Sangoma WAN EduKit

Sample Laboratory for Frame Relay

FR LAB 1 Loading and using the monitoring and testing tools for Frame Relay

Objective

Provide an introduction to the usage of the Sangoma WAN EduKit.

Background

A basic knowledge of the Frame Relay protocol is required to make full use of the Sangoma WAN EduKit. This knowledge should include the familiarity with commonly used definitions such as CPE, DLCI, CIR, FECN, BECN and DE as well as an understanding of the format of Frame Relay messages. Note that for Frame Relay, the Sangoma WAN EduKit is only configured for use with PVCs (Permanent Virtual Connections) and no reference is made to SVCs (Switched Virtual Connections).

Preparation

Ensure that the Sangoma WAN EduKit is installed as per instructions.

Lab Instructions

Starting the Sangoma WAN EduKit for Frame Relay

Click on “Start->Programs->Sangoma Tools->WAN EduKit”. Select “Frame Relay”. Two tester windows will be opened, one for the Access Node (Frame Relay Switch) emulation and one for the CPE (Customer Premises Equipment) emulation. Note that these windows are titled “Frame Relay Tester – Access Node” and “Frame Relay Tester – CPE” respectively. The Frame Relay firmware will be downloaded to the adapter and a network connection will be established. You will notice that the testers include a number of buttons that will allow you to execute functions such as setting the Frame Relay configuration, sending and receiving Information frames and controlling the status of the DLCIs. Each tester includes a status window that is used to display the details and results of commands issued by the tester to the hardware. There is a menu at the top of the tester application that allows access to various monitoring functions, protocol statistics and a line trace.

Reading the Frame Relay link status

From the “Link Monitor” menu in the ”Frame Relay Tester – CPE” window, select “Link Status”. The current Frame Relay link (channel) status will be shown and will indicate that the link is “OPERATIVE”. This means that In-channel Signaling frames are successfully being transferred between the CPE and the Access Node. Close the “Link Status” window.

Reading the station-specific operational statistics

From the “Link Monitor” menu, select “Station-Specific Statistics”. This window displays a counter of the various types of In-channel Signaling frames transmitted and received as well as error counters such as the number of T391 Link Integrity Verification polling timeouts. Close this window.

Reading the status of DLCIs

From the “DLCI Monitor” menu in the ”Frame Relay Tester – CPE” window, select “Configured DLCIs and Statistics”. This window lists the DLCIs that are configured at the Access Node and are currently being included in Full Status signaling messages being received by the CPE. You will notice that DLCI 16 is being reported as included (“Inc”) and active. Double click on the listed DLCI 16. The operational statistics for the selected DLCI will be displayed, including a count of the number of Information frames transmitted and received for that DLCI. Close the DCLI 16 statistics window as well as the “Configured DLCIs” status window.

Using the line trace

From the “Line Trace” menu in the ”Frame Relay Tester – CPE” window, select “Open Line Trace Window” and real-time line trace data will be displayed. Every five seconds, an In-channel Signaling frame will be transmitted from the CPE to the Access Node and the Access Node will respond appropriately. The default display is an interpreted dump of the transmitted and received data and the Message Type, Report Type, Send Sequence Number, Receive Sequence Number and DLCI status is displayed. Click on “Show Raw Data” and a hexadecimal dump of the transmitted and received data will be displayed. Close the line trace window.

FR LAB 2 Sending and receiving Information frames

Objective

Use the Sangoma WAN EduKit to send and receive Information frames across a Frame Relay network. Usage of FECN (Forward Explicit Congestion Notification), BECN (Backward Explicit Congestion Notification) and DE (Discard Eligibility) bits will be examined.

Background

Information frames may be transferred across a Frame Relay network on all DLCIs that are currently indicated to be in the active state. In addition to the actual user data, these frames include FECN, BECN and DE (Discard Eligibility) bits that are used for flow control and congestion management.

Preparation

The Sangoma WAN EduKit for both the Access Node and the CPE should be active. DLCI 16 must be active (the pre-configured state for this DLCI).

Lab Instructions

Displaying received Information Frames

Incoming Information frames will be displayed in the status window of the "Frame Relay Tester – Access Node" and "Frame Relay Tester – CPE" application programs.

Sending a single Information Frame

Using the window labeled "Frame Relay Tester – CPE", click on "Send I-Frames" to open a transmitter ("Send I-Frames") window. You will notice that the tester has been preconfigured to send the hexadecimal data "0x01 0x02 0x03" on DLCI 16 by default. Also, the FECN, BECN, DE and C/R options are not selected. Click on the "SEND" button and an Information frame will be transmitted on DLCI 16. Examine the status window of the "Frame Relay Tester – Access Node" application. You will see the following:

INFORMATION_READ	**(Rx Data on on DLCI 16, Length: 3, FECN: 0, BECN: 0, DE: 0, C/R: 0)** **Data: 01 02 03**

This indicates that 3 bytes of data were received on DLCI 16. Note that the BECN, BECN, DE and C/R bits were all set to 0 in the received Information frame.

Sending multiple Information Frames

At the bottom of the "Send I-Frames" window, click on the "Start" button. The CPE will now constantly send Information frames to the Access Node on DLCI 16. Note that the preconfigured data length is 100 bytes and that the transmitted data varies with each frame transmitted. You will see the received frames being displayed in the status window of the "Frame Relay Tester – Access Node" application.

Reading the operational statistics for a selected DLCI

From the "DLCI Monitor" menu in the "Frame Relay Tester – CPE" window, select "Configured DLCIs and Statistics". Double click on the listed DLCI 16. The count of the number of Information frames transmitted will be incrementing as the frames are sent on DLCI 16. Close the "DCLI 16 Statistics" window as well as the "Configured DLCIs" status window.

Monitoring Frame Relay traffic using the line trace

From the “Line Trace” menu in the ”Frame Relay Tester – CPE” window, select “Open Line Trace Window”. You will see the outgoing Information frames as well as the exchange of In-channel Signaling frames at five-second intervals. Toggle between the hexadecimal and interpreted trace modes by using the “Show Raw Data” and “Show Frame Relay Data” options. Close the line trace window.

Sending an Information Frame with the DE bit set

At the bottom of the “Send I-Frames” window for the CPE, click on the “Stop” button so as to stop transmitting Information frames to the Access Node. At the top of this window, enable the DE bit and click on the “SEND” button. The receiver window correctly indicates that the Access Node received the frame with the DE bit set (“DE: 1”). Note that a Frame Relay device configured as a CPE may set the DE bit to 1 in an outgoing Information frame to indicate to the network that this frame should be discarded in preference to other frames in a congestion situation. Now enable the FECN and BECN bits as well as the DE bit and click on the “SEND” button. The receiver window indicates that the Access Node received the frame with the DE bit set, but the FECN and BECN bits reset. This is correct as the FECN and BECN indicators are only used by the network (Access Node) side of the link and so are reset in an Information frame transmitted by the CPE. Close the “Send I-Frames” window for the CPE.

Sending an Information Frame with the FECN, BECN and DE bits set

Using the window labeled “Frame Relay Tester – Access Node”, click on “Send I-Frames” to open a transmitter (“Send I-Frames”) window. Click on the “SEND” button. An Information frame will be transmitted on DLCI 16 and the received data will be displayed in the status window of the “Frame Relay Tester – CPE” application. This window correctly indicates that the CPE received the frame with the FECN, BECN and DE bits reset. At the top of the “Send I-Frames” window for the Access Node, enable the FECN, BECN and DE bits and click on the “SEND” button. The status window of the CPE tester correctly indicates that the CPE received the frame with the FECN, BECN and DE bits set. The FECN and BECN bits are set to 1 by the network to indicate that the network may not have sufficient resources to continue handling the submitted traffic at the current rate. Close the “Send I-Frames” window for the Access Node.

FR LAB 3 Determining the status of a PVC

Objective

The Sangoma WAN EduKit is used to demonstrate the mechanics employed by a Frame Relay network in determining the state and availability of PVCs.

Background

The In-channel Signaling protocol provides a method for detecting the state and reliability of the Frame Relay link as well the state and availability of PVCs. Every T391 seconds (configured default is 5 seconds), the CPE sends a Status Enquiry message to the network and the Access Node responds to that message. Typically, there are two different types of reports requested by the CPE: Link Integrity Verification only (LIV) and Full Status (FS) reports. Every N391 polling cycles (configured default is 2), the CPE requests a Full Status report. The Full Status report returned to the CPE by the Access Node includes a PVC Status Information Element for each configured PVC and the CPE uses these elements to determine the state and availability of PVCs.

Preparation

The Sangoma WAN EduKit for both the Access Node and the CPE should be active. DLCI 16 must be active (the pre-configured state for this DLCI).

Lab Instructions

Reading the status of DLCIs using the Frame Relay Monitor

From the “DLCI Monitor” menu in the ”Frame Relay Tester – CPE” window, select “Configured DLCIs and Statistics”. DLCI 16 is listed as included and active. This means that the last Full Status report returned to the CPE by the Access Node included a PVC Status Information Element for DLCI 16, with the ‘Active bit’ set to 1.

Using the line trace to examine Full Status report frames

From the “Line Trace” menu in the ”Frame Relay Tester – CPE” window, select “Open Line Trace Window”. You will notice that the In-channel Signaling frames are alternating between two different types of reports: Link Integrity Verification only (LIV) and Full Status (FS) reports. In addition, the Full Status report returned to the CPE by the Access Node shows “DLCI 16 PRS ACT” (DLCI 16 is present/included and active).

Deactivating a DLCI on the Frame Relay network

Using the window labeled “Frame Relay Tester – Access Node”, click on “Deactivate DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK”. DLCI 16 will now be deactivated at the Access Node and this state change will be reported to the CPE in the next Full Status report returned to the CPE by the Access Node. Verify this by examining the line trace at the CPE. The DLCI status interpretation will change from “DLCI 16 PRS ACT” to “DLCI 16 PRS INACT” (DLCI 16 is present/included and inactive). Also, the “Configured DLCIs” status window reflects the change in status for DLCI 16.

Adding a DLCI to the Frame Relay network

Using the window labeled “Frame Relay Tester – Access Node”, click on “Add DLCIs at Node”. Select “17” from the list of configured DLCIs and click on “Add” to include DLCI 17 in the command to be executed. Click on “OK”. DLCI 17 will now be added at the Access Node and the inclusion of this additional DLCI will be reported to the CPE in the next Full Status report returned to the CPE by the Access Node. Verify this by examining the line trace at the CPE. The DLCI status interpretation will change from “DLCI 16 PRS INACT” to “DLCI 16 PRS INACT   DLCI 17 PRS INACT” (DLCIs 16 and 17 are present/included and inactive). Also, the “Configured DLCIs” status window reflects the addition of DLCI 17.

Deleting a DLCI to the Frame Relay network

Using the window labeled “Frame Relay Tester – Access Node”, click on “Delete DLCIs at Node”. Select “17” from the list of configured DLCIs and click on “Add” to include DLCI 17 in the command to be executed. Click on “OK”. DLCI 17 will now be deleted for the Frame Relay network and this process will be reported to the CPE in the next Full Status report returned to the CPE by the Access Node. Verify this by examining the line trace at the CPE. The DLCI status interpretation will change from “DLCI 16 PRS INACT   DLCI 17 PRS INACT” to “DLCI 16 PRS INACT”, indicating that DLCI 17 has been deleted. Also, the “Configured DLCIs” status window reflects the deletion of DLCI 17, as the “Inc” (included) qualifier is no longer associated with this DLCI.

Activating a DLCI on the Frame Relay network

Using the window labeled “Frame Relay Tester – Access Node”, click on “Activate DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK” and DLCI 16 will now once again be activated. Verify this by examining the line trace at the CPE. The DLCI status interpretation will change from “DLCI 16 PRS INACT” to “DLCI 16 PRS ACT” (DLCI 16 is present/included and active). Also, the “Configured DLCIs” status window reflects the change in status for DLCI 16. Close the “Configured DLCIs” status window as well as the line trace window.

FR LAB 4 Frame Relay configuration

Objective

Demonstrate commonly used Frame Relay configuration parameters and exhibit the importance of these parameters in maintaining a Frame Relay network.

Background

Parameters of importance when configuring a Frame Relay network include the following:

- The type of In-channel Signaling messages used, which include ANSI T1.617 Annex D, LMI and Q.933 signaling. Each of the signaling options listed has a specific frame format and the CPE and the Access Node must be configured to conform to the same specifications.

- T391 (Link Integrity Verification polling timer) – Valid at the CPE and indicates the number of seconds between the transmission of In-channel Signaling messages.

- T392 (Timer for verification of polling cycle) – Valid at the Access Node and indicates the expected number of seconds between the reception of In-channel Signaling messages transmitted by the CPE.

- N391 - Valid at the CPE and defines the frequency of transmission of Full Status enquiry messages.

- N392 - Valid at the CPE and the Access Node and defines the number of errors during N393 events which cause the channel to be inactive.

- N393 - Valid at the CPE and the Access Node and is an event counter for measuring N392.

Preparation

The Sangoma WAN EduKit for both the Access Node and the CPE should be active. DLCI 16 must be active (the pre-configured state for this DLCI).

Lab Instructions

Setting the type of In-channel Signaling used on a Frame Relay network

From the “Link Monitor” menu in the ”Frame Relay Tester – Access Node” window, select “Link Status”. The channel/link status will be shown to be “OPERATIVE”. From the “Link Monitor” menu in the ”Frame Relay Tester – CPE” window, select “Link Status”. The channel/link status will be shown to be “OPERATIVE”. From the “Line Trace” menu in the ”Frame Relay Tester – CPE” window, select “Open Line Trace Window”. Click on the “Show Raw Data” option so as to display a hexadecimal dump of the transmitted and received frames. The first two bytes in the frames are 0x00 0x01, which are indicative of ANSI T1.617 Annex D or Q.933 In-channel Signaling messages. Note that by default, the Sangoma WAN EduKit is configured to use ANSI T1.617 Annex D In-channel Signaling. Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. Select “LMI” in the “Signaling” section of the configuration and click “OK”. The CPE will be reconfigured to use LMI signaling. Examine the hexadecimal line trace dump in the CPE monitor. The first two bytes in the “OUTGOING” frames are 0xFC 0xF1, which are indicative of LMI In-channel Signaling messages. Note that there are no “INCOMING” frames, as there is a misconfiguration between the CPE and the Access Node The Access Node will not recognize and therefore will not respond to signaling frames transmitted by the CPE. Re-examine the “Link Status” windows in the monitors for the CPE and Access Node. The channel/link status will change or will have changed to be “INOPERATIVE” in both windows to indicate that there is no communication between the two stations. Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. Select “Annex D (T.617)” in the “Signaling” section of the configuration and click “OK”. The CPE will be once again configured to use Annex D signaling. Examine the hexadecimal line trace dump in the CPE monitor. Note that there are both “OUTGOING” and “INCOMING” frames, indicating that the misconfiguration has been corrected. Re-examine the “Link Status” windows in the monitor applications. The channel/link status will change or will have changed to be “OPERATIVE” to indicate that communications between the two stations has been restored.

Setting the T391 timer

Examine the line trace in the CPE monitor. Each frame is time stamped to a resolution of 1 millisecond and the time stamp rotates between 0 and 65535. Notice that the time stamps in “OUTGOING” frames indicate that the frames are transmitted at intervals of 5000 milliseconds. Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. The T391 timer in the “Timers and Counters” section is set to 5 seconds – this corresponds to the number of seconds between the transmission of In-channel Signaling messages from the CPE. Edit the T391 timer so as to change its value to 10 seconds and click “OK”. Examine the line trace in the CPE monitor. Notice that the time stamps in “OUTGOING” frames indicate that the frames are now being transmitted at intervals of 10000 milliseconds. Re-examine the “Link Status” window in the monitor for the CPE and Access Node. The channel/link status will change or will have changed to be “INOPERATIVE” at the Access Node, but will still be “OPERATIVE” at the CPE. This is because the T392 timer is set to 6 seconds at the Access Node, indicating the expected number of seconds between the reception of In-channel Signaling messages transmitted by the CPE. Because these messages are now only being issued at 10-second intervals, error conditions occur at the Access Node and the link is declared to be inoperative at that station. It is important to note that an error condition does not occur at the CPE, as the CPE is receiving a valid and timely response to each transmitted In-channel Signaling message. This ‘unbalanced’ error condition indicates the critical importance of having matching and compatible configuration parameters at connected stations. Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. Set the T391 timer in the “Timers and Counters” section back to the original value of 5 seconds and click “OK. The channel/link status will change or will have changed to be “OPERATIVE” at the Access Node, indicating the poll timer compatibility. Close the “Link Status” window for the Access Node.

Usage of the N392 and N393 configuration parameters

Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. The N392 and N393 parameters are set at 3 and 4 respectively. Click “Cancel” to close this window. Using the window labeled “Frame Relay Tester – Access Node”, click on “Disable Communications”. This will cause the Access Node to no longer receive (and therefore respond) to In-channel Signaling messages transmitted by the CPE. Examine the “Link Status” windows in the CPE monitor. The channel/link status will change from “OPERATIVE” to “INOPERATIVE”, but this process will take approximately 15 to 20 seconds. This is due to the configured requirement that 3 errors out of 4 events will cause the link to become inoperative. The 4 events are the non-reception of a response to the In-channel Signaling messages transmitted by the CPE at 5-second intervals. Using the window labeled “Frame Relay Tester – Access Node”, click on “Enable Communications”. The Access Node will once again respond to incoming In-channel Signaling messages transmitted by the CPE and the link will be restored after a 15 to 20 second delay. Close the “Link Status” window and the line trace window for the CPE.

FR LAB 5 CIR (Committed Information Rate) usage

Objective

Use the Sangoma WAN EduKit to explore the role of CIR usage in Frame Relay networks.

Background

The speed of transfer of Information frames is limited by the physical bandwidth of the Frame Relay connection. In addition, Committed Information Rate (CIR) pragmatics may be implemented to further limit to amount of bandwidth used. The CIR is the subscriber data throughput that the network commits to supporting on a PVC under normal network conditions. Each configured PVC may have a unique CIR, and each PVC may have a different CIR for the send and receive paths. The CIR is provisioned depending on user requirements and may influence the pricing of each circuit. For example, it is fair to assume that the cost for a PVC using a CIR of 64 Kbps is higher than that for a CIR of 8 Kbps.

Preparation

The Sangoma WAN EduKit for both the Access Node and the CPE should be active. DLCI 16 must be active (the pre-configured state for this DLCI).

Lab Instructions

Transmitting I-frames without CIR restrictions

Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. You will notice that in the ‘Hardware’ section, the ‘Baud rate’ has been set to 8 Kbps and that the ‘Restrict transmit date rate’ in the ‘Options’ section is un-checked. This means that data the CIR pragmatics have been disabled and that the speed of transfer of Information frames is limited by the physical bandwidth of the Frame Relay connection. Click “Cancel” to close the configuration window. From the “DLCI Monitor” menu in the ”Frame Relay Tester – Access Node” window, select “Configured DLCIs and Statistics”. Double click on the listed DLCI 16. Click of “Flush” to reset the count of the number of Information frames transmitted and received for the DLCI. Using the window labeled “Frame Relay Tester – CPE”, click on “Send I-Frames” to open a transmitter (“Send I-Frames”) window. At the bottom of the “Send I-Frames” window, you will see the “Start” button. Before starting frame transmission, zero a stopwatch and then click on the “Start” button and activate the stopwatch. The CPE will now constantly send Information frames of length 100 bytes to the Access Node on DLCI 16. You will see the received Information frame counter incrementing in the “DLCI 16 Statistics” window for the Access Node. After transmitting Information frames for 60 seconds, click the “Stop” button in the transmitter window. Note the frame count in the “DLCI 16 Statistics” window. Approximately 565 frames were received. This coincides with the theoretical frame throughput as follows:

> Number of bytes in one I-frame is 106 (2 byte for the Frame Relay header, 100 bytes data, 2 bytes CRC, 2 bytes HDLC flags).
>
> Number of I-frames transmitted in 60 seconds is (8 bits per byte)
>
> ((8000 / 8) X 60) / 106 = 566 frames

Using the CIR to restrict transmission throughput

Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. In the ‘Options’ section, check the ‘Restrict transmit date rate’ option so as to enable CIR usage. Note that the ‘CIR forward’ and ‘Bc forward’ options have both been preset to ‘4’, indicating that a CIR of 4 Kbps will be used. Click ‘OK, to modify the configuration and close the window. At the “DLCI 16 Statistics” window for the Access Node, click on “Flush” to reset the count of the number of Information frames transmitted and received for the DLCI. Zero your stopwatch and then click on the “Start” button in the CPE transmitter window while activating the stopwatch. After transmitting Information frames for 60 seconds, click the “Stop” button in the transmitter window. The frame count in the “DLCI 16 Statistics” window indicates that approximately 282 frames were received, which coincides well with the configured CIR of 4 Kbps. It should be noted that the throughput restriction was implemented by the Sangoma Frame Relay firmware running on the adapter and not by the CPE transmit application. Using the window labeled “Frame Relay Tester – CPE”, click on “Set Fr. Configuration” to open the Frame Relay configuration window. In the ‘Options’ section, uncheck the ‘Restrict transmit date rate’ option so as to disable CIR usage. Click ‘OK, to modify the configuration and close the window. Close the “Send I-Frames” window for the CPE. Close the “DLCI 16 Statistics” window and the “Configured DLCIs” window for the Access Node.

FR LAB 6 Frame Relay frame formats

Objective

To use the line trace utility included in the Sangoma WAN EduKit to examine the format of Frame Relay signaling frames.

Background

There are three types of In-channel Signaling messages used in Frame Relay: ANSI T1.617 Annex D, LMI and Q.933. In this laboratory we will use the line trace utility to examine ANSI T1.617 Annex D frames and match the trace data with the specified frame structure. It is recommended that this exercise be performed in conjunction with formal documentation describing the ANSI T1.617 Annex D frame format.

Note that all byte references will assume bit 0 to be the low order bit and bit 7 to be the high order bit. By default, all numbering is in decimal, and hexadecimal values are prefixed by “0x”.

The table below shows the basic format of an ANSI T1.617 Annex D In-channel Signaling frame. Note that the opening and closing HDLC flag characters have been omitted, as they are not shown in the line trace:

Offset (Dec)	**Value (Hex)**	**Definitions**
0	0x00	DLCI high order (bits 2-7, set to 0), C/R (bit 1, set to 0), EA (bit 0, set to 0)
1	0x01	DLCI low order (bits 4-7, set to 0), FECN (bit 3, set to 0), BECN (bit 2, set to 0), DE (bit 1, set to 0), EA (bit 0, set to 1)
2	0x03	Unnumbered Information Frame
3	0x08	Protocol Discriminator
4	0x00	Dummy Call Reference
5	0x7D or 0x75	Message Type: Status (0x75), Status Enquiry (0x7D)
6	0x95	Locking Shift Information Element
7	0x01	Report Type Information Element Identifier
8	0x01	Length of Information Element
9	0x00 or 0x01	Type of Report: Full Status (0x00), Link Integrity Verification (0x01)
10	0x03	Link Integrity Verification Information Element Identifier
11	0x02	Length of Information Element
12	0x01 to 0xFF	Send Sequence Number
13	0x01 to 0xFF	Receive Sequence Number – A value of 0x00 indicates an undefined value.
		For a frame shown in the line trace to be of length 16 bytes, the next two bytes (offsets 14, 15) are CRC bytes. Otherwise, the byte at offset 14 is the first byte of a PVC Status Information Element. Note that a Full Status Report may contain a number of PVC Status Information Elements, each of length 5 bytes and each indicating the status of a configured DLCI.
14	CRC or 0x07	CRC or PVC Status Information Element Identifier
15	CRC or 0x03	CRC or Length of Information Element
16		Extra - bit 7, Spare – bit 6, DLCI (most significant bits) – bits 0-5.
17		Extra – bit 7, DLCI (least significant bits) – bits 3-6, Spare – bits 0-2.
18		Extra – bit 7, Spare – bits 4-6, New – bit 3, Spare – bit 2, Active – bit 1, Spare – bit0.
19	CRC or 0x07	CRC or PVC Status Information Element Identifier
20	CRC or 0x03	CRC or Length of Information Element
ETC		

Table 1 - Basic Format of an ANSI T1.617 Annex D In-channel Signaling frame

Preparation

The Sangoma WAN EduKit for both the Access Node and the CPE should be active. DLCI 16 must be active (the pre-configured state for this DLCI).

Lab Instructions

Setting the line trace in a raw data mode

From the “Line Trace” menu in the ”Frame Relay Tester – CPE” window, select “Open Line Trace Window”. Click on the “Show Raw Data” option so as to display a hexadecimal dump of the transmitted and received frames. When the trace window is full of trace data, enable the “Stop autoscroll” feature on the line trace so as to freeze the display.

Examining bytes at offsets 0 and 1 in the frames

The ANSI T1.617 Annex D protocol specifies that the In-channel Signaling protocol takes place on DLCI 0. The first two bytes of the transmitted and received frames are always 0x00, 0x01, indicating DLCI 0, with the EA bit set to 1 in the byte containing the low order bits of the DLCI.

Examining bytes at offsets 2, 3 and 4 in the frames

Bytes at offset 2, 3 and 4 are always set to 0x03, 0x08 and 0x00, corresponding to the specified Unnumbered Information Frame, Protocol Discriminator and Dummy Call Reference values.

Bytes at offsets 5 - the Message Type

The byte at offset 5 is the Message Type and is seen to be 0x75 (Status Enquiry Message) in “OUTGOING” frames (transmitted by the CPE) and 0x7D (Status Message) in “INCOMING” frames (transmitted by the Access Node). This corresponds to the basic signaling protocol implemented in ANSI T1.617 Annex D: the CPE periodically queries the Access Node and the Access Node issues a response.

Bytes at offsets 7, 8 and 9 - the Report Type Information Element

The Report Type Information Element consists of the bytes at offset 7, 8 and 9. The byte at offset 9 indicates the Type of Report and may be set to Full Status (0x00) or Link Integrity Verification (0x01). The N391 Frame Relay configuration parameter defines the frequency of transmission of Full Status enquiry messages. Note that the N391 counter is generally set to a default value of 6 in most Frame Relay networks, indicating that every 6^{th} poll issued by the CPE requests a Full Status Report from the Access Node. However, the Sangoma WAN EduKit has this N391 value defaulted to 2 for demonstration purposes, so that a maximum of two polling cycles are necessary for before the CPE is made aware of PVC status changes at the Access Node.

Send and Receive Sequence numbering

The Link Integrity Verification Information Element consists of the bytes at offset 10, 11, 12 and 13. The bytes at offset 12 and 13 are the Send Sequence Number and Receive Sequence Number respectively. These numbers are used to detect link reliability, as the Send Sequence Number is incremented (using modulo 256, zero skipped) after the transmission of each In-channel Signaling message, so that the remote station may detect missing and out-of-sequence signaling frames. The Receive Sequence Number used in a transmitted signaling frame reflects the value of the Send Sequence Number previously received in a Link Integrity Verification Information Element. Examine the Send and Receive Sequence Numbers in the line trace to verify this theory.

The PVC Status Information Element

The byte at offset 14 is either the first byte of the Cyclic Redundancy Check (CRC) in the frame or it is the first byte of a PVC Status Information Element. Examine an “INCOMING” and “OUTGOING” frame of length 16 bytes. In these frames, the bytes at offset 14 and 15 are the two CRC bytes in the frame. Note that in the “OUTGOING” frames, the CRC bytes are always set to a dummy value of “0xFF 0xFF”, as the actual value of the CRC is calculated on transmission by the communications hardware and is not made available to the line trace. Examine an “INCOMING” frame (transmitted by the Access Node) of length 21 bytes. The byte at offset 9 (Type of Report) defines this frame as Full Status Report and so PVC Status Information Elements may be present in the frame. Indeed, the bytes at offset 14, 15, 16, 17 and 18 make up a PVC Status Information Element, as described in Table 1 above. The DLCI listed in this PVC Status Information Element is made up of bits 0-5 of the byte at offset 16 (0x01) and of bits 3-6 of the byte at offset 17 (0x80). This gives a 10-bit binary value of 0000010000, which is 16 (decimal). The byte at offset 18 (0x82) defines the status of the listed DLCI. Note that the “active” bit (bit 1) is set, indicating that the PVC is active.

Using the PVC Status Information Element to detect a change in the status of a DLCI

Disable the “Stop autoscroll” feature on the CPE line trace so that live data is once again being displayed in the monitor. Using the window labeled “Frame Relay Tester – Access Node”, click on “Deactivate DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK”. DLCI 16 will now be deactivated at the Access Node and this state change will be reported to the CPE in the next Full Status report returned to the CPE by the Access Node. Verify this by examining the “INCOMING” frames (transmitted by the Access Node) of length 21 bytes (Full Status Report). The byte at offset 18 that defines the status of the listed DLCI has changed from 0x82 to 0x80, indicating that the “active” bit (bit 1) is reset, confirming that that DLIC 16 is now inactive. Using the window labeled “Frame Relay Tester – Access Node”, click on “Activate DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK”. The byte at offset 18 in an “INCOMING” Full Status Report will change from 0x80 to 0x82, indicating that the DLCI is once again active.

Using the Full Status Report signaling frame to detect the presence of configured DLCIs on a Frame Relay network

Using the window labeled “Frame Relay Tester – Access Node”, click on “Delete DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK”. The deletion of DLCI 16 will now be reported to the CPE in the next Full Status Report returned to the CPE by the Access Node. Examine the line trace at the CPE monitor. The “INCOMING” Full Status Report frames (identified by the byte at offset 9 being 0x00) transmitted by the Access Node are now 16 bytes in length, as all DLCIs have been deleted at the Access Node and so no PVC Status Information Elements are included in the Full Status Report. Using the window labeled “Frame Relay Tester – Access Node”, click on “Add DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK”. Click on “Activate DLCIs at Node”. Select “16” from the list of configured DLCIs and click on “Add” to include DLCI 16 in the command to be executed. Click on “OK”. Examine the line trace at the CPE monitor. The “INCOMING” Full Status Report frames indicate that DLCI is once again included and active.

Using the PVC Status Information Element to detect the addition of DLCIs on a Frame Relay network

Using the window labeled “Frame Relay Tester – Access Node”, click on “Add DLCIs at Node”. Select “17” from the list of configured DLCIs and click on “Add” to include DLCI 17 in the command to be executed. Click on “OK”. The addition of DLCI 17 and the status of this DLCI will now be reported to the CPE in the next Full Status report returned to the CPE by the Access Node. Examine the line trace at the CPE monitor. The “INCOMING” Full Status Report frames (transmitted by the Access Node) of will now be of length 26 bytes as an additional PVC Status Information Element of length 5 bytes has been added. The bytes at offset 19, 20, 21, 22 and 23 make up an additional PVC Status Information Element, as described in Table 1 above. The DLCI listed in this PVC Status Information Element is made up of bits 0-5 of the byte at offset 21 (0x01) and of bits 3-6 of the byte at offset 22 (0x88). This gives a 10-bit binary value of 0000010001, which is 17 (decimal). Using the window labeled “Frame Relay Tester – Access Node”, click on “Delete DLCIs at Node”. Select “17” from the list of configured DLCIs and click on “Add” to include DLCI 17 in the command to be executed. Click on “OK”. Using the line trace at the CPE monitor, confirm that the PVC Status Information Element for DLCI 17 has been deleted and that the PVC Status Information Element for DLCI 16 is the only one present in the “INCOMING” Full Status Report frames. Close the CPE line trace window.