JDSU HST-3000 PRI Trunk Testing Guide

Version 1.3
January 14, 2014

Table of Contents

Scope

This document covers PRI Trunk testing procedures used for Business Services customer activation, fault isolation, and troubleshooting using the JDSU HST-3000 portable business services tester. This document provides procedures to place and receive calls on ISDN PRI trunks.

Revision History

Revision	*Description*	*Name*
1.0	*Initial Draft*	*Dave Baker, JDSU*
1.1	*Added instructions to save D-Channel capture file.*	*Dave Baker, JDSU*
1.2	*Added User Interface Description*	*Dave Baker, JDSU*
1.3	*Added instructions to view D Channel decodes* *Added Appendices with D-Channel Decode information*	*Dave Baker, JDSU*

1. Overview

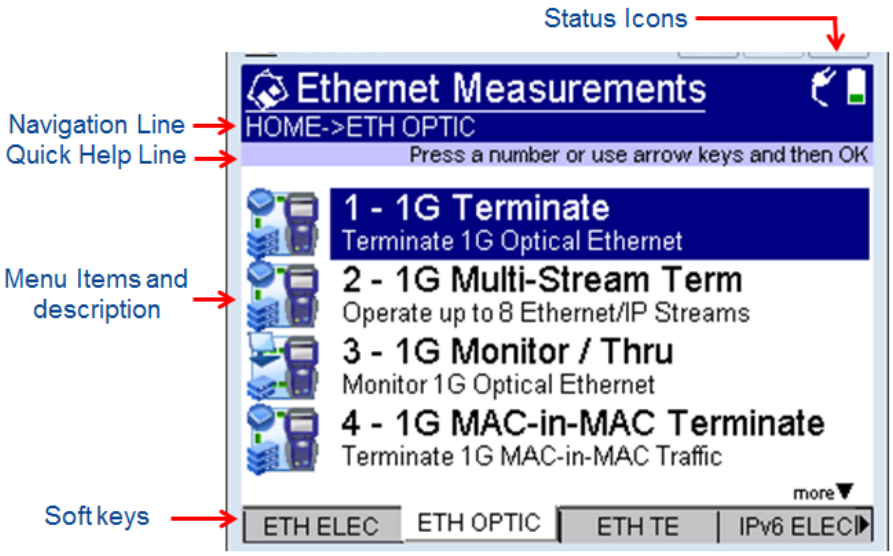
This document covers PRI Trunk testing procedures used for Business Services customer activation, fault isolation and troubleshooting. At customer activation, this test equipment is used to emulate the customer's PBX and validate the performance of a PRI trunk.

1.1 Hardware Description

The HST-3000 is a portable test tool for PRI testing. . The product supports a variety of subscriber interface modules (SIMs) to support Ethernet, T1/T3, Copper/DSL and other access technologies. A T1 SIM is required for this test. Menu selections are made from the HST-3000 front panel by using the keypad to select the option number or by using the arrow keys to scroll to the desired selection and pressing the **OK** key.

HST-3000 Front Panel:

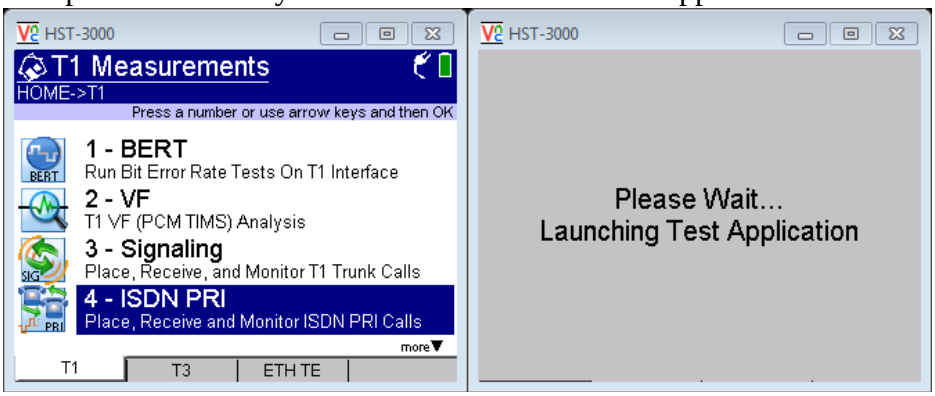
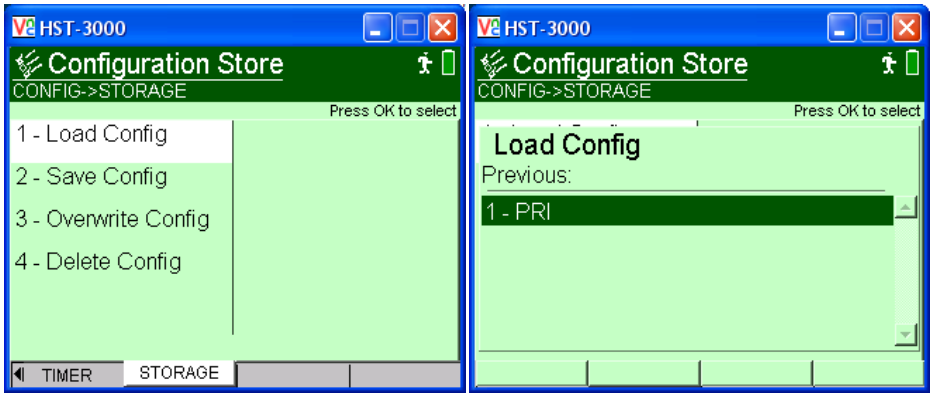
User Interface:


Status Icons
Navigation Line
Quick Help Line
Menu Items and description
Soft keys
Ethernet Measurements
HOME->ETH OPTIC
Press a number or use arrow keys and then OK
1 - 1G Terminate
Terminate 1G Optical Ethernet
2 - 1G Multi-Stream Term
Operate up to 8 Ethernet/IP Streams
3 - 1G Monitor / Thru
Monitor 1G Optical Ethernet
4 - 1G MAC-in-MAC Terminate
Terminate 1G MAC-in-MAC Traffic
more
ETH ELEC
ETH OPTIC
ETH TE
IPv6 ELEC

2. PRI Trunk Test Procedures

The following procedures describe how to test a PRI trunk using the HST-3000.

2.1 Configure Test

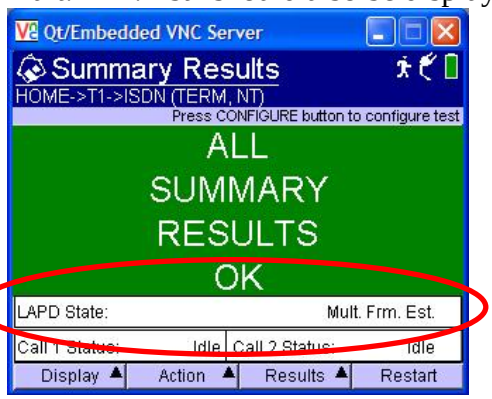
Step	*Action*	*Det-ails*
1.	Install SIM	Install T1 SIM on the HST-3000
2.	Power On	Press the green Power Key to turn on the HST-3000.
3.	Launch Test App	Press the **T1** Soft key. Press the **Down Arrow** key to select **ISDN PRI**, then press the **OK** key to launch the ISDN PRI test application. 
4.	Load Config	Press the **Configure** Navigation key to configure ISDN test setting. If a configuration template has been previously stored, press the Left Arrow key to select the **STORAGE** tab and display the **Config Store** menu. Select **Load Config**, select the desired Configuration template, and press **OK**. 

5. Configure Test

Using the **Right Arrow** key to scroll through menus, configure ISDN PRI test setting as follows. Leave all other values at default, unless specified in the Work Order:

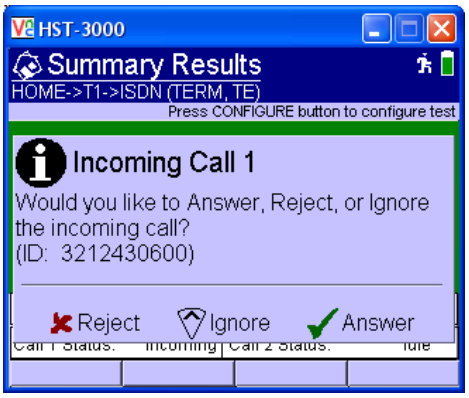
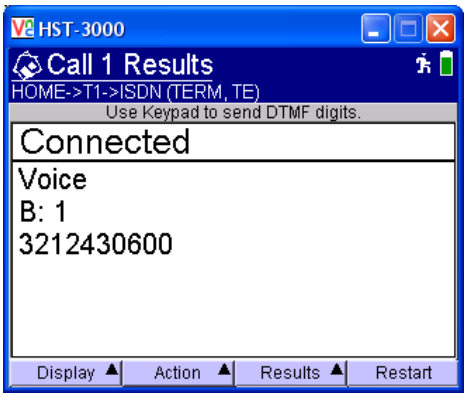
Menu	Option	Value	Comment
DS1	Test Mode	Terminate	
	Rx Input	Terminate	
	Framing	ESF	
	LBO Level	0	
	Line Code	B8ZS	
	Tx Clock	Recovered	
	Single/NFAS	Single	
ISDN	Emulation	TE Emulation	
	Call Control	See Work Order	If not specified, select “National”
	Numbering Type	Auto	
	Numbering Plan	ISDN	
	PRI D Channel	24	
	D Channel Rate	64K	
CALL	Dial Mode	Dual Call	
	Bearer Capability	Voice	
	Channel	Any	
	Directory Number	See Work Order	Enter Billing Telephone Number for the PBX
	Number To Call	Enter your 10 digit cell phone number	
	Call Answer Mode	Prompt	
	Pres. Ind. Status	Disabled	
DECODE	Decode Filter	Enable	Suppresses the capture of RR Frames.
	L2 Filter	Enable	
	All Other Filters	Disable	

2.2 Connecting to the Circuit

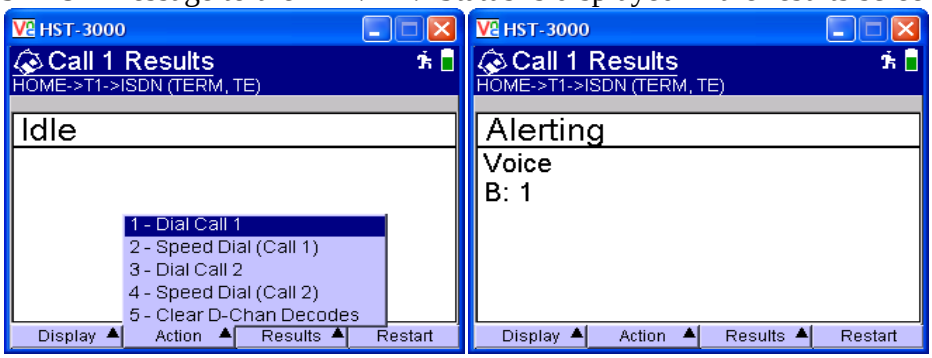
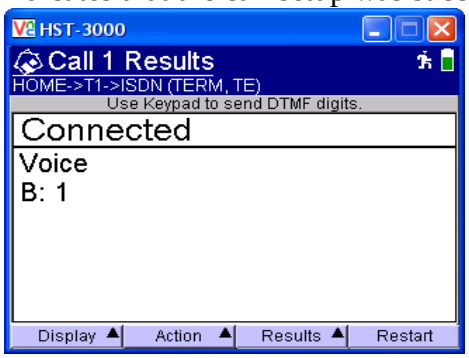
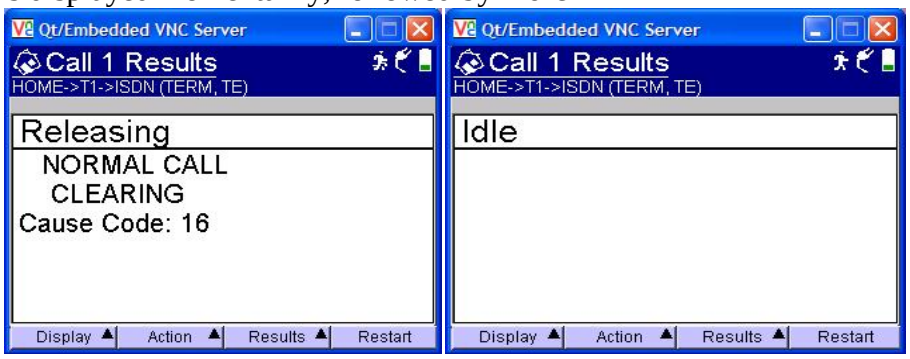
Step	*Action*	*Details*
1.	Connect	Connect the HST-3000 to the Network Termination (NT) or Integrated Access Device (IAD) using the RJ-48c to Dual bantam cable and the primary T1 connectors on the right side of the SIM. • If a straight through cable is required, connect the Blue bantam labeled **TRANSMIT** to the Primary Tx port of the T1 SIM. Connect the Red bantam labeled **RECEIVE** to the Primary Rx port of the T1 SIM. Connect the RJ-48c cable to the configured T1 port on the IAD/NT. • If a cross-over cable is required, connect the Blue bantam labeled **TRANSMIT** to the Primary Rx port of the T1 SIM. Connect the Red bantam labeled **RECEIVE** to the Primary Tx port of the T1 SIM. Connect the RJ-48c cable to the configured T1 port on the IAD/NT. 
2.	View Results	Press the **Home** key to display ISDN PRI Summary Results
3.	Check LED	A **Green** Sync LED indicates the HST-3000 has detected the T1 signal. 
4.	Restart	Press the **Restart** soft key to reset counter and alarms. **ALL SUMMARY RESULTS OK** should be displayed. "LAPD State: Mult. Frm. Est" should also be displayed. 

5.	Troubleshoot	If the **Sync** LED is not green or "LAPD State: Mult. Frm. Est." is not displayed, verify the following: • The HST-3000 is configured correctly, as outlined above. • The Port is configured properly and enabled in the IAD/NT. • Cables are good quality and properly connected. ➢ If a straight through cable is required, connect the Blue bantam labeled **TRANSMIT** to the Primary Tx port of the T1 SIM. Connect the Red bantam labeled **RECEIVE** to the Primary Rx port of the T1 SIM. Connect the RJ-48c cable to the configured T1 port on the IAD/NT. ➢ If a cross-over cable is required, connect the Blue bantam labeled **TRANSMIT** to the Primary Rx port of the T1 SIM. Connect the Red bantam labeled **RECEIVE** to the Primary Tx port of the T1 SIM. Connect the RJ-48c cable to the configured T1 port on the IAD/NT. If the **Sync** LED is still not green or "LAPD State: Mult. Frm. Est." is still not displayed, the HST-3000 failed to establish a datalink with the IAD/NT. Contact PRI Technical Support.

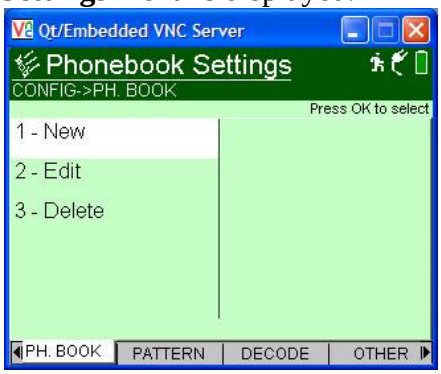
2.3 Inbound Call Testing

Step	*Action*	*Details*
1.	Dial	Using your cell phone, dial the Billing Telephone Number for the PBX.
2.	Answer	When an inbound call reaches the HST-3000, allow the call to ring at least 2 times. Confirm the Ring back tone is heard on your cell phone, and press the **OK** key to answer to call. "CONNECTED" indicates that the call setup was successful.  
3.	Converse	Confirm that Voice is heard and Voice Quality is good on the HST-3000 and on the Cell Phone.
4.	Disconnect Call	Hang up the call from your cell phone. Verify that the call state on the HST-3000 changes to **IDLE**

2.4 Outbound Call Testing

Step	*Action*	*Details*
1.	Dial	Press the **Action** soft key and select **Dial Call 1.** The HST-3000 sends a SETUP message to the IAD/NT. Status is displayed in the results screen. 
2.	Answer	Answer the incoming call on your cell phone. "CONNECTED" indicates that the call setup was successful. 
3.	Converse	Confirm that Voice is heard and Voice Quality is good on the HST-3000 and on the Cell Phone.
4.	Troubleshoot	If "**CONNECTED"** is not displayed in step 2 or voice is not heard in step 3, verify that the HST-3000 setup is correct and that your cell phone is working properly and repeat step 1. If "**CONNECTED"** is still not displayed, the test has failed. Contact PRI Technical Support.
5.	Disconnect Call	Press the **Action** soft key and select **Disconnect Call 1**. The Cause Code is displayed momentarily, followed by "**Idle**" 

2.5 Call Plan Testing

Step	*Action*	*Details*
1.	Phonebook	If Phonebook settings haven't been added yet, press the **Configure** Navigation key. Press the Right Arrow key until the **Phonebook Settings** menu is displayed. 
2.	Add Entries	Select **1 –New**, enter a descriptive name at the prompt, and press the **OK** button. At subsequent prompts, enter a Phone Number, Numbering Type , and Numbering Plan. Repeat this step for the desired numbers in your Call Plan. Numbers may include the following:
3.	Results	Press the **Home** key to return to the Results screen.

Name	*Number*	*Numbering Type*	*Numbering Plan*
Toll_Free	1800xxxxxxx	National	ISDN
Off_network	xxxxxxxxxx	Local	ISDN
On_network	xxxxxxx	Local	ISDN
Long_Distance	1xxxxxxxxxx	National	ISDN
International	011xxxxxxxxx	International	ISDN
Blocked_Call	xxxxxxxxx	National	ISDN
Community_services	211	Local	ISDN
Government_services	311	Local	ISDN
Directory_assistance	411	Local	ISDN
Traffic	511	Local	ISDN
Police_non-emergency_services	511	Local	ISDN
Customer service	611	Local	ISDN
TDD_relay	711	Local	ISDN
Public_utilities	811	Local	ISDN
Emergency_services	911	Local	ISDN

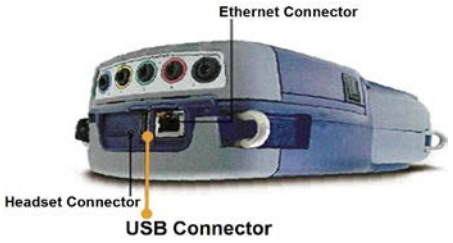
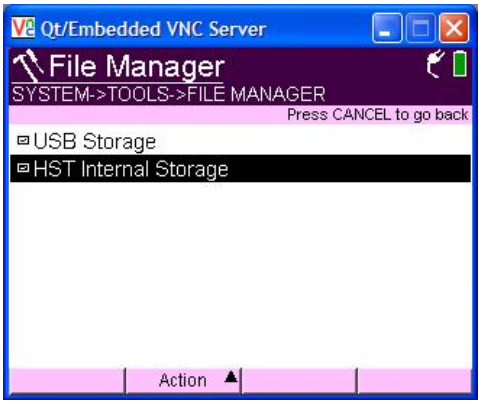
4.	Dial	Press the **Action** soft key and select **Speed Dial (Call 1),** select the first entry in the dial plan and press **OK**. The HST-3000 sends an SETUP message to set up the call. Call status is displayed in the **Call 1 Results** screen. Verify that you hear a ring back tone before the call is connected.

5.	Converse	Talk to the Called party and verify that voice quality is good for a period of at least 15 seconds.
6.	Disconnect Call	Press the **Action** soft key and select **Disconnect Call 1**. The Cause Code is displayed momentarily, followed by "**Idle**"
7.	Repeat	Repeat steps 4 through 6 for all numbers in the Speed Dial list.

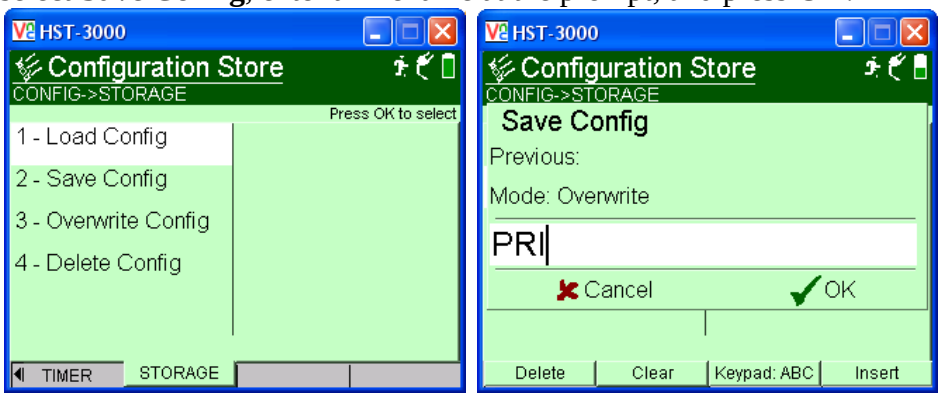
2.6 Viewing ISDN Decodes

Step	*Action*	*Details*
1.	Display	Press the **Right Arrow** key or the **Display** soft key to display D-Channel Decode Results
2.	View	Navigate through the messages: • Use the **Up** and **Down Arrow** keys to scroll through the text of a message. • Use the **Left Arrow** key to view the previous message in the buffer. • Use the **Right Arrow** key to view the next message in the buffer. • Use the **2nd function** key and the **Left Arrow** key to view the first message in the buffer. • Use the **2nd function** key and the **Right Arrow** key to view the last message in the buffer.
3.	Troubleshoot	Refer to Appendix 1: ISDN Decodes, Layer 3 on page 10, for an explanation of Layer 3 message flow.

2.7 Saving Test Results

Step	*Action*	*Details*
1.	Save Results	Press the **Results** soft key, select **Save,** and enter a filename to save the test results. Press **OK** after "<filename> was saved successfully" is displayed. Press the **Results** soft key again, select **Capture D-Chan decodes,** and enter a filename to save the Capture file. Press **OK** after "<filename> was saved successfully" is displayed. The files are saved to the /results/T1 folder.
2.	Connect	Connect the USB Flash Drive to the HST-3000's USB port on the top of the mainframe.  
3.	System Tools	Press the **System** Navigation key, and press the **TOOLS** soft key. Press the **OK** key to launch the **File Manager.**  
4.	Copy File(s)	Using the **OK** key, **Up Arrow** key, and **Down Arrow** key, navigate to the desired files in the /results/T1 folder. Press the **Action** Soft key and select "Copy to USB".

2.8 Saving Configuration Template

Step	*Action*	*Details*
1.	Save Config	If a configuration template has not been previously stored, press the **Home** Navigation key, then press the **Configure** Navigation key. Press the **Right Arrow** key several times to display the **Config Store** menu, select **Save Config**, enter a Filename at the prompt, and press **OK**. 
2.	Shutdown	Press the green power button to turn the unit off.
3.	Disconnect	Disconnect the USB Flash Drive from the HST-3000's USB port on the top of the mainframe.

Appendix 1: ISDN PRI Decodes, Layer 2

ISDN D channel decodes provide detailed information on maintenance of the D channel (Layer 2), as well as call related messaging (Layer 3). Layer 3 messages help the user to troubleshoot problems such as: who is disconnecting a call, why a call is rejected, or if calling party data is being provided. Layer 2 messages are used to troubleshoot malfunctions of the D channel itself such as: why the D channel will not establish, if a D channel link is being terminated or the cause for why a link is being terminated. This appendix addresses the messaging that takes place at Layer 2 and how they are involved in establishing, maintaining and terminating D channel communications.

LAPD (Link Access Procedure D-Channel) is the protocol used at Layer 2. There are 3 basic types of frames transmitted in LAPD:

- Supervisory frames - maintain link communications once the link has been established.
- Unnumbered frames - establish or terminate the D channel communications
- Information frames - contain Layer 3 call information

The following are Unnumbered frame types. Any of these messages can be sent from the network (NT) or the customer. (TE):

- SABME – Set Asynchronous Balanced Mode with Extended Sequence Numbering
- UA – Unnumbered Acknowledgement
- DISC – Disconnect (NOTE: Layer 3 also has a disconnect message, all references to disconnect in this section refer to Layer 2 and the D channel itself terminating)
- DM – Disconnect Mode
- FRMR – Frame Reject
- UI – Unnumbered Information

A SABME is the message that is sent to first establish D channel communications. The proper response, from the other end of the link, is a UA message. This is the initial handshake that is necessary to consider the D channel as operational.

The DISC message is the frame that is sent to terminate D channel communications. The proper response is also a UA. The DM can be seen as a negative response to the SABME request and would indicate that the node is not in a state that is ready for D channel communication. The DM may also be seen as a response to the DISC command and would be indicating that it is already in a disconnected state.

FRMR is sent when an unrecoverable link-level problem has occurred. This would occur on conditions that cannot be corrected by having a frame retransmitted (such as an invalid field content) and would be an indication of possible high level protocol issues between the two nodes.

UI frames are sent for link management activities that require some information exchange between the two nodes, such a TEI Request message which is sent by each BRI TE device during its initialization process.

Supervisory frames are used to maintain link communications once the link has been established. There are 3 supervisory frame types. Any of these messages can be sent from the network or the customer.

- RR – Receiver Ready
- RNR – Receiver Not Ready
- REJ – Reject

RR messages are the most commonly seen frames in D channel decodes. They are routinely exchanged between nodes as a keep-alive signal and are also used to acknowledge the reception of frames. The D channel is only allowed to be inactive (no frames sent) for a brief period of time. When there are no call related messages to send, the nodes will transmit RR frames to ensure that the D channel link remains in service. Failure to send frames within the allotted time period would be one reason for seeing a node terminate and re-establish the D channel. Timers that control activity such as this are programmable within the switches and are therefore a possible source of incompatibility between nodes. A receive sequence number field within the RR frame is used to inform the far-end node of the number of frames that have been successfully received by this node. A RR frame is indicating that the transmitting device is present, in service, capable of receiving traffic but does not currently have any call related messages to transmit.

A RNR message is sent when a node is experiencing difficulties (such as buffer depletion) and is informing the far-end node that it cannot accept any additional information frames (call related messages) at this time. RNR frames should rarely be seen and should be investigated by switch personnel as to their cause.

REJ frames are used to force retransmission of bad frames. Supervisory frames as well as information frames always contain sequence numbers. Some frame types have both send and receive sequence numbers and some only require receive sequence numbers. These numbers are used to keep track of the frames that have been transmitted or received by a node and are used during transmission of supervisory and information frames to ensure that all frames are properly communicated to the far end. Frequent REJ frames are a sign of miscommunications on the D channels, most likely due to frames experiencing errors during transmission.

When looking at D channel decodes, the TE>NT or NT>TE designation of the message will identify the source of the message. TE>NT indicates the message was sent by the Terminal Equipment (TE) whereas NT>TE indicates the message was sent by the Network Termination Equipment (NT). Complaints where it is pertinent to look at layer 2 messages include: failure to get the D channel to go in service, unexplained loss of D channel communications, excessive delays, or timeouts when trying to process calls.

Appendix 2: ISDN PRI Decodes, Layer 3

The following message exchange is a typical ISDN Layer 3 call setup sequence between ISDN Terminal Equipment (TE) such as a PBX or HST-3000, and ISDN Network Termination Equipment (NT) such as an IAD:

TE	NT
SETUP →	
	←CALL PROCEEDING
	← ALERTING
	← CONNECT
CONNECT ACK →	

In this example, the TE originated the call, but the same message types would have been exchanged for an incoming call from the network. In the following example, the TE disconnects the call by going on hook. The sequence would be the same if the disconnect originated from the network:

DISCONNECT →	
	← RELEASE
RELEASE COMPLETE →	

The Alerting message is not required and may not always be present. The Call Proceeding and Alerting are indications that the SETUP message has been received and that the network is attempting to process the call. The CONNECT message is the final indication that the call has completed and the calling party is connected with the called party.

These messages are formed by grouping together various different information elements. Some elements of the message are required (such as called number) and some are optional (such as calling party number). The following is an example of a PRI SETUP message decoded on the HST-3000.

TE>NT:R SAPI:000 TEI:000
TIME 09:35:00
PD=08…….CALL REFERENCE: **00100**

M	05	**SETUP**
I	04	**BEARER CAPABILITY**…..…….Len=3
	80	Coding Standard……..…….……..CCITT
		Transfer Capa…….……SPEECH
	90	Transfer Mode……..…..……CIRCUIT
		Transfer Rate…….…..…….....64 kbp/s
	A2	Layer 1 Protocol……...…….u-law
I	18	**CHANNEL ID**……...…….Len=3
	A9	Indicated Channel……..……Exclusive
		Channel Selection……..……B1
		Channel Identifier……..Not D-CH
I	6C	**CALLING PARTY NUMBER**……...……Len = 8
	C1	Type of Address……....Subscriber
		Numbering Plan ID…….……..ISDN
		5551234
I	70	**CALLED PARTY NUMBER**…..…...……Len = 8
	A1	Type of Number…….....National Number

Numbering Plan ID……..……..ISDN
5551212

The first line in the decode display tells us is that message was sent from the TE to the NT. The next important field is the Call Reference Number. The call originator assigns the call reference number. All other messages exchanged for this call will have the call reference number set to the same value. When viewing an active D channel, with messages for multiple calls, this field allows you to "match up" which message is for which call. Do not assume that the next message in the decode pertains to the same call. Always check the call reference value for a match.
On the next line, SETUP identifies the type of message being sent. As shown in the first example, SETUP is the first message sent when attempting to place an ISDN call. Bearer Capability, Channel ID, and Calling Party Number and Called Party Number are all information elements. Each element contains some type of information pertinent to the call. Fields of interest are: Transfer capability, Channel Selection, Calling Party Number (5551234) and Called Party Number. Transfer capability identifies whether it is a voice call or a data call. In this example the call is coded as SPEECH (voice). The Calling Party number identifies the party that is placing the call (5551234). Called party provides the phone number that the calling party is attempting to reach (5551212). These fields, within the setup message, give you the basics about what type of call is being attempted.

The next most valuable message types, when analyzing decodes, are the DISCONNECT and RELEASE messages. The following is an example of a DISCONNECT message.

TE>NT:R SAPI:000 TEI:000 TIME 09:35:00
PD=08…….CALL REFERENCE: **00100**

M	45	**DISCONNECT**
I	08	CAUSE…….Len = 02
	82	Coding Standard……..……CCITT
		Location…….Public Network
	90	Class……..…..Normal Event, Normal Clearing

The Disconnect message contains the CAUSE or reason for the call being disconnected. If the call never makes it to the CONNECT stage, but is immediately rejected by the network, the DISCONNECT step may be skipped and the RELEASE message will contain the cause information. In the above example, the cause was Normal Clearing. This cause code is sent when a call terminates normally because a user hung up the phone. When calls are not completing properly, the CAUSE field can provide valuable clues as to why the call did not complete. There are dozens of cause codes but the following are some of the codes seen for common problems.

- **16** Normal Call Clearing: No fault detected, the call is finished.
- **18** No User responding: No response to the call attempt within the allowed time.
- **21** Call Rejected: The receiving equipment refuses to accept the call. This is most commonly seen on BRI lines when the SPID information is not correct. Typically off of a 5ESS switch.
- **28** Invalid Number Format: Call can't be complete because the number is incomplete or in a format not considered valid by the receiving equipment. This can occur when the number sent does not match the dialing plan. Numbers sent as subscriber plan are normally expected to be 7 digits or less and numbers sent as national dialing plan are normally expected to be more than 7.
- **31** Normal Unspecified: The preverbal catch all but often seen when the call is terminating into something like a fast busy.

- **44** No channel available: The requested circuit/channel is not available. This cause is returned when the circuit or channel indicated by the requesting entity cannot be provided by the other side of the interface.
- **57** Bearer Capability not Authorized: The caller has asked for a call type or service that is not implemented in the receiving equipment for this line. Usually seen when trying to place voice calls on data only lines or vice versa.
- **88** Incompatible Destination: Destination is not capable of supporting the call type requested. Usually seen when trying to place data calls to a voice phone.
- **100** Invalid Information Element Contents: Protocol problem where the receiving equipment does not understand one of the fields inside of the call setup message. Verify the call control is correct (National or Custom). Normally would require a Tier II or Tier III technician or switch vendor to isolate and resolve.
- **102** Recovery on timer expiry: No response to generated messages. Can be seen on PRI NFAS circuits when equipment is trying to generate call activity on the backup D channel and not on the currently active D channel.

The message type and information elements within the messages can help to isolate and resolve call setup problems. Fields and exact message contents will vary depending on type of call control and the type of call being placed but the basic principles of call setup will remain the same. To be successful, try to limit the D channel capture time to cut down on the volume of messages that have to be screened. Ignore all **RR** messages as they are merely keep-alive messages and contain no call information. Try to get a detailed description of the failures being reported. Are they just to one phone number? Perhaps all long distance calls or all international calls? Inbound versus outbound? This information can help give you an idea on what to look for and what you can ignore in the Decode buffer. Busy PRI lines can generate an enormous amount of D channel messages in a short period of time. Sometimes knowing what you can ignore can help as much as knowing what to look at.