int buffer_size, void *ctx)

SNP_CALLBACK_A_TOI on data from Acceptor to Initiator with callback function of the form:

CONDITION callback_func_name(char *buffer, int buffer_size, void *ctx)

SNP_CALLBACK_STATE on state information with callback function of the form:

CONDITION callback_func_name(int state, void *ctx)

ctx
context pointers used by application that are passed back in callbacks

Description

This routine registers callback functions for the passing of parsed TCP data and state information to higher software layers. Use of the SNP facility for snooping requires that all three callback functions be registered. While snooping, the functions may be re-registered thus providing greater freedom to change callbacks during operation.

Return Values

SNP_NORMAL
SNP_Start

Name

SNP_Start - sets up and starts snooping on all TCP/IP associations with the same parameters (includes initiator name or IP address, acceptor name or IP address, acceptor TCP port)

Synopsis

CONDITION SNP_Start(char *device, int ppa, char *initiator, char *acceptor, int port, int timeOutCon, int timeOutBuf, int bufferSpace)

device shared media network device driver file name on which to be snooping e.g. Ethernet interface: “/dev/le”
ppa Physical Point of Access (PPA) - corresponds to the number of the above device e.g. 0 for /dev/le0 which is the first network device of type /dev/le
initiator host name or IP address of communication initiator
acceptor host name or IP address of communication acceptor
port port number on acceptor that will be used
timeOutCon number of seconds for timeout on connection for which there is no traffic and there are outstanding acknowledgements
timeOutBuf number of seconds for timeout by STREAMS buffer module in the kernel space
bufferSpace number of bytes of space used for chunks by STREAMS kernel buffer module

Description

SNP_Start starts the snooping for associations after setting up the STREAMS chain in the kernel for filtering and buffering of the TCP stream to be monitored, and interfacing with the network device driver. Upon return of this function, the set up for the monitoring is complete.

As the SNP facility uses asynchronous I/O, the snooping operation is then interrupt-driven using callbacks to pass data and state information. By examining the state information, the calling software is able to determine the end of associations. A coding example follows the function definitions to illustrate usage of the facility.

Return Values

SNP_NORMAL
SNP_CALLBACKSMISSING
SNP_ARGERROR
SNP_OPENERROR
SNP_MALLOCERROR
SNP_STREAMSETUP
SNP_SIGSETErrOR
SNP_LSTCREATFAIL
SNP_Stop

Name

SNP_Stop - To stop the snooping activities.

Synopsis

CONDITION SNP_Stop()

Description

SNP_Stop stops the snooping and performs most of the tear-down activities.

Return Values

SNP_NORMAL
SNP_CLOSEERROR
SNP_StateMsg

Name

SNP_StateMsg - To get the textual interpretation of a SNP facility state number.

Synopsis

char* SNP_StateMsg(int state)

state Number of state to be interpreted

Description

SNP_StateMsg returns the textual representation of state number provided

Return Values

Pointer to character string interpreting SNP facility state number.
**Name**

SNP_Debug - Turns on/off debugging messages of SNP facility.

**Synopsis**

```c
void SNP_Debug(BOOLEAN flag)
```

*flag*    TRUE to turn on debugging, FALSE to turn off debugging.

**Description**

*SNP_Debug* turns on/off debugging messages of SNP facility

**Return Values**

None
7 Code Examples

7.1 Generic usage of SNP facility

The following is an example of how the facility may be used to monitor some associations. Although, callback functions are registered in the code, they are not specified. The sequence of events for set up and tear down is important to note.

```c
/* Place SNP facility in debug mode - turn off for now */
SNP_Debug(FALSE);

/* Initialize SNP facilities */
cond = SNP_Init();
if (cond != SNP_NORMAL) {
    COND_DumpConditions();
    exit(1);
}

/* Register callback functions */
cond = SNP_RegisterCallback(callbackState, SNP_CALLBACK_STATE, NULL);
if (cond != SNP_NORMAL) {
    COND_DumpConditions();
    exit(1);
}
cond = SNP_RegisterCallback(callbackITOA, SNP_CALLBACK_ITOA, NULL);
if (cond != SNP_NORMAL) {
    COND_DumpConditions();
    exit(1);
}
cond = SNP_RegisterCallback(callbackATOI, SNP_CALLBACK_ATOI, NULL);
if (cond != SNP_NORMAL) {
    COND_DumpConditions();
    exit(1);
}

/* Commence the snooping with given arguments */
cond = SNP_Start("/dev/le", 0, "dicom1", "dicom2", 104, 20, 5, 32768);
if (cond != SNP_NORMAL) {
    COND_DumpConditions();
    exit(1);
}
```
printf("\nInitialization complete .... ready to monitor communications\n");

/* Until the correct number of associations have been monitored or until something goes wrong keep snooping - update user with number of associations to go (Note: Global variable "assoc" is the number of associations remaining, decrement by callback for state information on receiving each END_OF_ASSOC message)
*/

while (assoc > 0) {
    sleep(1);
}

/* If finished in a bad state .... something went wrong */

if (current_state != NORMAL) {
    printf("\nError: %s\n",SNP_StateMsg(current_state));
    exit(1);
} else
    printf("\nCompleted monitoring associations normally\n");

/* Discontinue snooping operations */

cond = SNP_Stop();
if (cond != SNP_NORMAL)
    COND_DumpConditions();

/* Terminate activities with SNP facility */

cond = SNP_Terminate();
if (cond != SNP_NORMAL)
    COND_DumpConditions();