Troubleshooting Analogue and Digital Dial Services

Session: 2903
Anatomy of a Voiceband Modem Call
Overview of Today’s Sessions

• Anatomy of a Voiceband Modem Call
• Understanding What V.90 Wants
• Verifying Basic Modem Performance
• Troubleshooting Individual Modems
• Troubleshooting Undesired Connection Problems

• Session Abstracts

• This session presents a model for troubleshooting voiceband modem performance problems. We will begin by mapping out the components of a modem connection in the modern PSTN. We will then examine the aspects of the connection that are relevant to common modem problems such as trainup failures, lower than desired connection speeds, poor throughput, and

• unexpected disconnects. We will cover the use of troubleshooting tools such as client and server side status reports, Cisco IOS software debugs, and audio analysis.
## Modem Protocol Chart—Transmission Plane

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<th>Protocols</th>
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<td>Modem Protocol Chart—Transmission Plane</td>
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<td>Loopstart Analog Local Lines</td>
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<td>E&amp;M Analog Trunks</td>
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<tr>
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<tr>
<td></td>
<td>SONET, HDSL, 2B1Q, etc.</td>
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</tbody>
</table>
What an Analog Modem Has to Work with:

- A passband between 2.4 and 4 Khz wide
- Some amount of near-end and far-end echo
- SNR between 25 and 40 dB
- Some amount of attenuation, hopefully < 20dB, increasing at higher frequencies (slope)
POTS Call Through the Modern PSTN

Telco Network

Analog 2 Wire

DS0 Trunks

Switch

DS0 Trunks

Switch

Analog 2 Wire

Signaling Network

Analog

Digital

Analog
Analogue modems modulate a digital signal (up to 33.6 Kb) in a 3.1 KHz analog channel which is transmitted through the network in a 64 Kb DS0, silly, isn't it?

How to take advantage of the digital nature of the PSTN to achieve faster speeds between the DTEs?
• How to take advantage of the digital nature of the PSTN to get faster speeds between the DTEs?
• The best way: ISDN—run pure digital end-to-end, and use the full 64Kb DS0 (but costs more)
Digital Modems in the PSTN

How to Take Advantage of the Digital Nature of the PSTN to Get Faster Speeds between the DTEs?

- **The cheap, complicated way: PCM modems**
  - Analog (client) PCM modem transmits an analog signal
  - Analog modem receives a digital (PCM) signal

- Traditional modem modulations - V.34, V.32bis, V.22bis, etc. - operate on a 3.1KHz (or so) analog voiceband channel.

- With PCM modulations - V.90, K56Flex, X2 - the digital modem directly transmits PCM codewords into the digital PSTN fabric.

- Since in the downstream direction (receive) there is digital to analog conversion, there is no loss due to quantization error. Hence higher speeds (upto 56Kbps ideally) are attainable.

- In the analog -> digital direction (or the upstream direction), a subset of V.34 is used.
PCM—Pulse Amplitude Modulation

- PCM modems do not modulate a carrier
- Information is carried as amplitude pulses encoded in the mu/A-law digitally encoded samples (PCM data)
- This is possible only because the transmit modem is directly connected to the digital network

PCM Modems Use a Technique Called Pulse Amplitude Modulation (PAM); Information Is Carried in the Amplitude of Each PCM Digital Sample

- PCM Modulations
  - X2—pre-standard PCM modulation from 3COM (USR)
  - K56Plus—pre-standard modulation from Rockwell (now Conexant)
  - K56Flex—Rockwell and Lucent’s update to K56Plus
  - V.90—ITU-T PCM standard
The V.90 Standard

- Ratified by the ITU-T in 9/98
- V.8 for capabilities; V.8bis is optional
- 28 to 56k in 1333 bps steps
- 3200/3000 Hz uplink support required (31200 bps); 3429 Hz optional
- Fractional digital pads detected via DIL (Digital Impairment Learning)
What V.90 Wants
What V.90 Wants…Piece by Piece

- Client DTE
- House Wiring
- Local Loop
- DS0 Circuit through PSTN
- Digital Line
- NAS
- Digital Modem
What V.90 Wants: Digital Modems

• MICA modems running good portware (2.7.2.0)
  
  Turn on digital pad compensation (S52=1) for higher speeds

• Microcom modems running good firmware (5.3.30)
  
  &F (digital pad compensation is on by default)
What V.90 Wants: NAS

• NAS model and Cisco IOS® version basically irrelevant to modem connections (NAS just passes DS0 through)

• Minimum Cisco IOS versions for V.90:
  - MICA: 12.0(1+)* 11.3(5+){T,AA,NA} (5300/3600)
  - Microcom: 11.3(5+){T,AA,NA} 12.0(1+)*

*This changes quite frequently. Please visit TAC page at www.cisco.com/tac and search on “Access” for the latest version information.
What V.90 Wants: Digital Line (T1, E1, BRI)

- Should have very low BER to switch
- PRI is better than RBS CAS CT1 (RBS damages 1333 bps per DS0)
  
  If CAS (RBS or R2), be sure NO signaling noise during call setup!

- Pure digital straight into digital switch: NO channel bank!
What V.90 Does **Not** Want: Digital Line

- Since V.90 requires a digital path from the digital modem to the last D/A on the client’s POTS line, a channel bank on the NAS access line will destroy V.90
- MICA is not supported in a channel bank application (because it doesn’t want to see near-end echo)
- Microcom is limited to mediocre V.34 in a channel bank topology
What V.90 Wants: PSTN Circuit

- Very few slips or BERs (fairly rare nowadays)
- No analog trunks (rare unless the NAS is connected to a PBX)
- Each RBS link destroys 1333 bps (unless they happen to align)
- No sub-64k coding (e.g. 32k ADPCM will limit you to 16800 bps V.34)
What V.90 Does Not Want in PSTN Circuit: Multiple D/A

Must Have Exactly One D/A Conversion in the Circuit!

Which Digital Modems Can Get PCM to Which Analog Modems?

- NASa to Client A?
- NASa to Client B?
- NASa to Client C?
- NASb to Client B?
- NASb to Client C?
- NASb to Client A?
Digital Pads and PCM Modulations

K56Flex can only cope with 3 and 6 dB digital pads (and has trouble with Nortel 3dB), K56Flex always does pad compensation (PCM level boost)

V.90 can learn any pad value, pad compensation is optional for V.90
V.90 Digital Pad Compensation

We Can Boost the PCM Amplitude if We Know There's a Pad

"I Can Build a PCM Constellation that Compensates for the Circuit Padding"

"OK, well I hear a 6dB Pad, So Boost Your PCM Signal"
V.90 with and without Pad Compensation

On This Circuit Path with a 6dB Pad, Turning on Pad Compensation Earned an Extra 4 kbps
What V.90 Wants: PSTN Circuit

• Basically, all V.90 really wants from the PSTN is a 64k clear channel data circuit, for the price of a POTS call!

• But, unlike 64k ISDN, V.90 can tolerate digital impairments, such as pads, a-law-to-u-law conversion, and robbed bits

• In the future: bidirectional V.90-like PCM? (“V.91”)

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Session: 2903   Networkers 2000
What V.90 Wants: Local Loop

- Less than 3 miles Good Old Twisted Pair Copper

- Less than 3 miles UTP
  - "Integrated" SLC
  - (Subscriber Line Concentrator)

or

PSTN

Digital Darrirer

PSTN
What V.90 Does **Not** Want:
Local Loop

- Load Coils (Every 18 kft on Long Loops)

  - PSTN

  or

  "Non-Integrated" AKA "Universal" SLC

  Digital Carrier

  PSTN
What V.90 Wants: House Wiring

• Note: V.90 does Not Require Any Particular House Wiring
• (in Fact, My Wiring Looks a Lot Like the Following Slide—Yet I Get Good V.90 Nonetheless)
• But: Poor House Wiring CAN Make the Difference
• between Good V.90 and Mediocre V.34
What V.90 (or V.34 for that Matter) Does Not Want: House Wiring

- 1. Crosstalk from Two Lines in the Same Quad Cable
- 2. Corroded or Shoddy Connectors
- 3. Bridge-Tapped Line Running Parallel to Fluorescent Light
- 4. Flat Silver Satin Parallel to Power Cable
- 5. Extraneous Equipment with Dubious Electrical Characteristics on the Same Line
Verifying Basic Modem Performance
Testing the DS0 Path Between NAS and Switch
Hook It Up Right—Prove Voice Path Through the LE

- The modem equivalent of a ping to the next-hop router
- Place a reverse telnet modem call out to the LE and back in again—should get a good 33600 (clear-channel DS0s), 31200 (RBS) or 26400 (channel bank) connection
$ telnet 172.16.24.116 2055 ! NAS IP, 2000+line
Trying... Connected.
access-3 line 26 MICA V.90 modems
atdt 5703932
CONNECT 33600 /V.42/V.42bis
access-3 line 52 MICA V.90 modems
router>term len 0
router>show modem log ! move some data
router>show modem op 1/1 ! µcom: “modem at”
  Param #9  TX,RX Bit Rate:  33600, 33600
  Param #11 TX,RX Symbol Rate:  3429, 3429
  Param #21 Signal Noise Ratio:  41 dB
  Param #26 Far End Echo Level:  -68 dBm ! <-55
Reverse Telnet Test—Good
Reverse Telnet Test—Bad

$ telnet 172.16.24.116 2055 ! NAS IP, 2000+line
Trying... Connected.
access-3 line 26 MICA V.90 modems
atdt 5703932
CONNECT 26400 /V.42/V.42bis
access-3 line 52 MICA V.90 modems
router>term len 0
router>show modem log ! move some data
router>show modem op 1/1 ! µcom: “modem at”
Param #9  TX,RX Bit Rate:  26400, 26400
Param #11 TX,RX Symbol Rate:  3200, 3200
Param #21 Signal Noise Ratio:  35 dB
Param #26 Far End Echo Level:  -39 dBm ! >-55
• Interpreting Reverse Telnet Test:
  • Examine line shape: should be no high-end rolloff (no codecs!)
  • Make sure that connection is solid - no periodic retransmits or errors (could be problems at T1 peer's receiver or slips)
Test Call from Known Good Client

Next, place a test call from a known good V.90 analog modem, on a known good POTS line, over a pure digital circuit path to the NAS, that SHOULD yield V.90.

Verify that the expected V.90 performance is realized.

Recommended method: dial using a terminal program. Log into the exec, receive much data, verify good performance.
• If the new NAS is connected properly to the public PCM network, then your test call from the known good client should perform just about as well as to a known good NAS. (Assuming compatible modulations.)
• Some differences may be seen due to RBS trunking and/or digital padding in the circuit.
Troubleshooting Individual Modem Problems
First, Be Sure that Things Are Basically Working Right

- At this point, you have proven that the NAS and its connection to the PSTN are healthy:
  - T1/E1 is proven to be (nearly) flawless
  - You can make a strong V.34 modem call thru the T1/E1, to the local switch, and back into yourself
  - You are running known good Cisco IOS and firmware/portware
  - You have dialed in from a known good client and have gotten the expected performance
- Now, let the users dial in and see how they do.
Perfection is unattainable in this world
Expect a CSR of 95% (V.34) or 92% (V.90), maybe 10% premature drops

Use:
- `show modem summary`
- `show modem connect-speeds`
- `show modem call-stats`

To get the overall picture
### Show Modem Summary

<table>
<thead>
<tr>
<th>Usage</th>
<th>Incoming calls</th>
<th>Outgoing calls</th>
<th>Busied</th>
<th>Failed</th>
<th>No Ans</th>
<th>Succ</th>
<th>Pct.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>6297</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Succ 185 64</td>
<td>Succ 0 0 0</td>
<td>Out 0 0</td>
<td>Dial 0</td>
<td>0 Ans 0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **No ans**: call came into modem but modem did not go offhook (CPU too busy?)
- **Fail**: modem went offhook but modems failed to train up
- **Succ**: modems trained up; Cisco IOS saw “DSR” go high (still doesn’t mean that PPP negotiated successfully, etc.)
Show Modem Call—Stats

<table>
<thead>
<tr>
<th></th>
<th>compress</th>
<th>retrain</th>
<th>lostCarr</th>
<th>rmtLink</th>
<th>trainup</th>
<th>hostDrop</th>
<th>wdogTmr</th>
<th>inacTout</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>9</td>
<td>41</td>
<td>271</td>
<td>3277</td>
<td>7</td>
<td>2114</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- rmtLink is good—it means that EC was in effect, and the client DTE decided to hang up
- hostDrop (aka dtrDrop) is usually good—it means that the host DTE (Cisco IOS) decided to hang up
  - Idle timeout
  - Circuit clear from the telco
  - PPP LCP termreq from the client
  (It’s hard to figure out dtrDrop reasons without AAA accounting)
- Other reasons are bad—should be <10% of total
• Look for a healthy distribution of V.34 speeds
  A peak at 26.4 (CT1s in rural areas) up to 31.2 (if using ISDN) is normal
• Look for good K56Flex, V.90 speeds
  A peak from 44–50k is normal
• Few connects at impaired V.34 (e.g. 9600) or V.90 (e.g. 29333) speeds
DCE Speed Distribution

N connections

Speed (bps)

Rx

Tx

0 10000 20000 30000 40000 50000 60000
Now that everything’s perfect on the NAS and in the digital line to the switch…it’s time to gather data; for each problematic call, get the following info if possible:

- `show modem op (MICA) / AT@E1 (Microcom)` while connected
- `show modem log` for the session of interest (after disconnect)
- ANI (caller’s number)
- Time of day
- Client modem hardware / firmware revision
- Interesting info from client (after disconnect)—`ATI6, ATI11, AT&V, AT&V1, etc.`
*May 31 18:11:09.558: %CALLRECORD-3-
MICA_TERSE_CALL_REC: DS0 slot/contr/chan=2/0/18, slot/port=1/29, call_id=378, userid=cisco, ip=0.0.0.0, calling=5205554099, called=4085553932, std=V.90, prot=LAP-M, comp=V.42bis both, init-rx/tx b-rate=26400/41333, finl-rx/tx b-rate=28800/41333, rbs=0, d-pad=6.0 dB, retr=1, sq=4, snr=29, rx/tx chars=93501/94046, bad=5, rx/tx ec=1612/732, bad=0, time=337, finl-state=Steady, disc(radius)=Lost Carrier/Lost Carrier, disc(modem)=A220 Rx (line to host) data flushing - not OK/EC condition - locally detected/received DISC frame -- normal LAPM termination
show modem operational-status (MICA)

- **show modem operational-status** dumps the parameters pertaining to the current (last) connection
  
  http://www.cisco.com/univercd/cc/td/doc/product/software/ios120/12cgcr/dial_r/drp1/drmgmt.htm#xtocid10451279

- **modem at-mode AT@E1** is the analogous feature for Microcom
  
  http://www.cisco.com/univercd/cc/td/doc/product/access/acs_serv/5300/mod_info/atcmnds1.htm#23729
show modem op—(Cont.)

as3# show modem op 1/3
Modem(1/3) Operational-Status:

Parameter #0  Disconnect Reason Info:  (0xA220)
    Type (=5 ):  Rx (line to host) data flushing - not OK
    Class (=2 ):  EC condition - locally detected
    Reason (=32):  received DISC frame -- normal LAPM termination
Parameter #1  Connect Protocol:  LAP-M
Parameter #2  Compression:  V.42bis both
Parameter #3  EC Retransmission Count:  0
Parameter #4  Self Test Error Count:  0
Parameter #5  Call Timer:  81 secs
Parameter #6  Total Retrains:  0
Parameter #7  Sq Value:  4
Parameter #8  Connected Standard:  V.90
Parameter #9  TX,RX Bit Rate:  52000, 28800
show modem op—(Cont.)

Parameter #11 TX,RX Symbol Rate:  8000, 3200
Parameter #13 TX,RX Carrier Frequency:  0, 1829
Parameter #15 TX,RX Trellis Coding:  0, 16
Parameter #16 TX,RX Preemphasis Index:  22, 6
Parameter #17 TX,RX Constellation Shaping:  Off, Off
Parameter #18 TX,RX Nonlinear Encoding:  Off, Off
Parameter #19 TX,RX Precoding:  Off, Off
Parameter #20 TX,RX Xmit Level Reduction:  0, 0 dBm
Parameter #21 Signal Noise Ratio:  38 dB
Parameter #22 Receive Level:  -23 dBm
Parameter #23 Frequency Offset:  0 Hz
Parameter #24 Phase Jitter Frequency:  0 Hz
Parameter #25 Phase Jitter Level:  0 degrees
Parameter #26 Far End Echo Level:  -56 dBm
Parameter #27 Phase Roll:  0 degrees
Parameter #28 Round Trip Delay:  7 msecs
Parameter #30 Characters transmitted, received: 99059, 7783
Parameter #32 Characters received BAD: 0
Parameter #33 PPP/SLIP packets transmitted, received: 222, 178
Parameter #35 PPP/SLIP packets received (BAD/ABORTED): 0
Parameter #36 EC packets transmitted, received OK: 676, 254
Parameter #38 EC packets (Received BAD/ABORTED): 1
Parameter #39 Robbed Bit Signaling (RBS) pattern: 0
Parameter #40 Digital Pad: 6.0 dB, Digital Pad Compensation: Enabled
show modem op—(Cont.)

52/28.8 V.90

Line Shape:

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It’s very important to gather client-side performance data, to find client-specific trends:

- Client hardware model, firmware version: ATI3I7
- Client-reported disconnect reasons:
  - ATI6 or AT&V1
  - PC's modemlog.txt, ppplog.txt
- 3Com stats: ATI6I11Y11
Analyze the Performance Data

• Now that you have collected and understood the performance data for your modem system, it’s time to look at any remaining patterns/components that may have room for improvement
• Are problems associated with particular NAS modems? *(show modem)*

• Are problems associated with specific DS0s on your digital line? *(show controller t1 call-counters)*
Problems with Particular Server Modems

- Use `show modem`, `show modem call-stats` and look for any modems with abnormally high rates of trainup failure or bad disconnects.

- (MICA) If adjacent pairs of modems look hosed, then probably a hung/dead DSP problem. Use `copy flash modem` or the `SPE` command in the configuration to the affected HMM to recover. If not using portware 2.7.2.0, please upgrade ASAP.

- Verify that all modems are correctly configured. Use `modem autoconfigure type` with `debug confmodem` to ensure correct settings. May need to reverse telnet to fix up modems that are badly misconfigured.
Problems with Particular DS0s

- Bad DS0s are rare but possible. (Always the telco’s fault, never ours :-)
- Use `show controller t1 call-counters`
- Look for any DS0s with abnormally high `TotalCalls` and abnormally low `TotalDuration`
- Busy out DS0s (`isdn service dsl, ds0 busyout`) to target specific suspected bad ones

<table>
<thead>
<tr>
<th>TimeSlot</th>
<th>Type</th>
<th>TotalCalls</th>
<th>TotalDuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pri</td>
<td>873</td>
<td>1w6d</td>
</tr>
<tr>
<td>2</td>
<td>pri</td>
<td>753</td>
<td>2w2d</td>
</tr>
<tr>
<td>3</td>
<td>pri</td>
<td>4444</td>
<td>00:05:22</td>
</tr>
</tbody>
</table>
Trend: Bad Circuit Paths

• If:
  - Long distance calls have problems but local do not (or vice versa)
  - Calls at certain times of day have problems
  - Calls from specific remote exchanges have problems

• Then:
  - You might be getting bad circuit paths through the PSTN
Trend: LD Bad, Local Good

• If long distance calls are bad but local calls are good, then:
  
  Double-check to make sure that the digital line connects into a digital switch \textbf{not} a channel bank
  
  Check with telcos to examine the circuit paths used for long distance

• If calls from specific geographical regions/exchanges tend to have problems:
  
  • Learn the network topology from the telco
  
  • If multiple A/D conversions (non-integrated SLCs, analog switches) are used to serve an area, then PCM modem connects will be impossible, and V.34 may be somewhat degraded
Trend: Particular Client Modems Have Particular Problems

• So now the great majority of calls connect in the desired modulation with the desired speed
• …but there are still a few particular client modems running some particular firmware on some particular POTS lines calling via some particular circuits which are failing to behave as desired…
• So you can now adjust to living with imperfection, or else move in for hand-to-hand combat
Living with Imperfection
The Underlying Causes

There are three fundamental causes of imperfect modem connections, the first two causes are just corollaries of each other:

• Poor circuit quality (relative to the desired modulation/speed)
• Excessive modulation/speed (relative to the circuit quality)
• The third underlying impediment to perfect modem connections is what one can call **modem quality**

• There are Several Aspects to Modem Quality:
  • The ability of the modem optimally to resolve the data from the analog signal received
  • The ability of the modem to select the optimal receive modulation/speed for the given circuit
  • The ability of the modem to interoperate nicely with the vast and evershifting range of peer modems (of various quality) encountered in the field
Addressing the Underlying Causes—Circuit Quality

- Circuit quality problems?
- Reengineer the circuit
- This may prove difficult, as it may require pulling new cable, replacing equipment, involving multiple providers, paying for new carrier facilities, etc
- To locate the problematic portion of the circuit, experiment with various call paths
Addressing the Underlying Causes—Modem Quality

• If all modems were of infinite quality, then, controlling for circuit quality, they would always select the optimal modulation/speed

• If you hold the peer modem and circuit constant, you can vary the modem to find another of higher quality (for that particular circuit and peer)

• If you have quality issues with a modem, you may contact the vendor for improved firmware, etc. See http://56k.com, http://808hi.com/56k/x2-lucent.htm, http://www.windrivers.com/alpha/modem for links to firmware updates.
Testing against Known Good Modems on a Known Good Circuit

- See if the client modem/circuit is capable of good V.90 connections by dialing a known good NAS with digital modems, on a known good circuit

- Cisco’s test AS5300 (MICA and Microcom modems) at +1 408 570 3930 / 3932
Addressing the Underlying Causes—Excessive Speed

- **Given** that circuits are in fact imperfect, so that they cannot always attain the ideal speed, and **given** that some modems are imperfect, so that they will not always choose the optimal speed for the imperfect circuit…

- The remaining option is to **help** the modems choose a better (slower) speed for the imperfect circuit
Detuning Modems

- Given a pair of modems and a circuit, they usually can (and sometimes will) select a carrier speed that yields an unstable connection.

- A nominally higher DCE speed may produce worse performance than a nominally lower one, due to retrains, EC retransmits and lost carrier.

- If you cap the modems to restrict their range of modulations and/or DCE speeds, they may be able to train up (where they had been unable to do so before), or may achieve more stable connections.
Detuning Modems (Cont.)

• You can cap the DCE modulations/speeds at the server side or the client side
• Server side caps will improve stability across the board, without requiring configuration effort on the client side; the downside is that this must be a lowest-common-denominator setting, and will therefore reduce performance for some \{modem, modem, circuit\} tuples that could handle a higher speed
• Client side caps can be used to achieve optimal performance on a link-by-link basis; the downside: greater configuration effort is required (often by unsophisticated users)

• Normally, the DTE speed will not directly affect the stability of a modem connection
• A properly implemented DTE will be able to handle the full speed (e.g. 115200 bps), and will use flow control as needed if it can't keep up.
• However, it has been reported that that some Windows systems can prematurely disconnect unless the DTE speed is reduced and/or the async serial buffer sizes are reduced.
• Consider (carefully!) configuring the server modems so as to be less aggressive and more persistent:

  MICA:
  
  S19 (EC retransmission limit), S34 (Fall-forward timer), S38 (Lost carrier timer), S40 (retrain threshold)
  
  Increase S32 (SQ threshold) to 3 (more conservative Rx speeds across the board)

  Microcom:
  
  Increase S10 (Lost carrier timer), disable rate renegotiates (:t110=0), increase EQM trip threshold (:t34)
Client Side Caps

- This is the same idea as server side caps:
  - At a gross level, you can successively disable modulations till you find one that works
  - At a fine level, you can keep stepping down through the DCE speeds supported by the top modulation, till you find a stable one
  - Remember: always test using a terminal program (e.g., Hyperterminal)...PPP just gets in the way

- Rockwell (ITU V.25ter): use the +MS command to control the modulations and DCE speeds
  - Example: AT+MS=12,1,300,36000
    - Allow V.90 and lower modulations; min speed 300; max speed 36000
- TI (USR/3COM): use &U to set minimum DCE speed, &N for maximum
  - Example: AT&U4&N11
    - Min speed 4800; max speed 21600
- PCTEL: use S37 with N0 for max DCE speed
  - Example: ATN0S37=12
    - Max speed 44k if V.90, 56k if K56Flex, 31200 if V.34
- Mwave: use S28 to cap DCE speed
  - Example: ATS28=15
    - Max speed 16800
- Lucent and Hayes: check docs
So You Really Want to Wrestle with a Modem Problem

• If you really want to get to the bottom of an individual modem problem, you’ll want to:

  Get your hands to the AT prompt at the client modem, while it’s attached to the POTS line of interest

  Be prepared to gather a .wav file of the trainup music
V.90 Training
V.90 Training

- **V.8 bis**
- **V.8 (Phase I)**
- **Line Probe (Phase II)**
- **Half Duplex Echo Cancel and Equalizer Training (Phase III)**
- **Data**
- **Full Duplex Training**
- **Digital Impairment Learning (DIL)**
Negotiation Overview

Rest of V.8 Bis. → Rest of V.8 Training

- K56Flex
- 2100 Hz ABT
- Phase Reversals and 15 Hz Modulation
- V.90 + V.34
- V.90
- K56Flex
- V.34
- V.22 bis
- MNP-3/4
- Optional
- Async. mode
- V.32
- Optional
- V.22 bis
- V.90
- Optional
- MNP-2/4
- FSK
- Complete Training

Off Hook V.8 Bis Tone
V.34 Training
Listening to the DILs

- The DIL (Digital Impairment Learning sequence) is the musical score (PCM sequence) that the V.90 analog modem tells the digital modem to play back to it, so that it can discern any digital impairments in the circuit; (such as multiple D/A conversions, a-law ↔ law, robbed bits, digital pads)

- If you don’t hear the DIL, then the modems did not negotiate V.90 in V.8/V.8bis (i.e., a modem compatibility issue; if you DO hear the DIL, but then a retrain in V.34, then the analog modem decided, on the basis of the DIL playback, that V.90 was infeasible
Some V.90 DILs

- Pctel 7.55
- USR (3COM)
- LT winmodem 5.28
- Rockwell (Conexant) 2.2
Hand-to-Hand Combat with Individual Connections
An Individual Modem Connection Will Manifest Various Symptoms of Suboptimality:

- Failure to train up
- Don’t train up in the desired modulation
- Don’t train up in the desired speed
- Train up, but no EC
- Inadequate performance (throughput)
- Premature disconnection
Symptom: Trainup Failure

• Is the symptom a failure to train?

  Does the music have noise in it? If so, then clean up the circuit

  Does the client give up quickly, without running V.34 training? E.g., perhaps it flips out when it hears V.8bis Cref; in which case, try disabling V.8bis (hence K56Flex) on the server (if acceptable), or get new client firmware, or swap it out
Symptom: Trainup Failure (Cont.)

- Does the client try training in an advanced modulation (V.90, K56Flex, V.34), but eventually give up? Then try capping the client at successively lower modulations/DCE speeds

- (Or improve the circuit, or improve the modem code, of course)
Symptom: Not the Desired Speed

- Does the client train up in the desired modulation, but at a slower than yearned-for speed?
- If so, then simply coercing the modems to connect at a faster nominal DCE rate would nearly always be a grave mistake
- The best solution to this problem will normally be to improve the circuit; improving the modem code will rarely yield results here (the exception being a modulation with much recent churn, such as V.90)
Symptom: Trainup, But No EC

- Does the client train up in the desired modulation, fail to negotiate error control?
  - If so, then the **probable** cause is high BER in the selected modulation, resulting in data damage or retrain during the sensitive EC negotiation phase, in this case, the useful approach will be to detune the client for a slower modulation/DCE speed.
- Another possibility is modem bugs in EC negotiation or late modulation trainup; (seen with some popular client firmware), in which case, pursue improved client firmware.
Symptom: Inadequate Throughput

- Is inadequate throughput observed thru the modem link (given the chosen modulation/speed)?
- If so, then first rule out the possibility of higher-layer protocol deficiencies, (e.g., do a simple ping through the link)
- Monitor the EC retransmits (block errors) on the link, if they are too high (> 5% of frames), then modem detuning is in order, similarly, if the slowness is due to excessive retraining, then detuning should help.
Symptom: Premature Disconnection

- Does the modem link terminate before the user wanted it to?
- If so, then first ascertain whether the disconnection was initiated by one of the DTEs, if so, then fix the DTE application
- If neither DTE initiated the disconnect, then (as always), modem detuning, circuit improvement, and/or a firmware upgrade, should yield good results
Symptom: Premature Disconnection (Cont.)

- Monitor the DTE links to see who initiates the disconnect
- Using the old RS-232/AT interface model, a DTE-initiated disconnect will show as a DTR drop or as "+++ATH<CR>" on the Tx lead, a DCE-initiated disconnect will show as a DCD drop (which Cisco IOS calls "DSR")

Tracking Whether DCE or DTE Initiated the Drop—from the Cisco IOS Side

- “Debug modem” will tell the truth, however, if the drop was initiated by a PSTN circuit clear, this will show as a DTR drop (because, on a system with digital modems, the DTE handles the PSTN interface), so also check the PSTN signaling (“debug isdn q931”, “modem-mgmt csm debug-rbs”)
- Use “modem call-record terse” to get all the good info in one nice package, if the disconnect was a pure Cisco IOS-side decision, then this will give the Cisco IOS explanation

Tracking Whether DCE or DTE Initiated the Drop—from the PC Side:

- Turn on the TAPI modem log (control panel -> modems -> properties -> connection -> advanced, or some such)
- After the disconnect, see whether the disconnect was initiated by the PC or by the modem; (don’t take TAPI’s interpretation of events very seriously, it tends to lie)
- If it was the PC that initiated the disconnect, next contact the friendly folks at Microsoft who will be eager to help solve the problem
Symptom: Premature Disconnection (Cont.)

DTE-Initiated Example: the PC User (Me) Clicked the DUN Disconnect Button

- “modem call-record terse” on Cisco IOS showed:
  disc(radius)=User Request/Received Terminate
disc(modem)=A220 received DISC frame --
normal LAPM termination

- PC’s modem log showed:
  Hanging up the modem.
  Hardware hangup by lowering DTR.
Symptom: Premature Disconnection (Cont.)

DCE-initiated example: the PC user (me) unplugged the phone cord while in the midst of transferring data

- “modem call-record terse” on Cisco IOS showed:
  disc(radius) = (n/a)/(n/a)
  disc(local) = 9 DTR Drop
  Alas this doesn’t tell the REAL reason why Cisco IOS dropped the call—that the caller line went loop-open.

- PC’s modem log showed:
  Remote modem hung up.
  Recv: <cr><lf>NO CARRIER<cr><lf>.
  Alas this shows that TAPI has no way of knowing what’s really going on—it’s default behavior when it sees a network-side disconnect is to blame the remote modem!

- If you’d been listening to the voiceband at this time, then you would have known what happened!

DCE-initiated example: the PC user (me) unplugged the phone cord while in the midst of transferring data
For Further Insight

- The cisco-nas mailing list
cisco-nas-request@datasys.net; archives at http://cisco-nas.datasys.net)
- John A. C. Bingham, *The Theory and Practice of Modem Design*
- John G. Proakis, *Digital Communications*
Troubleshooting Analogue and Digital Dial Services

Session 2903
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