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Network Troubleshooting

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Section III

Troubleshooting Wide-Area-Networks

Chapter 12

ISDN

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12.4 Troubleshooting ISDN

12.4.1 Gathering Information on Symptoms and Recent Changes

The first step in any troubleshooting process is to gather information. The more information you have about the symptoms and characteristics of a problem—including *when* it first occurred—the better your chances of solving the problem quickly and efficiently. Typical questions you might ask at this stage include:

- Was there any change in any hardware or software network component?
- Do the symptoms occur regularly or intermittently?
- Is it possible to reproduce or recreate the symptoms?
- When was the first occurrence of the symptom?
- Are the symptoms related to certain applications or connections, for example, outgoing or incoming calls only, or do they affect all network operations?
- Has anyone connected or disconnected equipment to/from the network?
- Has anyone replaced or installed an interface card in a computer?
- Has anyone stepped on a cable?
- Has any maintenance work been performed in the building recently (by a telephone company or building maintenance personnel, for example)?
- Has anyone (including cleaning personnel) moved any equipment or furniture?
- Has there been severe weather (thunderstorms, tornados) in the vicinity (North America, rural areas)?
- Is the network up and running?
- Does a service provider (Internet Service provider) experience general problems in your area?

As with any network topology, troubleshooting ISDN is greatly facilitated if records of the main operating statistics have been maintained prior to the occurrence of the error in question. In an ISDN network, it is also important to have detailed descriptions and user guides/manuals of all ISDN network components (such as bridges, ISDN routers, computer systems with ISDN cards, PBXs, and ISDN telephones), including configuration data and details about physical BRI/PRI interfaces, as well as the protocols and applications that are operated over ISDN lines. Statistics such as capacity use of B channels (peak and average values), sorted by service or by distribution of packet size (in the case of data transmission), can be compared with the corresponding data collected in the error situation: this often points directly to the source of the problem. Troubleshooting tools include an ISDN terminal device known to be in working order, an NT known to be in working order, and an ISDN analyzer—ideally an analyzer that can be used to simulate NT and TE interfaces, both BRI and PRI, as well as to monitor ISDN lines. In most cases a telephone connected to a different service, for example, a cell phone, can be used for testing outgoing and incoming connections.

The first step in diagnosis is to obtain a clear picture of the error symptoms. Is it possible to establish any connection at all on the ISDN line? Are existing connections cut off? Have response times in the ISDN line grown longer; has throughput diminished? What happens when the malfunctioning station is called from a telephone in another service, for example, a pay phone or cell phone?

Because most problems in networks occur in the physical layer, ISDN is no exception; the troubleshooting procedure should start with basic checks. This includes checking the physical interfaces and monitoring ISDN Layer 1 functions. If the symptoms seem to indicate a particular network component (an ISDN card, an ISDN telephone, or an NT), the next step is to replace the

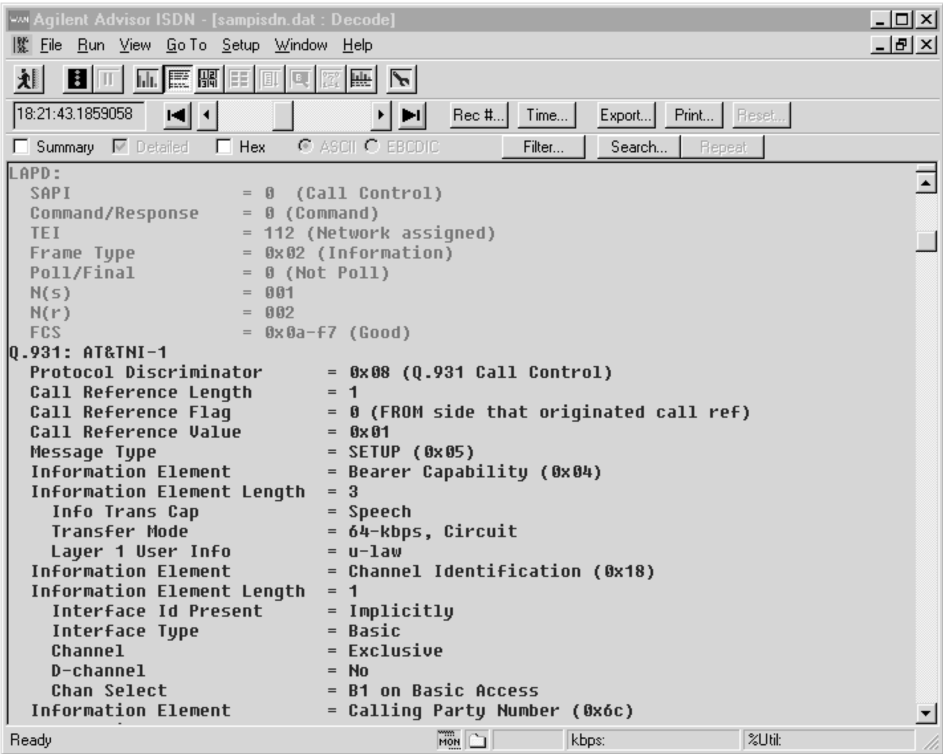

Figure 12.17 Using a protocol analyzer to decode ISDN Q.931 signals: SETUP message

component in question with one that is known to be in working order. If this does not resolve the problem, the next step is to check log data gathered by components in the affected network, such as routers and ISDN cards, for any error indication and to check the configuration of these components. If the source of the error still cannot be found, the use of an ISDN tester to check ISDN Layer 1, as well as the signaling and bearer channel protocols, is suggested. On a BRI line, Layer 1 should reach the Info 3 or 4 state automatically. On a PRI line, test the voltage level, the Layer 1 alarm states (AIS, RAI, CRC), the power supply to the NT (green LED on), and the PRI and U_{k2} (red LEDs off).

If the collected data corroborates that the physical layer connection can be established, then the LAP-D protocol should be analyzed. If no errors are detected there, the next step is to examine signaling procedures on the D channel. Figure 12.17 shows an ISDN SETUP message decoded by a protocol analyzer.

If problems persist despite the fact that ISDN connections can be set up successfully, the user data on the B channels must be analyzed. Factors to be checked include the bit-error rate (BER), capacity use, and the transport protocols used (such as IP or X.25).

12.4.2 Error Symptoms in ISDN

The three most common error symptoms in ISDN networks are a) problems establishing connections, b) interruptions of active connections, and c) significant losses of network performance accompanied by long response times in ISDN applications.

By far the most frequent symptom is the failure to establish a connection when a call is placed from an ISDN telephone or from a computer system with an ISDN card. This type of problem is usually the result of errors in the physical layer (OSI Layer 1); the cause is seldom found in higher layers. Typical causes include faulty power supplies, line breaks, miswired connectors, lack of terminating resistors (BRI), faulty network components (ISDN router ports, ISDN switches, ISDN PC cards, ISDN telephones), or noise on the line. Additional causes in PRI lines can include faulty grounding or faulty shielding in the cables between NT and TE. T1/E1 lines are usually terminated at digital cross connects or patch panels, which may introduce additional reasons for faulty connections, starting with using the wrong type of patch cords or termination resistors, ambiguous labeling of the patch panels, or simply patch cords plugged into the wrong connectors. Incorrect configuration of ISDN interfaces is another common source of errors. A terminal device on a BRI line operated in point-to-point mode rather than in bus mode, for example, results in frame collisions that make it impossible to establish a connection on the physical layer. TE equipment for primary rate interfaces generally require the correct settings of the framing format, line encoding, and the selection of the correct time slot assigned for the signaling channel. In the North American T carrier systems, it is also essential to know the T1 line service type. Due to some legacy services, T1 lines with Zero Code Substitution (ZCS) or Digital Data System (DDS) services cannot transmit unrestricted digital data at 64 Kbit/s. Certain local exchange carriers still offer a maximum data rate of 56 Kbit/s only. The TE equipment must be configured accordingly. The most common errors in Layer 2 occur in the TEI assignment procedure. If the ISDN components involved do not agree on the mode of TEI assignment (manual or automatic), then no communication is possible on the LAP-D protocol level and connection setup fails. Another error associated with TEI assignment is the duplicate assignment of a single TEI value: this also makes it impossible to establish a connection. For the evaluation of Layer 2 TEI assignment problems, it is essential to know how many Layer 2 links are required and configured (TEI values), which links are configured for fixed TEI values, and which ones are for automatic TEI assignment. In North American networks with at least NI-1 capabilities, the SPID values have to be entered into the terminal equipment's memory, therefore the user must be familiar with the configuration procedure for a particular terminal equipment.

Problems on ISDN Layer 3 can have any of a number of causes. Typical examples include incompatibility of Q.931 variants (national ISDN versus Euro-ISDN, for example), incompatibility or unavailability of ISDN services, incorrect implementation of ISDN protocols, and incorrect input of the subscriber number for the call destination.

When established connections are cut off, this is most likely due to the absence of keep-alive frames, such as Receive Ready frames (Layer 2) or Status Enquiry frames (Layer 3). This type of error is usually caused by a high bit-error rate or by terminals that are too slow in responding to polling frames. In North American networks the failure to respond to the periodic line audit (that is, identity check request messages over the broadcast link SAPI 63, TEI 127) will result in a TEI removal procedure by the network.

Long response times in applications operated over ISDN links may also be part of normal operating behavior if B-channel bandwidth is restricted, for example, or if a system that is accessed over ISDN necessitates a call setup for each transaction. If the ISDN router is configured to clear down connections automatically after a short period of line inactivity (to minimize connection costs), the necessity of re-establishing the connection means a few seconds' delay every time the application is accessed. If connections can be established only through the dial-back mode—that is, the calling party is called back by the remote station so that two call setup procedures take place for each call—this can slow network performance considerably. Another reason for long response times, however, might be incorrect configuration of the B-channel transport protocol. If this is the case, timers may expire too often or the window size may be too small. Other causes include problems in activating B channels, which is often the case when using multilink Point-toPoint protocol (PPP). If the threshold configured in the router for activation of the second B channel (of a BRI) is too high, then the second channel may be activated too late, deactivated too early, or not activated at all. As a result, the ISDN line appears to be overloaded even though the theoretical total bandwidth is not being used.

It is important to keep in mind the difference between the Point-to-Point and Point-to-Multipoint (that is, bus) ISDN line configurations. As described previously, the PRI can be operated only inPoint-to-Point mode, while BRI lines can be configured in either mode. If a large PBX is operated over multiple S_0 lines, for example, these generally should be configured for Point-to-Point operation because all connections go through the PBX, not between other devices on the same S_0 bus. If the line is configured for the wrong operating mode, TEI assignment cannot be performed correctly and network operation is impaired.

12.4.3 Symptoms and Causes: ISDN

Symptom: No Connection

Cause (1): Faulty cabling or connectors.
Cause (2): Power supply failure.
Cause (3): Crossed wires (in BRI).
Cause (4): Wrong number.
Cause (5): Faulty network components (ISDN router port, terminal adapter (TA), PBX, interface card, telephone).
Cause (6): Incorrect configuration of the ISDN interface (ISDN card, router port, or PBX).
Cause (7): Noise; high BER.
Cause (8): Problems in TEI assignment (manual vs. automatic mode).
Cause (9): Duplicate TEIs.
Cause (10): Incompatible Q.931 variants (national ISDN vs. Euro-ISDN).
Cause (11): Incompatible ISDN services.
Cause (12): Q.931 implementation errors.
Cause (13): Wiring faults on the S_0 bus.
Cause (14): Lack of terminating resistors on the S_0 bus.
Cause (15): Faulty grounding (PRI).
Cause (16): Non-shielded cabling between NT and TE (PRI).
Cause (17): Signaling messages are sent with wrong TEI value in the case of multiple signaling links (BRI North America).

Symptom: **Frequent Connection Loss**

Cause (1): High BER.
Cause (2): Slow terminal equipment.
(Receive Ready (RR) or Status Enquiry responses too slow).
Cause (3): Application does not respond.

Symptom: **Long Application Response Times over ISDN**

Cause (1): Additional call setup time due to automatic connection clear-down (during idle times) by the ISDN router.
Cause (2): Router does not activate additional B channels at high traffic load.
Cause (3): Small window size of the application protocol (such as IP) used over the B channel.
Cause (4): Timers expire in B channel application protocols.
Cause (5): Application is busy.
Cause (6): Rate adaptation handshake fails due to wrong terminal application settings.
Cause (7): Calling/called station is a mobile station.
Cause (8): Call not end-to-end ISDN.

The following list summarizes the most frequent sources of problems with ISDN (in alphabetical order):

- Call forwarding is active; no incoming calls
- Crossed wires (in BRI)
- Duplicate TEI assignment
- Electromagnetic interference
- Incorrect filter settings in the router
- High bit-error rates
- Incorrect input of multiple subscriber number (MSN)
- Incorrect physical installation of router or switch: loose cabling, connector, plug-in module, or card; faulty wiring on the back plane
- ISDN interface card defective
- ISDN interface incorrectly configured
(ISDN interface card, router port, PBX, ISDN telephone)
- ISDN line blocked or not enabled by service provider

Figure 12.18a The most common causes of ISDN problems

- ISDN network interface card incorrectly configured
  (wrong interrupt, driver, or timer configuration, etc.)
- ISDN router port defective
- Incompatible ISDN services; services not available
  (not ordered from ISDN provider)
- ISDN telephone defective
- Line breaks (in plug or cabling)
- Long response times due to automatic connection clear-down settings in the router
- Loose or defective connectors on network interface cards, in wall jacks, or patch panels
- No grounding (PRI)
- No terminating resistors on the S_0 bus
- NT defective
- PBX defective
- Power supply defective
- Protocol configuration in the router incorrect (address tables, mapping tables, subnet masks, default gateways, routing tables, timers)
- Q.931 implementation incorrect
- Q.931 variant incompatible (national ISDN vs. Euro-ISDN)
- Router does not activate the second (or nth, in PRI) B channel (configuration error)
- Router settings incorrectly configured: port not active, wrong operating mode, protocol not active
- Slow terminal devices (RR or Status Enquiry responses too slow)
- TEI assignment problems (manual vs. automatic mode)
- Terminal adapter defective
- Timers expire in B channel application protocols
- Unshielded cabling between NT and TE (PRI)
- Window size too small in the application protocol (such as IP) on the B channel
- Wrong number called

Figure 12.18b The most common causes of ISDN problems