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Avaya Solution & Interoperability Test Lab

# A Configuration of a T1 E&M Tie Trunk between an Avaya IP Office and a 3COM NBX 100 PBX - Issue 1.0

Abstract

These Application Notes describe the steps to replicate a tested configuration of T1 Tie Trunk networking between an Avaya IP Office IP412 Server and a 3COM NBX 100 PBX.

1. Introduction

These Application Notes describe the steps needed to replicate a configuration of a "robbed bit" E&M T1 tie trunk between an Avaya IP Office IP412 Server and a 3Com NBX 100 PBX, as shown in **Figure 1**. The Avaya IP Office IP412 and 3COM NBX do not support compatible ISDN signaling over T1.
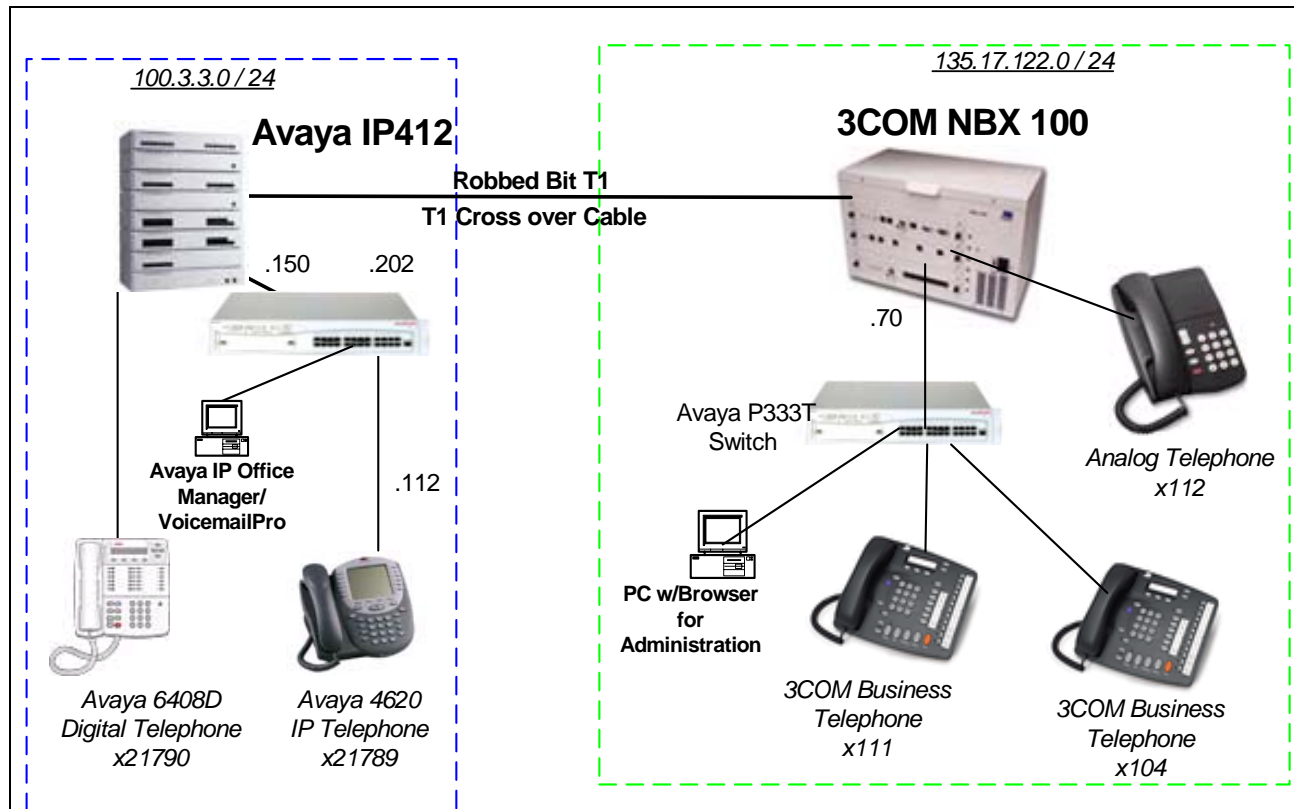
Figure 1: Tested Configuration

E&M tie trunks support basic calling, including direct extension dialing. More advanced features, such as Calling Party Name and Number, are not supported. Calls can be transferred and conferenced from either end, but note that calls that are allowed to transfer back from one system to the other will use a second T1 channel.

WJR; Reviewed:
WCH 9/15/2004
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2. Equipment and Software Validated

The following hardware and software were validated:

Equipment	Software
Avaya IP Office IP412 Server	2.1(15)
Avaya 4612 IP Telephone	2.0
Avaya 4620 IP Telephone	2.0
Avaya 6408D Digital Telephone	N/A
3COM NBX 100	R4_1_77
3COM Business Telephone	N/A

3. Configure the Avaya IP Office IP412 Server

This section provides instructions for setting up the IP Office T1 interface to the 3COM NBX 100. It is assumed that the user has access to the IP Office via the IP Office Manager Application.

Step 1) Open the IP Office from the IP Office Manager.
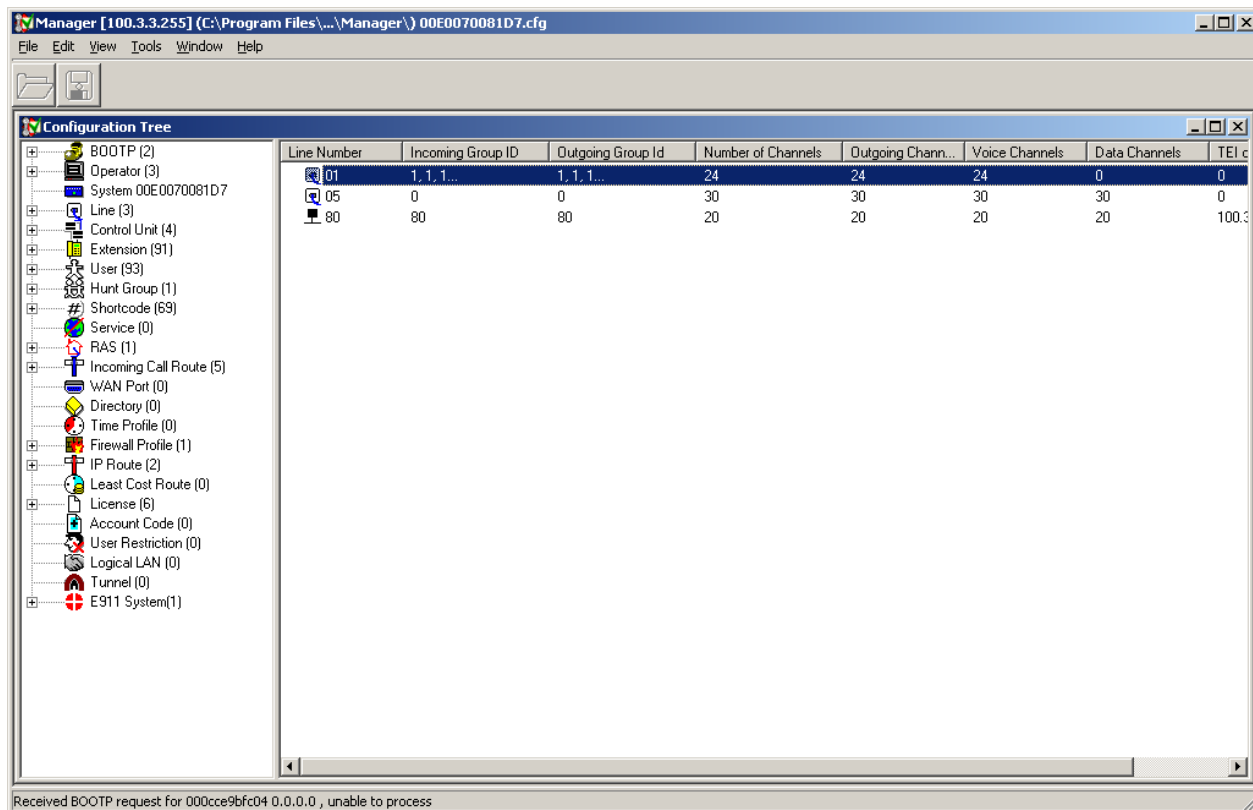
Figure 2: Manager Configuration Tree

Step 2) From *Line*, Click the Line number of the "PRI" module (*Line 1* for slot A, *Line 5* for slot B). Set the *Line Sub-type* to **T1.** Set the *Channel Allocation* to hunt in the opposite direction than the 3COM NBX hunts. In this configuration, the 3COM hunts for channels in descending order, but can be configured as shown in Section 4, step 6.

Figure 3: Line Tab

Step 2 a) Select all the channels that will be used for this trunk group. Set the *Incoming* and *Outgoing Group ID* that will be referenced in a later step for Incoming Call Routes and Short Codes, respectively. Set the *Type* to **E&M - Tie**, and the *Incoming* and *Outgoing Trunk Type* to **Wink-Start.** All remaining settings can be left as default, including those under the **Timers** tab.
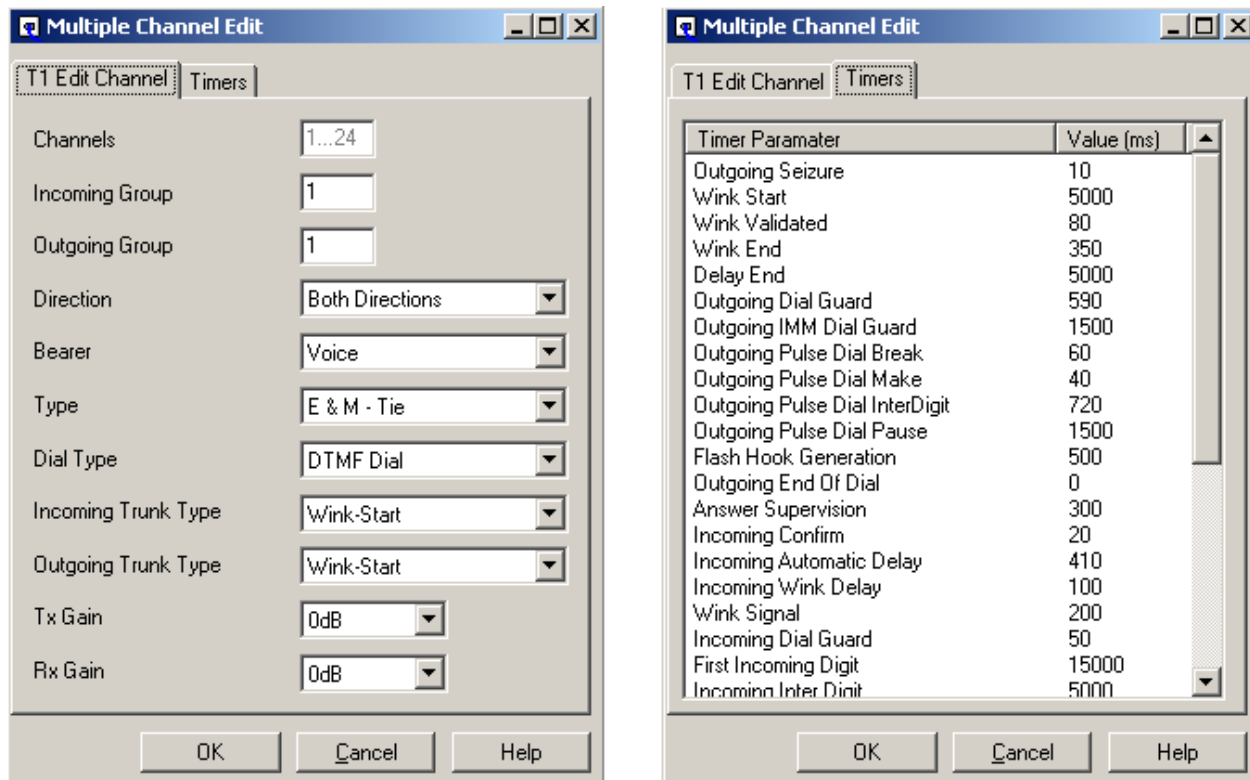
Figure 4: T1 Edit Channel and Timers

Click **OK**.

Step 3) Click the Line **Advanced** tab to ensure that the *Framing* is set to **ESF** and the *Zero Suppression* is set to **B8ZS**. For this configuration, the *Clock Quality* of the T1 is set to **Network** so that the IP Office synchronizes its clock to the T1 line and the *Line Compensation* is set to **0-115 ft**, based on the T1 wiring distance to the next T1 device, in this case the 3COM NBX itself. *Incoming Routing Digits* is set to **5**, which is consistent with the 3Com settings to out pulse all 5 digits of the called number to IP Office on calls to the IP Office.

Figure 5: Advanced Tab

Click **OK**.

Step 4) Create a *Shortcode* to direct the appropriate dialed calls from IP Office to the 3COM system via the outgoing trunk group. The *Short Code*, **66xxx**, is set to match a 5 digit dialed number where the last three digits correspond to a 3Com phone extension. The *Telephone Number* is set to "**N**" instructing the system to outpulse the last three dialed digits and the *Line Group ID* of **1** corresponds to the designated O*utgoing Group* assigned to the trunk group on the Line form.

.

Figure 6: Short Code

Click **OK**.

Step 5) For each dialable destination that can be reached from the T1 trunk group, there must be an Incoming Call Route. To create many similar call routes, select from the top IP Office Manager menu **Tools→MSN Configuration**. The large central box will list configured Incoming Call Routes. To add new Incoming Call Routes, set the *MSN* box to the numerically smallest IP Office extension (e.g., **21789**), the *Presentation Digits* to the extension length (**5**), the *Destination* to the destination for the extension (e.g., **21789**), the *Line Group ID* to the incoming Line Group ID (**1**) and the *Range* to the number of Incoming Call Route entries to create (**10**). Click **Add** to have the Manager create the entries and then **OK** when done. **Figure 7** shows the MSN form after a set of entries was added.

These entries can be managed from the Manager Configuration Tree *Incoming Call Route* area.

MSN Configuration

MSN		Presentation Digits	5
Destination	21789 Extn21789	Range	10
Line Group ID	1		

Line Group Id.	Incoming Number	Incoming Caller ID	Bearer Capability	Destination
0			AnyData	DialIn
0			AnyVoice	Main
1	20000		Any	Main
1	21789		AnyVoice	21789
1	21790		AnyVoice	21790
1	21791		AnyVoice	21791
1	21792		AnyVoice	21792
1	21793		AnyVoice	21793
1	21794		AnyVoice	21794
1	21795		AnyVoice	21795
1	21796		AnyVoice	21796
1	21797		AnyVoice	21797
1	21798		AnyVoice	21798

Add   Delete   OK   Cancel   Help

Figure 7: Incoming Call Routes

Click **OK**.

Step 6) Click **File→Save** from the top Manager Menu and allow the system to reboot to have the new changes take effect.

4. Configure the 3COM NBX 100

These notes assume the user has a properly configured browser and network connection to the 3COM NBX.
It is best to follow 3COM's NBX Administrator's Guide for general instructions, but the steps below show how this example was configured.

Step 1) Open a browser to the management address of the 3COM NBX and log in as the administrator. Click the **Tab To It** icon from where most of the steps are performed.
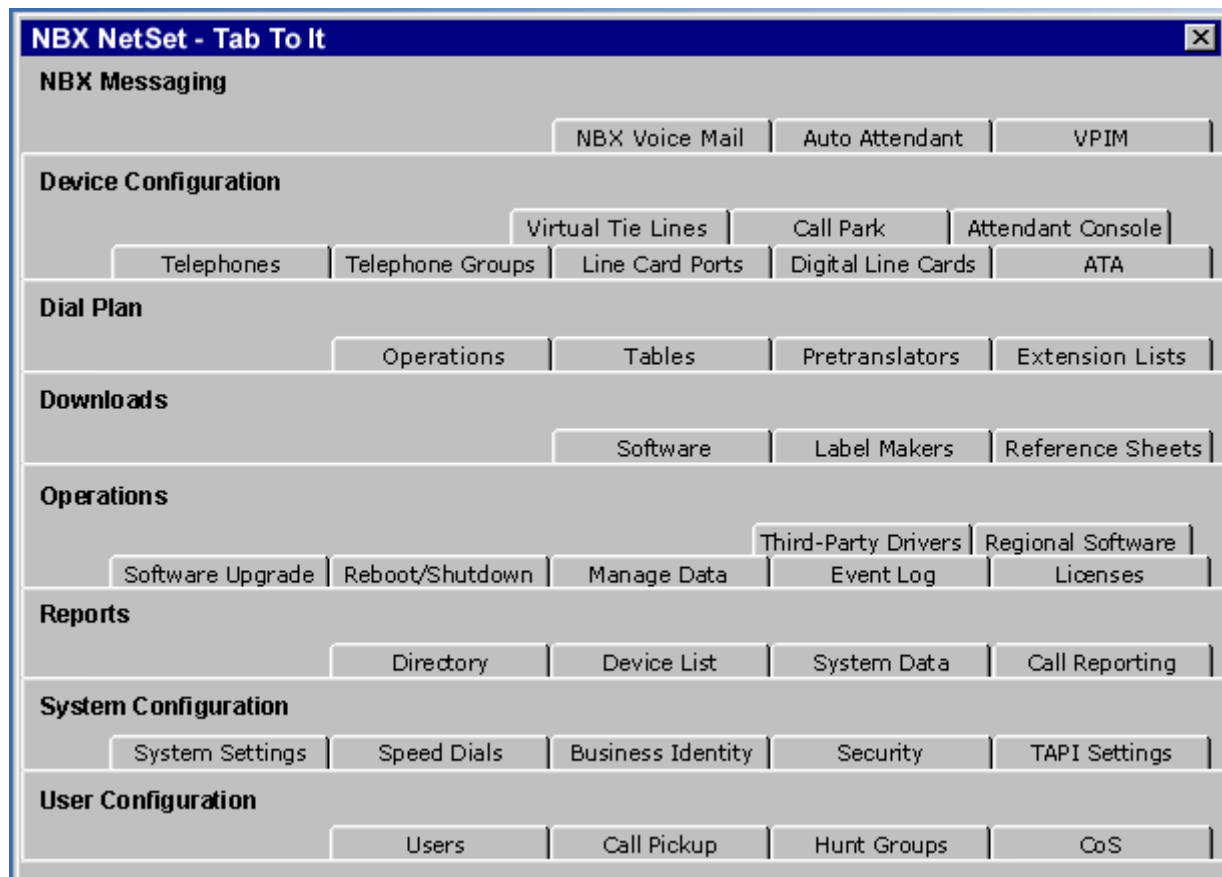
Figure 8: Tab to It

Step 2) Click the **Device Configuration→ Digital Line Cards** tab**.** Set the *Select Device Type* to **T1/ISDN Board List** and Click **Apply**.

Figure 9: Device Configuration

Step 3) Click **Modify** and ensure that the *Card Type* is **T1** and that the *On Line* box is **checked**. Click **Apply**. Click **OK**.

Figure 10: Digital Line Cards

Step 4) Click the **Device Configuration→Digital Line Cards** tab**.** Set *Select Device Type* to **T1 Span List**. Click **Apply**. Select the Span of interest and Click **Modify**. Set the *Framing Type* to **ESF**, the *Line code* to **B8ZS.** *Line Length* should be set to the wiring distance to the next T1 device. In this case, **0-35 Meters** is appropriate. The *Timing Mode* is set to **Internal** so that the NBX provides the clocking in this configuration.
In general, *Timing Mode* must be set consistently with an overall clock synchronization plan. Click **Apply**.
Click **OK**.

Figure 11: Digital Line Cards

Step 5) This step has two parts for configuring the trunk group.
Step 5 a) Click the **Device Configuration→Digital Line Cards** tab. Set *Select Device Type* to
T1 Group List. Click **Apply**. Select **Group 1**. Click **Modify**. Ensure the settings are as below.
In particular, the *Channel Protocol* must be **E&M** and the *Start Type* must be **Wink**. The *Called Party Digits* entry must be the length of the Extensions expected from IP Office (**3**) and **check** the *On Line* box. The *Trunk-to-Trunk* setting generally can be left as **restricted**, unless tandem trunking is allowed as in this configuration.
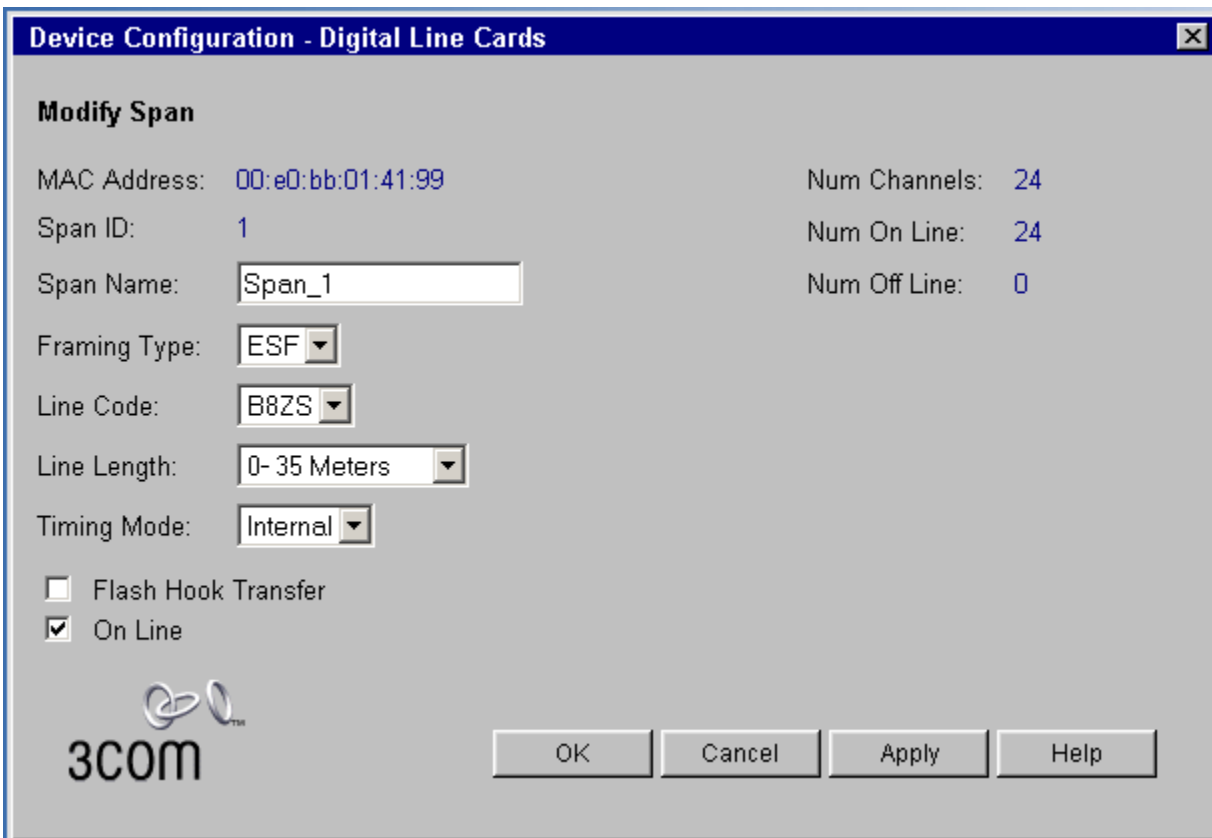Click **Apply**.
Click **OK**.

Figure 12: Digital Line Cards

Step 5 b) Click the **Device Configuration→Digital Line Cards** tab. Set *Select Device Type* to **T1 Group List.** Click **Apply**. Click **Group 1**. Click **Membership**. Ensure that the ports of the T1 that are to be used are moved from the non-member list to the member list. Click **Close**.
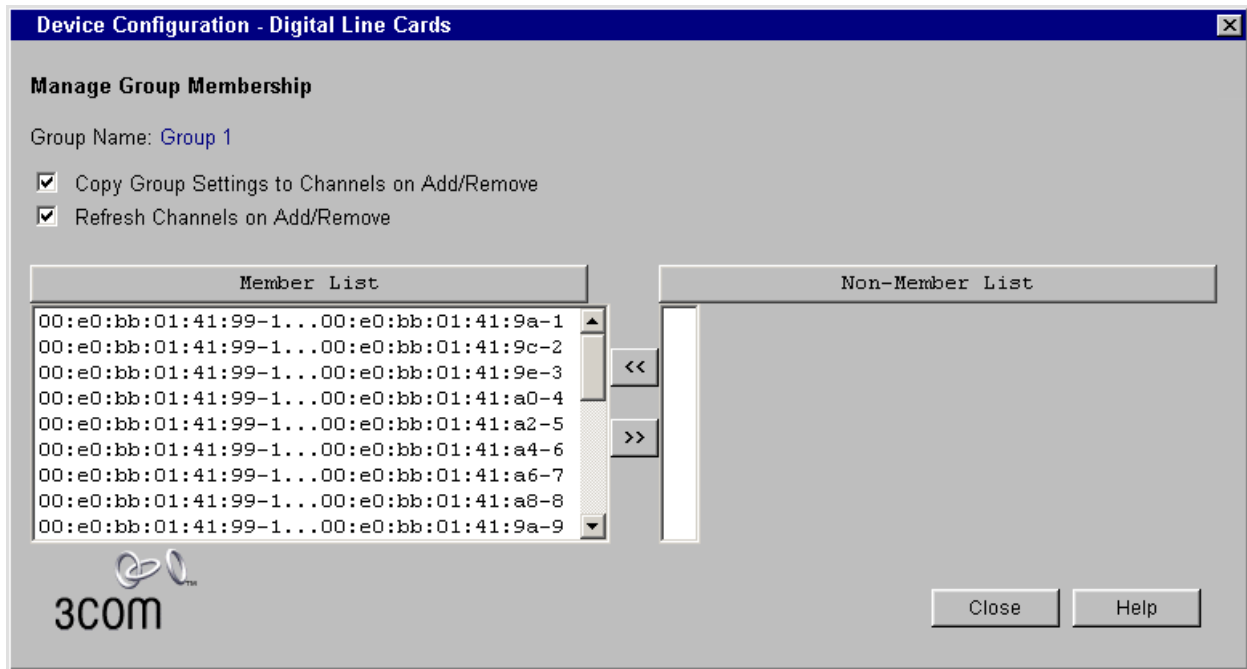
Figure 13: Group Membership

Step 6) Click the **Dialplan→Extension Lists** tab. Click the entry for **T1 Channels**. Click **Modify**. Ensure that the channels to be used for outbound calls are in the list. Note that by default this configuration will hunt outgoing from channel 24 as downward. The hunt order can be changed, but then the IP Office Line form must be changed to ensure that IP Office hunts in the opposite order.

Figure 14: Extension Lists

Step 7) Click the **Dialplan→Tables** tab. Click the **Internal 3 digit Extensions** table. Click the **Devices Using** button. Ensure that all the T1 trunks in this trunk group are listed in the *Devices Using* table. Click **Close**.
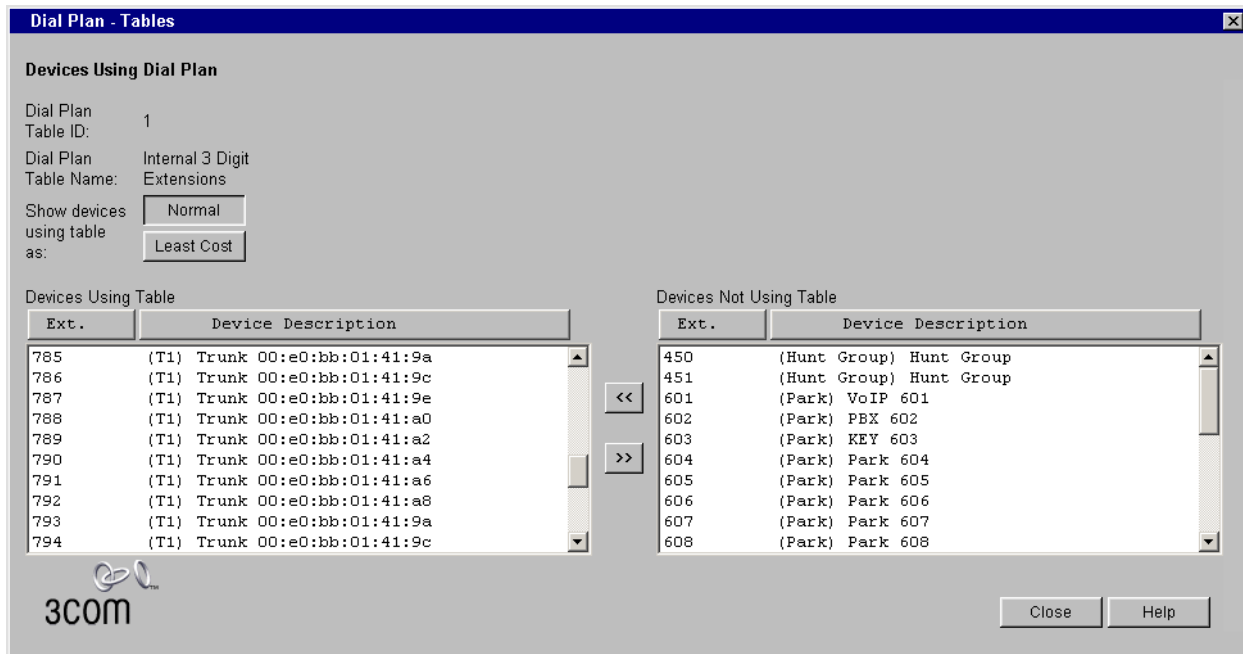
Figure 15: Dial Plan Table

Step 8) Click the **Dialplan→Operations** tab. Follow 3Com instructions to modify your dialplan to route calls to the T1 trunk. The table below shows the relevant parts of the dialplan that was used in this configuration, with comments.

```
Dial Plan
//////////////////////////////////////////////////////////////////////////////
/
/ NBX100 Dial Plan Configuration File
/ Generated from machine nbx100 135.17.122.70 owned by Valued Customer 0
/ Generated on WED JUN 23 14:00:14 2004
/
//////////////////////////////////////////////////////////////////////////////

/ First, delete all existing dialplan information

Table Delete *
DestinationRoute Delete *
TimedRoute Delete *
PreTranslator Delete *

/ Now, create all dialplan information

//////////////////////////////////////////////////////////////////////////////
/        Settings
//////////////////////////////////////////////////////////////////////////////

ExtensionLength 3
ExtensionRange Telephone     100 449
```

```
ExtensionRange Park          601 609
ExtensionRange AutoAttendant 500 599
ExtensionRange HuntGroup     450 499
ExtensionRange External      600 799
///////////////////////////////////////////////////////////////////////////////
/ The ExtensionRange External Setting MUST include the Park range.
/ If the Call Park range is outside of the ExtensionRange External,
/ the Call Park feature will not work.
///////////////////////////////////////////////////////////////////////////////
ExternalSettings 9 750 500

///////////////////////////////////////////////////////////////
/         Dial Plan Tables
///////////////////////////////////////////////////////////////

Table Create 1 Internal 3 Digit Extensions
/               Id Entry  Digits       Min Max Class           Prio Route
/               -- -----  -----------  --- --- -------------   ---- -----
TableEntry Create  1    1  0            1   1 Internal          0    4
TableEntry Create  1    2  1            3   3 Internal          0    0
TableEntry Create  1    3  2            5   5 Internal          0    2
TableEntry Create  1    4  3            3   3 Internal          0    0
TableEntry Create  1    6  5            3   3 Internal          0    3
TableEntry Create  1    7  7            3   3 Diagnostics       0    0
TableEntry Create  1    8  8            5   5 Internal          0    5
TableEntry Create  1    9  *9           9   9 Local             0    1
TableEntry Create  1   10  90           2  64 Operator          0    1
TableEntry Create  1   11  901          4  64 International      0    1
TableEntry Create  1   12  91           9  12 LongDistance      0    1
TableEntry Create  1   13  9101         9  64 AlternateLong     0    1
TableEntry Create  1   14  911          3   3 Emergency         0    2
TableEntry Create  1   15  91800       12  12 TollFree          0    1
TableEntry Create  1   16  91888       12  12 TollFree          0    1
TableEntry Create  1   17  91877       12  12 TollFree          0    1
TableEntry Create  1   18  91900       12  12 Toll              0    1
TableEntry Create  1   19  91976       12  12 Toll              0    1
TableEntry Create  1   20  9911         4   4 Emergency         0    1
TableEntry Create  1   21  9411         4   4 Operator          0    1
TableEntry Create  1   22  9*           4   4 COCode            0    1
TableEntry Create  1   36  38           5   5 Internal          0    2
TableEntry Create  1   37  V82          5   5 WAN               0    9

Table Create 2 Incoming DID and Auto Attendant
/               Id Entry  Digits       Min Max Class           Prio Route
/               -- -----  -----------  --- --- -------------   ---- -----
TableEntry Create  2    1  0            1   1 Internal          0    4
TableEntry Create  2    2  1            3   3 Internal          0    0
TableEntry Create  2    3  2            3   3 Internal          0    0
TableEntry Create  2    6  5            3   3 Internal          0    3

Table Create 3 Least Cost Routing

///////////////////////////////////////////////////////////////////////////////
/      Routes
///////////////////////////////////////////////////////////////////////////////

/                      Route Description
/                      ----- -----------
DestinationRoute Create     1 LocalCO
DestinationRoute Create     2 LocalCONoStrip
DestinationRoute Create     3 Voice Application
DestinationRoute Create     4 Attendant
```

If a caller dials 5 digits beginning with 2, use route 2 as defined below.

```
DestinationRoute Create       5 H323 ConneXtions Ports
DestinationRoute Create       8 8 Pool
DestinationRoute Create       9 VPIM to IP Office


/                        Route Entry DestinationExtension
/                        ----- ----- --------------------
DestinationRouteEntry Create     1     1 *0001
DestinationRouteEntry Create     1     2 *0002
DestinationRouteEntry Create     2     1 *0002
DestinationRouteEntry Create     3     1 *0003
DestinationRouteEntry Create     4     1 *0004
DestinationRouteEntry Create     5     1 *0005
DestinationRouteEntry Create     8     1 750
DestinationRouteEntry Create     9     1 *0003
```

Route 2, entry 1 sends all calls to the *0002 extension list. That list was administered to contain the outgoing T1 channels.

5. Verification Steps

I.   Is the T1 and framing operational?

Carrier Failure can be caused by poor cabling (e.g., using a straight cable or an Ethernet Cross-over cable when a T1 cross-over is required) or misconfiguration. Framing errors indicate that the signal is getting through, but the reporting end cannot find the expected framing sequence reliably. This is usually caused by misconfiguration (e.g., D4 framing vs. ESF) but can also be caused by poor signal quality.

      A. 3COM NBX side
           1. Check the equipment LEDs
           2. Check the LEDs on the 3COM T1 card.
                 CF – Carrier Fail
                 RA – Remote Alarm
                 LB – Card is in Loopback Mode.
                 Nominal – The T1 Line is framed (in other words, good).

           3. This status can also be seen through the **Device Configuration→Digital Line** Cards tab by selecting the T1 Span List and selecting **Apply**.

      B. IP Office side
           1. Check the IP Office controller Light associated with the T1 module. If it is off, there is likely a cabling or administration error.

           2. From the IP Office System Monitor, Click **Filters→Trace Options→T1.** Click **Clear All** to disable all non-T1 reporting**.** Enable **Channel and Line and** Click **OK.**

           The System Monitor should show the following sequence when the T1 is first plugged in and successfully activated and getting clock from the line:

```
80317690mS PRN: Slot A, Falc 1: LOCK RAI crc=1 set=0  FMR1=98  FMR2=60
80317702mS PRN: LockToFalc 1, TDM_CLOCK_SOURCE 0x14
80317719mS PRN: LockToFalc 1, TDM_CLOCK_SOURCE 0x14
80327593mS PRN: LockToFalc 1, TDM_CLOCK_SOURCE 0x14
```

For each in service channel, this should be followed by:

```
80332593mS PRN: T1 Channel: E&M 1.1: Link Up
80332593mS PRN: T1 Channel: E&M 1.1: StateChange Deactivated->Idle
80332593mS PRN: T1 Channel: E&M 1.1: Transmit T1EMOnHook
```

Followed by each line changing state to idle:

```
80332615mS PRN: T1 Line: 1.1: RxMessage state=Deactivated msg=LinkStatus
80332616mS PRN: T1 Line: 1.1: State Change Deactivated->Idle
```

3. Setting a T1 interface into "Loopback" mode causes the received T1 signal, depending on the loop-back type, to be retransmitted back toward the sender. Generally, this is a good tool to test line quality (e.g., by sending a known signal and checking that it is received with fidelity). Also, loopback can be used to investigate cabling and frame mismatch problems by activating loop-backs on a segment by segment basis (e.g., at a CSU/DSU) and checking, for example sending end achieves framing on its own signal sent back.
To activate the IP Office Loopback:
   a) From the System Monitor, select **Filters→Traces→T1.**
   b) Select the Line of interest under Loop-back Line Selection.
   c) Click the Loop-back Type (e.g., **Line Loop-back**).
   d) Click **OK**.
   e) The System Monitor should print:
   ```
   137938955mS PRN: Line 1: Manual: Line Loopback Up
   ```
   f) Now check the status of the sending end.
   g) From the System Monitor, Click **Filters→Traces→T1.**
   h) Click the Line of under Loop-back Line Selection.
   i) Unselect the Loop-back Type (e.g., **Line Loop-back**).
   j) Click **OK**.
   k) The System Monitor should print:
   ```
   138219822mS PRN: Line 1: Manual: Line Loopback Down
   ```

II. Is the call routing/dial plan properly taking calls to/from the T1 line?
   A. 3COM Side.
      1. In the 3Com NBX, Click **Dial Plan→Operations** and Click the **Test** button.
      2. Click a *Device to Dial From* (e.g., an extension on the NBX)
      3. Enter a *Number to Dial* (e.g., an IP Office extension).
      4. Click **Test**.
      5. Verify that the *Results* screen shows that the Trunk chosen and the Digits to outpulse match what the IP Office is configured to expect.

B. IP Office Monitor

　　1. From the System Monitor , Click **Filters**➔**Trace Options**➔**T1.** Under
　　Events, enable **CAS**, **Channel**, **Dialer**, **DSP**, and **Line**. Click **OK**.

Figure 16: T1 Tracing

2. Observe the System Monitor to see call protocol activity. The following example shows an outgoing call on channel 24 to 3COM extension 111.

```
139253407mS PRN: T1 Channel: E&M 1.24: Transmit T1EMOffHook
139253407mS PRN: T1 CAS: Channel E&M 1.24: TX: 0000 -> 1111
139253407mS PRN: T1 Channel: E&M 1.24: StateChange Idle->OutgoingHandshake
139253407mS PRN: Slot A T1 DSP: Chan 23 Speechpath Disconnected
139253417mS PRN: T1 Channel: E&M 1.24: StateChange OutgoingHandshake-
>AwaitWinkStart
139253863mS PRN: T1 CAS: Channel E&M 1.24: RX: 0000 -> 1111
139253863mS PRN: T1 Channel: E&M 1.24: Receive T1EMOffHook
139253863mS PRN: T1 Channel: E&M 1.24: EventRx T1EMOffHook state=AwaitWinkStart
139253863mS PRN: T1 Channel: E&M 1.24: StateChange AwaitWinkStart->WinkGuard
139253943mS PRN: T1 Channel: E&M 1.24: StateChange WinkGuard->WinkConfirm
139254058mS PRN: T1 CAS: Channel E&M 1.24: RX: 1111 -> 0000
139254058mS PRN: T1 Channel: E&M 1.24: Receive T1EMOnHook
139254058mS PRN: T1 Channel: E&M 1.24: EventRx T1EMOnHook state=WinkConfirm
139254059mS PRN: T1 Channel: E&M 1.24: StateChange WinkConfirm->OutgoingActiveDial
139254067mS PRN: T1 Line: 1.24: RxMessage state=Initiated msg=Wink
139254649mS PRN: T1 Channel: E&M 1.24: StateChange OutgoingActiveDial->Talk
139254649mS PRN: T1 Channel: E&M 1.24: Transmit T1EMOffHook
139254655mS PRN: T1 Line: 1.24: RxMessage state=Initiated msg=StartDial
139254655mS PRN: T1 Line: 1.24: State Change Initiated->OverlapSend
139254655mS PRN: T1 Line: 1.24: Sending LL Message: DialDigits
139254655mS PRN: T1 Dialler: 1.24: Digit Store: 111
139254656mS PRN: T1 Dialler: 1.24: Dial DTMF 1
139254656mS PRN: Slot A T1 DSP: Channel 24 Sent Digit: 1
139254796mS PRN: T1 Dialler: 1.24: Dial DTMF 1
139254796mS PRN: Slot A T1 DSP: Channel 24 Sent Digit: 1
139254936mS PRN: T1 Dialler: 1.24: Dial DTMF 1
139254936mS PRN: Slot A T1 DSP: Channel 24 Sent Digit: 1
139255076mS PRN: Slot A T1 DSP: Chan 23 Speechpath Connected
139255082mS PRN: T1 Line: 1.24: RxMessage state=OverlapSend msg=DigitsDone
139255082mS PRN: T1 Line: 1.24: State Change OverlapSend->Active
```

6. Conclusion

Following these steps will result in a successful implementation of tie trunk operation between an Avaya IP Office Server and a 3COM NBX 100.

7. References

Avaya product information and similar Application Notes can be found at www.avaya.com.

NBX Administration instructions were found in:
- January 2003, "NBX Administrator's Guide", Release 4.1, 3COM