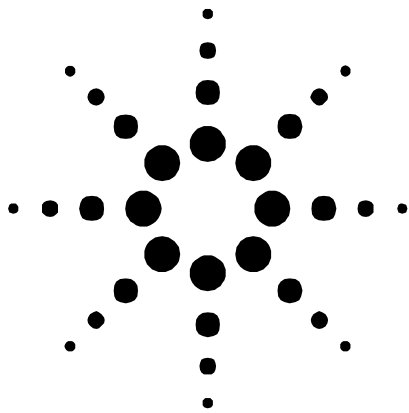# NNI Signalling Test Software Helps Ensure Seamless ATM Networks

Agilent Technologies Broadband Series Test System
Application Note

Introduction

Interconnecting the islands of ATM that exist today in public networks is an important step toward realizing the promise of broadband services. The Network Node Interface (NNI) signalling protocol is the link that makes it possible to interconnect and interwork ATM networks bringing us closer to having a global broadband communications network that seamlessly carries applications for video, frame relay, fast Internet access, and even voice.

Procedures and tools for testing NNI signalling protocols will play an important role in ensuring the integrity of NNI links in these seamless ATM networks. Just as importantly, NNI testing will help network operators to record consistent and accurate information for their billing systems, and it will assist network operators in delivering quality of service contracts for their customers.

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Two Flavors of NNI Create More Test Issues

Responding to industry demands, both the ATM Forum and the ITU-T have published versions of the NNI. The ATM Forum standards are used by private network operators and is called the PNNI. However, public network operators have been uncomfortable with the design of the routing functions in the PNNI, which would force them to expose their proprietary network topologies and network routing mechanisms.

Also, the PNNI does not support centralized billing. Thus public network operators worldwide have elected to standardize on the ITU-T's version of the NNI, which permits them to use their Signalling System 7 (SS7) networks, which are already in place and which are private to each operator, for deployment of highly reliable billing systems, intelligent networks, and other network management functions.

B-ISUP Protocol for NNI Signalling

Signalling has become the means by which network operators do billing, pass on user profile information, pass on equipment capability information, and route signals from one end of the network to the other.

The Broadband ISDN User Part (B-ISUP) protocol of the ITU-T NNI facilitates signalling between ATM switches (or ATM switches and the SS7) within a public network, and between ATM switches across other public networks. Based on the Narrowband ISDN User Part (N-ISUP), the B-ISUP has been enhanced for deploying switched virtual circuit (SVC) services over public ATM networks. It supports call and connection control at the NNI and at the User Network Interface (UNI) as well, as shown in Figure 1.
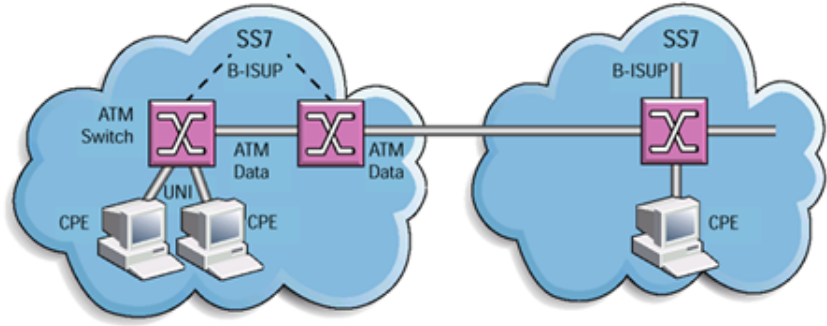

Figure 1: ATM interworking with ITU-T Network Node Interface (NNI).

A number of ATM network operators and core switch manufacturers have begun to actively develop and implement the B-ISUP protocol for their ATM networks.

Challenges of B-ISUP Implementation

To be first to market with ubiquitous broadband services, network operators are pushing ATM switch manufacturers to shorten their design, integration, and manufacturing cycles. To accomplish this, switch manufacturers must get their design right the first time, quickly locating and troubleshooting any problems.

Designing ATM network equipment is inherently complex. Adding to the complexity is the fact that NNI standards are continuing to evolve and new versions of the protocols are published periodically. Both manufacturers and network operators must contend with variants of the protocol implementation resulting from different interpretations of different versions of the standards. Interoperability testing will be an important part of NNI protocol implementation.

New Software Eases NNI Protocol Implementation

New software for the Agilent Broadband Series Test System (BSTS), E4217A NNI B-ISUP Signalling Test Software, provides features for analysing and verifying NNI protocols. It supports the monitoring of signalling messages with a live display, emulation of the SSCOP, SSCF, and MTP-3b, and simulation of the B-ISUP.

Switch manufacturers can use the software to identify and troubleshoot design flaws and to verify fixes. Network operators can use it to evaluate equipment from different manufacturers, to help create new services, and to aid regression testing.

The E4217A software offers manufacturers and network operators alike a first step at solving their implementation issues by providing the following:

- B-ISUP simulation and call generation
- B-ISUP protocol data unit (PDU) builder
- MTP-3b decode and partial emulation
- SAAL decode and emulation
- First step to address UNI and NNI interworking
- Basis for developing B-ISUP conformance tests

Major Features of the NNI B-ISUP Signalling Test Software

- SSCOP, SSCF, and MTP-3b reference emulation state machines
- B-ISUP decode and encode
- MTP-3b decode
- MTP-3b User Programming Environment (UPE) for emulation state machine
- SSCF UPE library
- SSCOP decode and encode
- SSCOP UPE library
- B-ISUP call setup and release generation test script (UPE sample program)
- Configurable emulation state machine via UPE(e.g., stack configuration, behavior, timer expires)
- Detailed analysis of signalling messages (complete message decoding)
- Diagnostic trace messages from emulation(e.g., state change, timer expiry, protocol violation)
- Easy-to-use powerful message editor for B-ISUP and SSCOP
- Bidirectional live data viewer
- Two signalling VCs per E4209B Cell Protocol Processor module

Supported ITU-T standards

- B-ISDN User Part (B-ISUP)
  - Q.2761: Functional description
  - Q.2762: General functions of messages and signals
  - Q.2763: Formats and codes
  - Q.2764: Basic call procedures
- MTP-3b
  - Q.704: Functional description
  - Q.2210: Level 3 functions and messages using the services of ITU-T recommendations Q.2140
- AAL-Service Specific Part
  - Q.2140: Service specific coordination function for signalling at the Network Node Interface (NNI)
  - Q.2110: Service Specific Connection Oriented Protocol (SSCOP)
- AAL-5
  - AAL-Common part

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Running NNI Protocol Tests

You can run a typical NNI protocol test to detect and determine the causes of interoperability problems; to validate the syntax of signalling PDUs; or to verify the correctness of protocol state machine implementation. For this type of testing, the Agilent BSTS and NNI software are configured for emulation, with a single port or with dual ports.

A single port configuration consists of one cell protocol processor, or CPP, and one line interface, or LIF. With a single port configuration, you can perform active testing and monitor both sides of the protocol exchange with the live data viewer. A dual port configuration requires two CPPs and two LIFs. A dual-port setup allows you to emulate two network nodes. See Figures 2 & 3.

Because the software provides reference state machines for SSCOP, SSCF, and MTP-3b, you can easily verify implementations of these protocols. For example, to test the B-ISUP call control procedure, you first activate SSCOP, SSCF, and MTP-3b emulation. See Figure 4. Then, using a sample program from software's default library, you can generate the NNI B-ISUP call and release messages, and you can modify the sample program using any text editor to test other B-ISUP procedures. In this example, to define call setup and release messages, you can use the powerful PDU editor of the Agilent BSTS to define fixed fields that include message type, message length, and message compatibility. See Figure 5.
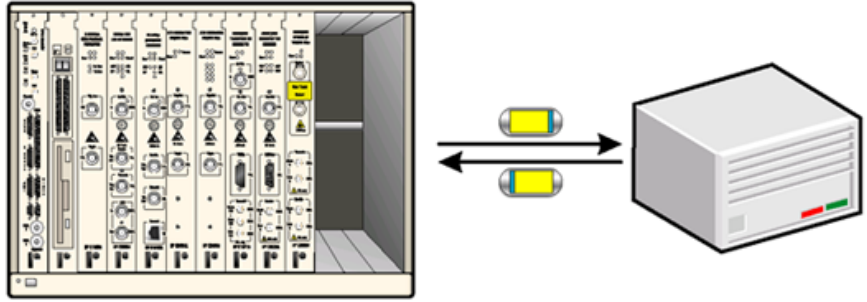

Figure 2: **Emulating one side of an NNI link.** By emulating a network node of an NNI link (for example, a switch, a router, or a hub), you can initiate and respond to call setups; test the handling of valid and errored messages and message sequences; and monitor the messages exchanged between the Agilent BSTS and the system under test. One CPP and line interface pair is required. During emulation, the CPP captures the data sent to and received from the system under test. All data is displayed on a single data viewer.
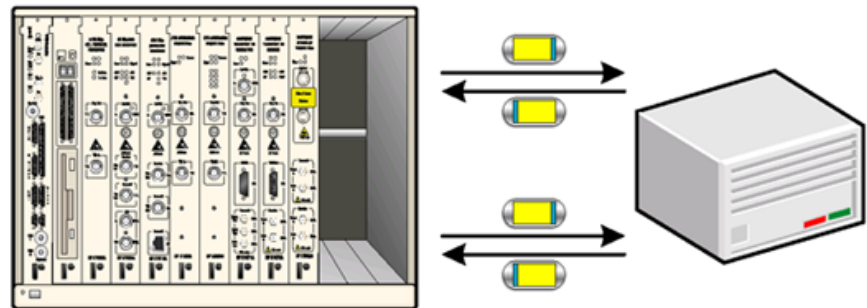

Figure 3:**Emulating two network nodes.** Emulating two network nodes enables you to verify that the system under test properly processes signalling calls and routes messages to their intended destinations. Two CPP and two line interface modules are used. Each CPP emulates one network node, receiving data from and sending data to the other network node.
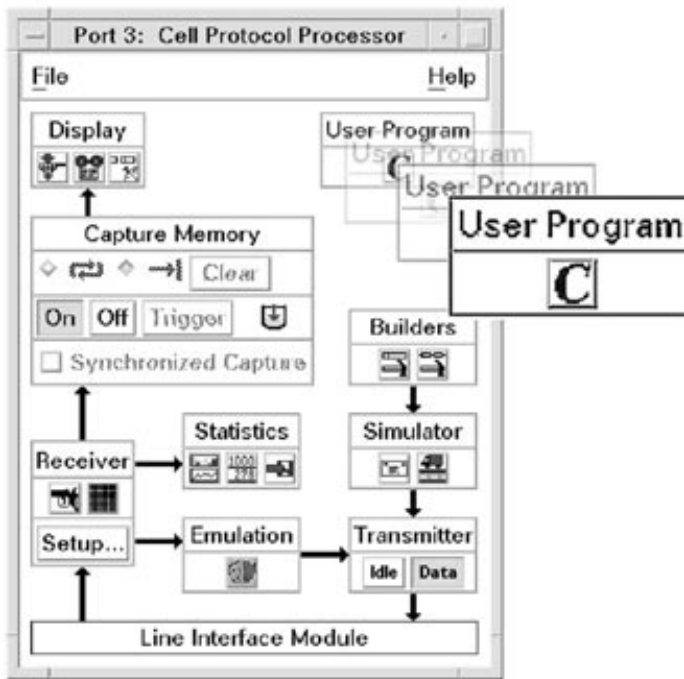
Figure 4: **Activating emulation functions.** Emulation functions are easily accessed and activated by selecting the User Programming Environment of the E4209B Cell Protocol Processor (CPP).To use the PDU editor to build and create B-ISUP messages see Figure 5.
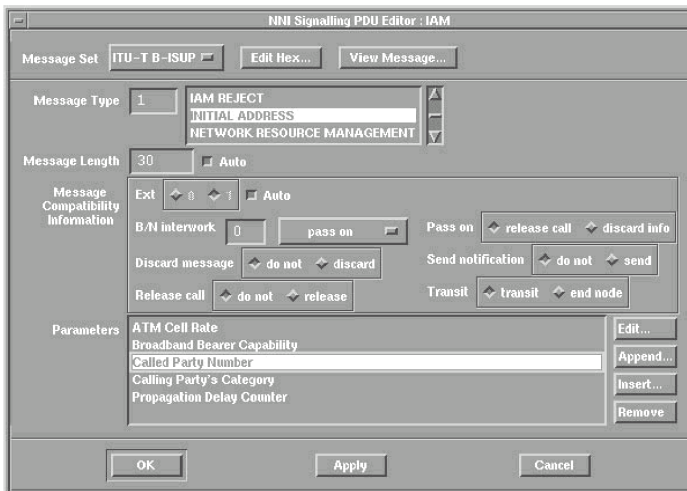

Figure 5: **Building and editing B-ISUP messages.** You can use the PDU Builder function to create B-ISUP signalling messages. After selecting ITU-T B-ISUP as the protocol variant or message set, you select INITIAL ADDRESS as the message type. Then you can modify other parameters-for example, you can select Called Party Number and edit the parameter as necessary.

The PDU editor provides lists of mandatory and optional parameters for the selected message types that can be included and positioned within a message. You can construct legal and illegal signalling messages, and you can view them as they are sent between the Agilent BSTS and the system under test on the live data viewer, which notifies you when decode errors occur. Protocol errors detected by the emulation can be reported as trace statements in the bi-directional live data viewer, and decode errors can be analysed using the playback viewer. See Figures 6 & 7.

Verifying Signalling Procedures

In order to verify that signalling between actual network equipment is proceeding correctly, you can use the test system and software for passive monitoring. In a dual port configuration, the Agilent BSTS monitors signalling message exchanges in both directions. See Figure 8. You can observe data traffic on an SVC established using any current Agilent BSTS ATM, AAL, and service layer protocol testing capabilities.
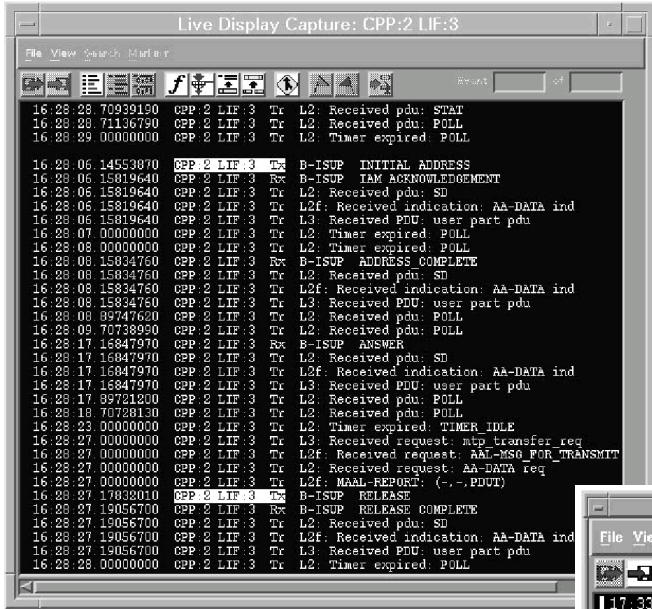
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Figure 6: **Viewing live data.** The Live Display Capture allows you to monitor data in real time, as it is transmitted. You can simply monitor the signalling messages sent by either side of an NNI link, or emulate a signalling device and monitor the data being sent to and from a system under test. During emulation, the viewer displays not only the data received from the system under test, but also the data transmitted to the system under test and trace statements generated by the protocol state machines.
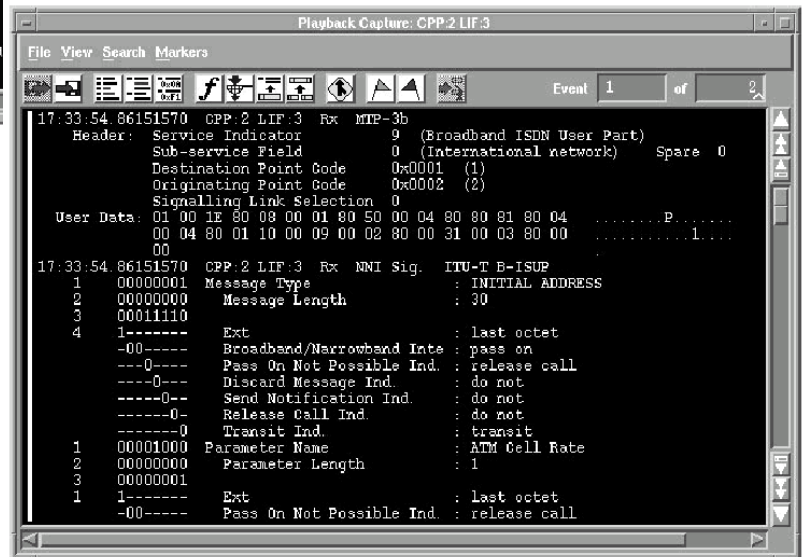
Figure 7: **Analyzing data off line.** Captured data can be filtered and displayed off line using the Playback Capture function. This playback viewer allows you to further analyse data, and to merge in chronological order the data captured by multiple CPP modules in the current test session.
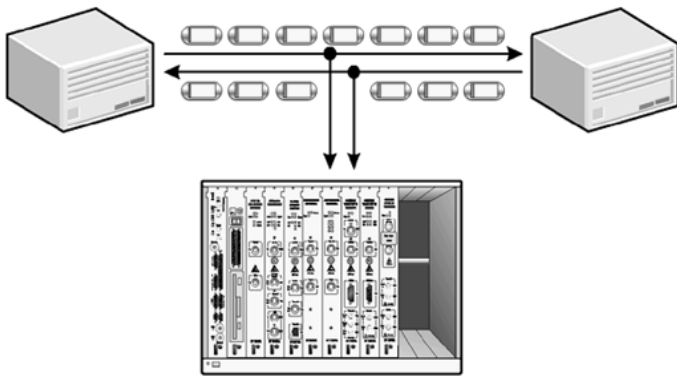

Figure 8: **Monitoring Two Systems Under Test** You can monitor the signalling messages exchanged between two network nodes of an NNI link (for example, between switches, routers, or hubs) in their attempt to establish and release calls. The BSTS is configured with two CPP and line interface pairs. One CPP captures the data sent by one network node, and a second captures the data sent by the other network node. The data from both CPPs is displayed in a single data viewer.

Testing UNI and NNI Interworking

To address interworking issues between UNI and NNI, you need to be able to look at both sides of a switch. Using the E4214A UNI test software and the E4217A NNI test software together (see Figure 9), you can look simultaneously at the UNI side and the NNI side of the switch with the same live data viewer, the same display, and the same relative time stamp. If you are checking a call setup problem, for example, these features will enable you to view corresponding messages in synchronization, which is a scenario difficult to achieve using two independent test systems.

The importance of signalling in ATM applications cannot be overstated. The NNI B-ISUP Signalling Test Software joins the growing family of signalling test products that help make the Agilent Broadband Series Test System the most powerful and flexible ATM test solution on the market. Other signalling products include the E4214A UNI Signalling Test Software and a comprehensive suite of conformance test software for UNI 3.0 and 3.1 protocol testing.
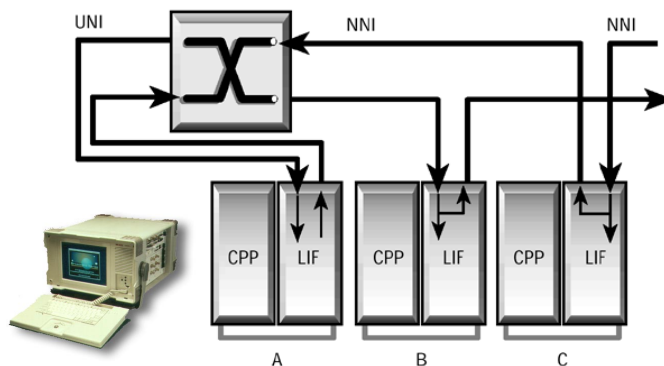

Figure 9: **Testing UNI and NNI interworking.** The Agilent BSTS can be used to test UNI/NNI interworking by configuring a three-port system that emulates UNI (Port A) and monitors NNI (Ports B and C) signalling messages.

Acronyms

AAL-5	ATM Adaption Layer 5
ATM	Asynchronous Transfer Mode
B-ISUP	Broadband ISDN User Part
BSTS	Agilent Broadband Series Test System
CPP	E4209 Agilent Cell Protocol Processor
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunications Union-Telecommunications Standardization Sector
LIF	Line Interface
MTP	Message Transfer Part
N-ISUP	Narrowband ISDN User Part
NNI	Network Node Interface
PNNI	Private Network to Network Interface
PDU	Protocol Data Unit
SAAL	Signalling ATM Adaption Layer
SS7	Signalling System 7
SSCF	Service Specific Coordination Function
SSCOP	Service Specific Connection Oriented Protocol
SVC	Switched Virtual Circuit
UNI	User Network Interface
UPE	User Programming Environment
VC	Virtual Channel

Broadband Series Test System

Agilent Technologies Broadband Series Test System

The Agilent Technologies BSTS is the industry-standard ATM/BISDN test system for R&D engineering, product development, field trials and QA testing. The latest leading edge, innovative solutions help you lead the fast-packet revolution and reshape tomorrow's networks. It offers a wide range of applications:

- ATM traffic management and signalling
- Packet over SONET/SDH (POS)
- switch/router interworking and performance
- third generation wireless tesing
- complete, automated conformance testing

The BSTS is modular to grow with your testing needs. Because we build all BSTS products without shortcuts according to full specifications, you'll catch problems other test equipment may not detect.

www.Agilent.com/comms/BSTS

Specifications subject to change.
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