Tenor Call Routing

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Introduction

The purpose of this document is to assist users of the Quintum Tenor products in understanding how the Tenor routes most calls. Call routing is probably the most important and most complex topic to explain. Some background in communications is required to understand how the Tenor routes calls.

This document covers the following:

- Basic routing model for H.323, SIP, and circuit calls

- Definition of some common routing terms and concepts

- Reference for the relevant Tenor commands

- Call examples

- Appendix covering the User Program Dial Plan

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Tenor Call Routing

Below is a detailed analysis of how the Tenor routes calls.

Basic Routing Model
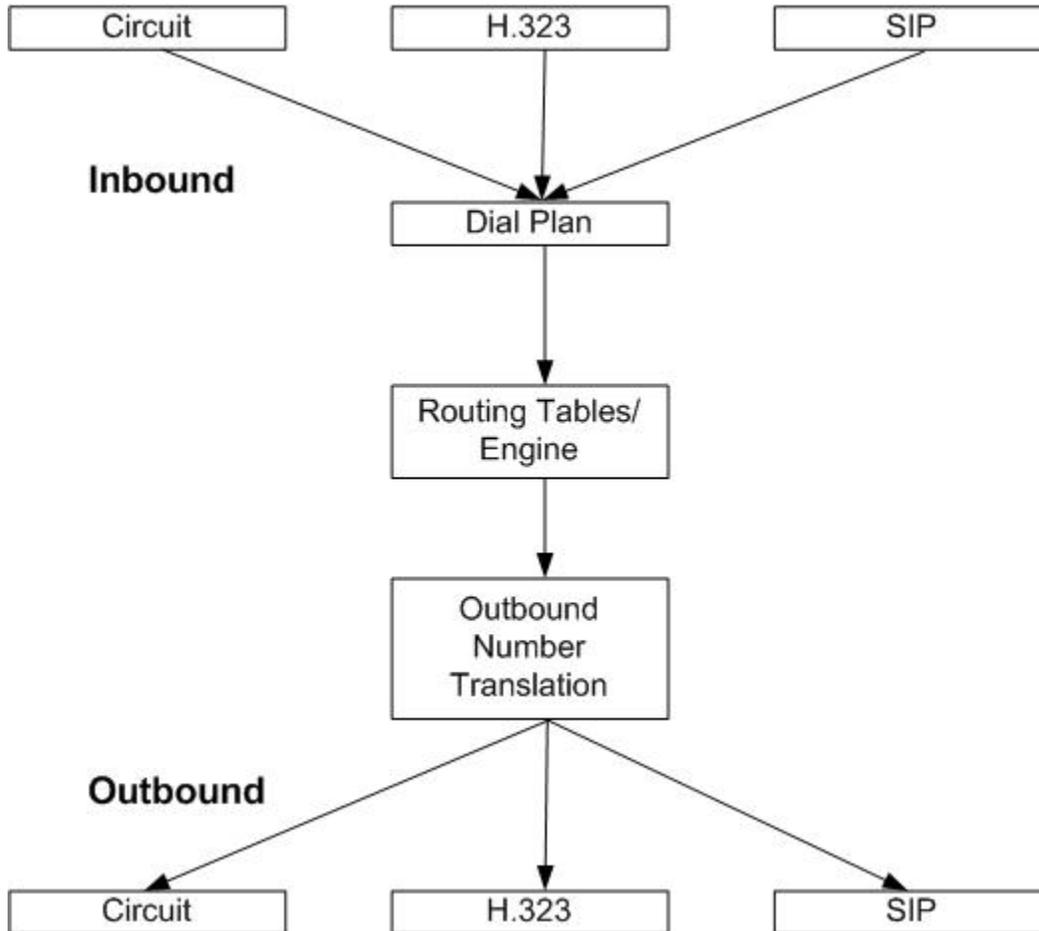
Figure 1 - Tenor process diagram

At the top of Figure 1, you see the possibilities for inbound signaling connections: Circuit, H.323, and SIP. The first level of dialed number analysis is performed according to the Dial Plan settings. The output of this stage is a normalized E.164 number. This is a globally unique number that Quintum prefers to use for routing.

Many of the Routing Tables/Engine processes can be performed within a single Tenor. For H.323, if a Tenor is configured as the Border Element and the Gatekeeper, then both of these processes are performed internal to the unit. If not, then the communication between these processes will be over IP.

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The Outbound Number Translation is performed using Hopoff Number Directories (PBX) and Hunt LDN Directories (PSTN). At the bottom of Figure 1 you can see the possible outbound signaling connections: Circuit, H.323, SIP.

Prerequisites

When you begin programming the Tenor for routing, you must come equipped with the IP address of at least one Termination Gateway, plus the number patterns that you want to assign to that destination.

Another important first step is to program the Country Code and Area Code under the Public Numbering Plan, and Long Distance Prefix and International Prefix under the Dial Plan. These settings should reflect the location in which the equipment is installed. This will allow the Tenor to translate numbers to E.164 format.

Note

If you want to route to SIP as well as H.323 Gateways , the only way to achieve this is to use the Routing Server.

H.323 Routing

The following steps are required to set up H.323 routing.

1. Create Static Routes

    A Static Route allows you to configure a destination IP (Call Signal IP) as a Gateway or Gatekeeper. You can then add Dialed Number patterns to the route, either Private or Public Dial Plan numbers.

    Keep in mind that there is a limit on how many Static Routes may be created:

    - CMS/CR SP -256 max. routes / 48 max. entries per route

    - Tenor AS/AX/DX/CR 60 - 128 max routes / 24 max. entries per route

2. Associate the routes with an IP Routing Group

    IP Routing Groups can be associated with various Static Routes. The IPRG parameters are used to configure the PacketSaver™ commands, Voice Activity commands, and IP call gain settings.

    You also need to associate each IPRG with a Codec Profile and an IP Dial Plan. The Codec Profile sets the Voice Codec negotiation priority; G.723 and G.729 works in most cases. The IP Dial Plan parameters are for interoperability with H.323 equipment or software from other vendors.

    Keep in mind that there is a limit on how many IPRGs may be created:

    - CMS/CR SP - 128

    - Tenor AS/AX/DX/CR 60 – 32

3. Specify Gatekeeper/Border Element IP addresses

    In H.323 routing, Gatekeepers and Border Elements maintain tables of routing information. A Border Element is a Master Gatekeeper for your 2G Tenor

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network. All the Gatekeepers in the network report their Zone Routing information (DNs, Hopoff Numbers, and IP addresses) to this single Border Element. The Border Element builds a Master Routing Table of all the Zones and sends this Master Table back to all registered Gatekeepers.

If no Gatekeeper is specified, the Tenor will perform its own Gatekeeper functions, and examine static routes. If an external Gatekeeper is to be used, you can configure it through an H.323 Signaling Group.

4.   Create H.323 Signaling Group

The H.323 Signaling Group allows you to tweak different H.323 messaging parameters to apply to your installation.

SIP Routing

The following steps are required to set up SIP routing.

1.   Select SIP Outgoing Routing

In order to use SIP, you must first select it with the **OutgoingIPRouting** command from the Gateway prompt:

```
config-GateWay-1# set outgoingiprouting or oipr 1
```

2.   Set up Registrar and Proxy Servers

SIP incorporates the concept of Registrar and Proxy Servers for routing, which you must specify. The SIP Registrar and SIP Proxy are two different entities. It is possible that the Proxy you are using may provide both Registrar and Proxy services at the same IP address, so there are two configurable items in the CLI.

- If you want to make an IP call using a SIP Proxy, you must configure your Proxy IP address at **PrimaryProxyIPAddr**.

- If you want REGISTER messages to be sent out, you have to configure the IP address of your Registrar at **PrimaryRegistrarIPAddr**.

- If your SIP Proxy also serves as the SIP Registrar, then you must configure the same IP address in both places.

You may also configure the port, user ID, and password for these servers.

3.   Configure a SIP Signaling Group

The SIP Signaling Group allows you to tweak different SIP messaging parameters that apply to your installation.

Circuit Routing

The following steps are required to set up circuit routing.

1.   Configure the physical interface

Depending on the type of line (digital, analog), you will need to configure the interface to match the parameters of your installaation. The Digital Interface consists of either a T1, E1, or BRI WAN interface card. The Analog Interface has two types: phone (toward the PBX) and line (toward the PSTN). The phone

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interface is associated with a Line Circuit Routing Group, and the line interface is associated with a Trunk Circuit Routing Group.

2. Configure a Channel Group

A Channel Group consists of one or more channels from a line device. All channels are associated with a particular Signaling Group for setting up a call or a service, and a Routing Group (either Line Side or Trunk Side).

When a T1/E1 Line Interface Card is installed, one Channel Group is automatically configured for each interface. It is assigned a name that represents its physical location; for instance, if an 8-port card is installed in Slot 11, the Channel Groups would be named SL11DV1DI1, SL11DV1DI2, SL11DV1DI3 through SL11DV1DI8. All available channels (24 for T1, 30 for E1) are pre-assigned to these Channel Groups.

A single Digital Interface may have multiple Channel Groups; e.g., to designate a certain range of channels just for Incoming or just for Outgoing Calls. A Channel Group may not be assigned channels from different Digital Interfaces.

Channel Groups are useful in creating associations with Signaling Groups and Routing Groups.

Keep in mind that there is a limit on the number of Channel Groups that can be created:

- 256 for CMS

- 64 for Tenor AS/AX/DX

3. Configure a Signaling Group

The ISDN Signaling Group or Common Channel Signaling (CCS) is a type of signaling that enables T1 or E1 interfaces to share the same signaling channel (D channel). ISDNSignalingGroup enables you to configure ISDN parameters for up to 8 groups for Tenor CMS, and 4 groups for Tenor DX. Keep in mind that there is a limit on how many ISDNSGs may be created:

- CMS - 8

- Tenor AS/AX/DX - 4

The CASSignalingGroup enables you to configure parameters including Signaling Type, Signaling Group Orientation, and a range of supporting parameters, These settings vary based on the Signaling Type that you have chosen. Basically, CAS Signaling is primarily used on T1 lines (and for the most part E&M is the Signaling Type of choice), and R2 is CAS Signaling on an E1 line. For analog, only Loop Start options are valid. Keep in mind that there is a limit on how many CASSGs may be created:

- CMS - 8

- Tenor AS/AX/DX - 4

4. Configure a Routing Group

A Trunk Circuit Routing Group is a collection of T1 or E1 channels used to connect the Tenor to the Public Switched Telephone Network (Trunk Circuit).

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For a Trunk Circuit Routing Group to be in effect, it must be associated with a Channel Group. Keep in mind that there is a limit on how many TCRGs may be created:

- CMS - 32
- Tenor AS/AX/DX - 24

A Line Circuit Routing Group is a collection of T1 or E1 channels used to connect the Tenor to the PBX (Line Circuit) in an enterprise application. For most 2G Tenor applications it is preferable to use Trunk Circuit Routing Groups (TCRGs) vs. LCRGs. TCRGs have more routing flexibility and are more adapted to typical Tenor trunking applications. LCRGs are designed primarily for enterprise applications where functions such as Pass-Through are desired. Otherwise, even if connecting to a PBX, TCRGs are recommended. Keep in mind that there is a limit on how many LCRGs may be created:

- CMS - 32
- Tenor AS/AX/DX - 24

5. Configure number patterns to route

    Routing for a PBX can be set up using a Hopoff Number Directory (HND). A Hopoff PBX call travels over IP, and then "hops" off into the public network (PSTN) on the distant side to reduce or eliminate public toll charges. This is also referred to as Leaky Area Mapping. For a HopoffNumberDirectory to be "in effect," you must associate it with a TrunkCircuitRoutingGroup.

    Keep in mind that there is a limit on the number of entries that can be added in the HopoffNumberDirectory:

    - CMS - 32 directories, 256 numbers per directory
    - Tenor AS/AX/DX - 16 directories, 64 numbers per directory

    Routing for the PSTN can be set up using a Hunt Local Directory Number Directory. A Hunt Local Directory Number Public is used to configure Local Directory Numbers, or Station Ranges, of calls to route to the line-side (PSTN) for a Public Dial Plan. A Hunt Local Directory Number should be specified in the local format and not the full International Format, even though these calls are matched based on the International Format. Tenor builds the number(s) to the international format based on the country code and area code you configured earlier.

    Keep in mind that there is a limit on the number of entries that can be added in the HuntLDNDirectory:

    - CMS - 4 directories, 64 numbers per directory
    - Tenor AS/AX/DX - 24 directories, 32 numbers per directory

    By default, the Tenor has 2 HuntLDN Directories already created (one public, one private).

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External Routing

The Trunk Groups in the Tenor can be configured to route calls using a Quintum Call Routing Server. The Routing Server connectivity information is configured at the RadiusInfo-RoutingServer prompt. It can then be enabled in different ways. You may specify that inbound calls on a specific routing group (IPRG, TCRG, or LCRG) should be routed by the Routing Server by turning on an "EnableExternalRouting" parameter.

Note on IPRG: In the Routing Server you can only create one IPRG, so if you want to turn on external routing on selective IP addresses, you need to create a static route for that IP address, attach a new IPRG to that static route, and then turn on "EnableExternalRouting" in that new IPRG.

If the feature is enabled in the Gatekeeper Parameters, it allows the Tenor Gatekeeper to act as a "proxy" and to check an attached Quintum Call Routing Server for registered gateways and LRQ requests.

If you want to route to SIP as well as H.323 Gateways , the only way to achieve this is to use the Routing Server. In the case of Call Relay , you can also achieve SIP to H.323 signaling conversion using the Routing Server.

Call Relay

The Tenor Call Relay product (session border controller) can support the same signaling protocols as all Tenors, and has the ability to route incoming IP calls back out as IP. When a Tenor Gateway receives an IP call, it can only route it as a circuit call.

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Common Terms

Dialplan

The dialplan is a set of algorithms that analyze incoming digits. It is critical for proper routing, as well as for minimizing PDD (Post Dial Delay).

The dialplan performs the following high level functions:

- Converts the incoming digits to the globally unique E.164 (International) format for routing purposes
- Determines when input is complete and it is time to route the call
- Identifies incorrectly dialed numbers so that they are not mistakenly sent for routing

When the dialplan is correctly configured, PDD is minimal, numbers are properly routed, routing is easier to configure, and costs from incorrectly dialed calls are minimized.

The dialplan is applied to all calls inbound to the system, whether they come from an analog port, digital port, ISDN, or VoIP. In ISDN and H.323, there is additional information available that can affect the dialplan. See the description of TON and NPI later in this document.

In the vast majority of cases, the built-in dialplan templates will cover most country's dialplans. This is configured in the "Site" prompt, Country command. Set this to your country, if listed. If not, set it to the country that uses the most similar dialing patterns. In many cases, outside the U.S. and other countries in the NANPA (North American Numbering Plan Area, or country code 1), it will work well to use Country 3, France. France's dialplan is similar or identical to many other countries in Europe and elsewhere.

In recent Tenor software, there is a Country "Generic" that is identical to France (Country 3). In less common cases, it may be required to configure a custom dialplan for some countries. This is covered later in this document under UPDP (User Programmable Dial Plan). UPDP is a feature set that provides an exceptionally flexible way to write custom dialplans for either countries without templates, or custom dialplan applications for enterprises.

The Country setting also affects various signaling tones such as dialtone, busy, ringback, etc.

Public vs. Private

A public number is one that a phone company accepts and is able to route to another phone on the public voice network. A private number is one that a phone company cannot route because it does not exist on the public voice network.

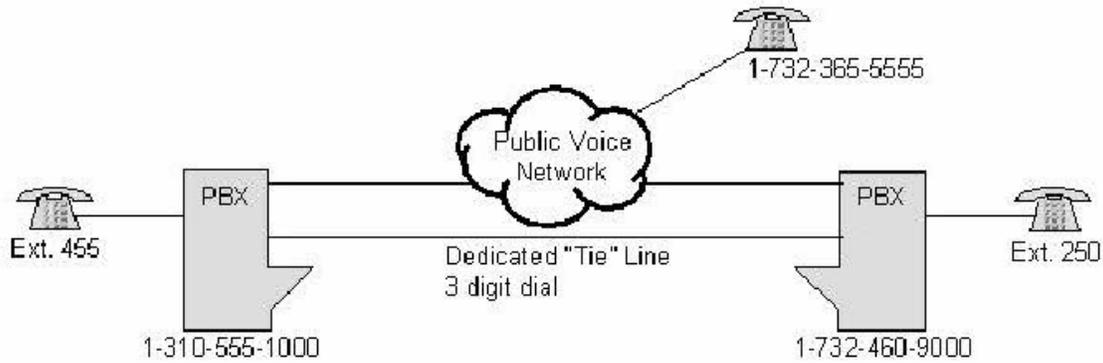An example of the two types of dialing is shown in Figure 2.

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Figure 2 - Public/Private dialplan example

In this example, a company has two locations, each with their own PBX. Each PBX has its own connection to the public voice network, provided by the local phone company, used for inbound and outbound calls. There is a dedicated "tie" line between the two PBXs. This allows the two locations to call each other by dialing the 3-digit extension of the destination. This 3-digit dialing is a private dialplan, as the public voice network would not be able to route the 3-digit call. Any calls that go out to the public voice network would use a public dialplan.

Each country decides how many digits and what format will be used for a public number. In the USA, a 7-digit (soon to be moving to a 10-digit) number defines a public local call, a 1+10-digit number defines a long distance call (with the 1 being the long distance prefix), and a 011+15-digit maximum number defines an international call (with the 011 being the international prefix).

Other countries use different prefixes and different numbers of digits for local and long distance calls. The ITU (International Telecommunications Union) has defined a standard that specifies how a public number should be formatted. This standard is called the E.164 numbering plan.

All public numbers must fit in to the format shown in Figure 3 below.

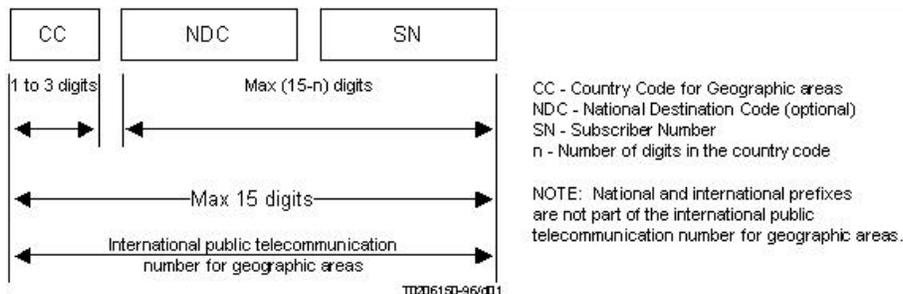**Figure 3 - International public telecommunication number structure for geographic areas**

The E.164 numbering plan does not include any dial prefixes, such as international dial prefix or long distance dial prefix. The Tenor adheres to the E.164 numbering plan for public calls strictly as outlined in the ITU document. Many other vendors do not, and this can cause problems in the routing algorithm.

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Public Numbering Plan (PUBNP)

There are two settings in PUBNP, CountryCode and AreaCode (in many countries this is referred to as the "city code"). If the Tenor is being used in a trunking application, where all calls come with country code and area code in the dial string, then you will likely want to set these to "not set". This may save you from some unexpected behavior. To do this, just issue the commands with no argument: "set cc" and "set ac".

For most applications, such as typical enterprise or last mile applications, it is critical that these values be set correctly for the location where the Tenor is operated. The purpose is to provide the dialplan with the ability to "normalize" the dialed number to E.164 format for routing.

Dial Prefixes

There are several types of dial prefixes. They are not part of the E.164 numbering plan, but it is important to understand their purpose and use.

International Prefix

INTernationaLPrefix (INTLP[x]) is the prefix(s) dialed before international numbers. The international prefix tells the phone switch (PBX, public phone company, etc.) that the following digits will be sent to another geographic area. Any time you want to call out of your country to another country, you will need to start the destination number with this prefix. In the USA, the international prefix is 011. Any call to another country outside of North America requires that you dial 011 + country code + city/area code (if available) + local number. In many other countries, the international prefix is 00. In some countries, there can be more than one international dialing prefix.

Long Distance Prefix

LongDistancePrefix (LDP) is the prefix dialed before national numbers (same country code, but different area/city code). The long distance prefix (usually just one digit) is used to dial a destination number outside of the local calling area as defined by the local phone company. In the USA, a "1" is used for the long distance prefix. For international customers, the country code for the USA is also 1, so at times this concept may seem a bit confusing. When dialing outside of the local calling area, people in the USA dial 1 + area code + local number. Not all countries have a long distance prefix, as there are no long distance calls, all calls are considered local. In many countries that do have a specific long distance prefix, it is usually "0."

A good place to check on the prefixes for a country is a website providing International dialing codes located at http://kropla.com/dialcode.htm?clkd=iwm. Quintum has no connection to this website, nor does it guarantee that the information provided there is 100% accurate and up-to-date, but it does seem to be the most accurate and well laid out of all the sites. It even provides the city/area codes for different countries.

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Note

In trunking applications, where the dialed number always includes the CC and AC, it is probably a good idea to configure both 00 and 011 to accommodate either pattern. If you do, you should not configure a LongDistancePrefix, as there will be a conflict between 0 as the LongDistancePrefix and a city code of 11, confusing the dialplan.

Examples

Let's assume the Tenor is being used in a mythical country where the country code is 99, and the area code is 22. 0 is the LongDistancePrefix, 00 is the only configured INTernationaLPrefix.

- If a user dials "5551212," the dialplan will recognize this as a local number, and prefix the country code and area code to the number for the purposes of routing. The resulting number that will be routed is 99225551212.

  If the country and area code were not configured, the number would be routed as 5551212, which would be difficult to discern from a number in Brazil for the purposes of routing.

- If a user dials "0295551212," the dialplan will recognize this as a "national" call, it will remove the zero, and add the country code. So, it will converted to 99295551212.

- If a user dials "0044999551212," the 00 INTernationaLPrefix will be stripped and nothing will be prefixed as this is now in E.164 format and is suitable for routing. The resulting number for routing will be 44995551212. (This is a mythical Mobile number in the UK – country code 44).

Carrier Selection Prefix

The carrier selection prefix is a set of digits that are used to pick a phone carrier on a call-by-call basis. This is not available in every country, but if you live in the USA, you are sure to have seen the hundreds of television ads promoting this service (such as 1010321) to save money on your calls. The actual prefix is 101 in the USA, while the remaining 4 digits identify the voice carrier that you are selecting. The ID for AT&T is 0288 (they claim that it is 288, which spells ATT on the telephone dial, but it is really 0288).

InterdigitTimeout and Post Dial Delay (PDD)

It was mentioned earlier that a properly configured dialplan will decrease PDD. This section describes how that works. As noted, most of this is hard-coded in the country dialplan template, or in the UPDP configuration.

Within the dialplan (country template or UPDP), there are settings for the minimum and maximum number of digits for any particular dialed pattern. The values affect various timers in the system, and are used to determine when to route the call, or terminate the call due to an error in the dialed number.

- If the dialed digits are less than the minimum number of digits for that pattern, a 20- to 24-second timer is in use, waiting for additional input from

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the user. If the timer expires, the call will be terminated as there are not enough digits to proceed. This timer is hard-coded, not configurable.

This is one cause of "bad format dialed" error in CH event logs. The other common cause is there is no matching pattern in the dialplan. In all cases, this error is related to a matching the dialplan problem.

- If the dialed digits are at least "minimum" for that dial pattern, but less than the maximum, a much shorter timer is used. This is the value of InterdigitTimeout in the DialPlan prompt. The default is 4 seconds.

  It is not recommended to change InterdigitTimeout, at least not less than 4 seconds, or calls may be routed with an incomplete number and will fail. Increasing this is less hazardous, but could negatively impact PDD.

  If calls are dialed with an auto dialer, it may be OK to decrease InterdigitTimeout. If users are dialing by hand, and calls are routing too quickly sometimes, increase InterdigitTimeout. A common default in most countries is 4 seconds, and this is what most users are accustomed to. Make any changes in small increments, and stay close to 4 seconds.

- If the dialed pattern matches the maximum digits for that pattern, the call is routed immediately, no timer. This shortens PDD.

  It is possible, even common, depending on the dial pattern, for the minimum and maximum number of digits to be the same. For example, if local numbers are always 8 digits, a 20-second timer is in use until 8 digits are entered, and the call is routed immediately once 8 digits are entered. This reduces PDD by several seconds, while preventing many misdialed calls to route through and fail.

  Most other gateways, and many PBXs, will not recognize apply any intelligence to the dialed pattern, always just applying an interdigit timeout. This is often 2-3 seconds, as they try to keep PDD low. This causes several negative side-effects:

    - Routing is not done in a consistent manner, causing routing issues.

    - Calls will route through too fast, often with incomplete numbers if the user pauses for a moment while dialing.

    - PDD will be longer as a call that is completely dialed has to wait several seconds for additional digits to be sure it has all the digits.

  This can cause a double delay if a PBX that does not do intelligent dialplans is used in series with a VoIP gateway. The PBX will wait for a timeout, then the VoIP gateway will wait for the length of its InterdigitTimeout. The Tenor's dialplan code cannot fix the PBX problem, but it can minimize or eliminate the double delay.

Overlapdial

Overlapdial is a parameter in both LCRG and TCRG (though not IPRG). This has a significant effect on the timers mentioned in the previous sections, PDD in particular. This parameter has a very different effect on ISDN vs. CAS trunks.

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ISDN

In ISDN, particularly ETSI protocols, the concept called Overlapdial is most common on BRI lines, and E1 PRIs from PBXs. It might also apply to ETSI PRIs from the PSTN.

Enable Overlapdial on TCRG- and LCRG-managed ISDN trunks that may receive calls with partial dialed number in the SETUP message. The remainder of the digits will come in INFO messages in Q.931 signaling. The originating ISDN device can signal that dialing is complete with a "Sending Complete" message, or by setting the "Sending Complete" single byte IE in the SETUP message. When Sending Complete is received, the call routes immediately. Until Sending Complete is received, the timers are in use. This takes care of cases where Sending Complete will never be sent (most common on BRI phones).

If Overlapdial is disabled on an ISDN trunk, the call is routed immediately, and the number in the Called Party IE of the SETUP message is used. The system will NOT recognize any additional digits received after the SETUP.

CAS (includes analog phones, as well as T1/E1 non-ISDN trunks)

Disabling Overlapdial on a TCRG/LCRG for CAS trunks has the net effect of setting the InterdigitTimeout to 1 second (for these trunks only, not the entire system). Normally, Overlapdial is enabled on analog trunks to accommodate humans dialing. If the trunks/lines controlled by this TCRG/LCRG only receive calls generated by a machine, you will reduce PDD by disabling Overlapdial on this Routing Group.

Note

Do **NOT** disable Overlapdial if the calls are dialed by a human, or dialing errors will almost certainly occur!

TON and NPI

On ISDN and H.323 calls, you can set TON and NPI in the SETUP message. This has a significant impact on how the dialplan is applied to the number.

Unfortunately, some gateways do not implement these properly, setting random settings, triggering normalization problems. It is possible to correct for these situations using the IgnoreTONNPI parameter, discussed further below.

NPI (Number Plan Indicator)

We will not go deeply into NPI, but the main thing to understand is this can be used for Private numbering plans. It is out of the scope of this document to go into private number plans. Normally, on public calls, this is either 1 (ISDN) or 0 (unknown).

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TON (Type of Number, also known as "Nature of Address")

TON in the CallED number party Information Element in a SETUP message says what kind of number is specified. The DialPlan will use this to determine how to normalize the number.

- TON: 0 (unknown)

This says the type of number is unknown. In this case, the number will be analyzed by the full DialPlan, just as it if were entered by a human. This is the most common.

- TON: 1 (Iinternational)

This specifies the number is already in E.164 format. Nothing will be done to the number, as it is assumed to be already in a form that can be routed by the Tenor. This is very common on inbound H.323 calls, and somewhat common in trunking applications.

- TON: 2 (National)

This specifies the number is in National format. So, similar to a number with a leading 0 (or 1 in the NANPA), the DialPlan will prefix the Country code and route. This is primarily seen in inbound calls from the PSTN to an enterprise PBX PRI.. This is very rare on H.323 calls, and is probably incorrect if it is seen there (see IgnoreTONNPI below).

- TON: 4 (Local or Subscriber)

This specifies the number is just the subscriber portion of the number. The CC and AC will be prefixed before routing. Almost never seen, except, as above, in inbound calls from the PSTN to an enterprise PBX. Again, if the number is not really a Subscriber number, see IgnoreTONNPI below.

IgnoreTONNPI

IgnoreTONNPI is probably misnamed. It is really more like "ForceTONNPI". It is set in ISDNSignalingGroupfor ISDN circuits. It is set in IPRoutingGroups for inbound IP calls.

The most common settings for IgnoreTONNPI are:

- 0, respect the TON and NPI provided

- 128, force to unknown/unknown. Apply full DialPlan, fully analyze dial string

- 145, force to International TON, ISDN NPI. Take the number as-is, as E.164.

This parameter overrides the TON and NPI on inbound calls for this trunk group. For example, calls may be coming in E.164 format, but are coded as TON:0 (unknown) NPI:0 (unknown). Perhaps a call comes in coded as unknown, but is 449995551212. As an unknown/unknown number, only the first 7 or 8 digits are kept, and the CC and AC are prepended. Using our earlier example, the call would probably be normalized as 99224499955, which is incorrectly prepending the CC and AC, as well as truncating the last several digits. If IgnoreTONNPI is set to 145, the delivered TON and NPI is overridden with 1 international, 1 ISDN, and the number will be taken as-is and routed as 449995551212.

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Related Tenor CLI Commands

What follows is a list with descriptions of the Tenor CLI commands that are directly related to how the Tenor routes calls. For more information on the individual commands, please see the CLI manual. If you do not have this manual, you can get it either by emailing the QTAC at service@quintum.com or by checking the customer service section on our website at www.quintum.com.

You may not see all of these commands in your Tenor, depending on the software release.

CLI Prompt Level	Command Name	Description
config-PUBlicNumberingPlan-1#	CountryCode	Sets the country code where the Tenor is installed.
	AreaCode	Sets the city/area code where the Tenor is installed. If there is no city/area code, set to null.
config-HuntLDNDirectory-pub1#	PrefixCCAC	Determines whether the dialplan should prefix the Country Code and Area Code to the LDNs in that particular Public Hunt LDN Directory, for the purposes of matching inbound calls to LDNs. This is enabled by default, which means the prefix is not added.
config-DialPlan-1#	MINDNlength	Identifies the minimum number of digits for a public number. If the Tenor receives a public number with less than the mindn, then it will not be able to route the call.
	MAXDNlength	Identifies the maximum number of digits for a public number. The Tenor only accepts the maxdn number of digits for a public number, so if set to 7, the Tenor only accepts a maximum of 7 dialed digits.
	INTernationaLPrefix	Identifies the international prefix(es) for the country where this Tenor is installed. Up to 5 entries are permitted (for countries that have more than 1).
	LongDistancePrefix	Identifies the long distance prefix for the country where the Tenor is installed. If there is no long distance prefix in your country, set this to null.
	CarrierPrefixPattern	Identifies the carrier selection prefix pattern. This should include the actual prefix and X's to identify the variable carrier ids. For example, the USA pattern would be 101xxxx, which identifies the 101 as the carrier selection prefix, followed by any 4-digit number that identifies the actual carrier to use.

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CLI Prompt Level	Command Name	Description
	10DigitlocalDial	Used only in North America. Up until recently in the USA, to dial a local number you need only dial the 7-digit number, but we are moving to a 10-digit dial plan in that when you want to make a local call, you will need to dial 10 digits (area code plus 7-digit number), even to your next door neighbor. This has not happened across the entire country as of yet, but every month, more areas are doing this. If you happen to be in an area that does this 10-digit local dial, you will need to set this to yes.
	IntercomEnable	Allows the Tenor to handle both public and private numbers simultaneously so that you can dial a private number between Tenors for one call (like a 3-digit extension), and then dial a public number for the next, without changing the configuration of the Tenor. This is usually recommended when you have a phone connected directly to the PBX interface of an Analog Tenor. This feature is only available when calls originate from the LCRG of the Tenor. Any call that comes in to the Tenor from the LCRG, the Tenor will treat as a private call unless the number begins with any of these prefixes: PSTNRoutePrefix, IPRoutePrefix, MultipathPrefix. When a number is received by the Tenor without any of the above prefixes as the first digit, the Tenor will only accept the number of digits that has been specified in the PRIVateDNLength and route the call as a private number.
	PSTNRoutePrefix	Used in conjunction with intercom dialing. See IntercomEnable above for more information. When IntercomEnable is set to yes, and you configure a digit here as the PSTNRoutePrefix, any number that is received by the Tenor on its LCRG that begins with this prefix will be treated as a public number and be routed to a local TCRG that has a matching PassThroughID (see below for more information on this command). The PSTNRoutePrefix will be deleted from the dialed number before sending to the public voice network.

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CLI Prompt Level	Command Name	Description
	IPRoutePrefix	Used in conjunction with intercom dialing. See IntercomEnable above for more information. When IntercomEnable is set to yes, and you configure a digit here as the IPRoutePrefix, any number that is received by the Tenor on its LCRG that begins with this prefix will be treated as a public number. The Tenor will then look for a route over IP to send the call. If no route exists, the call will be terminated. The IPRoutePrefix will be deleted from the dialed number before sending over IP.
	MultipathPrefix	Used in conjunction with intercom dialing. See IntercomEnable above for more information. When IntercomEnable is set to yes, and you configure a digit here as the MultipathPrefix, any number that is received by the Tenor on its LCRG that begins with this prefix will be treated as a public number. The Tenor will then look for a route over IP to send the call to first. If no route exists, the call will be routed to a local TCRG that has a matching PassThroughID (see below for more information on this command). If a match is found on the IP network, the call will be routed over the IP network. The MultipathPrefix will be deleted from the dialed number before sending.
config-PRIVateNumberingPlan-1#	PRIVateDNEnabled	Tells the Tenor that a private dial plan will be used. When you set IntercomEnable to yes, this command will automatically be set to yes.
	PRIVateDNLength	Used in conjunction with PRIVateDNEnabled and IntercomEnable. Defines the number of digits for a private number. When IntercomEnable is set to yes and this command is set to 3, if a number is received by the Tenor on its LCRG without any of the above related prefixes, the Tenor only accepts 3 digits and routes the call as a private number with 3 digits. If IntercomEnable is set to no, then the number used in the LCRG must be set to private so that the Tenor knows that all calls coming in to that trunk group will be private.

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CLI Prompt Level	Command Name	Description
config-TrunkCircuitRoutingGroup-1#	PassThroughEnable	When set to Yes (default), will unconditionally route any incoming calls from this TCRG to a LCRG that has a matching PassThroughID. If set to No, will look to route the call based on the digits received. This route could be over IP or to a LCRG that has a matching PassThroughID.
	PassThroughID	Associates a TCRG with a LCRG for passthru operation. When a call needs to go from a TCRG to a LCRG, the call can only go to a LCRG that has the same PassThroughID as the TCRG where the call came in to on the same unit.
	EndOfDial	Enables the end-of-dial digit. When this is set and the end-of-dial digit is set, users can dial this digit to tell the Tenor that they are done dialing, and the Tenor will start routing the call without waiting for more digits. This is very useful if you are dialing calls that are more than the MINDNlength, but less than the MAXDNlength number of digits.
	EndOfDialDigit	Sets the actual end-of-dial digit. Typically, this is set to '#'.
	AddEndOfDialDigit	Sets the Tenor to keep the end-of-dial digit on the number sent out to the PSTN. If set to No (default), the Tenor strips this digit off before routing the call.
	IVRType	Allows the Tenor to provide a dial tone to a call when it is received on the TCRG. The passthru command must be set to No for this to work. When configured to 2, 7 or 8, and a user dials in to the Tenor from the TCRG, the Tenor answers the call and provides a dial tone to the user. The user can then dial a number and the Tenor routes the call to the appropriate destination based on the digits dialed.
	PIN	Used in conjunction with IVRType. This allows you to configure a pincode so that when IVRType is set to 2, 7 or 8 and users call in to this trunk group, they will hear a beep tone. They must enter a pincode at this point. If they enter the correct pincode, the Tenor provides them with the second dial tone and they may dial as described above. If they enter a wrong pincode, the Tenor provides a fast busy tone.

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CLI Prompt Level	Command Name	Description
	ForcedRoutingNum	Forces any incoming call on this trunk group to the DN set in this parameter, and sends the call over IP only. There must be a match for the ForcedRoutingNum on the IP network.
config-HopoffNumberDirectory-1#	Pattern	Defines the "hop-off" patterns or calls that this unit will allow out of this TCRG. When dealing with a public number, the pattern should be based on the E.164 numbering plan (country code + city/area code + local number). No prefixes should be used as part of the pattern for a public number. For a private number, use the actual digits that will be dialed. You do not need to enter the specific number, you may enter just the beginning part of the number. For example, to allow all calls for the USA to hop-off of a Tenor in NJ, you would enter a pattern of 1, which is the country code for the USA. To allow hop-off calls only to the NJ area code, the pattern would be 1732, which is the country code of the US and the NJ area code. It is important to understand that when a number matches a Pattern, the digits that match are deleted from the number dialed, so if the number dialed was 12125551212, and it matches to the first Pattern of 1, the number that would be sent out of the TCRG would be 2125551212, and the PSTN would not be able to route this. See Replacement for more information.
	Replacement	Adds digits on to a "hop-off" number after it has matched the associated Pattern and the matching digits have been deleted from the number. As discussed above, when the number 12125551212 is dialed and matches to the Pattern of 1, the number that would be sent out of the TCRG would be 2125551212. The PSTN would not be able to route this call because it is a long distance number and requires the long distance prefix (1 in the US) to be added. The Replacement would be 1 for this Pattern.
	NumberType	Sets whether the associated Pattern will be used for public or private numbers.
config-LineCircuitRoutingGroup-1#	PassThroughEnable	When set to Yes (default), the Tenor looks to see if a match is on the IP network. If none is found, the call is routed to a local TCRG that has a matching PassThroughID.

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CLI Prompt Level	Command Name	Description
	PassThroughID	Associates a LCRG with a TCRG for passthru operation. When a call needs to go from a LCRG to a TCRG, the call can only go to a TCRG that has the same PassThroughID as the LCRG where the call came in to on the same unit.
	EnableMultiPath	When set to No, all calls will be forced over IP, if a match is found. If no match is found, the call will not complete. The exception to this is if there is a bypass number configured that matches the number dialed, then this call will go out to the PSTN and not over IP.
	EndOfDial	Enables the end-of-dial digit. When this is set and the end-of-dial digit is set, users can dial this digit to tell the Tenor that they are done dialing, and the Tenor starts routing the call without waiting for more digits. This is very useful if you are dialing calls that are more than the MINDNlength, but less than the MAXDNlength number of digits.
	EndOfDialDigit	Sets the actual end-of-dial digit. Typically, this is set to '#'.
	AddEndOfDialDigit	Sets the Tenor to keep the end-of-dial digit on the number sent out to the PBX. If set to No (default), the Tenor strips this digit off before routing the call.
	PUBlicNumDigits	Sets how many digits are sent to the PBX for an incoming public IP call.
	PRIVateNumDigits	Sets how many digits are sent to the PBX for an incoming private IP call.
	BypassNumber DirectoryAttached	Sets the bypass numbers. Bypass numbers are numbers that never go over IP.
	PUBHuntLdn DirAttached	Sets the public local directory numbers that are assigned to the local PBX. These will be the public numbers where that user calls you.
	PRIVHuntLdn DirAttached	Sets the private local directory numbers that are assigned to the local PBX. These will be the private numbers where that user calls you.
config-IPDialPlan-1#	INcomingPrefix	Prepends the specified digits to all incoming IP calls.
	INcomingDelDigits	Deletes, from the left, the specified number of digits on all incoming IP calls.
	OUTgoingPrefix	Prepends the specified digits to all outgoing IP calls.
	OUTgoingDelDigits	Deletes, from the left, the specified number of digits on all outgoing IP calls.

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Call Examples

The following examples show actual call routing with the Tenor. Not all routing possibilities are shown here as there are too many of them.

When reading the examples, please refer to Figure 4 as the base starting point. Any other configuration settings will be shown as part of the example.
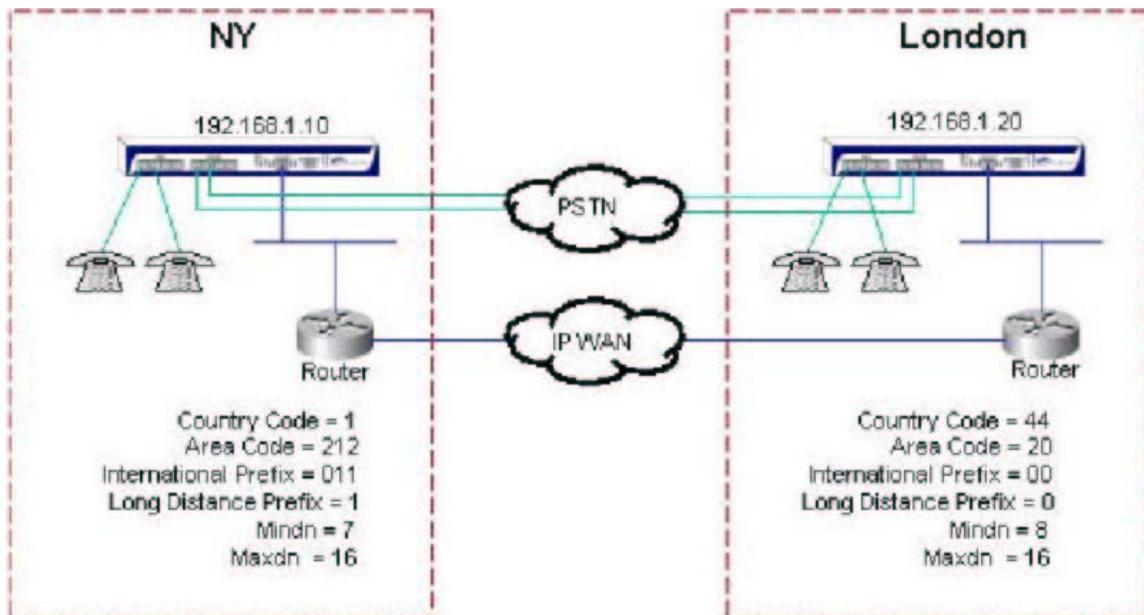

Figure 4 - Sample Setup

Example 1 - Normal Dialing Pattern

Site-to-Site Dialing

1. An NY user picks up a phone and dials 011442054443201.

2. The Tenor receives all digits, strips off the international prefix (011), and sends an address request (ARQ) for 442054443201 to the Gatekeeper.

3. The GK finds a match and sends the destination IP address of 192.168.1.20 to Tenor.

4. The Tenor routes the call over IP, with digits of 442054443201 (E.164 format), to the London Tenor.

5. The London Tenor receives the call with digits 442054443200 and looks for a match.

6. The London Tenor finds a match in LCRG-1 to the E.164 format of 44205443201.

7. The London Tenor routes the call to LCRG-1.

8. LCRG-1 deletes all but the last four digits and sends the call on LCRG-1.

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9. If the call does not connect, the NY Tenor receives a release from the distant end, returns the number to the original dialed format of 011442054443200, and routes the call to TCRG-1 (both LCRG-1 and TCRG-1 have a PassThroughID of 0).

10. The TCRG goes off-hook to the PSTN and dials out digits.

11. The call routes through the public voice network to London Tenor.

12. The London Tenor receives a call from the PSTN and because PassThroughEnable on TCRG-1 is set to yes, immediately routes the incoming PSTN call to LCRG-1 (which has the same PassThroughID).

Hop-off Dialing

1. An NY user picks up a phone and dials 0114417133334321.

2. The NY Tenor receives all digits, strips off the international prefix (011), and sends an ARQ to the Gatekeeper for 4417133334321.

3. The GK finds a match (London Pattern of 44) and sends the destination IP address of 192.168.1.20 to the Tenor.

4. The NY Tenor routes the call over IP with digits 4417133334321 (E.164 format) to the London Tenor.

5. The London Tenor receives the call with digits 4417133334321 and looks for a match.

6. The London Tenor finds a match in both the TCRG-1 and TCRG-2 Pattern of 44.

7. The call is routed to the first available TCRG.

8. The matching Pattern digits of 44 are deleted, leaving 17133334321.

9. Since a Replacement of 0 is set for this Pattern, 0 is added back to the number, making it 017133334321.

10. The call is routed to the PSTN for connection.

11. If the call fails to connect, the NY Tenor will set the number back to "as dialed" (0114417133334321) and route the call out of TCRG-1, which has the same PassThroughID as LCRG-1, where the call originated.

Local Dialing

1. An NY user dials 5551212.

2. The Tenor receives 5551212 on LCRG 2.

3. Since this is a public number and it is not in the E.164 format, the Tenor adds country code (1) and area code (212) to number to make it 12125551212.

4. The Tenor sends an ARQ to the GK for the route.

5. The GK looks for a route for 12125551212, but finds no match on the IP network.

6. The Tenor sets the number back as originally dialed (5551212), and routes out of TCRG-2, since the PassThroughID (1) matches the origination LCRG.

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Example 2 – Intercom/Private Dialing Pattern

Phone-to-phone (Extension) Dialing – Within Same Location

1. An NY user on phone extension 1001 dials 1002.

2. The Tenor receives digits 1002 from LCRG-1. Because the number does not begin with a 7, 8 or 9 (PSTNRoutePrefix, IPRoutePrefix, or MultiPathPrefix), the Tenor will only accept the PRIVateDNLength number of digits specified (in this case 4), and treats the call as a private call.

3. The Tenor looks for a route within itself and finds a match on LCRG-2.

4. The Tenor routes the call to LCRG-2, and the phone rings.

Site-to-Site Dialing – 4-digit Dialing

1. An NY user, on LCRG-1, dials 3201.

2. The NY Tenor receives digits 3201 from LCRG-1. Because the number does not begin with a 7, 8 or 9 (PSTNRoutePrefix, IPRoutePrefix, or MultiPathPrefix), the Tenor will only accept the PRIVateDNLength number of digits specified (in this case 4), and treats the call as a private call.

3. The Tenor does not change the number since it is a private number.

4. The Tenor looks for a route within itself, but finds no match for the private 3201.

5. The Tenor sends an ARQ to the GK for an IP route.

6. The GK finds a match at 192.168.1.20 and returns this IP address to the Tenor.

7. The NY Tenor routes the call to London Tenor (192.168.1.20).

8. The London Tenor receives an incoming call from IP for a private number of 3201.

9. The London Tenor does not change the number because it is private and looks for a match to the private number.

10. A match is found on LCRG-1 (PRIVHuntLdnDirAttached = 3201) and the call is routed to LCRG-1.

Hop-off Dialing

1. A London user dials 90017324609000.

2. The London Tenor starts to receive the number. Since the first digit begins with a 9 (the MultiPathPrefix), the Tenor will accept all the digits that are dialed and treat the call as a public call.

3. The London Tenor strips off the MultiPathPrefix (9) from the number and puts the number in E.164 format by stripping the 00 international prefix from the number.

4. The London Tenor sends an ARQ to the GK for a route for the public number of 17324609000.

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5.   The GK finds a match of 1 as a Pattern in the NY Tenor (192.168.1.10) and tells the London Tenor to route the call there.

6.   The London Tenor routes the call to 192.168.1.10 and the call is routed over IP to the NY Tenor.

7.   The NY Tenor receives the incoming call (17324609000 public) from IP and looks for a match for the call.

8.   The Tenor finds a match in both the TCRG-1 and TCRG-2 as a Pattern of 1.

9.   The Tenor decides to which TCRG to route the call.

10. The Tenor then deletes the Pattern from the number. In this case the Pattern is 1, so 1 (representing the country code) is deleted from the number leaving 7324609000.

11. The Tenor then adds the Replacement for this Pattern to the number. In this case, the Replacement of 1 (representing the long distance prefix) is added to the number leaving 17324609000.

12. The call is routed out of the TCRG to the PSTN for connection.

13. If there was no match to the call originated in London, because the MultiPathPrefix was used, the call would be routed to the local PSTN connection.

2nd Dial Tone Dialing

1.   A user in NY, but not in the NY office, dials the phone number for the analog line from the PSTN.

2.   The PSTN delivers the call to the TCRG of the Tenor in NY.

3.   The NY Tenor answers the call and provides a dial tone to the user.

4.   The user can now dial any number on the network, like 011442054443202.

5.   The NY Tenor receives the dialed digits and puts them into E.164 format by stripping off the international dial prefix (011) from the number.

6.   The Tenor sends an ARQ to the GK for a route for the number 442054443202.

7.   The GK finds a match and sends the destination IP of 192.168.1.20 (London) to the Tenor.

8.   The Tenor routes the call over IP to 192.168.1.20.

9.   The London Tenor receives the IP call 442054443202 and looks for a match.

10. A match is found on LCRG-2 and the call is routed to the phone.

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Appendix A - User Program Dial Plan (UPDP)

The UPDP feature allows you to identify a completely customizable set of digit sequences for the Tenor. Once you have enabled the **UserProgramDialPlanEnabled** parameter, you may start adding dialing patterns so that the Tenor can identify specific sequences of digits, and treat them accordingly.

The UPDP feature lets you customize the way the Tenor reads and sends the sequence of digits that you enter. In general, the dial plan defines which sequences of digits will be recognized by the Tenor as valid dial strings, suitable to send through the network (e.g., 555-1212, 1-408-555-1212, 011 46 8 1234 1234).

Once you enable the UPDP feature, all Dial Plan information is controlled by the UPDP feature only; the Country value and the other Dial Plan settings are ignored. However, the Country Code and Area Code found in the Config Manager Dial Plan window still participate in constructing the E.164 Normalized number.

Specifically, the following parameters are ignored: 10DigitlocalDial, MINDNlength, MAXDNlength, CarrierPrefixPattern, IPRoutePrefix, PSTNRoutePrefix, MultipathPrefix, IntercomPrefix, CentrexPrefix.

The parameters LongDistancePrefix and INTernationaLPrefix are still used in case of number normalization or an autoswitch number.

A dialing plan consists of the following elements:

- **Number Pattern** - Used to define a dial plan format, such as E.164 prefix (long distance, local, international, etc.), PBX extension number, special code, etc. Maximum of 8 digits. Valid entry is 0-9, and '~' (indicates a range, for example, 192~9 means, 192, 193, 194, 195, 196, 197, 198, 199). In addition, the characters * and # can be used for types 6 and 8.

- **Type of Number** - A single digit from 1-8 may be used as a value. The different types of DN sequences are:

  International - Designates an international dial plan.

  Long Distance (National) - Designates that this pattern is supported within the domestic long distance calling area, but not internationally

  Carrier Selection Prefixes - Designates a carrier (e.g., Verizon); used mostly for connecting to an LD service provider.

  Local - Designates that the dial plan is supported within the local calling area.

  Special Service - Designates a Special Service, other than international, long distance, local, carrier selection.

  Supplementary Service 1 - Designates Supplementary services, such as call waiting, call forwarding, call transfer, call forwarding, 3 way call, conference call etc. All supplementary services have individual "codes" provided by the Central Office. You can start any of these services by entering type 6

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followed by the activation or termination code. An activation code will turn on the service. For example, type *xx# or #xx# where xx indicates the number that corresponds to the service. For example, to turn on call waiting, type 6 *31#.

Supplementary Service 2 - The difference between Supplementary service 1 and 2 types is that in the case of type 1 the digits will be sent immediately, but type 2 service waits for the next digit to be entered. The next DP should be registered in the same dial plan.

Private - If UPDP is selected and a private number is activated, UPDP becomes the dial plan used for the Tenor. To activate a private number using UPDP, ensure the private option is enabled (1), the private DN is defined, and the updp option is enabled (1).

- **Minimum Digit** - Defines a minimum number of digits to receive; once this limit is met, the string can be sent. This setting is optional. If you enter less than the minimum and the interdigit timer expires, a fast busy tone will be heard. If pattern length is same as min_digit, this field is not required. Min_digit must be equal to or greater than pattern length.

- **Maximum Digit** - Defines a maximum number of digits to receive. This setting is optional. If max_digit is same as min_digit, this field is not required. Max_digit must be larger than min_digit. Once this number of digits is met, the Tenor will stop receiving characters immediately and send the string.

- **Prefix Length** - Defines a number of prefix digits to delete. If this field is not set, it is set to the default value as follows:

pattern length (international)

1 (long distance)

0 (local)

0 (special service)

pattern length (carrier selection)

The default value will cover most cases except for some international dial plans. For example, in China, the international dial plan is 001-009. If the PSTN requests the last digit (1-9) to select a service provider, the prefix number is 2. Otherwise, prefix number is 3, which means three digits will be deleted.