Nortel Networks Media Gateway 7480/ 15000

Technology Fundamentals

NN10600-780

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About this document

This guide contains information about installing, configuring, and maintaining narrowband services trunking over ATM (NSTA). To use this guide effectively, see the following sections:

Who should read this guide

This guide is useful for anyone who installs, configures, and maintains either switched or non-switched ATM Media Gateway in Nortel Networks Multiservice Switch networks.

How this guide is organized

The NN10600-780 *Nortel Networks Media Gateway 7480/15000 Technology Fundamentals* is organized as follows:

- "Introduction to Multiservice Switch Media Gateway" (page 31) provides an overview of Nortel Networks Multiservice Switch Media Gateway for non-switched Media Gateway using ATM, and switched Media Gateway using both ATM and IP.

- "Non-switched Media Gateway using ATM functionality" (page 41) provides an overview of the non-switched Media Gateway feature.
- "Switched Media Gateway using ATM functionality" (page 57) provides an overview of the switched Media Gateway using ATM feature.
- "Switched Media Gateway using IP functionality" (page 69) provides an overview of the switched Media Gateway using IP feature.
- "Switched Media Gateway using ATM or IP functionality" (page 89) provides an overview of functionality that is common to switched Media Gateway using both ATM and IP.
- "ATM connections for Media Gateway" (page 119) describes how Media Gateway can use the various types of ATM connections.
- "Installing and setting up Media Gateway" (page 141) provides prerequisites to set up the ATM and time division multiplexing (TDM) interfaces and link them to create a voice gateway.
- "Traffic management for Media Gateway" (page 149) contains guidelines for configuring ATM traffic management parameters for Media Gateway.
- "Fault management for Media Gateway" (page 161) contains information about troubleshooting NSTA (the software component of Media Gateway), including how to fix specific problems.
- "Definitions of audible tones by country" (page 179) contains information about the audible tones that Nortel Networks Multiservice Switch Media Gatewaycan generate for different countries.

What's new in this document

The following features were added to this document:

- "Media Gateway 4pGe Carrier Grade Integration" (page 21)
- "Media Gateway - Tones and Continuity Test for Switched Voice" (page 22)
- "PTS trunks on VSP3-o" (page 24)
- "T.38 Fax & DMTF interworking with H.323" (page 24)
- "Voice Services Processor 3 with Optical TDM Interface (2pOc3ChSmIrVsp3)" (page 24)

Other changes made to this document include the following:

- The terms Passport and PVG have been rebranded in conjunction with the new Nortel Networks' brand simplified naming format. Passport is now referred to as the Nortel Networks Multiservice Switch, and PVG is now Media Gateway 7480/15000. For more information on the product rebranding, refer to NN10600-000 *Nortel Networks Multiservice Switch 7400/15000/20000 What's New in PCR6.1*.
- changed two headings to "Tone name" and "Package/identifier" for all the tables in the appendix "Definitions of audible tones by country" (page 179)
- clarified the description of section "Voice-band connection admission control" (page 159)
- added new section "Switching TDM traffic in a LAPS configuration" (page 110)
- clarified the descriptions of sections "System requirements for Media Gateway" (page 142), "Configuring logical processor types for Media Gateway" (page 145), "Configuring logical processors for Media Gateway" (page 146), and "Configuring function processors for Media Gateway" (page 147)

Media Gateway 4pGe Carrier Grade Integration

The following sections were updated for this feature:

- "Switched Media Gateway using IP functionality" (page 69)
- "VoIP using Ethernet transport and VR" (page 74)
- "4pGe FP card support of VoIP" (page 75)
- "4pGe FP card support of carrier grade" (page 75)
- "Media Gateway carrier grade" (page 111)
- "Hot CPSO" (page 112)
- "Hitless equipment protection (HEP)" (page 113)
- "VSP HEP for switched Media Gateway with VR interworking" (page 114)
- "Hitless software migration (HSM)" (page 115)

- “VSP HSM for switched Media Gateway with VR interworking” (page 116)
- “Application and features for installing Media Gateway software” (page 144)
- “Hitless software migration (HSM)” (page 115)

Media Gateway - Tones and Continuity Test for Switched Voice

The following sections were updated for this feature:

- “Audible tones for switched Media Gateway” (page 90)
- “Supported tone packages for tones controlled by the MGC” (page 91)
- “Definitions of audible tones by country” (page 179)
- “Definition of supported tones for Argentina” (page 181)
- “Definition of supported tones for Australia” (page 183)
- “Definition of supported tones for Austria” (page 185)
- “Definition of supported tones for Belgium” (page 188)
- “Definition of supported tones for Brazil” (page 191)
- “Definition of supported tones for Canada” (page 194)
- “Definition of supported tones for Chile” (page 197)
- “Definition of supported tones for China” (page 199)
- “Definition of supported tones for Czech Republic” (page 201)
- “Definition of supported tones for France” (page 204)
- “Definition of supported tones for Germany” (page 207)
- “Definition of supported tones for Greece” (page 210)
- “Definition of supported tones for Hong Kong” (page 212)
- “Definition of supported tones for India” (page 215)
- “Definition of supported tones for Ireland” (page 217)
- “Definition of supported tones for Israel” (page 219)
- “Definition of supported tones for Italy” (page 222)

PTS trunks on VSP3-o

The following section was updated for this feature:

- “Per-Trunk Signaling” (page 109)

T.38 Fax & DMTF interworking with H.323

The following sections were updated for this feature:

- “DTMF relay” (page 82)
- “Fax relay” (page 82)
- “VBD terminal support” (page 83)
- “Dual-tone multifrequency digit collection for switched Media Gateway” (page 95)
- “Custom Local Area Signaling Services (CLASS)” (page 108)

Voice Services Processor 3 with Optical TDM Interface (2pOc3ChSmIrVsp3)

The following sections were updated for this feature:

- “Echo cancellation” (page 34)
- “Considerations for G.729 Annex A and B voice encoding” (page 38)
- “Data calls” (page 39)
- “Supported packet features using VSP2/VSP3/VSP3-o and ATM functionality” (page 62)
- “VoIP using ATM transport and external routing” (page 70)
- “G.711 voice call compression” (page 79)
- “G.729a voice call compression” (page 79)
- “Switched IP-to-TDM gateway” (page 80)
- “DTMF relay” (page 82)
- “VBD terminal support” (page 83)
- “VoIP services for voice calls” (page 85)
- “RTP, UDP, IP and ICMP support” (page 85)

- “Supported packet features using VSP3-o and IP functionality” (page 86)
- “PRI backhaul for switched Media Gateway” (page 98)
- “On-switch PSVC loops” (page 140)

What you need to know

In order to understand and configure Media Gateway in Nortel Networks Multiservice Switch systems, you need a basic understanding of the following areas:

- Multiservice Switch hardware, including installation and maintenance procedures
- Multiservice Switch operations and maintenance procedures, including how to configure a node
- Multiservice Switch ATM services

Text conventions

There are a number of documentation conventions you should know about.

- `nonproportional spaced plain type`

  Nonproportional spaced plain type represents system generated text or text that appears on your screen.

- **nonproportional spaced bold type**

  Nonproportional spaced bold type represents words that you should type or that you should select on the screen.

- *italics*

  Statements that appear in italics in a procedure explain the results of a particular step and appear immediately following the step.

  Words that appear in italics in text are for naming.

- [optional_parameter]

  Words in square brackets represent optional parameters. The command can be entered with or without the words in the square brackets.

- <general_term>

  Words in angle brackets represent variables which are to be replaced with specific values.

- UPPERCASE, lowercase
  Nortel Networks Multiservice Switch system commands are not case-sensitive and do not have to match commands and parameters exactly as shown in this document, with the exception of string options values (for example, file and directory names) and string attribute values.

- ...

  Three dots in a command indicate that the parameter can be repeated more than once in succession.

- |

  This symbol separates items from which you can select one; for example, ON|OFF indicates that you may specify ON or OFF. If you do not make a choice, a default ON is assumed.

The term absolute pathname refers to the full specification of a path starting from the root directory. Absolute pathnames always begin with the slash (/) symbol. A relative pathname takes the current directory as its starting point, and starts with any alphanumeric character (other than /).

Procedure conventions

This document uses the following procedure conventions:

- You can enter commands using full component and attribute names, or you can abbreviate them. The commands used in the procedures contain the full component and attribute names in the first instance. In the second instance, the component and attribute names are abbreviated. For more information on abbreviating component and attribute names, see

NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*. All component and attribute names are formatted in italics.

- The introduction of every procedure states whether you must perform the procedure in operational mode or provisioning mode. For more information on these modes, see “Operational mode” (page 27) or “Provisioning mode” (page 27).
- When you complete a procedure, you can verify your changes and then activate them as the new node configuration. For more information on completing configuration changes and exiting provisioning mode, see “Activating configuration changes” (page 28).

Operational mode

Procedures contained within this document can either be performed in operational mode or provisioning mode. When you initially log into a Nortel Networks Multiservice Switch node, you are in operational mode. The system uses the following command prompt when you are in operational mode:

```
#>
```

where:
is the current command number

In operational mode, you work with operational components and attributes. In operational mode, you can

- list operational components and display operational attributes to determine the current operating parameters for the node
- control the state of parts of the node by locking and unlocking components
- set certain operational attributes and enter commands to perform diagnostic tests

Provisioning mode

To change from operational mode to provisioning mode, type the following command at the operator prompt:

```
start Prov
```

Only one user can be in provisioning mode at a time. The system uses the following command prompt whenever you are in provisioning mode:

```
PROV #>
```

where:

is the current command number

In provisioning mode, you work with the provisionable components and attributes that contain the current and future configurations of the node. You can add and delete components, and display and set provisionable attributes. For information on completing the configuration changes, exiting provisioning mode, and returning to operational mode see "Activating configuration changes" (page 28).

For information on operational and provisionable attributes, see NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference*.

Activating configuration changes

Several procedures in this document ask that you complete the configuration changes. When you complete the configuration changes, you are activating the configuration changes, confirming that you want to activate them, and saving the changes. You are instructed to complete the configuration changes only at the end of procedures that you perform in provisioning mode.

CAUTION
Activating a provisioning view can affect service
Activating a provisioning view can result in a CP reload or restart, causing all services on the node to fail. See NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference*, for more information.

1. Verify that the provisioning changes you have made are acceptable:

   `check Prov`

   Correct any errors and then verify the provisioning changes again.

2. If you want to store the provisioning changes in a file, save the provisioning view:

```
save Prov
```

3 If you want these changes as well as other changes made in the edit view to take effect immediately, activate, confirm, and commit the provisioning changes:

```
activate Prov
```

```
confirm Prov
```

```
commit Prov
```

4 End the provisioning session:

```
end Prov
```

Related documents

This guide makes reference to several documents. Some procedures require you to use one or more documents in conjunction with a given procedure. Other documents are sources of more detailed or related information.

- NN10600-175 *Nortel Networks Multiservice Switch 7400 Hardware Installation, Maintenance, and Upgrade*
- NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*
- NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*
- NN10600-130 *Nortel Networks Multiservice Switch 15000/20000 Hardware Installation, Maintenance, and Upgrade*
- NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*
- *DMS-MMP Base Product Description*, Issue M13.3 (approved), 5 May 2000.
- GR-CORE-506, *LSSGR: Signaling for Analog Interfaces*, November 1996
- ITU-T Recommendation E.180, *Technical Characteristics for Tones in the Telephone Service*.
- ITU-T Recommendation E.180, Supplement 2, *Various Tones Used in National Networks*, 1/94.

Chapter 1
Introduction to Multiservice Switch Media Gateway

Nortel Networks Multiservice Switch Media Gateway (MG) acts as a gateway between an ATM or IP network and the time division multiplexing (TDM) devices in service provider networks. Multiservice Switch MG allows service providers to carry more voice and voice band data using fewer trunks by passing traffic between the narrowband devices of the public switched telephone network (PSTN) over a broadband ATM or Internet Protocol (IP) network.

For more information about Nortel Networks Multiservice Switch MG functionality, see the following sections:

- “Non-switched Media Gateway using ATM functionality” (page 41)
- “Switched Media Gateway using ATM functionality” (page 57)
- “Switched Media Gateway using IP functionality” (page 69)
- “Switched Media Gateway using ATM or IP functionality” (page 89)

For more information about Nortel Networks Multiservice Switch requirements, see the section “Media Gateway requirements” (page 32).

MG supports the following types of calls:

- “Voice calls” (page 32)
- “Fax and modem calls” (page 37)
- “Data calls” (page 39)

Media Gateway requirements

To support Nortel Networks Multiservice Switch Media Gateway, you must install a Multiservice Switch device that incorporates some of the following hardware and software components:

- a voice services processor (VSP) FP card
- a time-division multiplexing (TDM) FP card
- an asynchronous transfer mode (ATM) FP card
- an Ethernet FP card
- an internet protocol (IP) FP card
- Multiservice Switch base software
- Multiservice Switch networking software
- ATM networking (ATM core) software
- Media Gateway software

Note: Multiservice Switch Media Gateway supports the automatic interoperation with T1 or E1 trunks on the TDM side. MG automatically selects the companding standard as mu-law for T1 trunks or A-law for E1 trunks.

For more information about Multiservice Switch hardware, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*. For more information about Multiservice Switch software, see NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation* and NN10600-272 *Nortel Networks Multiservice Switch 7400/15000/20000 Upgrading Software*.

Voice calls

MG provides various services for voice calls, including:

- “Silence suppression” (page 33)
- “Echo cancellation” (page 34)
- “Packet delay variation and the de-jitter buffer” (page 36)

- "Non-switched Media Gateway using ATM services for voice calls" (page 44)
- "Switched Media Gateway using ATM services for voice calls" (page 60)
- "VoIP services for voice calls" (page 85)
- "Switched Media Gateway using ATM or IP services for voice calls" (page 90)

Silence suppression

Speech in telephone conversations contains many periods of silence. To save bandwidth, MG suppresses silence and avoids sending these packets over the link. You can apply silence suppression on all voice calls, or only during periods of congestion.

MG suppresses silence on the ingress path after echo cancellation and before speech encoding. Therefore, only speech packets are sent to the far-end device. The far-end device replaces silence with comfort noise. The measured background noise at the near end determines the level of comfort noise at the far end.

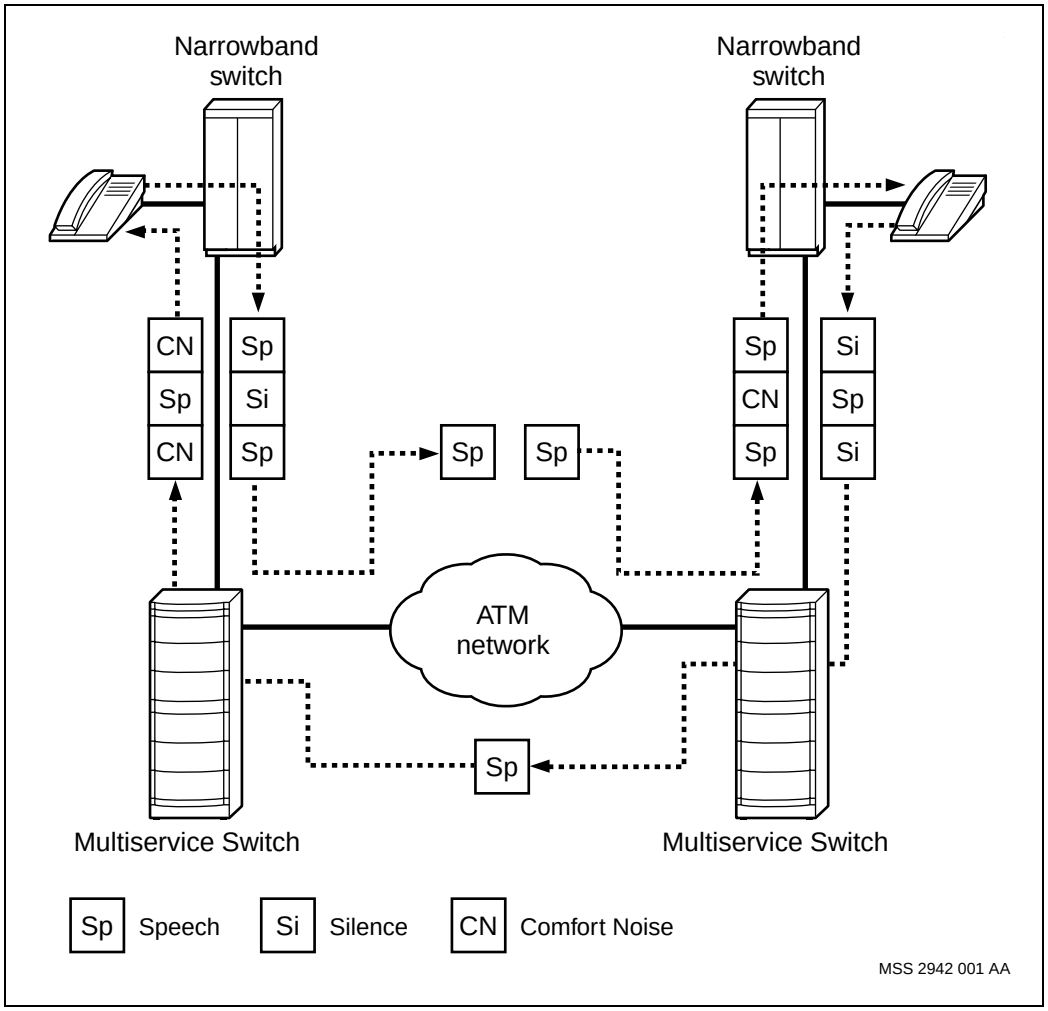
The speech activity detection (SAD) mechanism dynamically tracks the background noise and sets the speech detection threshold relative to this noise. The purpose of this mechanism is to minimize the audibility of silence suppression. The level of comfort noise matches the background noise level to within 1 dB.

The figure "Silence suppression and comfort noise generation" (page 34) shows the process of replacing silence with comfort noise.

MG uses the following methods to prevent speech clipping:

- MG does not delay the speech signal relative to the SAD threshold. The threshold determines the level over which all traffic is treated as speech. Therefore, there is no delay or holdover for the start of speech.
- MG delays the detection of the end of speech so that it does not clip the end of words. This is called silence detection hang-over time.

Figure 1
Silence suppression and comfort noise generation



Echo cancellation

To improve voice quality, MG uses echo cancellation. The hybrids that convert between 2-wire and 4-wire facilities often introduce the strongest echo. The figure “Echo cancellation and gain control for MG” (page 36) shows the typical sources of echo.

Nortel Networks Multiservice Switch devices cancel echo at the edges of the network to maintain toll quality voice and to prevent echo from traveling across the network. Echoes that travel across the network minimize bandwidth savings from silence suppression.

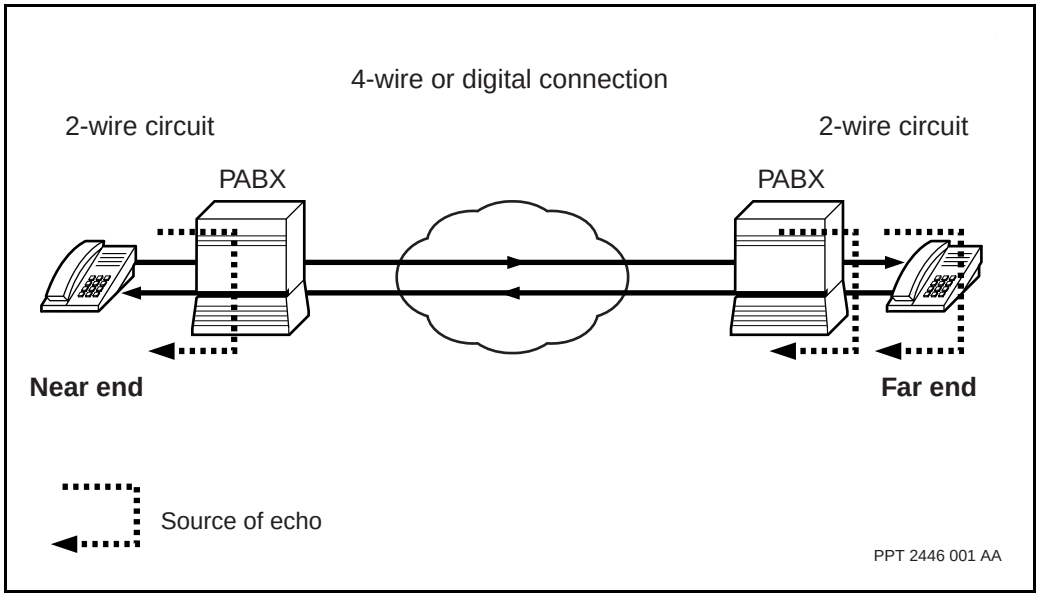
To successfully cancel echo in a system requires a network loss plan. A network loss plan specifies the signal levels throughout a network to which a network conforms. MG provides default settings for echo cancellation (egress and ingress gain control) to satisfy standard North American networks. However, egress and ingress gain control are configurable to support different requirements of international networks.

MG can support two lengths of tail delay for echo cancellation. A 32-milliseconds tail delay is available on the VSP2 for switched MG using ATM or IP. A 128-millisecond tail delay is available on VSP3 and voice services processor 3 with optical TDM interface (VSP3-o) for switched VoAAL2 and VoIP applications. Semantic checks will prevent the 128 ms option from being selected on VSP2 cards.

MG also enables you to disable echo cancellation for fax and modem calls. For more information, see “Fax and modem calls” (page 37).

> ***Note:*** Echo cancellation for switched Media Gateway is controlled by the MGC. In tandem environments, echo cancellation for switched MG may cause some problems due to the simultaneous convergence of echo cancellers placed in series. If the canceller converges on signaling tones, the tones may be distorted. A non-linear distortion of the signal will also impact echo cancellation performance. To prevent this problem, the MG echo canceller will turn off if it detects that it is the inner echo canceller in a tandem environment. In addition for echo cancellers in general, a proper gain-loss plan is needed to prevent signal distortion and gain is to be avoided at all times.

Figure 2
Echo cancellation and gain control for MG



Packet delay variation and the de-jitter buffer

Packet generation and multiplexing introduce variable delays between the arrival of packets at a destination and ATM network node re-transmissions. This variable delay is called packet delay variation (PDV). To ensure high quality voice, MG provides a de-jitter buffer at the egress of the ATM network. This buffer removes the packet jitter without affecting the isochronous nature of the voice traffic.

When voice packets arrive, the de-jitter buffer builds a reserve of packets before it begins to transmit. This reserve of packets and the capacity of the buffer determine the amount of PDV the system can tolerate. The time it takes for the buffer to build up the reserve of packets is called packet delay variation tolerance (PDVT). Typically, the buffer size is twice that of the PDVT value.

If packets arrive too quickly, the buffer overflows, which causes the system to drop packets. If packets experience excessive delay, the buffer underflows. Buffer underflow causes MG to transmit comfort noise. However, if the condition persists for more than the configured length of time, MG activates

trunk conditioning. Therefore, you must carefully set the PDVT and buffer size values. To avoid problems, MG provides default settings for these values. Switched MG using IP does not turn on trunk conditioning if buffer underflows persist.

Fax and modem calls

MG identifies modulated data calls (typically fax and modem calls) by detecting 2100 Hz tones with or without phase reversals. Non-switched MG using ATM functionality detects the 2100-Hz tone from the TDM side only. Switched MG using ATM or IP detects the 2100-Hz tone from the TDM side and the packet side. Calls can be transported at two speeds:

- MG will automatically upspeed from a G.729a speed of 8 kbit/s to a G.711 speed of 64 kbit/s, or
- the system can compress these calls and transport them at 32 kbit/s using G.726 encoding (not applicable to switched MG using IP).

Nortel Networks recommends transporting higher speed fax and modem calls (above 9.6 kbit/s) as uncompressed 64 kbit/s channels. Lower speed fax and modem calls (at or below 9.6 kbit/s) can be transported at either 32 kbit/s or 64 kbit/s.

To further reduce the bandwidth for fax calls in non-switched MG, you can enable fax idle suppression (FIS). FIS can reduce the use of bandwidth by up to 45%. FIS applies to non-switched MG only.

To avoid data corruption, you can configure MG to disable echo cancellation when it detects 2100 Hz tones in accordance with ITU-T Recommendation G.165. If you set the *echoCancellation* attribute to g165Mode, the system disables echo cancellation when it detects 2100 Hz tones with 180 phase reversals. For g165Mode, echo cancellation is re-enabled when 150- to 350-milliseconds of silence in both directions is detected.

If you set the *echoCancellation* attribute, on the VSP1 or VSP2, to *alwaysOn*, the system does not disable echo cancellation for any calls, regardless of the presence of tones. This setting can cause call connection problems for some modems. The value *alwaysOn* is not applicable on the VSP3 and VSP3-o FP cards.

Non-switched MG and switched MG are compliant with call compression algorithms of G.726 and G.729a for fax or modem calls. See the following sections for more information:

- "G.726 fax and modem call compression" (page 38)
- "G.729a fax and modem call compression" (page 38)

G.726 fax and modem call compression

You can configure MG to compress these calls and transport them as 32-kbit/s channels using the G.726 standard. Using the G.726 standard for voice band data (VBD) only applies to ATM adaptation layer 2 (AAL2) traffic.

G.729a fax and modem call compression

You can configure MG to compress calls to 8 kbit/s using G.729a then upspeed to a G.711 speed of 64 kbit/s for fax and modem transport.

Note: Non-switched MG only supports upspeeding on detection of 2100 Hz and DTMF tones.

Considerations for G.729 Annex A and B voice encoding

When MG uses the G.729 Annex A and B encoding with echo cancellation (ECAN), VAD, and dual tone multi-frequency (DTMF) tone detection and upspeed, the capabilities are as follows:

Using the voice services processor (VSP) FP in Nortel Networks Multiservice Switch 7400 devices:

- 432 G.729 channels per VSP FP card
- 128 virtual channel connections (VCCs) per VSP FP card

Using the voice services processor 2 (VSP2) FP in Multiservice Switch 7400 devices:

- 720 G.729 channels per VSP2 FP card
- 1024 VCCs per VSP2 FP card

Using the voice services processor 2 (VSP2) FP in Multiservice Switch 15000 and Multiservice Switch 20000 devices:

- 800 G.729 channels per VSP2 FP card

- 1024 VCCs per VSP2 FP card

Using the voice services processor 3 (VSP3) FP for switched MG using IP in Multiservice Switch 15000 and Multiservice Switch 20000 device:

- 2016 G.711 / G.726 channels per VSP3 FP card
- 1512 G.711 / G.726 / G.729 channels per VSP3 FP card
- 1024 VCCs per VSP3 FP card

Using the voice services processor 3 with optical TDM interface (VSP3-o) FP for switched MG using ATM or IP in Multiservice Switch 15000 and Multiservice Switch 20000 device:

- 2016 G.711 / G.729 channels per VSP3-o FP card
- 1500 VCCs maximum per VSP3-o FP card

Data calls

Data calls in MG are carried over CCD connections. Each CCD connection carries a contiguous data stream from the TDM network across the ATM network.

If you configure MG to monitor signaling information, the system can identify the type of traffic on each channel. Note that non-switched MG does not support monitoring of E1 signaling information. To avoid data corruption, MG treats video and data from the TDM network as a contiguous data stream. MG packages the data into AAL2 cells and sends the data to the ATM network as clear 64-kbit/s channels. The clear 64-kbit/s channels run as CCD calls.

MG enables you to configure specific time slots to run as CCD, regardless of the type of signaling used, and regardless of whether the system monitors signaling on other channels.

For non-switched MG, if you use common channel signaling (CCS) on other channels, the time slots that you specify as CCD are transported at 64 kbit/s. If you use channel associated signaling (CAS) at the DS1 level, the time slots that you specify as CCD are transported at 56 kbit/s.

For switched MG using ATM, CCD calls are initiated by the media gateway controller (MGC). The CCD calls provide test trunk capability and end-to-end CCD calls across the ATM network.

CCD calls in switched MG using ATM or IP have the same following requirements:

- no limit on the number of CCD endpoints
- no support for limiting the number of CCD calls per VCC
- supports only narrowband connections of 64-kbit/s for voice or CCD/no support for more than one 64-kbit/s B channel
- CCD can be carried over both IP and ATM but not on the same VSP2 and not on the same MG shelf

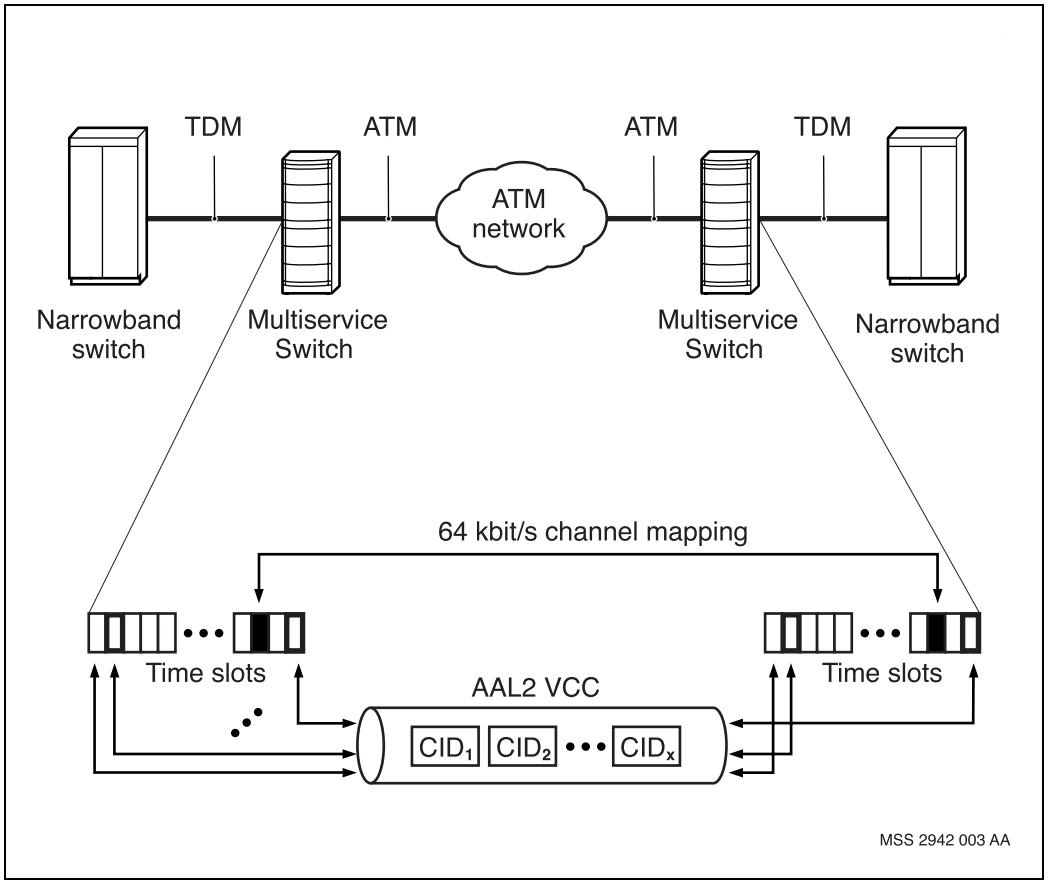
Switched MG using IP CCD calls provide test trunk capability and hairpinning of CCD calls out on the same VSP2, VSP3, or VSP3-o FP. CCD calls in switched MG using IP have the following requirements:

- supported on VSP2, VSP3, and VSP3-0 FPs/not supported on the VSP FP
- not recommended to transport ISDN data over CCD connections
- CCD packets sent using real -time protocol (RTP) with payload type (PT) equal to 101 and a 10-milliseconds packet length

Chapter 2
Non-switched Media Gateway using ATM functionality

In non-switched Media Gateway, a narrowband call arriving at the Nortel Networks Multiservice Switch node is statically mapped to a VCC. The VCC can be an ATM adaptation layer type 2 (AAL2) connection or an ATM adaptation layer type 5 (AAL5) connection. Calls are generally transported as AAL2 for voice data. If component *Nsta Conn Brag Ccst* is provisioned for CCS, the signaling data is transported end-to-end using AAL5. The call is transported in ATM cells through the ATM network to another Multiservice Switch node. At the remote end, it is mapped back to TDM time slots and passed to another narrowband node in the service provider's network. In this node, but rather travel transparently over the ATM network. This configuration is shown in the figure "Non-switched Media Gateway application" (page 42).

Figure 3
Non-switched Media Gateway application



Non-switched Media Gateway using ATM can use the following ATM VCs to route the voice and voice band data traffic through the ATM network.

- a permanent virtual circuit (PVC)
- a provisioned switched virtual circuit (SVC)
- a provisioned soft permanent virtual circuit (SPVC)

See “ATM connections for Media Gateway” (page 119) for a description of how Media Gateway can use each type of ATM connection.

For ATM PVC use, each service interface time slot is statically mapped to a particular AAL2 channel identifier (CID) within an ATM VCC. When there is no call present in a time slot, another narrowband call using another time slot does not use the corresponding VCC/CID. The non-switched Media Gateway is transporting the narrowband call through an ATM PVC.

For narrowband services, such as voice and voice band data (fax and modem calls), Multiservice Switch Media Gateway transports traffic over AAL2 and AAL5 PVCs. AAL2 PVCs carry voice traffic and in-band signaling information. AAL5 PVCs carry out-of-band signaling information.

Non-switched Media Gateway using ATM can also use ATM PSVCs and SPVCs, to route the voice and voice band data traffic through the ATM network. See “ATM connections for Media Gateway” (page 119) for a description of how Media Gateway can use each type of ATM connection.

Support for PSVCs and provisioned SPVCs in non-switched Media Gateway is as follows:

- supported for voice services processor 2 (VSP2) and not VSP
- supported for Media Gateway-to-Media Gateway connections only
- supported for point-to-point ATM PSVCs and provisioned SPVCs and not point-to-multipoint
- transports CCS as CCD by provisioning timeslot 24 for DS1 and timeslot 16 for E1
- transports E1 CAS as CCD by provisioning timeslot 16
- no support for transporting CAS for DS1
- supports PVC, PSVC, and provisioned SPVC simultaneously
- supports ATM static routing user-to-network interface (UNI) 3.0/3.1/4.0
- supports ATM dynamic routing private network-to-network interface (PNNI) 1.0
- supports alarm indication signal (AIS) and remote defect indication (RDI)

To provision non-switched Media Gateways, see NN10600-781 *Nortel Networks Media Gateway 7480/15000 Non-switched Service Configuration Management*. For more information about non-switched Media Gateway using ATM, see the following sections:

- "Introduction to Multiservice Switch Media Gateway" (page 31)
- "Non-switched Media Gateway using ATM services for voice calls" (page 44)
- "Non-switched Media Gateway interworking function" (page 45)
- "Non-switched trunking using AAL2" (page 47)
- "Congestion management for non-switched Media Gateway using ATM" (page 49)
- "CCS and CAS signaling transport" (page 51)
- "Standards compliance for non-switched Media Gateway" (page 54)

Non-switched Media Gateway using ATM services for voice calls

Non-switched Media Gateway using ATM provides the following services for voice calls:

- "Voice compression algorithms supported by non-switched Media Gateway using ATM" (page 44)
- "Voice calls" (page 32)

Voice compression algorithms supported by non-switched Media Gateway using ATM

Non-switched Media Gateway is compliant with two compression algorithms, G.726 adaptive differential pulse code modulation (ADPCM) and G.729a Conjugate Structure - Algebraic Code Excited Linear Prediction (CS-ACELP). See the following sections for more information:

- "G.726 voice call compression" (page 45)
- "G.729a voice call compression" (page 45)

G.726 voice call compression

Non-switched Media Gateway supports G.711 pulse code modulation (PCM) voice and G.726 ADPCM voice at 32, 24, and 16 kbit/s. Non-switched Media Gateway enables you to set the maximum and minimum voice rates.

By default, the maximum voice rate is 32 kbit/s ADPCM, which means that non-switched Media Gateway transmits voice calls at this rate when there is no congestion on the ATM link. By default, the minimum voice rate is 16 kbit/s ADPCM. During periods of heavy congestion, non-switched Media Gateway compresses voice calls to the minimum rate, and admits all new calls at this rate, until congestion is relieved. During periods of light to moderate congestion, non-switched Media Gateway can compress voice calls to a rate between the maximum and minimum voice rates.

G.729a voice call compression

Non-switched Media Gateway supports G.711 PCM voice at 64 kbit/s and CS-ACELP voice at 8 kbit/s. Non-switched Media Gateway enables you to set both minimum and maximum voice rates to either 8 kbit/s or 64 kbit/s. The default for minimum and maximum voice rate is 8 kbit/s.

When DTMF tones are detected, Media Gateway will upspeed from a G729 Annex A speed of 8 kbit/s to a G.711 speed of 64 kbit/s for the duration of the tone and then return to 8 kbit/s.

> ***Note 1:*** Non-switched Media Gateway only supports upspeeding on detection of 2100 Hz and DTMF tones.

Non-switched Media Gateway interworking function

A non-switched gateway uses Media Gateway software to provide standards-based multiplexing and demultiplexing of AAL2 ATM VCCs and all voice band services. A non-switched gateway statically maps time slots from a TDM network onto AAL2 ATM VCCs. See figure “Non-switched ATM-to-TDM gateway bearer traffic path” (page 47).

Nortel Networks Multiservice Switch receives TDM data through a TDM FP. The FP demultiplexes the incoming bit stream into standard 64 kbit/s channels and encapsulates them in AAL1 cells. The system then transfers these cells to the voice services FP for encoding. Media Gateway identifies

the cell streams as voice, fax/modem, or data calls. The Media Gateway can be provisioned for CAS, CCS or no signaling types. See figure “Non-switched ATM-to-TDM gateway bearer traffic path” (page 47).

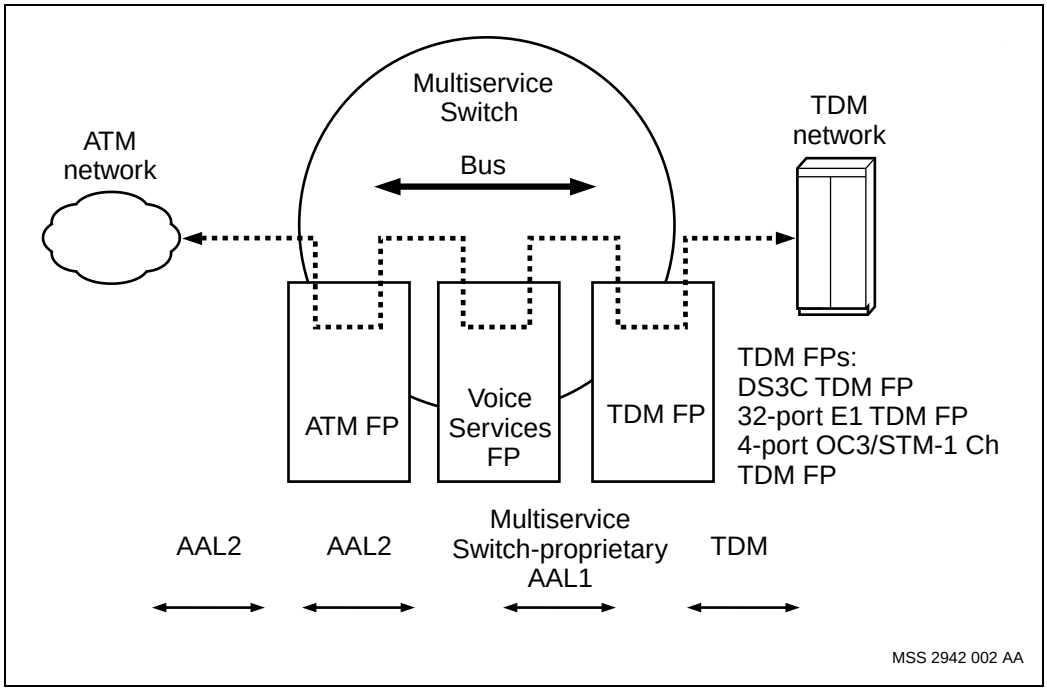
For information on which TDM FPs support non-switched Media Gateway, see NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

CAS or CCS signaling may be transported using AAL2 voice channels configured for clear channel data or by using a 64kbps CES service over AAL1.

At the VSP, Multiservice Switch processes incoming cells according to the type of input and the attributes you have set. After the VSP processes the cell streams, it packages the input into AAL2 cells. The VSP transfers the AAL2 cells to an ATM FP. The ATM FP then transmits the AAL2 cells across the ATM link using PVC, SVCs, or SPVCs, whichever type of connection the network has been configured to use.

Media Gateway processes time slots from a TDM port and multiplexes them onto AAL2 ATM VCCs. It maps each TDM time slot to a statically configured AAL2 CID within an ATM VCC. See figure “Non-switched Media Gateway application” (page 42).

Figure 4
Non-switched ATM-to-TDM gateway bearer traffic path



Non-switched trunking using AAL2

The ATM Forum implementation agreement for ATM trunking using AAL2 describes two modes of operation: switched and non-switched. Media Gateway supports both non-switched trunking and proprietary switched trunking.

This section describes non-switched trunking. Switched trunking is described in “Switched Media Gateway using ATM functionality” (page 57).

Non-switched trunking does not terminate signaling, but instead transports it transparently. Media Gateway supports non-switched trunking using AAL2.

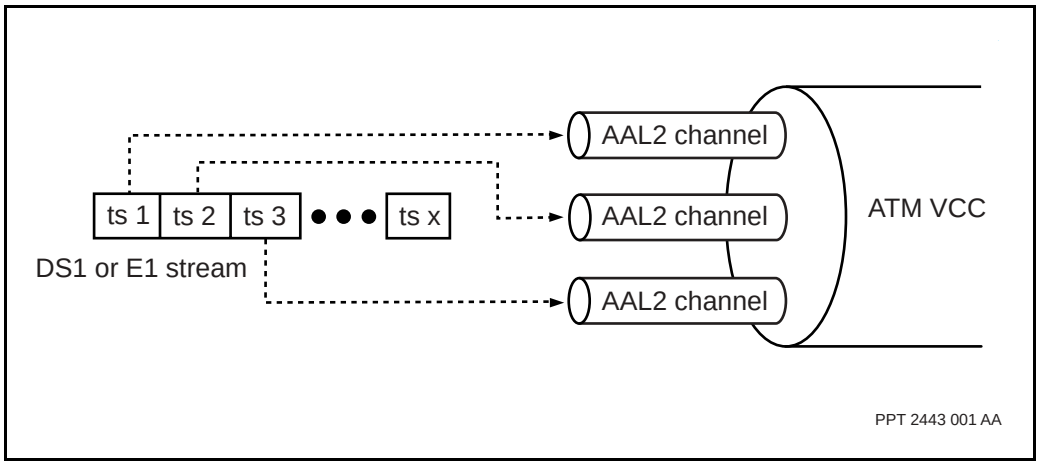
By default, each time slot within the service interface (DS1 or E1) maps to a statically configured AAL2 CID within an ATM VCC. See the figure “Non-switched ATM trunking using AAL2” (page 48). The lowest numbered time

slot corresponds to the first CID in the list, starting with CID number 8. Additional time slots increment the value of the CID. If you do not configure specific CID values, the system maps values based on the TDM trunk, as follows:

- A DS1 trunk with CCS uses CIDs 8 to 30.
- A DS1 trunk without CCS uses CIDs 8 to 31.
- An E1 trunk with CCS uses CIDs 8 to 37.
- An E1 trunk without CCS uses CIDs 8 to 38.

The CID mapped to each time slot depends on the type of signaling used. For CAS, each DS1or E1 stream uses a separate AAL2 ATM VCC. For CCS, each DS1 or E1 channel uses two ATM VCCs: one AAL2 VCC carries the B channel; one AAL5 VCC carries the D channel.

Figure 5
Non-switched ATM trunking using AAL2



Congestion management for non-switched Media Gateway using ATM

Congestion management techniques prevent the system from transmitting too much traffic across the ATM link. Non-switched Media Gateway applies various congestion handling techniques at different congestion levels.

The speed at which Nortel Networks Multiservice Switch nodes send data across the ATM link is determined by the call type, the level of congestion, and the configured values for peak cell rate (PCR), sustained cell rate (SCR), and maximum burst size (MBS). The values of PCR, SCR, and MBS are based on the quality of service required by the customer. See the chapter entitled "Traffic management for Media Gateway" (page 149) for details on calculating the values for PCR, SCR, and MBS.

Non-switched Media Gateway supports both dynamic compression and congestion triggered SAD techniques to reduce bandwidth requirements without impacting the voice traffic.

See the following sections for more information:

- "Congestion management with G.726" (page 49)
- "Congestion management with G.729a" (page 50)
- "Connection admission control" (page 158)

Congestion management with G.726

When there is no congestion on the ATM link, non-switched MG transmits voice calls at the maximum rate you have configured.

Voice call transport rates can change as congestion levels rise and fall. Non-switched MG allows you to set maximum and minimum voice call transport rates. During normal operation (no congestion), non-switched MG carries voice calls at the maximum rate. During heavy congestion, MG carries voice calls at the minimum rate. During light to moderate congestion, non-switched Media Gateway carries voice calls at rates between the maximum and minimum rates.

To gauge congestion levels, non-switched MG checks the number of cells the system transmits toward the ATM network at configured intervals. If the number of cells exceeds the congestion threshold, non-switched MG compresses voice calls to the rate that you configure for the system. If you have configured MG to apply silence suppression whenever the system experiences congestion, non-switched MG activates silence suppression on all voice calls on that link. The level of congestion is continuously rechecked. If the link is not congested, non-switched MG starts to upspeed active voice channels.

During periods of congestion, Nortel Networks Multiservice Switch nodes admit new calls at the compressed rate that you have defined for the system. If the ATM link is still congested after the settling down period, non-switched MG

- compresses some or all voice calls to the lowest configured rate, for example, 16 kbit/s ADPCM
- admits new calls only at this lowest rate, including data calls, if the number of data calls exceeds the number of data calls configured for the link

Non-switched MG maintains these levels of compression until the congestion level falls below the congestion threshold.

Congestion management with G.729a

Regardless of congestion on the ATM link, non-switched MG transmits calls at the configured rate, either 8 kbit/s or 64 kbit/s. Non-switched MG transmits data calls at 64 kbit/s. Modem and fax calls are transmitted at 64 kbit/s PCM. Rate of transport for fax, modem, and data calls do not change except under heavy congestion.

To gauge congestion levels, non-switched Media Gateway checks the number of cells the system transmits toward the ATM network at configured intervals. Non-switched MG activates voice activity detection (VAD) on all voice calls if the number of cells exceeds the congestion threshold and the system has been configured to apply VAD whenever congestion occurs. Non-switched Media Gateway continuously rechecks the level of congestion. If the link is still congested, non-switched Media Gateway admits new data calls at 64 kbit's provided that it can downspeed the appropriate number of voice calls.

If the G.729a standard is configured then upon congestion the VAD will be enabled and hence the data calls will be transported using the G.729 Annex B standard.

CCS and CAS signaling transport

Non-switched Media Gateway provides transparent transport for CCS and CAS. It also supports unsignaled trunks. If you use CCS, non-switched Media Gateway can monitor signaling information to determine the type of call and the call state.

Non-switched Media Gateway software does not support CCS monitoring for E1 interfaces. For E1 interfaces, CAS can be transported as clear channel data only.

If SVCs, SPVCs, or the 4-port OC-3/STM-1Ch TDM/CES FP is used then CCS or CAS signaling transport over AAL5 is not available. However, both CAS and CCS signaling can be transmitted in AAL2 cells with PSVCs and provisioned SPVCs in a non-switched Media Gateway, as follows.

- CAS signaling for E1 can be transmitted in AAL2 cells by provisioning timeslot 16 (E1) to CCD.
- CCS signaling for DS1 or E1 can be transmitted in AAL2 cells by provisioning timeslot 24 (DS1) or 16 (E1) to CCD.

When CCS or CAS information is monitored, the system transports the bearer time slots only when they become active. With CCS monitoring, the connection type (voice, voice band data, or clear channel data) is determined by the signaling information (rather than the bearer data stream). CCS monitoring and CAS monitoring are not supported by non-switched Media Gateway for PSVCs and provisioned SPVCs.

> ***Note:*** If SVCs, SPVCs, or the 4-port OC-3/STM-1Ch TDM/CES FP is used then CCS or CAS signaling transport over AAL5 is not available.

If a timeslot is configured for clear channel data transport, the voice services FP does not perform voice processing on the bearer data (no voice codec, no upspeeding or downspeeding). The binary data is transported as is across the ATM network to the destination TDM network. If no voice codec function is desired then setting the timeslot for clear channel data is an option.

For more information, see the following sections:

- "Common channel signaling" (page 52)
- "Channel associated signaling" (page 53)
- "Unsignaled trunks for non-switched Media Gateway using ATM" (page 53)

Common channel signaling

If you use CCS, non-switched Media Gateway maps each D channel to an AAL5 ATM VCC. Non-switched Media Gateway maps each B channel to a channel on an AAL2 ATM VCC. Non-switched Media Gateway interprets CCS signaling information and does the following:

- suppresses idle channels and does not transmit them over the ATM link
- transmits uncompressed digital data channels
- compresses and transmits voice channels according to how you configure the system

Monitored or unmonitored CCS DS1s contain 23 64 kbit/s bearer channels while unmonitored E1s contain 30 64-kbit/s bearer channels. (Non-switched Media Gateway software does not support CCS monitoring for E1 interfaces.) DS1s that do not use CCS contain 24 64-kbit/s bearer channels. E1s that do not use CCS contain 31 64-kbit/s bearer channels.

CCS in Media Gateway, is the use of D-channel signaling for the bearer B-channels of a primary rate interface (PRI) circuit.

Non-switched Media Gateway supports CCS transport by provisioning timeslot 24 on the DS1 or timeslot 16 on the E1 as a CCD timeslot.

Note: If SVCs, SPVCs, or the 4-port OC-3/STM-1Ch TDM/CES FP is used then CCS signaling transport over AAL5 is not available.

Channel associated signaling

If you use DS1 CAS, non-switched Media Gateway maps the AB/ABCD signaling bits to the same AAL2 ATM VCC as the data. There are signaling bits in every sixth frame of a superframe (12 consecutive frames) or extended superframe (24 consecutive frames). For DS1 trunks, bit 8 of each traffic channel time slot is the signaling bit.

For E1 trunks, only timeslot 16 carries the signaling information. E1 CAS can be transported by configuring the system to transport timeslot 16 as clear channel data.

You can configure one or more CAS DS0s. The CAS signaling handler

- interprets CAS signaling information to determine when a channel is active. Non-switched Media Gateway does not transmit idle channels.
- transmits signaling bits only when a call state changes

Unsignaled trunks for non-switched Media Gateway using ATM

Non-switched Media Gateway supports unsignaled trunks. When a DS1 or E1 TDM stream does not contain signaling, or if you are signaling over another connection or network (for example, over SS7 signaling links) you can configure all the channels on the trunk as unsignaled and use the full bandwidth on the ATM link to transport bearer channels. If the TDM stream contains any type of signaling (for example, PRI D-channel signaling or E1 CAS, which is transported in time slot 16), you can configure the system to transport that signaling over the ATM link by configuring one or more time slots as clear channel data. CAS information cannot be monitored over unsignaled trunks.

With the 4-port OC-3/STM-1Ch TDM/CES FP CCS and E1 CAS information can be transported using AAL1 CES. The TDM trunks in the VSP are configured as unsignaled trunks and the signaling channel is bypassed by the VSP. There is a limitation of 64 TDM to VSP connections per VSP2.

Non-switched Media Gateway using ATM on Multiservice Switch 15000 and Multiservice Switch 20000 nodes

There is a capacity issue with CAS-monitored voice trunks when used with Nortel Networks Multiservice Switch 15000 or Multiservice Switch 20000 Media Gateway in the non-switched voice mode. Nortel Networks recommends you provision no more than 15-CAS monitored trunks on a single voice services processor 2 (VSP2) card. There is no restriction on the number of CAS-unmonitored, CCS-monitored/unmonitored, or unsignaled trunks that can be configured.

Standards compliance for non-switched Media Gateway

Non-switched Media Gateway complies with the following voice, ATM, and signaling standards:

- ITU-T G.711
- ITU-T G.164
- ITU-T G.165
- ITU-T G.168
- ITU-T G.726. The 40 kbit/s compression mode is not implemented.
- ITU-T G.729 Annex A and B. Compliant with VAD and voice compression only.
- ITU-T Recommendation T.30
- ITU-T Recommendation I.363.2
- BTD-VTOA LLTAAL2-0.01
- AT&T Technical Report 41459
- AT&T Technical Report 41458

Note: Either the ITU-T G.726 standard or G.729 A and B standard can be used with non-switched Media Gateway.

For standards compliance information, see NN10600-170 *Nortel Networks Multiservice Switch 7400 Hardware Description* or NN10600-120 *Nortel Networks Multiservice Switch 15000/20000 Hardware Description*. For

standards compliance for the ATM Core service, see NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*.

Chapter 3
Switched Media Gateway using ATM functionality

In switched Media Gateway using ATM, an interworking function (IWF) terminates narrowband signaling. This method allows Nortel Networks Multiservice Switch Media Gateway to dynamically create voice and voice band data connections between the service provider's TDM network and the ATM network. Incoming TDM time slots are dynamically mapped to outgoing AAL2 CIDs within an ATM VCC for each call. This mapping can also occur in the reverse direction with incoming ATM VCCs/CIDs being mapped to outgoing TDM time slots.

For switched Media Gateway using ATM, the IWF consists of the following three parts:

- a voice gateway service (provided by Multiservice Switch Media Gateway)
- a MGC (provided by third-party equipment)
- an SS7 gateway (also provided by third-party equipment)

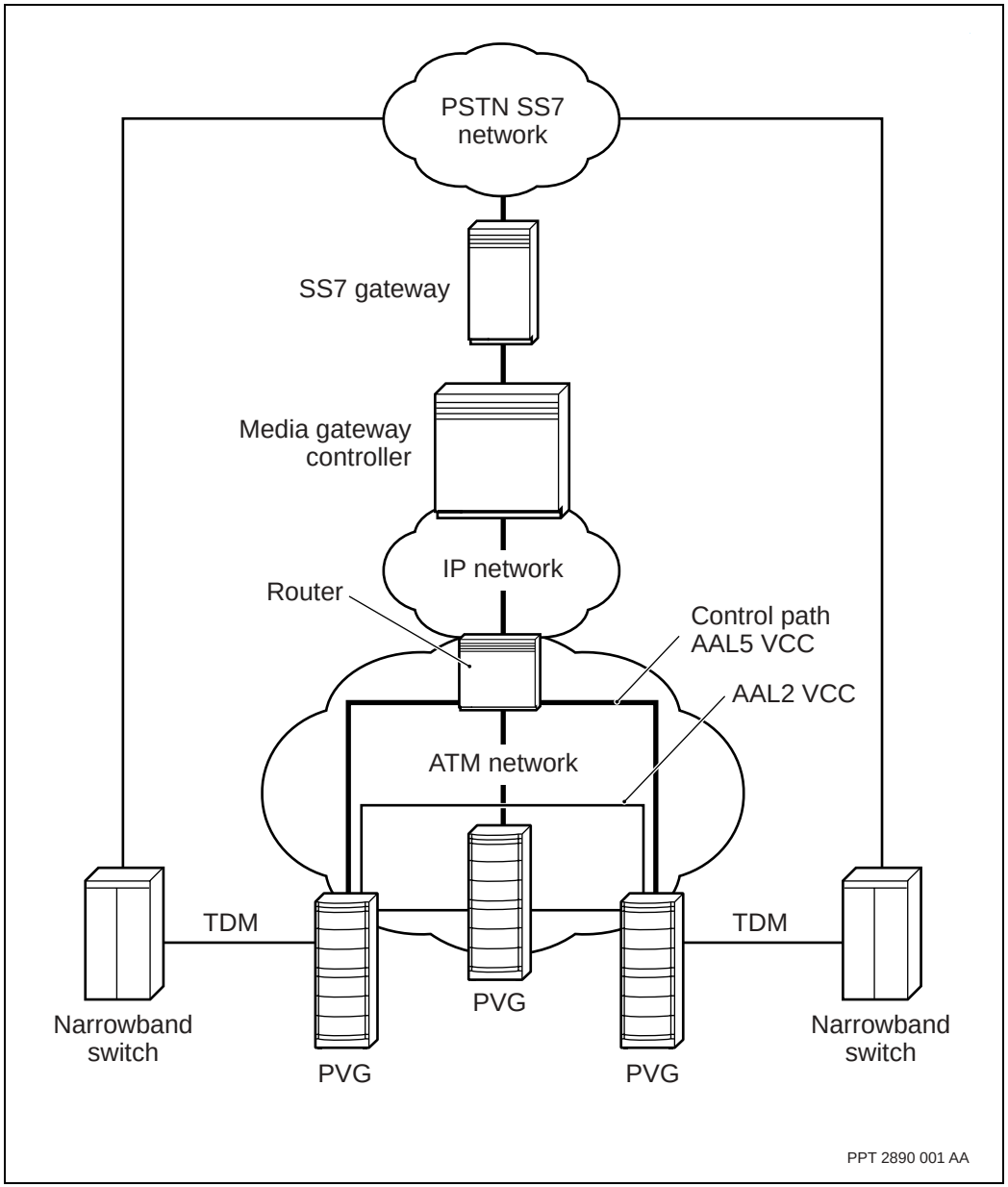
The relationship between each element in the interworking function is shown in the figure "Switched Media Gateway using ATM" (page 59). Multiservice Switch Media Gateway performs the role of the voice gateway service, which handles all the bearer traffic functionality using AAL2 VCCs. The media gateway controller (MGC) handles all the signaling and call control functionality between the PSTN and Multiservice Switch Media Gateway. The SS7 gateway provides the controller with links into the SS7 network.

Control traffic between each element is carried over an IP network, with Multiservice Switch Media Gateway connecting with the IP network on a single AAL5 VCC.

Switched Media Gateway using ATM can use ATM PVCs, provisioned SVCs or SPVCs to route the voice and voice band data traffic through the ATM network. See “ATM connections for Media Gateway” (page 119) for a description of how Media Gateway can use each type of ATM connection.

Switched Media Gateway using ATM can also use ATM SVCs to route the voice and voice band data traffic through the ATM network.

Figure 6
Switched Media Gateway using ATM



To provision switched Media Gateway using ATM, see "Installing and setting up Media Gateway" (page 141) and NN10600-782 *Nortel Networks Media Gateway 7480/15000 Switched Service Configuration Management*. For more information about switched Media Gateway using ATM functionality, see the following sections:

- "Introduction to Multiservice Switch Media Gateway" (page 31)
- "Switched Media Gateway using ATM services for voice calls" (page 60)
- "Switched ATM-to-TDM gateway" (page 62)
- "Unsignaled trunks for switched Media Gateway using ATM" (page 63)
- "Local traffic switching for switched Media Gateway using ATM" (page 64)
- "Call control for switched Media Gateway using ATM" (page 65)
- "Switched Media Gateway using ATM or IP functionality" (page 89)

Switched Media Gateway using ATM services for voice calls

Switched Media Gateway supports the following voice services:

- "Voice compression for switched Media Gateway using ATM" (page 60)
- "Supported packet features using VSP2/VSP3/VSP3-o and ATM functionality" (page 62)
- "Voice calls" (page 32)
- "Switched Media Gateway using ATM or IP services for voice calls" (page 90)

Voice compression for switched Media Gateway using ATM

Switched Media Gateway using ATM is compliant with three standards of voice compression. The G.711 standard, the G.726 standard, or the G.729 Annex A and B standard can be provisioned for switched Media Gateway using ATM. See the following sections for more information:

- "G.711 voice call compression" (page 61)
- "G.726 voice call compression" (page 61)
- "G.729 Annex A and B voice call compression" (page 61)

G.711 voice call compression

Switched Media Gateway using ATM supports A-law and mu-law PCM voice at 64 kbit/s.

G.726 voice call compression

Switched Media Gateway using ATM supports ADPCM voice at 32 kbit/s. Using the G.726 standard for VBD only applies to AAL2 traffic.

G.729 Annex A and B voice call compression

Switched Media Gateway using ATM supports PCM voice at 64 kbit/s and CS-ACELP voice at 8 kbit/s. Support of the G.729 Annex A and B voice call compression has the following considerations:

- not supported for packet loss concealment (PLC)
- supports upspeeding for fax/modem, DTMF, and CNG
- supports squelch for DTMF (squelch removes DTMF signal from encoded voice path)
- supports G.729 Annex A and B in codec selection negotiation
- supported for voice services processor 2 (VSP2) on Nortel Networks Multiservice Switch 7400 (720-DS0 channel capacity) nodes, and on Multiservice Switch 15000 and Multiservice Switch 20000 (800-DS0 channel capacity) nodes
- supported for voice services processor 3 (VSP3) on Multiservice Switch 15000 and Multiservice Switch 20000 (1512-DS0 channel capacity) nodes
- supported for voice services processor 3 with optical TDM interface (VSP3-o) on Multiservice Switch 15000 and Multiservice Switch 20000 nodes with the following channel capacities:
  - 1953 channels of STM-1
  - 2016 channels for OC-3
- supports simultaneous transmission of DTMF tones and digit collection
- supports DTMF Relay over AAL2
- supports I.366.2 Annex P profile 7 (5-ms G.711, 10-ms G.729, and G.729 silence insertion descriptor (SID))

- supported for H.248 version 1 protocol or supported for ASPEN version 2.1 protocol (also known as voice gateway control protocol (VGCP))
- The VSP3-o FP card only supports H.248 version 1 protocol and does not support ASPEN version 2.1 protocol.

When DTMF tones are detected, Media Gateway will upspeed from a G729 Annex A speed of 8 kbit/s to a G.711 speed of 64 kbit/s for the duration of the tone and then return to 8 kbit/s.

Note: G.729 Annex A and B encoding is a G.729 Annex A compression standard with a G.729 Annex B standard of VAD enabled.

Supported packet features using VSP2/VSP3/VSP3-o and ATM functionality

Switched Media Gateway using ATM functionality and using the VSP2/VSP3/VSP3-o FPs, supports the following packet features.

- Detect 2100-Hz tones with and without phase reversal on the packet side and on the TDM side. The Media Gateway can determine if the 2100-Hz tone is from the packet side or from the TDM side. The packet side can have VoIP or VoATM packets.
- Indicate a profile in the session description protocol (SDP) in accordance with standard RFC3108 of the Internet Engineering Task Force (IETF).

Switched ATM-to-TDM gateway

The basic gateway mechanism is explained in “Non-switched Media Gateway interworking function” (page 45). A switched gateway is similar to a non-switched gateway except in the following areas:

- The switched gateway dynamically maps time slots from a TDM network onto AAL2 ATM VCCs.
- The switched gateway can use ATM PVCs, provisioned SVCs and SPVCs to route the voice and voice band data traffic through the ATM network.
- The switched gateway can also use ATM SVCs to route the voice and voice band data traffic through the ATM network.

- The switched gateway uses an interworking function consisting of a voice gateway service and a media gateway controller to terminate signaling traffic from the PSTN.
- The VSP2/VSP3/VSP3-o FPs processes incoming cells according to the type of input, the attributes you have set and the switching instructions received from the media gateway controller. See “Signaling between the narrowband network and Media Gateway for switched Media Gateway using ATM” (page 63).

See also “Switched Media Gateway using ATM” (page 59).

Signaling between the narrowband network and Media Gateway for switched Media Gateway using ATM

Signaling between the narrowband network and Media Gateway is handled by an SS7 gateway and a media gateway controller. When using ASPEN to make a bearer traffic connection in the Media Gateway, the MGC sends a CREATE CONNECTION (CRCX) message with the appropriate parameters to the Media Gateway. When using H.248 to make a bearer traffic connection in the Media Gateway, the MGC sends an ADD command with the appropriate parameters to the Media Gateway. In Nortel Networks Multiservice Switch Media Gateway, the voice services processor-type (VSP2, VSP3, or VSP3-o) FP acts on instruction from the media gateway controller to make or break narrowband connections between TDM trunks and AAL2 trunks.

For more information about the control connections between Nortel Networks Multiservice Switch Media Gateway and the media gateway controller, see “Call control for switched Media Gateway using ATM” (page 65).

Unsignaled trunks for switched Media Gateway using ATM

Switched Media Gateway using ATM supports unsignaled trunks. When an E1 or DS1 TDM stream contains no signaling, or if you are signaling over another connection or network (for example, over SS7 signaling links) you can configure all the channels on the trunk as unsignaled and use the full bandwidth on the ATM link to transport bearer channels.

Local traffic switching for switched Media Gateway using ATM

Nortel Networks Multiservice Switch Media Gateway supports local traffic switching through AAL2. Local traffic switching through AAL2 means to originate and terminate a TDM-to-TDM call on the same VSP2/VSP3/VSP3-o FP (also called TDM-TDM hairpinning) or on separate VSP2/VSP3/VSP3-o FPs on the same shelf. The Media Gateway supports local traffic switching through AAL2 using virtual channel connections (VCC) to either of the following:

- internal switching across the backplane of a Nortel Networks Multiservice Switch 7400 node or across the fabric cards of Multiservice Switch 15000 and Multiservice Switch 20000 nodes

  — Internal switching is configured through provisioned switched virtual circuits (SVC) connections using active access points (AAP) and passive access points (PAP). See “ATM connections for Media Gateway” (page 119) for a description of how Media Gateway can use each type of ATM connection.

  — Internal switching method must have each end of the VCCs provisioned on the Multiservice Switch Media Gateway as separate ATM connections with adjacent virtual channel connection identifiers (VCCI) of an even number and the next greater sequential number (for example, 100 and 101). As well, the remote network service access point (NSAP) address must be set to the local NSAP address value. The gateway recognizes its own address in an incoming session descriptor and swaps the VCCI values accordingly in the outgoing session descriptor. When a gateway is selecting a trunk and receives a session descriptor with a remote address that is identical to the local address, it considers only even numbered VCCIs that have matching equivalent odd numbered VCCIs.

- external switching through the external ATM network

  — External switching is configured through provisioned soft permanent virtual circuit (SPVC) connections that use SPVC access points (SPVCAP). The SPVC connections must be made using two separate VSP2/VSP3/VSP3-o FPs to process the origination and termination of the TDM-to-TDM call. See “ATM connections for

Media Gateway" (page 119) for a description of how Media Gateway can use each type of ATM connection.

Note: The recommended method is to use internal switching across the backplane of Multiservice Switch 7400 nodes, or across the fabric cards of Multiservice Switch 7400 and Multiservice Switch 20000 nodes, and not use external switching through the external ATM network.

Call control for switched Media Gateway using ATM

The MGC is responsible for terminating the signaling received from the PSTN through the SS7 gateway.

When the media gateway controller receives signaling information, it sends the appropriate commands for call establishment, release, and maintenance to the Media Gateway through a single control link to the VSP2/VSP3/VSP3-o FP. The control protocol for sending commands between the media gateway controller and Nortel Networks Multiservice Switch Media Gateway can be H.248 or VGCP (also known as ASPEN).

The following sections describe the various aspects of the media gateway controller:

- "Media gateway controller connections for switched Media Gateway using ATM" (page 65)
- "Communication between media gateway controllers for switched Media Gateway using ATM" (page 67)
- "PRI backhaul for switched Media Gateway" (page 98)
- "EN 300 V5.2 backhaul for switched Media Gateway" (page 102)
- "Voice profiles" (page 67)

Media gateway controller connections for switched Media Gateway using ATM

Call control connections can be configured as follows:

- "AAL5 VCC configuration for call control connections" (page 66)

AAL5 VCC configuration for call control connections

Control traffic travels over an IP network. Each Nortel Networks Multiservice Switch Media Gateway connects with the IP network using a single AAL5 VCC. This VCC carries IP datagrams using RFC 2684 encapsulation and terminates on an IP router that has an ATM interface. The router supports the inverse ATM address resolution protocol (inATMARP), which allows the router to discover the binding between the configured PVC and the IP address of the control interface on the Media Gateway. The Media Gateway sends an inATMARP request message once the IP address is provisioned.

Voice services FPs must be linked with AAL2 VCCs (PVCs) to successfully establish calls. Therefore, all voice calls can be directly routed over a single VCC from an originating Media Gateway (where conversion from TDM takes place) to a terminating Media Gateway (where conversion back to TDM takes place).

Each PVC in the intermeshing of voice services FPs is labeled with an identifier that is identical at both ends of the connection. This identifier is referred to as the VCCI and is used in the process of establishing calls. For the originating and terminating Media Gateways to connect their respective TDM end points to the same CID in the same VCC for the same call, communication between the two Media Gateways is required. Each Media Gateway needs to know the following information:

- the identity of its remote peer (formatted as an network service access point (NSAP) address)
- the VCCI for each VCC connecting the two gateways
- the CID for each AAL2 channel
- the voice profile (including information such as the maximum number of channels that can be assigned for a particular VCC)

When using ASPEN, a maintenance interface between the Media Gateway and the media gateway controller (MGC) is set up to support STARTUP messages and HEARTBEAT messages. The controller sends a STARTUP message to the Media Gateway when it is first brought into service or when it needs to be restarted. Receipt of the STARTUP message establishes the MGC as the current active controller and deletes all current connections. The MGC sends HEARTBEAT messages to the Media Gateway to detect its presence

and the status of the network path over which the messages are sent. After receiving a HEARTBEAT message, the Media Gateway returns an ACKNOWLEDGE message.

Note: ASPEN is not supported by the voice services processor 3 with optical TDM interface (VSP3-o) FP card.

When using H.248, the status of the MGC to Media Gateway connection is controlled by ServiceChange commands. Media Gateway brings the connection into service by sending a cold boot (serviceChange command with reason 901 cold boot) and the link is established after an Acknowledge has been received from the MGC. To check for inactivity, an inactivity timer is set by the MGC on Media Gateway. If Media Gateway does not detect any messages for the defined period of time, it will send a time-out message (a H.248 observed event). If the Media Gateway does not reply after a provisioned number of attempts and has not received any other messages from the MGC, the Media Gateway will "failover". In a Succession Networks application, a ServiceChange command with reason disconnect is sent to the MGC until an acknowledgement is received.

Communication between media gateway controllers for switched Media Gateway using ATM

Communication between two Media Gateways is achieved through the exchange of session descriptors. When a call is to be setup, the originating Media Gateway produces a session descriptor with its ATM NSAP address specified and the VCCI and CID fields left blank. The Media Gateway also sets the voice profile to a list of the profiles that it supports. This session descriptor is delivered, through the media gateway controller, to the terminating Media Gateway. The terminating Media Gateway selects an available VCCI and CID and an appropriate voice profile, includes its own ATM NSAP address, and returns the session descriptor through the media gateway controller. At this point, associations between TDM time slots and CIDs within a VCC can be dynamically established.

Voice profiles

The voice profile of a call is specified by a message from the MGC to the Media Gateway through the SDP. Voice and BD use voice profiles as an agreement on how to interpret the contents of packets in both the transmitting and receiving directions.

Media Gateway supports the following voice profiles:

- ITU I.366.2 standard profile P-1: G.711 64-kbit/s mu-law PCM without silence suppression for both voice calls and VBD calls. Data is carried in 40-byte packets with 5-ms packet data samples.
- ITU I.366.2 standard profile P-2: G.711 64-kbit/s mu-law PCM with silence suppression supported for voice calls only. The SID indicates the need for comfort noise when silence suppression is used. No silence suppression is used for VBD calls. Data is carried in 40-byte packets with 5-ms packet data samples.

Chapter 4
Switched Media Gateway using IP functionality

Switched Media Gateway (MG) using IP functionality (VoIP) is a configuration to connect the MG to the IP network. The VoIP configuration uses one of the following transport applications:

- ATM transport application
- Ethernet transport application

In addition to the transport application, VoIP uses one of the following routing methods:

- an external router
- virtual routing (VR) functionality
- VR interworking functionality through component *VirtualRouterAccessPoint (VrAp)*; also referred to as VR AP

For information on VoIP using ATM transport applications see:

- “VoIP using ATM transport and external routing” (page 70)
- “VoIP using ATM transport and VR” (page 73)

For information on VoIP using Ethernet transport applications see:

- “VoIP using two gigabit Ethernet ports of VSP3 and external routing” (page 73)
- “VoIP using Ethernet transport and VR” (page 74)

- "VoIP using Ethernet transport and VR on Multiservice Switch 7400 and Multiservice Switch 15000 VSS nodes" (page 76)

For details on services for switched Media Gateway using IP, see the following sections:

- "Introduction to Multiservice Switch Media Gateway" (page 31)
- "Voice compression for VoIP" (page 79)
- "Switched IP-to-TDM gateway" (page 80)
- "DTMF relay" (page 82)
- "Fax relay" (page 82)
- "VBD terminal support" (page 83)
- "VoIP services for voice calls" (page 85)
- "Call control for VoIP" (page 87)
- "Switched Media Gateway using ATM or IP functionality" (page 89)

To provision VoIP, see "Installing and setting up Media Gateway" (page 141) and NN10600-782 *Nortel Networks Media Gateway 7480/15000 Switched Service Configuration Management*.

VoIP using ATM transport and external routing

Media Gateway connects with the IP network using ATM. Media Gateway converts TDM traffic to IP and encapsulates the IP in ATM AAL5 cells for transport through the ATM network to the IP network.

In VoIP using ATM transport and external routing, an interworking function (IWF) terminates narrowband signaling in a manner similar to that of switched Media Gateway using ATM. This method allows Nortel Networks Multiservice Switch Media Gateway to dynamically create voice and voice band data connections between the service provider's TDM network and the IP network. Incoming TDM time slots are dynamically mapped or switched to outgoing UDP ports for each call. This mapping can also occur in the reverse direction, with incoming UDPs being switched to outgoing TDM time slots.

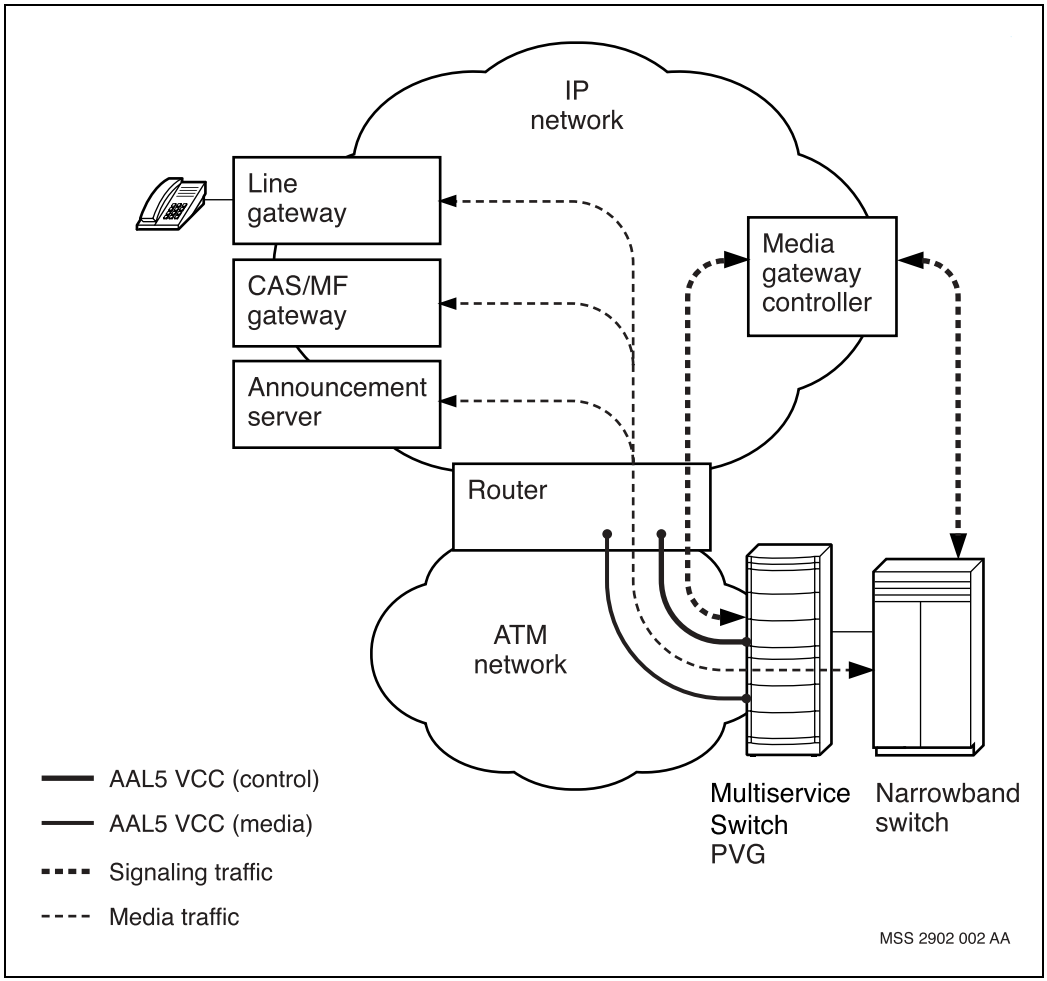
For VoIP, the interworking function consists of the following two parts:

- a voice gateway service (provided by Multiservice Switch Media Gateway)
- a MGC such as Nortel Networks Succession Networks CS2000 or CS2000 Compact

The relationship between each element in the interworking function is shown in “VoIP using ATM transport and external routing” (page 72).

VoIP using ATM transport and external routing can use PSVCs or SPVCs to route the voice and voice band data traffic through the ATM network to the IP interface. See “ATM connections for Media Gateway” (page 119) for a description of how Media Gateway can use each type of ATM connection.

Figure 7
VoIP using ATM transport and external routing



Bearer traffic travels over the IP network using RTP/UDP/IP. When using ASPEN to make a bearer traffic connection in the Media Gateway, the MGC sends a CREATE CONNECTION (CRCX) message with the appropriate parameters to the Media Gateway. When using H.248 to make a bearer traffic connection in the Media Gateway, the MGC sends an ADD command with

the appropriate parameters to the Media Gateway. In the Media Gateway, the voice services FP acts on instructions from its MGC to make or break narrowband connections between TDM trunks and IP flows.

VoIP using ATM transport and external routing is supported on the following types of voice services processor cards:

- voice services processor 2 (VSP2) FP
- voice services processor 3 (VSP3) FP
- voice services processor 3 with optical TDM interface (VSP3-o) FP

VoIP using ATM transport and VR

Media Gateway connects with the IP network using virtual router access point (VR AP) functionality. Media Gateway sends TDM traffic to the IP network as IP through VR AP functionality and an ATM IP FP card (4-port OC-3 ATM IP FP or 4-port OC-12 ATM IP FP).

Note: VSP hitless equipment protection (HEP) and hitless software migration (HSM) are supported in the VoIP using ATM transport (4-port OC-3/STM-1 ATM FP and 4-port OC-12/STM-4 ATM FP) and VR configuration.

VoIP using two gigabit Ethernet ports of VSP3 and external routing

Media Gateway connects with the IP network using the 2 gigabit Ethernet ports of the VSP3 FP. Media Gateway sends TDM traffic to the IP network as IP through the gigabit Ethernet ports of the VSP3 FP card. A router is required for connectivity to other subnets. A router that also supports bridging, is the recommended router for a direct connection from the IP network to the 2-port gigabit Ethernet ports of the VSP3 FP.

To configure VoIP using two gigabit Ethernet ports of VSP3 and external routing, you must install a Nortel Networks Multiservice Switch 15000 or Multiservice Switch 20000 node that contains the following:

- at least one VSP3 FP
- at least one 4-port OC-3/STM-1Ch TDM/CES FP

- one or two CPs

Note 1: VSP3 gigabit Ethernet ports are only supported on VSP3 FP cards.

Note 2: VSP3 gigabit Ethernet ports support media traffic and support call control signaling to the MGC. VSP3 gigabit Ethernet ports do not support operations, administration, and maintenance (OAM) activities.

VoIP using Ethernet transport and VR

MG connects with the IP network using virtual router (VR) interworking functionality through component *VirtualRouterAccessPoint (VrAp)*. MG sends TDM traffic to the IP network as IP through VR interworking functionality and a 4-port gigabit Ethernet FP card (4pGe).

Note: VSP HEP is supported for VoIP using Ethernet transport (4pGe card) and VR configuration. VSP HEP is not supported for VoIP over Ethernet when Ethernet ports on VSP3 card are used.

To configure VoIP using Ethernet transport and VR interworking, you must install a Nortel Networks Multiservice Switch 15000 or Multiservice Switch 20000 node that contains the following:

- at least one VSP2, VSP3, or VSP3-o FP
- between one and three of the 4-port OC-3/STM-1Ch TDM/CES FP cards (only when using VSP2/VSP3 FP cards and not using VSP3-o FP cards)
- one or two CPs
- at least one 4-port gigabit Ethernet FP card (4pGe, NTHW49); see “4pGe FP card support of VoIP” (page 75)

  Note: Carrier grade support requires a minimum of two CP cards, two VSP-type FP cards, two TDM FP cards (if using VSP2/VSP3), and two 4pGe FP cards.

4pGe FP card support of VoIP

The 4pGe card of MG supports VoIP using Ethernet transport and VR as follows.

- uses DiffServ (differentiated service) to manage IP traffic to VR interfaces (DiffServ supports egress treatment only on gigabit Ethernet link)
- provides inter-VR connectivity of media traffic through the virtual media (VM) application (connects multiple VRs and multiple VSP-type cards on the same MG)
- supports a maximum of four VRs per 4pGe card
- provides carrier grade support; see "4pGe FP card support of carrier grade" (page 75)

4pGe FP card support of carrier grade

Carrier grade features are supported on the 4pGe card for switched MG using IP functionality and virtual router (VR) interworking through component *VirtualRouterAccessPoint (VrAp)*. The 4pGe card supports carrier grade as follows.

- recovery from port/card failure with a maximum of 1 s of IP traffic loss from moment of failure
- HSM with a maximum of 1 s of IP traffic loss from the moment of the switch between shelf running old software and shelf running new software (supported for traffic originating on the Media Gateway)
- CPSO with a maximum of 50 ms of IP traffic loss when using static routes and open shortest path first (OSPF) routes (OSPF are dynamic routes)

Carrier grade support by the 4pGe card in a configuration of switched Media Gateway using IP (VoIP) with Ethernet transport and VR, has the following considerations:

- support of carrier grade on the Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes only
- protection of static IP routes using protected default route (PDR) for IP forwarding

- protection of dynamic IP routes (OSPF) using protected routes configuration for IP forwarding
- protection of 4pGe ports and bandwidth aggregation using link aggregation (LAG) protocol of grouped Ethernet ports
- hot CPSO support

VoIP using Ethernet transport and VR on Multiservice Switch 7400 and Multiservice Switch 15000 VSS nodes

Media Gateway connects with the IP network using Ethernet transport and VR functionality. Media Gateway sends TDM traffic to the IP network as IP through VR functionality. This implementation is only available on Nortel Networks Multiservice Switch 7400 or Nortel Networks Multiservice Switch 15000 Variable Speed Switch (VSS) nodes.

> ***Note:*** The VR functionality used by this configuration is different than VR AP functionality used in section "VoIP using Ethernet transport and VR" (page 74).

To configure VoIP using Ethernet transport and VR on Multiservice Switch 7400, you must install a Multiservice Switch 7400 node that contains the following:

- one or two VSP2 FPs
- one or two ATM FPs. The OC-3 ATM IP FP is recommended.
- one or two of the 2-port DS3C TDM FP or 32-port E1 TDM FP
- between one and four 100BaseT Ethernet FPs
- one or two control processors

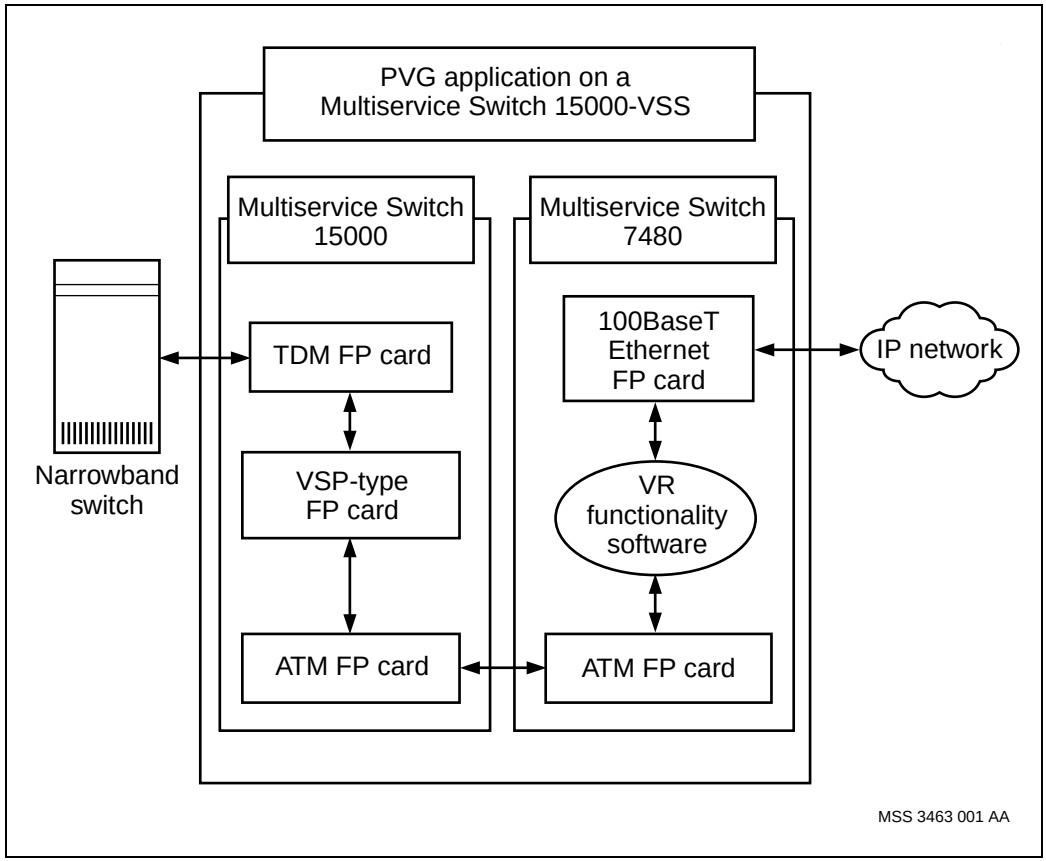
To configure VoIP using Ethernet on Multiservice Switch 15000 VSS, you must install a Multiservice Switch 15000 VSS node that contains the following:

- On the Multiservice Switch 7400 node
  - between one and three ATM FPs. The OC-3 ATM IP FP is recommended.
  - between one and eight 100BaseT Ethernet FPs

  - — one or two control processors
- On the Multiservice Switch 15000 VSS node
  - — one or two ATM FPs
  - — between one and four of either the VSP2 FP or VSP3 FP
  - — between one and three of either the 2-port DS3C TDM FP, 32-port E1 TDM FP, or 4-port OC-3/STM-1Ch TDM/CES FP
  - — two control processors

The relationship of the two shelves of the Multiservice Switch 15000 VSS for VoIP using Ethernet is shown in “VoIP using Ethernet transport and VR on Multiservice Switch 15000 VSS” (page 78).

Figure 8
VoIP using Ethernet transport and VR on Multiservice Switch 15000 VSS



The following software is required for the VoIP using Ethernet transport and VR configuration:

- the base application and its atmCore feature
- the Media Gateway application and its nsta and vgsIp features if 2-port DS3C TDM FP or 32-port E1 TDM FP are used
- the WanDte application and its AtmMpe feature (see note)
- the IP application and its IP feature (see note)

Note: Applications WanDte (and its AtmMpe feature) and Ip (and its IP feature) are required for OAM control of CP.

Voice compression for VoIP

VoIP is compliant with two standards of voice compression. Either G.711 or G.729a can be provisioned for VoIP. See the following sections for more information:

- "G.711 voice call compression" (page 79)
- "G.729a voice call compression" (page 79)

G.711 voice call compression

VoIP supports G.711 voice call compression for A-law and mu-law PCM voice at 64 kbit/s. Support of the G.711 voice call compression has the following considerations:

- supported for VSP2 on Nortel Networks Multiservice Switch 7400 nodes (1008-DS0 channel capacity), and on Multiservice Switch 15000 and Multiservice Switch 20000 nodes (1120-DS0 channel capacity)
- supported for VSP3 on Multiservice Switch 15000 and Multiservice Switch 20000 nodes (2016-DS0 channel capacity)
- supported for VSP3-o on Multiservice Switch 15000 and Multiservice Switch 20000 nodes with the following channel capacities:
  - 1953 channels for STM-1
  - 2016 channels for OC-3
- supports 10-milliseconds and 20-milliseconds RTP packets

G.729a voice call compression

VoIP supports G.729a PCM voice at 64 kbit/s and CS-ACELP voice at 8 kbit/s. Support of the G.729a voice call compression has the following considerations:

- not supported for packet loss concealment (PLC)
- supports upspeeding for fax/modem, DTMF, CNG, and text telephony terminals (VSP3 only)

- supports squelch for DTMF (squelch removes DTMF signal from encoded voice path)
- supports 10-milliseconds and 20-milliseconds RTP packets
- supports RTP static payload types to the RFC 1890 document
- supports G.729 Annex A and B in codec selection negotiation
- supported for VSP2 on Nortel Networks Multiservice Switch 7400 (720-DS0 channel capacity) nodes, and on Multiservice Switch 15000 and Multiservice Switch 20000 nodes (800-DS0 channel capacity)
- supported for VSP3 on Multiservice Switch 15000 and Multiservice Switch 20000 nodes (1512-DS0 channel capacity)
- supported for VSP3-o on Multiservice Switch 15000 and Multiservice Switch 20000 nodes with the following channel capacities:
  - 1953 channels for STM-1
  - 2016 channels for OC-3
- supports simultaneous transmission of DTMF tones and digit collection
- supported for H.248 version 1 protocol or ASPEN version 2.1 protocol (ASPEN is also known as VGCP)

When DTMF tones are detected, Media Gateway will upspeed from a G729a speed of 8 kbit/s to a G.711 speed of 64 kbit/s for the duration of the tone and then return to 8 kbit/s. When using the VSP3 card, Media Gateway can transmit DTMF digits in RTP packets using the Named Telephone-Event (NTE) as described in RFC2833.

Switched IP-to-TDM gateway

A switched IP-to-TDM gateway uses Media Gateway software to provide standards-based multiplexing and demultiplexing of IP connections and all voice band services. Traffic from the narrowband network is terminated by an interworking function consisting of a voice gateway service and a media gateway controller. See “VoIP services for voice calls” (page 85). Switched Media Gateway dynamically maps time slots from a TDM network onto real-time transport protocol (RTP) flows.

From the TDM side, Nortel Networks Multiservice Switch nodes receive TDM data through a TDM FP. The FP converts the incoming bit stream into standard 64 kbit/s channels and encapsulates them in AAL1 cells. The system then passes these cells to the voice services FP (VSP2 or VSP3) for encoding. Media Gateway identifies the cell streams as voice, fax/modem, or data calls.

A MG configuration using a VSP3-o FP card supports TDM optical connectivity through its front panel and therefore does not use the 4-port OC-3/STM-1 Ch TDM/CES FP card to supply the TDM connectivity. Even though the MG VSP3-o FP card has two optical TDM (OC-3/STM-1) interfaces, only port 0 is the active optical TDM interface for the VSP3-o. Other TDM FP cards can not be used with the VSP3-o FP card.

For Nortel Networks Multiservice Switch 7400 VSP2, the maximum number of VPMs per VSP2 is eighteen. For Multiservice Switch 15000 and Multiservice Switch 20000 VSP2, the maximum number of VPMs per VSP2 is twenty. Each VPM can support up to fifty-six time slots. For Multiservice Switch 15000 and Multiservice Switch 20000 VSP3, there are twenty-one VPMs and each VPM can support up to ninety-six time slots. All VPMs are collectively assigned an IP address, which is used to carry IP traffic over a media VCC. Therefore, all media traffic to and from the VPMs originate from a single IP host, the advantage being a reduction in the number of IP addresses required compared to earlier releases. Each media connection is defined by an *IpMConn* component.

Traffic within the VSP2 or VSP3 share the same source and destination addresses and an IP packet can be routed internally to the Multiservice Switch Media Gateway.

Traffic within the VSP2, VSP3, or VSP3-o share the same source and destination addresses and an IP packet can be routed internally to the Multiservice Switch Media Gateway.

Signaling between the narrowband network and Media Gateway for VoIP

Signaling between the narrowband network and Media Gateway is handled by a MGC. When using ASPEN to make a bearer traffic connection in the Media Gateway, the MGC sends a CREATE CONNECTION (CRCX) message with the appropriate parameters to the Media Gateway. When using

H.248 to make a bearer traffic connection in the Media Gateway, the MGC sends an ADD command with the appropriate parameters to the Media Gateway. In Nortel Networks Multiservice Switch Media Gateway, the voice services FP acts on instruction from the MGC to make or break narrowband connections between TDM trunks and RTP flows.

For more information about control connections between Multiservice Switch Media Gateway and the MGC, see "Call control for VoIP" (page 87).

DTMF relay

VoIP functionality supports DTMF relay on Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes using the VSP3 FP or VSP3-o FP cards. DTMF relay is the transport of DTMF digits from the TDM circuit over a packet network to a remote TDM circuit. DTMF relay support includes:

- DTMF relay of digits 0-F via IETF document RFC2833
- negotiation of digit relay for DTMF
- ability to enable/disable digit relay via provisioning
- dynamic payload type definition for IETF document RFC2833
- support for transport of DTMF level parameter
- support for DTMF text telephony (ITU recommendation V.18 Annex B)

Fax relay

VoIP functionality supports fax relay on the Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes using the VSP3 FP. Fax relay is the transport of facsimile from the TDM circuit over a packet network to a remote TDM circuit. Fax relay support includes:

- support of fax relay through ITU-T recommendation T.38 via UDP/IP
- ability to enable/disable autonomous fax relay support through provisioning
- support of transferred training check frame (TCF)
- support for redundancy UDP error correction

- provisionable redundancy depth up to three secondaries of ITU-T recommendation T.38
- support for all rates of ITU-T recommendations V.17, V.27, and V.29
- fax call establishment using proprietary autonomous mode
- fax call establishment per ITU-T recommendation T.38 appendix V and Annex E
- fax relay support negotiation with remote peer
- support for IP datagrams up to 612 bytes
- new call type enumeration called faxRelay
- mapping of fax statistics to standard ASPEN end-of-call statistics
- provisionable ability to defer ITU-T recommendation T.38 in order to support ITU-T standard V.34 over VBD mode
- support for transfer of fax calling tone CNG by either moving to VBD mode or to ITU-T recommendation T.38 mode
- support for up to 40% of simultaneous channels of ITU-T recommendation T.38
- support to scale up to 2016 simultaneous channels of ITU-T recommendation T.38
- no internally designed limit on fax capacity
- support of the MGC Transitioning Method for transitioning between Voice and T.38.
- Support of the CNG and V.21 Preamble enumerations of the ‘dtt’ parameter of the ‘dtone’ observedEvent within the ‘ctyp’ package (described in H.248.2).

VBD terminal support

VoIP functionality supports VBD terminals (per ITU V-series recommendations) as VBD on Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 nodes using the VSP3 FP or VSP3-o FP cards. VBD terminal support includes:

- upspeed for all non-T30 facsimile terminals

- upspeed for all modems that use V.25 calling tone and/or ANS tone
- upspeed for all modems that use V.8
- support for text telephony terminals per “Support for text telephony terminals” (page 84)
- support of only the ‘dtt’ parameter of the ‘dtone’ event of the ‘ctyp’ package with the restriction that only the following ‘dtt’ enumerations are supported:

  For fax:

  — CNG (0x0001)

  — V21 Flag (0x0002)

  Common to text and data:

  — BellHi (0x0006)

  — Baudot45 (0x0008)

  — V21hi (0x000D)

  — V21lo (0x000E)

  — CT (0x000C) *N.B. VSP3 detects 1300 Hz which is the CT tone as well as the mark bit (Fz) of V.23 for both low and high channels.*

  For modems:

  — ANS (0x0012)

  — ANSbar (0x0013)

  — V8BIS (0x0020)

Support for text telephony terminals

Text telephony terminals are supported in “VBD terminal support” (page 83) as follows:

- upspeed for Baudot terminals (V.18 Annex A)
- upspeed for European deaf telephone terminals (V.18 Annex C)
- upspeed for Bell 103 terminals (V.18 Annex D)

- upspeed for V.18 native mode terminals (V.18 Annex G)

VoIP services for voice calls

Switched Media Gateway supports various services for voice calls, including

- "RTP, UDP, IP and ICMP support" (page 85)
- "Supported packet features using VSP2 and IP functionality" (page 86)
- "Supported packet features using VSP3 and IP functionality" (page 86)
- "Supported packet features using VSP3-o and IP functionality" (page 86)
- "Voice calls" (page 32)
- "Switched Media Gateway using ATM or IP services for voice calls" (page 90)

RTP, UDP, IP and ICMP support

Nortel Networks Multiservice Switch Media Gateway uses real-time transport protocol (RTP) to encapsulate voice packets so they can be transported with the user datagram protocol (UDP) over IP. Multiservice Switch Media Gateway accepts RTP packets with payload types of G.711 voice, comfort noise and named signal event (NSE). Multiservice Switch Media Gateway processes the RTP payload according to the sequence number, time stamp, and payload type. Media Gateway can support real-time conferencing protocol (RTCP) on VSP3 FP and VSP3-o FP cards.

All packets generated on a single VSP-type card have the same value of differentiated services code point (DSCP).

Nortel Networks Multiservice Switch Media Gateway uses IP version 4 and supports provisionable differentiated services code point. Multiservice Switch Media Gateway supports 10 and 20 milliseconds payload sizes for processing incoming IP packets.

The internet control message protocol (ICMP) is an integral part of IP that handles IP error and query messages. Multiservice Switch Media Gateway can count ICMP dest not reachable errors.

Supported packet features using VSP2 and IP functionality

VoIP functionality and using the VSP2 FP, supports the following packet features.

- Send and receive 10-millisecond and 20-milliseconds packets. Media Gateway only sends and receives 10-milliseconds packets for CCD transmission.
- Detect 2100-Hz tones with and without phase reversal on the packet side and on the TDM side. The Media Gateway can determine if the 2100-Hz tone is from the packet side or from the TDM side. The packet side can have Media Gateway using IP or VoATM packets.
- Transmit RTP comfort noise (CN) packets with the payload type (PT) field in the RTP header set to the value 13 decimal. Media Gateway will receive as CN packets, all RTP packets that have a PT field in the RTP header set to either of values 13 or 19 decimal.
- Indicate a dynamic payload type in the session description protocol (SDP) in accordance with standard RFC2327 of the Internet Engineering Task Force (IETF).

Supported packet features using VSP3 and IP functionality

The VSP3 FP supports interoperability with the VSP2 in VoIP functionality. The VSP3 supports the packet features referenced in “Supported packet features using VSP2 and IP functionality” (page 86). Both VSP2 and VSP3 FPs can be used in the same shelf.

Supported packet features using VSP3-o and IP functionality

The VSP3-o FP supports interoperability with the VSP2 FP or VSP3 FP cards on Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 for VoIP functionality. The VSP3-o FP supports the packet features referenced in “Supported packet features using VSP2 and IP functionality” (page 86). The VSP2 FP, VSP3 FP, and VSP3-o FP cards can be used in the same shelf.

Call control for VoIP

The MGC is responsible for terminating the signaling received from the PSTN. The MGC uses a single control VCC to communicate to each voice services FP in Nortel Networks Multiservice Switch Media Gateway. Each voice services FP in Multiservice Switch Media Gateway acts as an independent gateway.

When the MGC receives signaling information, it sends the appropriate commands for call establishment, release, and maintenance to the Media Gateway through its control VCC. By following these commands, the Media Gateway creates a dynamic media channel between itself and another media gateway. The control protocol for sending commands between the MGC and Multiservice Switch Media Gateway can be H.248 or ASPEN (ASPEN is also known as VGCP). Call control is not supported for backward compatibility with ASPEN versions before ASPEN version 2.1 (for example, ASPEN version 2.06 is not compatible).

Multiservice Switch Media Gateway maintains a series of point-to-point connections under the direct control of the MGC. A “connection” is the association of a TDM endpoint with an RTP stream of voice packets to or from a remote transport address. A remote transport address consists of an IP address and a UDP port. The connection also includes the voice service and adaptation attributes that affect the bidirectional traffic as it flows between the two endpoints. By associating connections on two MGs connected to the IP network, the controller allows a call to be switched across the IP network.

The following sections describe the various aspects of the MGC:

- “Call setup for VoIP” (page 87)
- “PRI backhaul for switched Media Gateway” (page 98)
- “EN 300 V5.2 backhaul for switched Media Gateway” (page 102)

Call setup for VoIP

For the originating and terminating gateways to send and receive packets from the correct remote transport address, communication between the two gateways is required. Each gateway needs to know the following information:

- the remote transport address to which packets will be sent

- the acceptable encoding payload types

This information is determined through the exchange of session descriptors. The MGC sends the originating gateway's transport address and acceptable encoding payload types in an outgoing session descriptor to the terminating gateway. The MGC then sends the terminating gateway's transport address and acceptable encoding payload types back to the originating gateway in a return session descriptor.

Chapter 5
Switched Media Gateway using ATM or IP functionality

This section describes common functionality between switched Media Gateway using ATM and switched Media Gateway using IP. For more information, see the following sections:

- “Switched Media Gateway using ATM or IP services for voice calls” (page 90)
- “PRI backhaul for switched Media Gateway” (page 98)
- “EN 300 V5.2 backhaul for switched Media Gateway” (page 102)
- “Anchor Packet Gateway” (page 106)
- “Custom Local Area Signaling Services (CLASS)” (page 108)
- “Per-Trunk Signaling” (page 109)
- “Switching TDM traffic in a LAPS configuration” (page 110)
- “Media Gateway carrier grade” (page 111)

For more information about switched Nortel Networks Multiservice Switch Media Gateway functionality, see the following sections:

- “Introduction to Multiservice Switch Media Gateway” (page 31)
- “Switched Media Gateway using ATM functionality” (page 57)
- “Switched Media Gateway using IP functionality” (page 69)

Switched Media Gateway using ATM or IP services for voice calls

This section includes Media Gateway services for voice calls for both switched voice over ATM and IP. For more information about switched Media Gateway services for voice calls, see the following sections:

- "Voice calls" (page 32)
- "Switched Media Gateway using ATM services for voice calls" (page 60)
- "VoIP services for voice calls" (page 85)
- "Audible tones for switched Media Gateway" (page 90)
- "Dual-tone multifrequency digit collection for switched Media Gateway" (page 95)
- "PSTN continuity testing for switched Media Gateway" (page 97)

Audible tones for switched Media Gateway

Nortel Networks Multiservice Switch Media Gateway plays audible tones towards the TDM ports when the MGC instructs it to do so.

The audible tones consist of one or more tone bursts interspersed with periods of voice traffic or silence. The tone bursts are inserted into the voice traffic path to replace audio signals from the packet side of the Media Gateway. In between tone bursts, there may be periods of silence in accordance with cadence definitions except when the voice services processor 3 (VSP3) FP card is used. When the VSP3 is used, periods of either voice traffic or silence are supported between the tone bursts, in accordance with cadence definitions.

Multiservice Switch Media Gateway supports the concurrent playout of multiple tonesets. You can set a global default with the *defaultToneset* attribute of the *Nsta Vgs* component to make it easier to provision the toneset for multiple DS1 or E1 ports. The toneset for individual DS1 or E1 ports can then be provisioned separately with the *toneset* attribute of individual *Nsta Vgs Brag* components.

To play the full set of audible tones, the MGC must communicate with the Media Gateway using either the VGCP based on ASPEN 2.1, or the H.248 control protocol.

Supported tone packages for tones controlled by the MGC

The MGC instructs the Media Gateway to play individual tones using a specific tone identifier within a particular tone package.

The following table provides detailed information about the packages and tones that Nortel Networks Multiservice Switch supports.

Table 1
Supported packages and tones

Package name and identifier	Tone Identifier	Tone name
basic call progress (cg) under VGCP and H.248 basic call progress with bidirectionality (bcg) under H.248 only ***Note:*** See notes in the last row of this table.	dt, bdt	dial
	rt, brt	(audible) ringing
	bt, bbt	busy
	ct, bct	congestion
	sit, bsit	special information
	wt, bwt	warning
	wt, bwt	toneburst on answer
	pt, prt, bpt, bprt	pay phone recognition
	cw, bcw	call waiting
	cr, bcr	caller waiting
extended call progress (xcg) under VGCP and H.248	cmft	comfort
	roh	off-hook warning
	nack	negative acknowledge
	vac	vacant number
	spec	special conditions dial

(Sheet 1 of 2)

Table 1 (continued)
Supported packages and tones

Package name and identifier	Tone Identifier	Tone name
basic services tone generator (srvtn) under VGCP and H.248	rdt	recall dial
	conf	confirmation
	ht	held
	mwt	message waiting
All tone definitions under H.248 are the same as those under VGCP, with the following notes: ***Note 1:*** cg/pt under VGCP is cg/prt under H.248 and has the same tone definition. ***Note 2:*** Tone identifiers starting with a “b” apply to the bcg package, under H.248. ***Note 3:*** All tone definitions in the bcg package under H.248 are the same as those in the cg package under H.248 and VGCP. However: • Despite the bidirectional nature of the bcg package, Media Gateway supports tones towards TDM only. • The bcg and cg package names are aliased. • Media Gateway supports aliases of bcg/bpt and bcg/bprt (same tone as cg/prt) • Media Gateway supports a new tone, bcg/bpy. This definition of this tone is “Do nothing. Signal complete immediately when requested”.		
(Sheet 2 of 2)		

The toneburst-on-answer tone replaces the warning tone for the following countries: Belgium, France, Italy, Ireland, Netherlands, Spain and the UK.

The voice services processor 2 (VSP2) FP card and the voice services processor 3 with optical TDM interface (VSP3-o) FP card can play up to three simultaneous monotones, whereas the voice services processor 3 (VSP3) FP card can play up to four. Some tones use four simultaneous monotones, such

as the off-hook warning tone for some countries. In this case, the definitions of those tones are slightly different, depending on which type of voice services processor card is used.

> ***Note:*** The VSP3-o FP card supports tones to the TDM side of the MG and does not support tones for the packet side of the MG.

Tone power level definitions are with respect to an egress gain of 0 dB. Any non-zero setting of egress gain accordingly affects the output power level of the tones.

For the tone definitions for each country that Media Gateway supports, see "Definitions of audible tones by country" (page 179).

Behavior of tones controlled by the MGC

The MGC activates a tone by requesting its specific mnemonic in a SIGNAL REQUEST message to the Media Gateway. The Media Gateway plays the tone, immediately pre-empting any existing playout.

Nortel Networks Multiservice Switch Media Gateway can play any tone on any endpoint regardless of the tones or services being played on any other endpoint.

Tones are played continuously (aside from cadencing) regardless of

- the state of any connection or mode of a connection associated with the endpoint
- any changes to the state of any connection or mode of a connection associated with the endpoint

Endpoints that are in loopback mode are an exception to this rule. These endpoints have the loopback asserted rather than the tone. When loopback is removed, the tone is re-asserted.

A tones plays until one of the following conditions is met:

- The timer (if applicable) expires.
- The Media Gateway receives a SIGNAL REQUEST message without a specific mnemonic.

- The control protocol is H.248 version 1 or ASPEN version 2.1 (ASPEN is also known as VGCP) and an appropriate event occurs as requested by a REQUESTED EVENT message. For example, if dialed digits are requested for notification at the same time tone playout is requested, the dial tone ceases when the first DTMF digit is detected.

The Media Gateway rejects SIGNAL REQUEST messages that ask for

- simultaneous playout of more than one tone on the same endpoint
- concatenated playout of more than one tone on the same endpoint

At any time, you can reprovision the toneset used. For example, if you reprovision the toneset from Portugal to Spain, the following is the resulting behavior:

- For tones in progress during reprovisioning, the Media Gateway continues to play out those tones from the Portuguese toneset.
- For new SIGNAL REQUEST messages, the Media Gateway plays out tones from the Spanish toneset.

Tone packages are supported in their entirety. The Media Gateway always acknowledges valid requests for tones within packages that it supports.

Where the combination of tone identity and toneset identity is undefined, Media Gateway plays no tone. When the tone package is unknown or the tone identity within the package is unrecognized, Media Gateway returns an appropriate error code.

The MGC instructs the Media Gateway to notify the MGC when the tone or toneset ceases because of a time-out or a failure. If no tone is played, the notification (if requested) is sent immediately after the request is acknowledged.

Dual-tone multifrequency digit collection for switched Media Gateway

Nortel Networks Multiservice Switch Media Gateway can collect and report digits on the TDM circuit side, under MGC control. Multiservice Switch Media Gateway collects DTMF digit strings up to 32 digits in length, including the digits *, #, 0–9, and A-D. As well, Media Gateway can detect the difference between short and long * and # digits.

DTMF digit generation via use of the H.248 ‘dg’ package and the capability to set the duration of the digits by the MGC, allows the Media Gateway to be interoperable with H.323 GWs.

> ***Note:*** To use Media Gateway to collect and report digits, the MGC must use the H.248 version 1 protocol or the ASPEN version 2.1 protocol (ASPEN is also known as VGCP) protocol to communicate with the Media Gateway.

For more information about digit collection, see

- “Types of digit collection” (page 95)
- “Digit collection timers” (page 96)
- “Digit collection statistics” (page 96)
- “Digit collection buffer” (page 97)

Types of digit collection

Nortel Networks Multiservice Switch Media Gateway is capable of three types of digit collection:

- digit collection with digit maps
- digit collection without digit maps
- mid-call digit collection

During digit collection with digit maps, the Media Gateway collects dialed digits using any digit map or digit map combinations transmitted or supported by H.248 version 1 control protocol or ASPEN version 2.1control protocol (ASPEN is also known as VGCP). The length of the digit map is limited to 400 characters.

Multiservice Switch Media Gateway supports digit collection without digit maps by collecting individual digits. Single digits are collected using either the H.248 or ASPEN (VGCP) Notify Immediately action code.

During mid-call digit collection, the MGC arms the Media Gateway digit buffer with the mid-call digit pattern. If that pattern is detected during the call, the MGC is informed. The MGC will only be notified if the exact character string is matched. Mid-call triggers are frequently used for call re-origination. In North America, the re-origination tone is achieved by holding the # digit for the duration specified by the *longDigitTimer*Duration attribute. For more information about digit timers, see “Digit collection timers” (page 96).

Digit collection timers

Nortel Networks Multiservice Switch Media Gateway uses the provisionable timer attributes of the *Vgs DigitCollection* component to control digit collection. The timers use default values unless a value is supplied by the MGC. When the timers expire, a NOTIFICATION message is sent to the MGC.

The *initialDigitTimer* attribute controls the maximum length of time allowable between the digit collection request and the entering of the first digit. The *shortInterDigitTimer* and *longInterDigitTimer* attributes, when activated, control the length of time between each key press. The timer is reset after each key press is received by the Media Gateway. The MGC REQUEST message determines if and when these timers are applied to digit collection.

The *longDigitTimerDuration* attribute specifies the length of time the * or # digits must be pressed to be recognized as a long digit.

Digit collection statistics

Digit collection statistics are collected with the *collectionsInProgress* and *peakCollectionsInProgress* operational attributes of the *Vgs DigitCollection* component.

The *collectionsInProgress* attribute tracks the percentage proportion of digit collection resources that are currently being used. This value excludes endpoints that are collecting mid-call triggers.

The *peakCollectionsInProgress* attribute tracks the percentage proportion of digit collection resources that have been used at any point since the last reset of the attribute. This value excludes endpoints that have been requested to collect mid-call triggers.

The rejectedCollectionRequests attribute counts the number of digit collection requests that are rejected due to lack of resources. On overwrap this counter will start at zero again. If the *pmodule fails, the count is reset.* Persistent increase of this statistic indicates an engineering mismatch between demand and capacity of the digit collection resources. Multiservice Switch Media Gateway can allocate 120 resources per VSP2 FP card and 200 resources per VSP3 or voice services processor 3 with optical TDM interface (VSP3-o) FP card to simultaneous digit collection, excluding mid-call trigger. Mid-call trigger may be enabled on 100% of endpoints.

The Zero verb can be used to re-initialize the *peakCollectionsInProgress* operational attribute. For more information, see NN10600-782 *Nortel Networks Media Gateway 7480/15000 Switched Service Configuration Management*.

Digit collection buffer

Collected digits are placed in a digit buffer. The digit buffer has finite capacity, and once full, it discards digits until the buffer is reduced or cleared. The digit buffer is cleared when

- an explicit notification request against the specific endpoint is received without digits as requested events
- a maintenance action is taken to free accumulated resources
- an explicit flush request is received as part of a new request
- a mismatch or time-out occurs in a mid-call trigger

PSTN continuity testing for switched Media Gateway

Nortel Networks Multiservice Switch Media Gateway supports both terminating and originating 4-wire continuity testing to the PSTN network.

Terminating 4-wire continuity testing is supported through the loopback response signal.

In originating 4-wire continuity testing, the MGC requests the Media Gateway to send a continuous 2010 Hz tone towards the TDM ports and search for the same tone as a response. During this process, echo cancellation is disabled if it appears in the continuity path. The return tone is not transmitted towards the packet network regardless of mode. Instead, silence or comfort noise is played out if the endpoint is in Send mode.

The Media Gateway assumes that the MGC contains the continuity timer. The Media Gateway plays the continuity tone until requested to stop by the MGC or until the return tone is detected.

> ***Note:*** For the VSP3 and VSP3-o FP cards, continuity testing only arms the tone detectors when a continuity test has been requested by the MGC. During normal call operation, the echo canceller will not become disabled when 1780 Hz and 2010 Hz tones are detected.

Multiservice Switch Media Gateway rejects any request from the MGC to

- perform a continuity check while playing another tone on the same endpoint
- concatenate the playout of a tone with a continuity test on the same endpoint

The specifications and tolerances of the continuity tone are located in

- Annex B1.2 of ANSI document T1.113.4, *ISDN User Part 1995*
- Section 7.1 an 7.2 of ITU-T Recommendation Q.724, *SS7 Signaling Procedures*

PRI backhaul for switched Media Gateway

Nortel Networks Multiservice Switch Media Gateway can serve as a signaling gateway (SG) for primary rate interface (PRI) backhaul. In PRI backhaul, the Media Gateway serves as a SG to transport ISDN PRI signaling between a PRI-controlled device and a MGC. PRI backhaul is defined as the termination at the SG of the lower layers of the signaling stack for a switched circuit network and the transport (or backhaul) to the MGC of the higher layers of the same signaling stack. The PRI D-channel signaling of PRI backhaul through the Media Gateway, is for call control and not for

connection control. PRI-controlled devices are private branch exchanges (PBX), remote access servers (RAS), local area networks (LAN), and host computers to the networks.

The Media Gateway has two links to transport PRI D-channel signaling as follows:

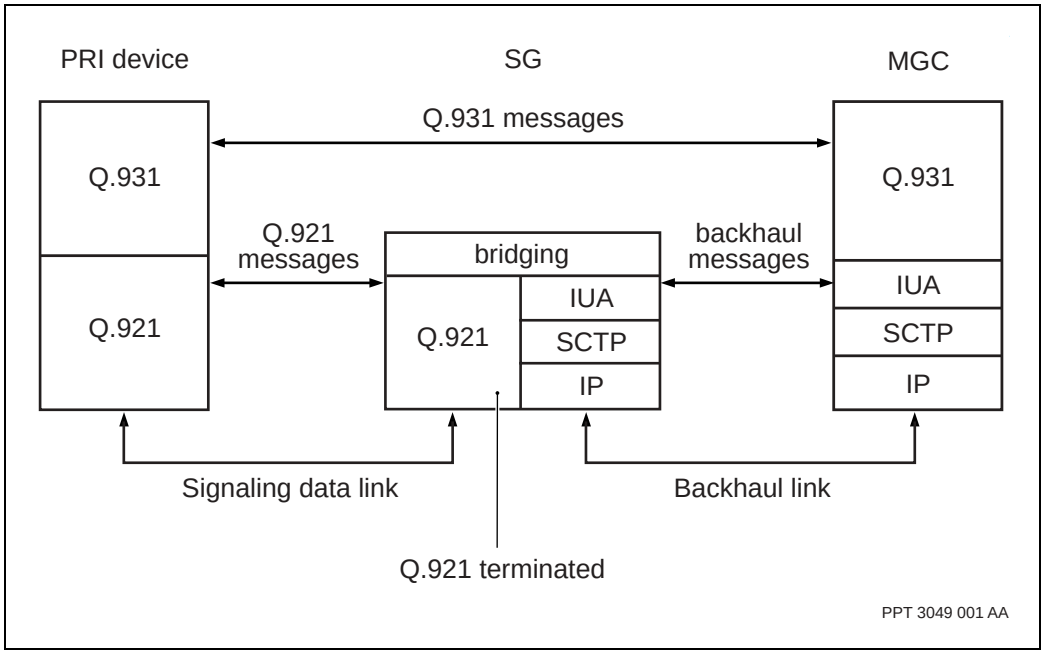
- a signaling datalink between the Media Gateway and PRI-controlled device
- a backhaul link between the Media Gateway and the MGC

PRI backhaul uses an interworking protocol called ISDN Q.921 user adaptation layer protocol (IUA)/stream control transmission protocol (SCTP). PRI D-channel signaling is transported between the Media Gateway and the PRI-controlled trunks using protocol of Q.931 encapsulated in Q.921 over the signaling datalinks. The Media Gateway terminates Q.921 messages from the PRI-controlled trunks. The IUA/SCTP protocol is used to transport Q.931 signaling messages between the Media Gateway and the MGC over the backhaul links.

Media Gateway can be configured to be the network end or the user end of the PRI trunk. The default configuration is for the Media Gateway to be the network end.

The protocol layers for control messages of PRI backhaul are shown in “Protocol layers for control messages of PRI backhaul” (page 100).

Figure 9
Protocol layers for control messages of PRI backhaul



PRI backhaul enables the Media Gateway to act as an integrated services hub (ISH) handling both call control and connection control messages. The ISH is divided into two logical parts as follows:

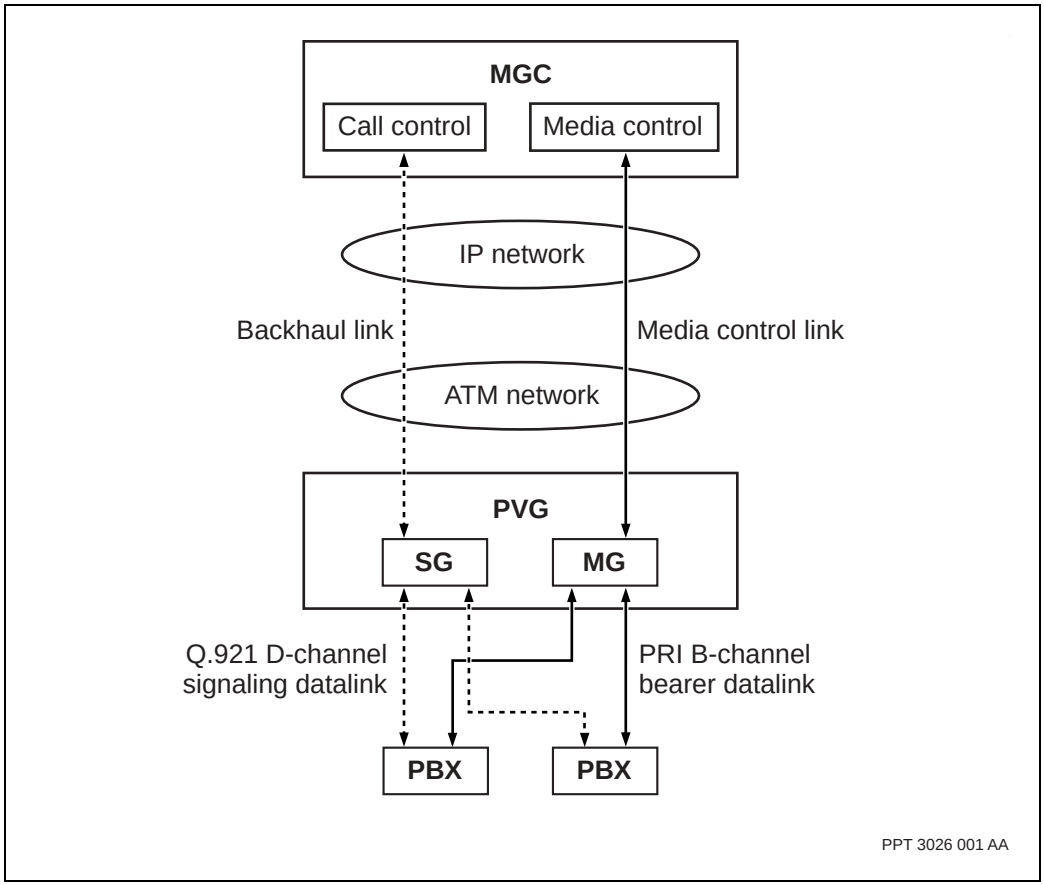
- the signaling gateway (SG) part
- the media gateway (MG) part

The SG part uses IUA/SCTP/IP to backhaul call control messages between the PRI-controlled device and the MGC (IUA is ISDN Q.921 user adaptation layer; SCTP is stream control transmission protocol; IP is internet protocol).

The MG part uses H.248 or ASPEN control protocol, UDP, and IP to transport connection control messages between the MGC and the Media Gateway (ASPEN is also known as VGCP; UDP is user datagram protocol; IP is internet protocol).

The SG and MG logical parts of the ISH are shown in “Architecture diagram of PRI backhaul for Media Gateway” (page 101). For more information on the MG, refer to “Media gateway controller connections for switched Media Gateway using ATM” (page 65).

Figure 10
Architecture diagram of PRI backhaul for Media Gateway



PRI backhaul for Media Gateway requires the following:

- VSP2, VSP3, or VSP3-o FP
- SG sparing by VSP2, VSP3, or VSP3-o FP sparing using cold standby for unrecoverable failures

- one D-channel maximum per T1/E1 carrier facility
- each SG entity of Nortel Networks Multiservice Switch Media Gateway can be controlled by only one MGC at a time (each VSP2, VSP3, or VSP3-o FP card can contain one SG entity)

EN 300 V5.2 backhaul for switched Media Gateway

Nortel Networks Multiservice Switch Media Gateway can serve as a SG to backhaul signaling information from interfaces conforming to the V5.2 specification as laid out in the ETSI EN 300 324-1 and EN 300 347-1 standards. These interfaces are called *V5.2 interfaces* in this document.

A V5.2 interface connects a local exchange in the PSTN network to a number of remote end users. The remote end users are connected through a hub forming an access network. The V5.2 interface connects the hub to the PSTN network. The V5.2 interface supports up to 16 E1 links, where each link can contain bearer channels (B-channels) and signaling channels (C-channels). The V5.2 interface supports several signaling protocols, including:

- PSTN analog
- ETSI BRI and PRI
- other analog and digital accesses, both semi-permanent and permanent

Note: Although the V5.2 specification supports ETSI BRI and PRI, the current version of V5.2 backhaul for switched Media Gateway does not.

In V5.2 backhaul, the Media Gateway serves as a SG to transport V5.2 signaling between an access network device and a MGC. V5.2 backhaul is defined as the termination at the SG of the lower layers of the signaling stack for a switched circuit network and the transport (or backhaul) to the MGC of the higher layers of the same signaling stack. The protocol layers for control messages of V5.2 backhaul are shown in “Protocol layers for control messages of V5.2 backhaul” (page 103).

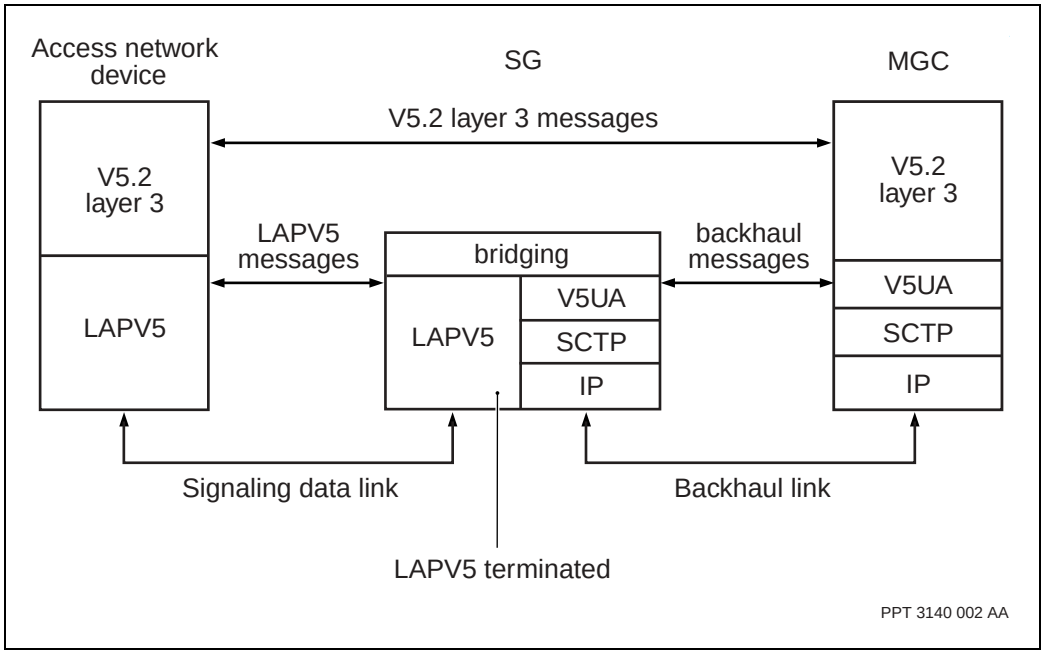
The Media Gateway has two links to transport V5.2 layer 3 signaling messages as follows.

- a signaling datalink between the Media Gateway and access network device

- a backhaul link between the Media Gateway and the MGC

V5.2 backhaul uses an interworking protocol called V5.2 user adaptation layer protocol (V5UA)/SCTP. V5.2 channel signaling is transported between the Media Gateway and the access network device using LAPV5 messages. LAPV5 messages consists of LAPV5-DL packets encapsulated in LAPV5-EF packets over the signaling datalinks. The Media Gateway terminates V5.2 layer 2 messages from the access network device. The V5UA/SCTP protocol is used to transport V5.2 layer 3 messages between the Media Gateway and the MGC over the backhaul links.

Figure 11
Protocol layers for control messages of V5.2 backhaul



V5.2 backhaul enables the Media Gateway to be divided into two logical parts as follows:

- the SG part, that transport signaling data and provides connection control
- the MG part, that transport bearer traffic

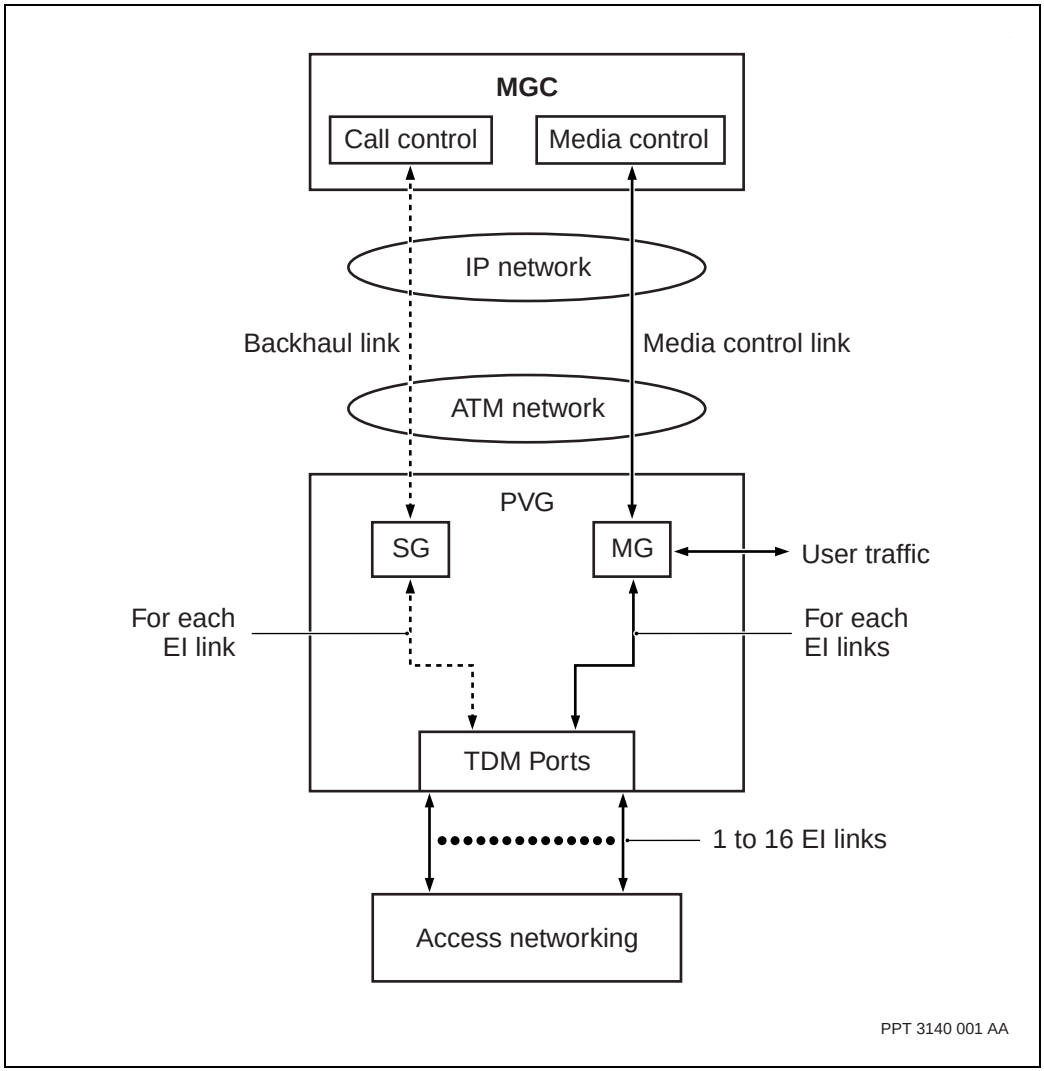
The SG part uses V5UA/SCTP/IP to backhaul the following types of messages between the access network device and the MGC:

- maintenance messages and link identification messages for each E1 link
- call control messages for each E1 link that has active C-channels

The MG part uses H.248 or ASPEN control protocol, UDP, and IP to transport connection control messages between the MGC and the Media Gateway (ASPEN is also known as VGCP).

The SG and MG logical parts of the Media Gateway are shown in “Architecture diagram of V5.2 backhaul for switched Media Gateway” (page 105). For more information of the MG, refer to “Media gateway controller connections for switched Media Gateway using ATM” (page 65).

Figure 12
Architecture diagram of V5.2 backhaul for switched Media Gateway



V5.2 backhaul for switched Media Gateway requires the following:

- VSP2 or VSP3

- SG sparing by VSP2 or VSP3 sparing using cold standby for unrecoverable failures
- each SG entity of Nortel Networks Multiservice Switch Media Gateway can be controlled by only one MGC at a time (each VSP2 or VSP3 card can contain one SG entity)

Note: The VSP3-o FP card does not support V5.2 backhaul.

As well, V5.2 backhaul cannot be performed with the 4-port OC-3/STM-1Ch TDM/CES FP.

For additional information, see “V5.2 backhaul network configurations” (page 106).

V5.2 backhaul network configurations

A single V5.2 interface can be implemented across one or more VSP-type cards. When more than one VSP-type card is used, they can be located on the same or on different Media Gateway equipment racks. In addition, a single VSP-type card can support more than one V5.2 interface.

Each VSP-type card implements the SG function to handle the C-channel signaling transport as well as the MG function to handle B-channel transport. Each SG has separate SCTP associations to each of the controlling MGCs. A single SCTP association can carry the C-channels of several V5.2 interfaces in different streams. There is an SG on every VSP-type card involved in V5.2 processing, whether there are any C-channels configured on the links handled by the VSP-type card or not.

Splitting the V5.2 interface across many VSP-type cards and Media Gateways provides protection against single point failures.

Anchor Packet Gateway

The Anchor Packet Gateway (APG) is a Media Gateway that accepts calls originating from the packet network and relays them to another destination in the packet network.

The APG is used when different media gateway controllers manage the originating and terminating Media Gateway and it is necessary to perform additional functions on the call such as providing tones or digit-collection. The APG allows the service provider to perform these additional functions on the call.

The APG uses hairpin connections between two ports of a TDM FP to relay calls.

The following describes a typical scenario where an APG is used:

- A call must be placed between two Media Gateways: Media Gateway1 and Media Gateway2. Media Gateway1 is controlled by MGC1 and Media Gateway2 is controlled by MGC2. MGC2 also controls a third Media Gateway that acts as an APG.
- The call goes from Media Gateway1 through the packet network to the APG.
- The APG accepts the call from Media Gateway1 and processes it internally to one of its DS3 TDM FP ports.
- The call goes through the hairpin connection to the second DS3 TDM port of the FP.
- The APG processes the call from the second DS3 TDM port back to the packet network.
- The call goes from the APG through the packet network to Media Gateway2.
- Media Gateway2 accepts and completes the call.

The APG function requires each MG to have a minimum of one VSP2, VSP3, or VSP3-o FP card. The VSP2, VSP3, or VSP3-o FP cards that are used for the APG function can co-exist in the same MG as other VSP2, VSP3, or VSP3--o FP cards that are used for TDM trunk gateways.

APG processing adds minimal latency to call processing and call completion as long as G.711 speech encoding is performed.

Each APG is controlled by an MGC that does the anchor control function. The anchor control MGC can perform both anchor control and TDM control functions.

Custom Local Area Signaling Services (CLASS)

Custom Local Area Signaling Services (CLASS) adds functionality to the switched mode Media Gateway on V5.2 to allow the generation of Terminal Equipment (TE) display/indicator information (e.g. calling line identity) on TDM trunks.

For a traditional V5.2 configuration, CLASS functions are normally performed by the Local Exchange (LE). For voice over packet configurations, the LE is replaced with the Media Gateway (MG) and Media Gateway Controller (MGC). The media path CLASS functionality is performed by the MG when commanded by the MGC.

The following features are supported:

- VSP2 (PP7000 and PP15000) and VSP3 support
- VSP3-o supports only the ‘dg’ package
- V.23 Frequency Shift Keyed (FSK) TE display/indicator procedures as per the European Telecommunications Standards Institute (ETSI) specifications, except for those functions that can only be achieved by line gateways
- Japan Calling Number Display FSK procedure
- FSK payload data up to 80 octets
- Generation of DTMF digit sequences as per ETSI specifications
- DTMF digit sequence generation up to 32 digits, with a default digit duration of 70ms (which can be modified by the MGC via the signal duration parameter), and interdigit duration of 70ms (which cannot be modified by the MGC). This only applies to the ‘dg’ package.
- Support for VoIP and VoAAL2
- Support for the 32-port E1 TDM FP card only
- Support for “burst” call waiting tones that are short in duration.
- CLASS functionality controlled using H.248

— The parts of the “alert” and “andisp” packages applicable to non-line gateways

— Sequential signal lists for the generation of DTMF digit sequences

— The DTMF tones defined in the “dg” package

Note: The VSP3-o FP card does not support CLASS.

The CLASS functionality is always enabled for the software load, but can be disabled at the MGC.

Per-Trunk Signaling

Per-Trunk Signaling (PTS) is supported on VPS3-o using the concept of CAS Profiles. The profile contains the line and register signaling details that are particular to a certain variant of CAS signaling, such as values of particular ABCD bits mapping to certain generic CAS states, timings, and tolerances. The profiles do not completely define the CAS protocol, only those behaviors locally performed by the gateway.

Incoming signals on the TDM interface are extracted from their CAS variant waveform according to the profile associated with each TDM endpoint and they are backhauled to the MGC using H.248. In reverse direction, incoming CAS signals from the MGC are applied to the designated TDM endpoints following the description indicated in the associated profile.

Media Gateway supports MF R1, DTMF, and Dial Pulse register signaling.

PTS trunks are only supported on DS1-formatted OC3 ports on VSP3-o. A VSP3-o FP may support PTS trunks, PRI and ISUP trunks simultaneously, each of which may be provisioned at a DS1 granularity.

Media Gateway supports the following North American PTS trunks in conjunction with CS2k:

- DAL
- ONAT
- EANT
- OP

- ES
- IT
- ATC
- Supercama
- PX
- CELL
- IBN (basic calls: TI/TO/T2)

Switching TDM traffic in a LAPS configuration

CAUTION

Risk of service interruption for a LAPS configuration

Other than up to 50 milliseconds of lost traffic due to a switchover in a line automatic protection switching (LAPS) dual-FP configuration, a service outage is possible if the command *switch laps* is not used to switch activity while the spare card is locked. For example, you might enter the command *lock* on a port on the active card while the spare card or port is locked. A service outage will occur because both the active and spare ports are locked. The command *switch laps* checks whether the spare is in-service and available before attempting the switchover. When the port or card is not available, this command prevents the switchover.

When a 4-port OC-3/STM-1 Ch TDM/CES FP (with PEC NTHW70 and card type 4pOC3ChSmIr), or any other optical FP, is set up in a dual-FP LAPS configuration, use the command *switch laps* to switch over traffic from the active card or port to a spare card or port on a Media Gateway shelf. When the spare TDM card is locked, the command *switch laps* will respond with a message that the spare card or port is unavailable and the command will abort. The aborted command results in traffic remaining on the active port. The full description of the command *switch laps* is in NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference*.

Media Gateway carrier grade

Media Gateway has robustness functionality in support of carrier grade standards of reliability on Nortel Networks Multiservice Switch 15000 nodes. The following carrier grade features are supported by Media Gateway on Multiservice Switch 15000 nodes:

- "Hitless equipment protection (HEP)" (page 113)
- "Hitless software migration (HSM)" (page 115)

Media Gateway support of the carrier grade features HEP and HSM only apply to the following types of FPs on a Media Gateway:

- 4-port OC-3/STM-1Ch TDM FP
- VSP2/VSP3 FP (except gigabit Ethernet features of the VSP3 FP which are not supported)
- voice services processor 3 with optical TDM interface (VSP3-o) FP
- ATM FP
- 4-port gigabit Ethernet FP card as described in "4pGe FP card support of carrier grade" (page 75)

Other considerations for support of HEP and HSM are as follows:

- supported for switched Media Gateway using either ATM or IP
- supported for the ASPEN version 2.1 protocol for connection control between the MG and the media gateway controller (MGC); also note that ASPEN protocol is not supported by the voice services processor 3 with optical TDM interface (VSP3-o) FP card
- supported for the H.248 version 1 protocol for connection control between the MG and the MGC
- supports VrAp <--> SpvcAp data network access reprovisioning without VSP-type card reset
- cannot provision border gateway protocol (BGP) when 4-port gigabit Ethernet FP card is on the Media Gateway shelf (a warning is generated when BGP is provisioned as part of another VR on the Media Gateway shelf and a 4-port gigabit Ethernet FP card is on the Media Gateway shelf)

- integrates support of multiple virtual routers (MVR) on 4-port gigabit Ethernet FP card
- supports hot control processor switchover (CPSO) for switched Media Gateway using ATM or IP with virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* (see "Hot CPSO" (page 112))

HEP or HSM switchovers on Media Gateway have the following impacts:

- packet data loss of voice and VBD is limited to 100 ms (except for virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* that is limited to one second)
- period of degraded performance for quality of voice is normally limited to 400 ms (except for virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* that is limited to one second)
- narrowband call setup outage (setup, modify, delete) has a maximum value of 15 s (the typical value is less than 10 s)
- SPVC connections are maintained across HEP or HSM
- SVC connections both endpoint provisioned or dynamic are maintained across HEP or HSM
- PVC connections are not maintained across HEP or HSM
- there is a small chance that clear channel data (CCD), fax, and modem calls might not survive HEP or HSM switchovers with VrAp (there is small packet loss under one second for these types of calls)

Hot CPSO

Hot control processor switchover (CPSO) allows FPs with services running to continue operating without interruption during a CP switchover of node control from the active CP to the standby CP. For additional information on CPSO, see 241-5701-600 *NN10600-550 Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures*. Media Gateway support of hot CPSO has the following impacts:

- hot CPSO is supported for static IP routes and dynamic open shortest path first (OSPF) routes enabled on the VR

- Media Gateway recovery is limited to 50 ms
- hot CPSO is supported in a configuration of switched Media Gateway using IP (VoIP) with Ethernet transport and VR; see “4pGe FP card support of carrier grade” (page 75)

Hitless equipment protection (HEP)

Media Gateway supports HEP to preserve service on supported FP cards in a 1 + 1 or 1:1 processor sparing configuration. A configuration of 1 + 1 sparing has two active FP cards but only one of the cards has active service and the other card is in a standby state prepared to change to the active service. A configuration of 1:1 sparing has two FP cards with one card in active service and the other card not active but can be brought into active service as a replacement for the first card. Media Gateway support of HEP requires a standby configuration of each of the FP cards in a Media Gateway. HEP supports the following:

- supports hitless protection on 1:1 sparing configuration of VSP2/VSP3 FPs (one card is active and other card is standby)
- supports hitless protection on 1 + 1 sparing configurations of VSP3-o FPs (both cards are active but one card has the active service and the other card has the standby service)
- supports hitless protection on 1 + 1 sparing configurations of 4-port OC-3/STM-1Ch TDM FPs (both cards are active but one card has the active service and the other card has the standby service)
- supports the addition of a hot-standby 1:1 sparing pair of VSP2/VSP3 FPs on the Nortel Networks Multiservice Switch 15000 shelf
- supports the addition of a hot-standby 1 + 1 sparing pair of VSP3-o FPs on the Nortel Networks Multiservice Switch 15000 shelf
- supports the provision of an unprotected active VSP2/VSP3 FP with hot-standby 1:1 sparing configuration of VSP2/VSP3 FPs
- supports the provision of an unprotected active VSP3-o FP with hot-standby 1 + 1 sparing configuration of VSP3-o FPs
- supports all the Media Gateway services that are supported by HSM

- VSP HEP is supported by virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* for switched Media Gateway (VoATM and VoIP) - see “VSP HEP for switched Media Gateway with VR interworking” (page 114)

VSP HEP for switched Media Gateway with VR interworking

VSP HEP is supported for switched Media Gateway using IP or ATM functionality when using VR interworking (by provisioning component *VrAp*), and a 4-port gigabit Ethernet FP card or an ATM IP FP card that is carrier grade compliant. VR interworking with the VSP2, VSP3, and VSP3-o FP cards, provides IP routing on the Media Gateway without the need for an external router (an external router is not required for traffic forwarding between VSP2/VSP3/VSP3-o FP cards connected to the same VR).

Considerations for support of VSP2 and VSP3 HEP for switched Media Gateway using VR interworking, are as follows:

- supports VSP2 and VSP3 in 1:1 spared configuration (does not support 1:N spared configuration of VSP2 and VSP3)
- supports static routing and dynamic routing through open shortest path first (OSPF) routes
- supports a maximum outage time of one second for VSP2 and VSP3 HEP

VSP2 and VSP3 HEP is supported for the following cards in a Media Gateway shelf configuration:

- 4-port OC-3/STM-1Ch TDM FP
- control processor 3 (CP3) that support building integrated timing supply (BITS) as follows:
  - DS1 BITS CP (NTHW06)
  - E1 BITS CP (NTHW08)
- 4-port OC-3/STM-1 ATM FP (PQC12-based NTHW05)
- 4-port OC-12/STM-4 ATM FP (PQC12-based NTHW86)
- 4-port gigabit Ethernet FP (NTHW49)

Considerations for support of VSP3-o HEP for switched Media Gateway using VR interworking, are as follows:

- supports VSP3-o in 1 + 1 spared configuration (does not support 1:N spared configuration of VSP3-o) for the TDM ports and using dual LP equipment protection (DLEP) sparing through the *Vsp* subcomponent of component *DualLpEquipmentProtection (Dlep)*
- supports static routing and dynamic routing through open shortest path first (OSPF) routes
- supports a maximum outage time of one second for VSP3-o HEP

VSP3-o HEP is supported for the following cards in a Nortel Networks Multiservice Switch 15000 Media Gateway shelf:

- control processor 3 (CP3) that support building integrated timing supply (BITS) as follows:
  - DS1 BITS CP (NTHW06)
  - E1 BITS CP (NTHW08)
- 4-port OC-3/STM-1 ATM FP (PQC12-based NTHW05)
- 4-port OC-12/STM-4 ATM FP (PQC12-based NTHW86)
- 4-port gigabit Ethernet FP (NTHW49)

Hitless software migration (HSM)

Media Gateway supports HSM to allow for changes to the Media Gateway software load without service interruption. Media Gateway support of HSM requires all the CP and FP cards involved in a Media Gateway call to have HSM functionality. This HSM functionality includes the synchronization of call states across the fabric interface. HSM supports the following:

- supported on Media Gateway configurations of 1:1 sparing for VSP2/VSP3 FPs and 1 + 1 sparing for 4-port OC-3/STM-1Ch TDM FPs
- supports hitless recovery sequence and operator control
- supports echo cancellation, silence suppression, and comfort noise
- supports VBD, CCD, and upspeed to G.711 call compression (CCD calls are not supported for configurations using VrAp functionality)

- supports DTMF relay and fax relay (no support for T.38 fax relay in progress; fax calls are not supported for configurations using VrAp functionality)
- supports hard-coded tones and continuity test (COT) to the public switched telephone network (PSTN)
- supports PRI backhaul (no support of V5.2 backhaul)
- supports mid-call digit collection (except for mid-call, HSM has no support for digit collection in progress using digit maps and individual digit collections)
- management connectivity is not maintained in full during HSM
- hitless software downgrade to a previous release is not supported
- HSM progress indication is not supported
- virtual router (VR) interworking by provisioning component *VirtualRouterAccessPoint (VrAp)* is supported for VSP HSM (using VSP2, VSP3, and VSP3-o) in the configuration of switched Media Gateway with VR interworking - see “VSP HSM for switched Media Gateway with VR interworking” (page 116)
- HSM is supported in a configuration of switched Media Gateway using IP (VoIP) with Ethernet transport and VR; see “4pGe FP card support of carrier grade” (page 75)

A description of HSM for Multiservice Switch 15000 nodes is found in NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation*.

VSP HSM for switched Media Gateway with VR interworking

VSP HSM is supported for switched Media Gateway using IP or ATM functionality in a configuration using VR interworking (by provisioning component *VrAp*) and PQC12-based ATM IP FP cards (4-port OC-3/STM-1 ATM FP or 4-port OC-12/STM-4 ATM FP). The ATM IP FP cards need to be spared with line automatic protection switching (LAPS).

Considerations for support of VSP HSM for switched Media Gateway using VR interworking, are as follows:

- supports VSP2, VSP3, and VSP3-o in 1:1 spared configuration (does not support 1:N spared configuration of VSP2, VSP3, and VSP3-o)
- supports static routing (does not support dynamic routing through OSPF routes)
- supports a maximum outage time of one second for VSP HSM
- no support when the 4-port gigabit Ethernet FP is part of the Media Gateway shelf

VSP HSM is supported for the following types of cards in a Media Gateway shelf configuration:

- VSP-type cards as follows:
  - VSP2 FP (NT0482 on Multiservice Switch 7400, NTHW87 on Multiservice Switch 15000/Multiservice Switch 20000)
  - VSP3 FP (NTHW84)
  - VSP3-o FP (NTHW77)
- 4-port OC-3/STM-1Ch TDM FP
- control processor 3 (CP3) that support building integrated timing supply (BITS) as follows:
  - DS1 BITS CP (NTHW06)
  - E1 BITS CP (NTHW08)
- 4-port OC-3/STM-1 ATM FP (PQC12-based NTHW05)
- 4-port OC-12/STM-4 ATM FP (PQC12-based NTHW86)

Chapter 6
ATM connections for Media Gateway

This section describes ATM connections and how Nortel Networks Multiservice Switch Media Gateway uses them. For more information, see

ATM PVCs

ATM PVCs are static datapaths that run through the ATM network. PVCs use permanent connections that are provisioned at the originating Media Gateway, each ATM node in the ATM network, and the terminating Media Gateway. The user selects the route for an ATM connection and provisions this connection at each hop in the ATM network.

If a network facility fails along the selected route, the ATM connection also fails for the duration of the outage. There is no automatic rerouting possibility. This type of connection failure may require re-provisioning of the ATM node that caused the fault.

All types of Media Gateway can use ATM PVCs, including non-switched Media Gateway, and switched Media Gateway using ATM.

For details on how Media Gateway can use ATM PVCs, see

- "Network scenarios for using Media Gateway and ATM PVCs" (page 120)
- "Application access points" (page 121)

Additional details about ATM PVCs can be found in NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Network scenarios for using Media Gateway and ATM PVCs

For non-switched Media Gateway, PVCs can be used for both the AAL2 VCCs that carry voice traffic and in-band signaling information and the AAL5 VCCs that carry out-of-band signaling information. This network scenario is shown in "Non-switched Media Gateway application" (page 42).

For switched Media Gateway using ATM, PVCs can be used for AAL2 VCCs that carry bearer traffic, AAL5 VCCs that carry control information, and AAL1 VCCs that carry signaling from the 4-port OC-3/STM-1Ch TDM/CES FP. This network scenario is shown in "Switched Media Gateway using ATM" (page 59).

Also, the router that directs traffic from the ATM network to the IP network must support ATM PVCs. This network scenario is shown in "VoIP using ATM transport and external routing" (page 72).

Note 1: The 4-port OC-3/STM-1 Ch TDM/CES FP does not support PVCs for the TDM FP connection to the voice services processor (VSP), VSP2, or VSP3 FP.

Note 2: The voice services processor 3 with optical TDM interface (VSP3-o) FP card does not support PVC connections.

Application access points

An access point is used by an application to define the ATM network access. It is linked to the connected endpoint of an ATM network. For Media Gateway, the *Nsta Vgs AtmTConn* component, the *Nsta Vgs Ctrl* component, and the *Nsta Conn* component, are examples of applications that use access points.

To use PVCs, Media Gateway applications have a *Nailed-up AccessPoint* (NAP) subcomponent. The NAP is manually linked to a *Nailed-up EndPoint* (NEP) subcomponent of a provisioned ATM VCC.

Note 1: The 4-port OC-3/STM-1 Ch TDM/CES FP does not support PVCs for the TDM FP connection to the VSP, VSP2, or VSP3 FP.

Note 2: The voice services processor 3 with optical TDM interface (VSP3-o) FP card does not support PVC connections.

ATM SPVCs

ATM SPVCs are permanent connections established automatically through an ATM network. SPVCs allow ATM connections to be made between one end that supports SVCs and another end that supports only PVCs.

When SPVCs are used, the source application originates an ATM call to a destination ATM interface. The ATM networking system terminates the ATM call at the destination ATM interface. The ATM networking system selects an optimal route and establishes the connection using signaling procedures. Once the connection is established, the source endpoint of the ATM connection is linked to the source application.

All types of Media Gateway can use a type of ATM SPVC called an ATM provisioned SPVC.

For details on how Media Gateway uses ATM PSVCs, see

- “Network scenarios for using Media Gateway and ATM provisioned SPVCs” (page 122)
- “Application access points” (page 123)
- “ATM signaling” (page 124)

- "ATM call processing" (page 125)

Additional details about ATM SPVCs can be found in NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

Network scenarios for using Media Gateway and ATM provisioned SPVCs

For non-switched Media Gateway using ATM, provisioned SPVCs can be used for the AAL2 VCCs. The AAL2 VCCs carry bearer traffic. CCS is transported as CCD by provisioning timeslot 24 for DS1 and timeslot 16 for E1. CAS is not supported for provisioned SPVCs in non-switched Media Gateway. This network scenario is shown in "Non-switched Media Gateway application" (page 42).

For switched Media Gateway using ATM, ATM SPVCs can be used if the router that directs control information from the ATM network to the IP network and to the MGC supports only ATM PVCs. In this case, the ATM VCCs from the source application are terminated on the node at the edge of the ATM network. The router is then linked to the ATM edge node using PVCs. This network scenario is shown in "Switched Media Gateway using ATM" (page 59).

> ***Note:*** The voice services processor 3 with optical TDM interface (VSP3-o) FP card does not support PVC connections.

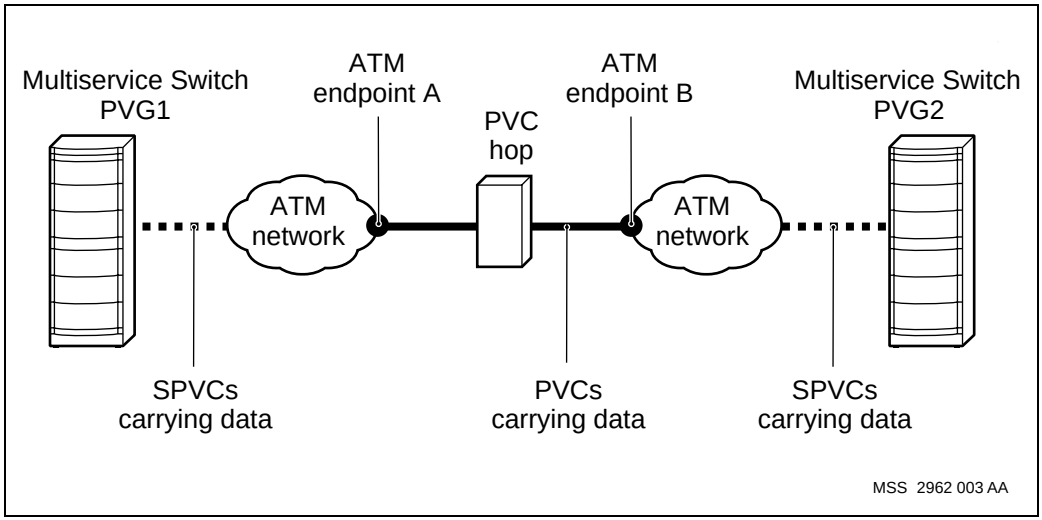
Similarly, ATM SPVCs can be used if the router that directs traffic from the ATM network to the IP network supports only ATM PVCs. This network scenario is shown in "VoIP using ATM transport and external routing" (page 72).

As well, ATM SPVCs can be used where two ATM networks are between two Media Gateways and the two ATM networks are connected together by a hop that supports only ATM PVCs. See "ATM SPVCs for trunks between two Media Gateways" (page 123).

In this case, SPVCs are used to create dynamic trunks. The ATM trunk between Media Gateway1 and Media Gateway2 consists of two SPVCs and one PVC that connects the SPVCs together. One SPVC runs from Media

Gateway1 and terminates at ATM endpoint A. The other SPVC runs from Media Gateway2 and terminates at ATM endpoint B. The PVC connects points A and B. Both Media Gateways establish SPVCs with the same remote VPI/VCI combination that is used by the PVC.

Figure 13
ATM SPVCs for trunks between two Media Gateways



Application access points

An access point is used by an application to define the ATM network access. It is linked to the connected endpoint of an ATM network. For Media Gateway, the *Nsta Vgs AtmTConn* component, the *Nsta Vgs Ctrl* component, and the *Nsta Conn* component, are examples of applications that use access points.

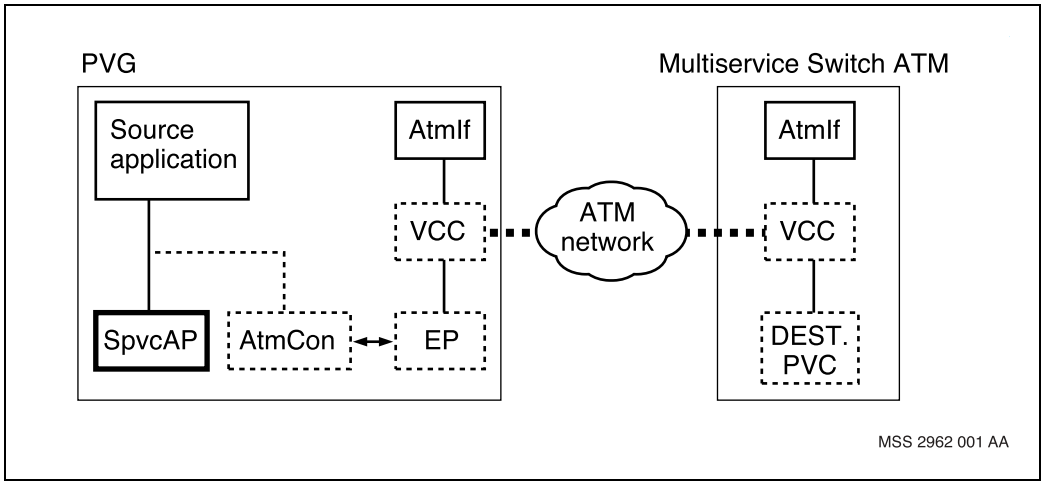
For provisioned SPVCs, applications use an *SpvcAccessPoint (SpvcAp)* component as the access point.

> ***Note:*** The *Nsta Vgs AtmTConn SpvcAp* component is not identical to the *Nsta Vgs Ctrl SpvcAp* component. For example, you can set three addresses in a list for the *addressToCall* attribute of the *Nsta Vgs Ctrl SpvcAp* component while you can only set one address for the equivalent attribute of the *Nsta Vgs AtmTConn SpvcAp* component.

The *SpvcAp* subcomponent of an application defines SPVC connectivity information and generates SPVC calls to the ATM network. The ATM network terminates the SPVC call on a provisioned ATM VCC. If the destination ATM interface is on a Nortel Networks Multiservice Switch node, a dynamic VCC with a *DestinationPVC (DST)* subcomponent is the end point of the SPVC. The figure "SPVC access point and destination PVC for ATM SPVCs" (page 124) shows this relationship.

Once the ATM connection is established, the application on the calling end is linked through an *atmConnection (atmCon)* component and an *EndPoint (EP)* component. The *EP* component is a subcomponent of a dynamic VCC under the ATM interface at the calling end of the connection. The *atmCon* component is a dynamic operational component and is linked to the *EP* component. The *atmCon* component acts as a dynamic bridge for the application.

Figure 14
SPVC access point and destination PVC for ATM SPVCs



ATM signaling

Nortel Networks Multiservice Switch Media Gateway establishes, maintains and clears ATM SPVCs by using three types of ATM signaling messages:

- SETUP, to request the establishment of a connection
- CONNECT, to show that a connection has been established

- RELEASE, to clear a connection

For additional information on ATM signaling, see NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

ATM call processing

Nortel Networks Multiservice Switch Media Gateway applications can originate SPVC calls, but cannot terminate them.

For non-switched Media Gateway using ATM, the Media Gateway application is:

- the *Nsta Connection (Conn)* component, for the AAL2 VCCs carrying bearer traffic and in-band signaling with control information

For switched Media Gateway using ATM, the Media Gateway applications are

- the *Nsta Vgs ControlConnection (Ctrl)* component, for the AAL5 VCC carrying control information
- the *Nsta Vgs AtmTrunkConnection (AtmTConn)* component, for the AAL2 VCCs carrying bearer traffic

For switched Media Gateway using IP, the Media Gateway applications are

- the *Nsta Vgs ControlConnection (Ctrl)* component, for the AAL5 VCC carrying control information
- the *Nsta Vgs IpMediaStreamConnection (IpMConn)* component, for the AAL5 VCCs carrying bearer traffic

The *SpvcAp* subcomponent of the *Ctrl* component has three provisioned attributes related to call processing: *localAddress*, *addressToCall* and *remoteVpiVci*. The *localAddress* attribute specifies the Media Gateway application's unique ATM address. As with the PSVC active access point, the *addressToCall* attribute can contain up to three remote ATM addresses. The *remoteVpiVci* attribute specifies the virtual path identifier/virtual channel identifier (VPI/VCI) combination for the remote VCC. The VPI/VCI

combination is independent of the remote end's ATM address. The VPI/VCI combination is the same regardless of which address is used from the *addressToCall* list.

The *SpvcAp* subcomponent of the *AtmTConn* component has only two provisioned attributes related to call processing: *addressToCall* and *remoteVpiVci*. The local ATM address is derived from the *gatewayAtmAddress* attribute of the parent *Vgs* component. The *addressToCall* and *remoteVpiVci* attributes are similar to those for *SpvcAp* subcomponent of the *Ctrl* component described previously.

The *SpvcAp* subcomponent of the *IpMConn* component is similar to the *SpvcAp* subcomponent of the *Ctrl* component described previously.

When the called end receives an SPVC call, it is terminated on the local application with a *localAddress* that matches the called address in the received SETUP message.

ATM SVCs

ATM SVCs are dynamic virtual circuit datapaths that run through the ATM network. They are dynamically set up and torn down as required by end-user applications.

When SVCs are used, the source application originates an ATM call to a destination application. The destination application terminates the ATM call. The ATM networking system selects an optimal route and establishes the connection using signaling procedures. Once the connection is established, the endpoints of the ATM connection are linked to the applications.

Switched Media Gateway using ATM can use SVCs.

> ***Note:*** In this release, Nortel Networks Communication Server 2000 (CS2000) with VGCP running ASPEN 2.1 protocol or with H.248 protocol, is supported.

See NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals* for a more complete description of ATM SVCs.

Network scenarios for using Media Gateway and ATM SVCs

For switched Media Gateway using ATM, SVCs can be used for the AAL2 VCCs that carry bearer traffic.

The VSP2/VSP3/VSP3-o FP from one Media Gateway can automatically create an AAL2 VCC using SVC signaling over the ATM network to a remote Media Gateway when extra bandwidth is required between the two Media Gateways. When the bandwidth is no longer required, the Media Gateway which originated the SVC, deletes it.

SVC creation is triggered by connection requests received from the media gateway controller which requires more bandwidth than is available in current SVCs. SVC deletion decisions are triggered by timeout expiry on empty SVCs.

Once SVC creation has been triggered, the SVC lifecycle is independent of the call that triggered its creation. In this way, SVCs can be used for single calls or multiple calls.

Media Gateway can also be provisioned to pre-create SVCs. This means that an SVC set up is initiated when the bandwidth available in existing VCCs between two Media Gateways is reduced to a level that would require a new SVC for the next call.

All SVCs automatically created by a VSP2/VSP3/VSP3-o FP are of the same type, size, and characteristics. The parameters used for the creation of automatic SVCs are defined in the *Profile* component. One *Profile* component is supported per VSP2/VSP3/VSP3-o FP. Profile changes while Media Gateway is in service are supported; the changes will only affect SVCs created after the profile changes.

SVCs can co-exist with PSVCs, SPVCs, and PVCs on the same VSP2/VSP3/VSP3-o FP.

> ***Note 1:*** There is a limit of 500 inbound SVCs and 500 outbound SVCs. There is also a limit of a total of 1500 VCCs which can consist of 1000 SVCs along with 500 VCCs consisting of any combination of PSVCs, SPVCs, and PVCs.

Note 2: SVCs are supported on Nortel Networks Multiservice Switch 15000 and Multiservice Switch 20000 VSP2/VSP3/VSP3-o FP cards and Multiservice Switch 7400 VSP2 FP cards. All Multiservice Switch 7400 CQC-based ATM FPs are supported but not recommended.

ATM PSVCs

ATM SVCs are dynamic virtual circuit datapaths that run through the ATM network. They are dynamically set up and torn down as required by end-user applications.

When SVCs are used, the source application originates an ATM call to a destination application. The destination application terminates the ATM call. The ATM networking system selects an optimal route and establishes the connection using signaling procedures. Once the connection is established, the endpoints of the ATM connection are linked to the applications.

Nortel Networks Multiservice Switch Media Gateway uses a type of SVC called PSVC where the user must provision the application to use SVCs instead of PVCs or SPVCs. However, once the initial provisioning is done, SVC generation is automatic.

All Media Gateway applications can use PSVCs.

For details on how Media Gateway uses ATM PSVCs, see:

- “Network scenarios for using Media Gateway and ATM PSVCs” (page 129)
- “Application access points” (page 129)
- “ATM signaling” (page 131)
- “ATM call processing for non-switched and switched Media Gateway using ATM” (page 131)
- “ATM call processing for switched Media Gateway using IP” (page 133)
- “Additional call processing details” (page 134)
- “Additional call processing details” (page 134)

See NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals* for a more complete description of ATM SVCs.

Network scenarios for using Media Gateway and ATM PSVCs

For non-switched Media Gateway using ATM, PSVCs can be used for the AAL2 VCCs. The AAL2 VCCs carry bearer traffic. CCS is transported as CCD by provisioning timeslot 24 for DS1 and timeslot 16 for E1. CAS is not supported for provisioned SPVCs in non-switched Media Gateway. This network scenario is shown in "Non-switched Media Gateway application" (page 42).

For the 4-port OC-3/STM-1 Ch TDM FP PSVCs can also be used for AAL1 VCC's carrying signaling information.

For switched Media Gateway using ATM, PSVCs can be used for the AAL2 VCCs that carry bearer traffic. Also, the router that directs control information from the ATM network to the IP network and to the media gateway controller must support ATM SVCs. This network scenario is shown in "Switched Media Gateway using ATM" (page 59).

For switched Media Gateway using IP, PSVCs can be used for the AAL5 VCCs that carry bearer traffic. The PSVCs are IP encapsulated VCCs using the protocol specified in RFC 1483. Also, the router that directs traffic from the ATM network to the IP network must support ATM SVCs and the Interim Link Management Interface (ILMI). This network scenario is shown in "VoIP using ATM transport and external routing" (page 72).

> ***Note:*** Depending on the level of ILMI that the router supports, additional restrictions may apply.

Application access points

An access point is used by an application to define the ATM network access. It is linked to the connected endpoint of the ATM network. For switched Media Gateway using ATM, the *Nsta Vgs AtmTConn* component and the *Nsta Vgs Ctrl* component are examples of applications that use access points. For non-switched Media Gateway using ATM, the *Nsta Conn* component, is an example of applications that use access points.

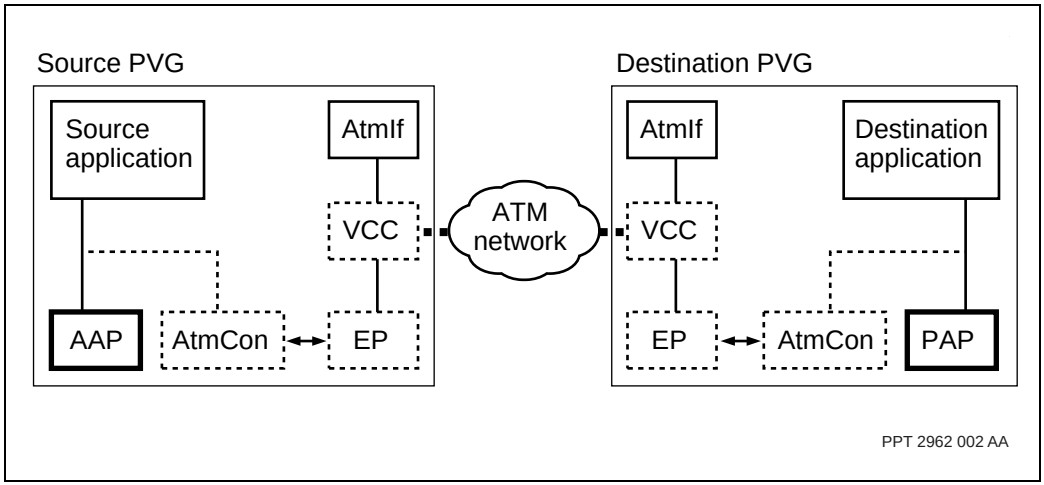
To use PSVCs, applications use a switched access point that can be either an active access point (AAP) or a passive access point (PAP).

The AAP of an application defines PSVC connectivity information and generates PSVC calls to the destination application through the ATM network. It is the ATM connection's calling end. The PAP of an application defines the ATM access information and receives the calls from the source. It is the ATM connection's called end. The figure "Active access point and passive access point for ATM PSVCs" (page 130) shows this relationship.

> ***Note:*** The AAP of an application can also receive a call. However, the PAP of an application can never generate a call. Connections from an AAP to an AAP are not currently supported.

Once the ATM connection is established, the applications on both ends are linked through *atmConnection (atmCon)* components and *EndPoint (EP)* components. The *EP* components are subcomponents of a dynamic VCC under the ATM interface at each end of the connection. The *atmCon* components are dynamic operational components and are linked to both *EP* components. The *atmCon* components act as a dynamic bridge for the applications.

Figure 15
Active access point and passive access point for ATM PSVCs



ATM signaling

Nortel Networks Multiservice Switch Media Gateway establishes, maintains and clears ATM PSVCs by using three types of ATM signaling messages:

- SETUP, to request the establishment of a connection
- CONNECT, to show that a connection has been established
- RELEASE, to clear a connection

For additional information on ATM signaling, see NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

ATM call processing for non-switched and switched Media Gateway using ATM

To originate and terminate PSVC calls, the Media Gateway applications at both ends of a connection must have ATM addresses. See “ATM network addressing” (page 135) for more details.

For non-switched Media Gateway using ATM, the Media Gateway application is the *Nsta Connection (Conn)* component, for the AAL2 VCCs.

For switched Media Gateway using ATM, the Media Gateway applications are

- the *Nsta Vgs ControlConnection (Ctrl)* component, for the AAL5 VCC carrying control information
- the *Nsta Vgs AtmTrunkConnection (AtmTConn)* component, for the AAL2 VCCs carrying bearer traffic

For the AAL5 VCCs, the *Aap* subcomponent of the *Ctrl* component has two provisioned attributes related to call processing: *localAddress* and *addressToCall*. The *localAddress* attribute specifies the Media Gateway application’s unique ATM address. The *addressToCall* attribute specifies the remote end’s ATM address. For switched Media Gateway using ATM, the remote end may be a router. Furthermore, the router may be spared. The *addressToCall* attribute can contain up to three remote addresses.

Even if the *addressToCall* attribute contains more than one remote address, the PSVC call remains a point-to-point connection. When the calling end prepares the SETUP message, it specifies only the first remote address. The calling end uses the second remote address in a SETUP message only when a call fails, or if an established PSVC fails, and the application receives AIS or RDI fault indication. Otherwise, the calling end continues to use only the first remote address in its SETUP message.

The *Pap* subcomponent of the *Ctrl* component has a *localAddress* attribute and an *expectedRemoteAddress* attribute.

When the called end receives a PSVC call, it is terminated on the local *Ctrl* component with a *localAddress* that matches the called address in the received SETUP message and an expectedRemoteAddress, if it is provisioned, that matches the calling address in the received SETUP message. See also “Additional call processing details” (page 134).

For AAL2 VCCs, the Media Gateway application needs to establish many connections to remote ATM end points. Because of this, the individual connections are specified by the remote address, and a unique identifier called a virtual channel connection identifier (VCCI).

Each *AtmTConn* component is automatically associated with the *gatewayAtmAddress* of its parent *Vgs* component. As well, each *AtmTConn* component has a provisioned *remoteAddress* and a *vcci* attribute. So, each *AtmTConn* component has a local address (from the parent VGS *gatewayAtmAddress* attribute), a remote address and a VCCI.

A *Vgs* component can have some *AtmTConn* subcomponents that have the same VCCI, but different remote addresses. The combination of remote address and VCCI must be unique across *AtmTConn* components within the same *Vgs* component.

When the called end receives a PSVC call, it is terminated on the local *AtmTConn* component with a *remoteAddress* and a *vcci* attribute that both match the calling address and VCCI in the received SETUP message.

ATM call processing for switched Media Gateway using IP

To originate and terminate PSVC calls, the Media Gateway applications at both ends of a connection must have ATM addresses. See “ATM network addressing” (page 135) for more details.

For switched Media Gateway using IP, the Media Gateway applications are

- the *Nsta Vgs ControlConnection (Ctrl)* component, for the AAL5 VCC carrying control information
- the *Nsta Vgs IpMediaStreamConnection (IpMConn)* component, for the AAL5 VCCs carrying bearer traffic

The *Aap* subcomponents of the *Ctrl* and *IpMConn* components each have two provisioned attributes related to call processing: *localAddress* and addressToCall. The *localAddress* attribute specifies the Media Gateway application’s unique ATM address. The *addressToCall* attribute specifies the remote end’s ATM address. For switched Media Gateway using IP, the remote end is a router that may be spared. The *addressToCall* attribute can contain up to three remote addresses.

> ***Note:*** Depending on the level of ILMI that the router supports, additional restrictions on router sparing may apply.

Even if the *addressToCall* attribute contains more than one remote address, the PSVC call remains a point-to-point connection. When the calling end prepares the SETUP message, it specifies only the first remote address. The calling end uses the second remote address in a SETUP message only when a call fails, or if an established PSVC fails, and the application receives AIS or RDI fault indication. Otherwise, the calling end continues to use only the first remote address in its SETUP message.

The *Pap* subcomponents of the *Ctrl* and *IpMConn* components each have a *localAddress* attribute and an *expectedRemoteAddress* attribute.

When the called end receives a PSVC call, the call is terminated on the application with a *localAddress* that matches the called address in the received SETUP message and an expectedRemoteAddress, if it is provisioned, that matches the calling address in the received SETUP message. See also “Additional call processing details” (page 134).

Additional call processing details

A Media Gateway application with an *Aap* component can set up outgoing calls and receive incoming ATM calls. During PSVC call establishment, the *Aap* component behaves as follows:

- As soon as an incoming or outgoing call is established, all other outgoing call attempts stop and incoming calls are rejected.
- Calls are processed sequentially. A new incoming call is processed once the call before it has been rejected.
- While an outgoing call is in progress, an incoming call is accepted only if the calling party address has a lower value than the called party address. The application end with the higher address becomes the passive end for the call during a call collision.
- If the calling party number is not included in a received SETUP message, priority is given to the outgoing call.
- If both ends are active and provisioned with different parameters, Media Gateway uses the parameters in the end that successfully sets up the call. Parameters from the other end are ignored.

Additional call processing details for AAL5 VCCs

Nortel Networks Multiservice Switch Media Gateway provides a filter for incoming SETUP messages for PSVCs with the *expectedRemoteAddress* attribute of the *Aap* and *Pap* components.

- If the *expectedRemoteAddress* attribute is empty, the *Aap* or *Pap* component processes incoming connection requests from any remote address.
- If the *expectedRemoteAddress* attribute is provisioned with an address that is 40 characters long, the connection is set up only if the remote address in the incoming SETUP message exactly matches the one that is provisioned.
- If the *expectedRemoteAddress* attribute is provisioned with an address that is less than 40 characters long, the connection is set up only if the remote address in the incoming SETUP message begins with the characters that are provisioned.

ATM network addressing

ATM network addressing is a 20-byte network service access point (NSAP) address. It consists of a 13-byte prefix and a 7-byte end system identifier (ESI). Nortel Networks Multiservice Switch ATM network addressing is explained in detail in NN10600-702 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Routing and Signalling Fundamentals*.

For Media Gateway, the address prefix is determined by the *nodePrefix* attribute from the Multiservice Switch shelf. Multiservice Switch Media Gateway applications are assigned addresses with the same prefix but with different ESI. For Media Gateway, the *Nsta Vgs AtmTConn* component and the *Nsta Vgs Ctrl* component are examples of applications.

For details on ATM network addressing, see

- "Network addresses for the Vgs component" (page 135)
- "Network addresses for the Ctrl component" (page 135)
- "Network addresses for the IpMConn component" (page 136)
- "Network addresses for the AtmTConn component" (page 136)
- "Network addresses for the Conn component" (page 136)

Network addresses for the *Vgs* component

Switched Media Gateway using ATM assigns a network address to each VSP2/VSP3/VSP3-o FP card. The address is stored in the *gatewayAtmAddress* attribute of the relevant *Nsta Vgs* component.

Switched Media Gateway using IP also assigns a network address to each VSP2/VSP3/VSP3-o FP card in a similar way.

See NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference* for a description of the network address.

Network addresses for the *Ctrl* component

Switched Media Gateway using ATM assigns a network address to each *Nsta Vgs Ctrl* component. The address is stored in the *localAddress* attribute of the relevant *Aap*, *Pap*, or *SpvcAp* subcomponent.

Switched Media Gateway using IP assigns a network address to each *Nsta Vgs Ctrl* component in a similar way.

See NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference* for a description of the network address.

Network addresses for the *IpMConn* component

Switched Media Gateway using IP assigns a network address to each *Nsta Vgs IpMConn* component. The address is stored in the *localAddress* attribute of the relevant *Aap*, *Pap*, or *SpvcAp* subcomponent.

See NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference* for a description of the network address.

Network addresses for the *AtmTConn* component

Each *AtmTConn* component is automatically associated with the *gatewayAtmAddress* of its parent *Vgs* component, which is used as a local ATM network address.

Network addresses for the *Conn* component

Non-switched Media Gateway using ATM assigns a network address to each *Nsta Conn* component. The address is stored in the *localAddress* attribute of the relevant *Aap*, *Pap*, or *SpvcAp* subcomponent.

See NN10600-060 *Nortel Networks Multiservice Switch 7400/15000/20000 Component Reference* for a description of the network address.

Monitoring alarm signals and indications

Nortel Networks Multiservice Switch Media Gateway applications can detect and react to ATM alarm indication signal (AIS) and remote defect indication (RDI) conditions. Both AIS and RDI indications can be received from the ATM network and processed by the relevant Media Gateway application.

When a Media Gateway application receives an AIS or RDI indication from the ATM network:

- and only one remote address is provisioned, the Media Gateway application does not release the failed PSVC or SPVC. Instead, the application is disabled and re-enabled after the AIS or RDI condition is cleared.
- and many remote addresses are provisioned, the Media Gateway application tears down the failed PSVC or SPVC and establishes a new PSVC or SPVC with the next remote address on the list. The retry mechanism is described in “Retry mechanism” (page 137). During this time, the Media Gateway application uses a hold-off process to accommodate any CONNECT messages that may arrive from the MGC.

While establishing a new PSVC or SPVC, a Media Gateway application waits 2.5 seconds to determine if AIS or RDI conditions exist.

If AIS or RDI conditions do not exist, the Media Gateway application is enabled.

If AIS or RDI conditions do exist:

- and the indication comes from a PAP, the Media Gateway application is not enabled.
- and the indication comes from an AAP or SPVC access point with many provisioned remote addresses, the Media Gateway application releases the PSVC or SPVC and tries to establish a new connection to an alternative address.
- and the indication comes from an AAP or SPVC access point with only one provisioned remote address, the Media Gateway application accepts the connection and the AIS and RDI conditions are noted.

Retry mechanism

If an attempt to make an ATM call fails or an established ATM connection is released, the Media Gateway application with the AAP or the SPVC access point uses a retry mechanism to attempt to establish a new ATM connection.

The retry mechanism is used when a Media Gateway application with an AAP or SPVC access point receives

- a RELEASE message
- an AIS or RDI indication and more than one remote address is provisioned

If the retry mechanism is started due to receipt of a RELEASE message, the first retry address is the current failed address. If the retry mechanism is started due to receipt of an AIS or RDI indication and more than one remote address is provisioned, the first retry address is the address after the current failed address.

The retry mechanism tries each address once before moving on to the next one. There is no waiting time between these two attempts.

Once all the addresses in the remote address list have been tried, a retry round counter is incremented. The *retryLimit* attribute of the *Aap* and *SpvcAp* components specifies the maximum number of unsuccessful retry rounds. If the retry limit is reached, the *Aap* or *SpvcAp* component generates an alarm and further attempts must be manually started with the *restart* command.

The *restart* command applies only to the *Aap* and *SpvcAp* components. See NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference* for a description.

If the *retryLimit* attribute is provisioned with the value of zero, retry attempts continue indefinitely until a successful connection is established.

The *retryFailures* attribute of the *Aap* and *SpvcAp* components stores the number of consecutive retry rounds that have failed. The number is reset when the retry sequence is restarted.

Each retry round is separated by a retry interval. Following an unsuccessful retry round, the retry interval is incremented. The amount it is incremented as well as its maximum value depends on the parent of the *Aap* or *SpvcAp* component. See the following sections for details:

- “Retry interval for AtmTConn components” (page 139)

- “Retry interval for Ctrl or IpMConn components” (page 139)

For dynamically created SVCs, the endpoint which initiated the connection attempts to re-establish the connection up to a maximum of 5 seconds.

Retry interval for *AtmTConn* components

The retry interval for each *AtmTConn* component is initially set to 0.5 seconds. The retry interval is increased by 0.1 seconds for every RELEASE message that is received, up to its maximum. The maximum is determined by the following formula:

```
maximum interval = 0.5 + 0.1 x <dis_AtmTConn>
```

where:
<dis_AtmTConn> is the number of disabled *AtmTConn* components

For example, if there is only one *AtmTConn* component that provisioned and disabled, the initial retry interval is 0.5 seconds and the maximum is 0.6 seconds.

If there are ten *AtmTConn* components that provisioned and six are disabled, the initial retry interval is 0.5 seconds and the maximum is 1.1 seconds.

The retry interval is reset to 0.5 seconds when the VCC is re-established.

Retry interval for *Ctrl* or *IpMConn* components

The retry interval for each *Ctrl* or *IpMConn* component is initially set to 2 seconds. The retry interval is increased by 2 seconds every time a connection attempt is made and fails, up to a maximum of 600 seconds.

For example, if the *retryLimit* attribute is set to 5, the initial retry interval is 2 seconds and increases to 12 seconds before the retry limit is reached, the *Aap* or *SpvcAp* component generates an alarm and further attempts must be manually started with the *restart* command.

The retry interval is reset to 2 seconds when the VCC is re-established.

Behavior on CP switchover

During a CP switchover, a state change indication notifies the Media Gateway applications of the event. Attempts to originate new ATM calls are suspended until the Media Gateway application receives another state change indication that the CP switchover is complete.

During a CP switchover, trunks that are already established are maintained and ATM calls that are being established proceed as usual.

On-switch PSVC loops

Two Media Gateway applications can be created on the same VSP/VSP2/VSP3/VSP3-o FP and place calls to create a PSVC to each other, creating an on-switch loop. One application contains an *Aap* subcomponent and acts as the calling end. The other application contains a *Pap* subcomponent and acts as the called end.

However, an application is not allowed to originate and terminate calls to itself. This applies to the AAL5 VCC for control information for switched Media Gateway using ATM.

This applies also to the AAL5 VCCs for bearer traffic and the AAL5 VCC for control information for switched Media Gateway using IP.

For AAL2 VCCs carrying bearer traffic for switched Media Gateway using ATM, an *AtmTConn* component can call another *AtmTConn* component that is part of the same parent VGS, even though both share the same local address. The distinction is that they are assigned different VCCIs. The PSVC call can be accepted when the received VCCI is different from the assigned VCCI.

Because there may be many AAL2 loops on a single VSP, the AAP and PAP are added in pairs with the AAP on one end and the PAP on the other end. In this situation, the VCCI must have adjacent values. The VCCI with the lowest value must be even-numbered and assigned to the AAP.

Chapter 7
Installing and setting up Media Gateway

Before you configure Media Gateway, you must be familiar with Nortel Networks Multiservice Switch network operations and maintenance, and with provisioning commands. See the following documents before you configure Media Gateway:

- NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures* provides background and descriptive information and procedural for operating and maintaining Multiservice Switch nodes.
- NN10600-050 *Nortel Networks Multiservice Switch 7400/15000/20000 Command Reference* provides information about provisioning commands.

The system requirements for Media Gateway are listed in "System requirements for Media Gateway" (page 142).

The prerequisites for configuring Media Gateways on a Multiservice Switch node are

System requirements for Media Gateway

To configure Media Gateway, you must install a Nortel Networks Multiservice Switch node that contains the following:

- at least one VSP or VSP2 in Multiservice Switch 7400 nodes, or one VSP2, VSP3, or voice services processor 3 with optical TDM interface (VSP3-o) in Multiservice Switch 15000 and Multiservice Switch 20000 nodes.

  Note: On Multiservice Switch 15000 and Multiservice Switch 20000 nodes, 1:1 and 1:N sparing of the VSP2 and VSP3 FP cards can be done where the maximum value of N is 13. The VSP3-o FP card supports 1:1 sparing but does not support 1:N sparing. Sparing must be performed on the same type of VSP (for example sparing between VSP2 and VSP3 is not supported).

- at least one TDM FP card (not required for optical TDM interface of the VSP3-o FP card)
- at least one ATM FP card or one 4-port gigabit Ethernet FP card (except when using the gigabit Ethernet interface of the VSP3 FP card)
- one or two control processors
- at least one ATM line or one IP line to connect the node to an ATM/IP device or network
- at least one TDM line to connect a TDM FP card (or the optical TDM interface of the VSP3-o FP card) to a narrowband node or TDM network

In addition to the Multiservice Switch base software, you must install the following:

- Multiservice Switch Media Gateway software
- networking software (switched mode only)
- atmNetworking software (switched mode only)

Lastly, for switched Media Gateway using ATM and switched Media Gateway using IP, you need an ATM connection to a router that provides an IP connection to the media gateway controller.

Installing Multiservice Switch hardware

Before you configure Media Gateway, you must physically install theNortel Networks Multiservice Switch node, including the processor cards, termination panels, and cabling. You must also connect a VT-100 or similar terminal to the CP. Follow the procedures in NN10600-175 *Nortel Networks Multiservice Switch 7400 Hardware Installation, Maintenance, and Upgrade* or NN10600-130 *Nortel Networks Multiservice Switch 15000/20000 Hardware Installation, Maintenance, and Upgrade*.

Commissioning the node for Media Gateway

Nortel Networks Multiservice Switch allows a network operator to configure and maintain the Multiservice Switch network using a set of operator commands on a VT-100 terminal. However, you can also use a network management system to configure and maintain your network.

After you install the hardware, run StartUp to configure the control processor(s), connect your node to the rest of your network, and connect to a network management system. See NN10600-271 *Nortel Networks Multiservice Switch 7400/15000/20000 Network Management Connectivity* for further instructions.

You can use Nortel Networks Multiservice Data Manager to manage Multiservice Switch nodes. Run StartUp to connect to Multiservice Data Manager. Then see 241-6001-023 *Nortel Networks Multiservice Data Manager Configuration Management Tools for Multiservice Switch*.

> ***Note:*** This chapter and the rest of this guide provides instructions based on the command line interface that a VT-100 or similar terminal uses.

Installing Media Gateway software

Use the procedures in NN10600-270 *Nortel Networks Multiservice Switch 7400/15000/20000 Software Installation* to install Media Gateway software. Before you can configure Multiservice Switch Media Gateway, you must install the appropriate software, for each type of Media Gateway, on your CP.

Table 2
Application and features for installing Media Gateway software

Application or feature	Non-switched Media Gateway	Switched Media Gateway using ATM	Switched Media Gateway using IP
avList	base, pvg, aal1Ces	base, aal1Ces, pvg, atmNetworking	base, pvg, atmNetworking
Lpt/ATM	atmCore	atmCore, atmUni, atmIisp, atmPnni	atmCore, atmUni, atmIisp, atmPnni
Lpt/TDMDS3 or E1 or DS1	nsta	nsta	nsta
Lpt/TDMOC3	aal1Ces	aal1Ces	aal1Ces
Lpt/PVG	nsta or pvgG726 or pvgG729 or nsAtmG726 or nsAtmG729		
Lpt/VGS		VgsAtm or VgsAtmG729 or VgsAtmDc	VgsIp or VgsIpG729 or VgsIpGigE or VgsIpG729GigE
Lpt/vgsIP			vgsIP or vgsIPG729 ip atmMpe ipCos ipDiffServ ***Note:*** Features ipCos and IpDiffServ are not required for VoIP using Ethernet transport and VR configuration (uses default DiffServ functionality).

Echo canceller options for Multiservice Switch 7400 with VSP

Media Gateway with the VSP FP on Nortel Networks Multiservice Switch 7400 nodes, has two echo canceller options. One echo canceller option supports 576-DS0 timeslots per VSP. To provision this echo canceller option, provision the feature as *nsta* for the logical processor type (LPT) *12mVspAal*. For a previously-installed Media Gateway on the node that requires support for a capacity of 720-DS0 timeslots per VSP, use the second echo canceller option. To provision the second echo canceller option, provision the feature as *pvgG726* for the logical processor type (LPT) *12mVspAal* and make sure the echo canceller is disabled; that is, the attribute *echoCancellation* set as *disabled*.

Configuring logical processor types for Media Gateway

After you install the appropriate software on the node, you must configure the LPTs for Media Gateway. Follow the procedures in NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures* or NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

Configure the following logical processor types (LPTs):

- Create an ATM LPT. For switched Media Gateway using ATM, set its *featurelist* attribute to *atmCore*. For switched Media Gateway using IP, set its *featurelist* attribute to *ip atmMpe*.
- Create an NSTA LPT and set its *featurelist* attribute to *nsta*.
- Create a VGS LPT. For switched Media Gateway using ATM, set its *featurelist* attribute to *vgsAtm*. For switched Media Gateway using IP, set its *featurelist* attribute to *vgsIP*.
- For the 4-port OC-3/STM-1Ch TDM/CES FP create an OPTTDM LPT and set its *featurelist* attribute to *aal1ces*.

Configuring logical processors for Media Gateway

After you install the LPTs on the node, you must configure the LPs for Media Gateway. Follow the procedures in NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures* or NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

Configure the following logical processor (LPs):

- Create an LP for the ATM interface:
  - Set its *maincard* attribute to the ATM FP card for switched Media Gateway using ATM, or set its *maincard* attribute to the IP service card for switched Media Gateway using IP.
  - Set its *lpt* attribute to *lpt/ATM*, as defined earlier.
- Create an LP for voice services:
  - Set its *maincard* attribute to the voice services FP in the shelf.
  - Set its *lpt* attribute to *lpt/VGS*, as defined earlier.
- Create an LP for the TDM interface (not required for optical TDM interface of the VSP3-o FP card):
  - Set its *maincard* attribute to the TDM FP in the shelf.
  - for the 32-port E1 and 2-port DS3 TDM FPs set its *lpt* attribute to *lpt/NSTA*, as defined earlier.
  - for the 4-port OC-3/STM-1Ch TDM/CES FP set its *lpt* attribute to *lpt/OPTTDM*.

  Note: OPTTDM is used to distinguish the features for the optical TDM FP. OPTTDM is the name that you used to define the featurelist for the 4-port OC-3/STM-1Ch TDM/CES FP in the section “Configuring logical processor types for Media Gateway” (page 145)

Configuring function processors for Media Gateway

After you configure the LPs on the node, you must configure the FPs. Follow the procedures in NN10600-550 *Nortel Networks Multiservice Switch 7400/15000/20000 Common Configuration Procedures* or NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

Configure the FPs as follows:

- for the ATM FP:
  - Set the card's *cardtype* attribute to the appropriate value, for example *12pDS3Atm*.
  - Add to the associated LP any required interface components. For example, for an 12-port DS3 ATM FP, you would add *DS3* components under the *Lp* component.
- for the IP service FP:
  - Set the card's *cardtype* attribute to the appropriate value, for example *4pGe*.
  - Add to the associated LP any required interface components. For example, for an 12-port DS3 ATM FP, you would add up to four ports using the *ethernet* components under the *Lp* component.
- for the voice services FP:
  - Set the card's *cardtype* attribute to the appropriate value, for example *12mVspAal*.
  - Add to the associated LP a *vsp* component.
- for the TDM FP:
  - Set the card's *cardtype* attribute to the appropriate value, either *2pDS3cAal*, *32pE1Aal*, or *4pOC3ChSmIr*.
  - Add to the associated LP any required interface components. For example, for an 2-port DS3C TDM, you would add *DS3* and *DS1* components under the *Lp* component.

For switched Media Gateway using IP, Nortel Networks recommends that the ATM FP be either DS3 or OC-3 to provide the necessary bandwidth. As well, the *linetype* attribute of each *DS1* component must be set to *esf*.

After you configure the LPTs, the LPs and the FPs, ensure that you activate and confirm the provisioning.

Chapter 8
Traffic management for Media Gateway

Different types of traffic have unique traffic characteristics (in terms of rate and density variation) and performance needs (in terms of delay and loss). Media Gateway supports different types of traffic over the ATM link. You must provision the service for each link in accordance with the traffic contract between the service provider and the subscriber. Effective traffic management satisfies the quality of service (QoS) requirements for each subscriber and manages network resources so that the service offering is cost-effective.

For Media Gateway, the service requirements of each subscriber translate into an ATM service category and traffic descriptor type and parameters for each VCC link. You must allocate an appropriate amount of bandwidth and priority to each service so that the delivered services meet the traffic contract during both normal operation and when links are congested.

If voice-band connection admission control (V-CAC) is not used, see the following sections for more information:

- "Configuring ATM traffic management" (page 150)
- "Determining values for ATM cell rates for non-switched Media Gateway" (page 151)
- "Determining congestion thresholds" (page 154)
- "Adjusting hold-over time" (page 154)
- "Adjusting PDVT and buffer size" (page 156)
- "Considerations for switched ATM connections" (page 157)

If V-CAC is used, see section "Voice-band connection admission control" (page 159) for more information.

Configuring ATM traffic management

For each link, you must configure one VCC for each type of traffic. For example, if you want to carry voice with CCS, you need to configure two VCCs. For each VCC, you need to set the following traffic management attributes: *atmServiceCategory*, *txTrafficDescType*, and *txTrafficDescParm*. See the following sections:

- "atmServiceCategory attribute" (page 150)
- "txTrafficDescType attribute" (page 151)
- "txTrafficDescParm attribute" (page 151)

atmServiceCategory attribute

The *atmServiceCategory* attribute defines the ATM service category for traffic in both directions on the ATM link. For voice and voice band data (fax and modem) calls, rtVariableBitRate is the recommended setting. For data such as frame relay, nrtVariableBitRate is the recommended setting.

For signaling, you can set the *atmServiceCategory* attribute to *rtVariableBitRate* or *nrtVariableBitRate*. However, if you want to ensure that signaling traffic maintains priority over data traffic during periods of heavy congestion, set the *atmServiceCategory* attribute for the signaling VCC to *rtVariableBitRate*. Signaling can not be set to the same VCC as voice traffic. If voice is set to CBR then signaling may be *rtVariableBitRRate*. If voice traffic is set to *rtVariableBitRate* then signaling must be set to *nrtVariableBitRate*. If you need a VCC for a network management system, set the attribute to *nrtVariableBitRate* or *rtVariableBitRate*. If you want to ensure this traffic maintains priority over data traffic, set the attribute to *rtVariableBitRate*.

> ***Note:*** Setting the *atmServiceCategory* attribute is only one way of establishing priority for traffic. Nortel Networks Multiservice Switch systems allow you to establish bandwidth pools to manage traffic. You can establish up to three pools for each ATM port. For more information, see NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/ 20000 ATM Technology Fundamentals*.

txTrafficDescType attribute

The *txTrafficDescType* attribute specifies the type of traffic management parameters you can set for the connection. The setting for this attribute determines the number and meaning of the parameters set by the *txTrafficDescParm* attribute. For Media Gateway, set this value to 6, 7, or 8.

txTrafficDescParm attribute

After you set the *txTrafficDescType* attribute to 6, 7, or 8, you can set the values for the peak cell rate (PCR), sustainable cell rate (SCR), and maximum burst size (MBS) for the VCC. Parameter 1 is the value for PCR. Parameter 2 is the value for SCR. Parameter 3 is the value for MBS. You must specify each value as an integer, for example

```
set atmIf/6 vcc/16.32 vcd Tm txTrafficDescParm 1 3620
2 1300 3 2000
```

You can also set the values individually, for example

```
set atmIf/6 vcc/16.32 vcd Tm txTrafficDescParm 2 1300
```

Determining values for ATM cell rates for non-switched Media Gateway

The values you specify for the ATM Peak Cell Rate (PCR), Sustained Cell Rate (SCR) and Maximum Burst Size (MBS) are a function of many factors. For example, for a voice VCC, you must consider the values you have configured for the maximum voice rate, the maximum number of voice calls, and whether or not you have enabled silence suppression. Typical speech patterns for the serviced area also affect traffic levels.

- “Calculating PCR for non-switched Media Gateway” (page 151)
- “Calculating SCR for non-switched Media Gateway” (page 152)
- “Calculating MBS for non-switched Media Gateway” (page 154)

Calculating PCR for non-switched Media Gateway

Generally, the value for PCR is equal to (or is the nearest rounded value) of the link rate. Therefore, for a DS1 TDM link, you can set the PCR to 3622. For an E1 TDM link, you can set the PCR to 4678.

In a multi-service network with link rates of DS3, OC3, and faster calculate PCR for the number of DS0s to be transported. To determine the number of cells per second, see the table "Packet bandwidth requirements" (page 152).

Table 3
Packet bandwidth requirements

CODEC type	Encoding rate	Bandwidth per DS0	Cells/second
G.711	64 kbits/s	77.6 kbits/s	183
G.726	32 kbits/s	38.8 kbits/s	91.5
G.726	24 kbits/s	29.8 kbits/s	70.2
G.726	16 kbits/s	21.7 kbits/s	51.2
G.729A	8 kbits/s	11.7 kbit/s	27.6

Generally, the AAL5 VCC that carries the PRI (CCS) signaling for the Media Gateway connection has a PCR value of 300.

Calculating SCR for non-switched Media Gateway

The following calculations for SCR with silence suppression disabled and enabled provide the minimum SCR required to provide the minimum acceptable quality of service when all time slots are active. During less busy periods, the system transports voice calls at the maximum voice rate, therefore delivering a higher quality of service.

The minimum value of SCR is the sum for all channel rates. The result of the calculation must be rounded to the next multiple of 100. Voice traffic, with silence suppression enabled, tends to be bursty therefore, the calculation of SCR differers when silence suppression is enabled or disabled.

- "Calculation of SCR with silence suppression disabled" (page 152)
- "Calculation of SCR with silence suppression enabled" (page 153)

Calculation of SCR with silence suppression disabled

```
SCR =
(<chan_rate>*<num_of_chan>*(<p_payload>+3)*<PEAF>)/
(<p_payload>*8*<c_payload>)
```

Table 4
Calculation of SCR with silence suppression disabled variable values

Variable	Value
<chan_rate>	The channel rate.
<num_of_chan>	The number of channels.
<p_payload>	The packet payload.
<PEAF>	The packing efficiency adjustment factor the value is 1.1.
<c_payload>	The cell payload.

Calculation of SCR with silence suppression enabled

```
SCR =
(<chan_rate>*<num_of_chan>*(<p_payload>+3)*<PEAF>*
<SAF>*<BMAF>)/(<p_payload>*8*<c_payload>)
```

Table 5
Calculation of SCR with silence suppression enabled variable values

Variable	Value
<chan_rate>	The channel rate.
<num_of_chan>	The number of channels.
<p_payload>	The packet payload.
<PEAF>	The packing efficiency adjustment factor.
<SAF>	The speech activity factor. The value of this factor is 0.6.
<BMAF>	The burst margin adjustment factor. The value of this factor is 1.1.
<c_payload>	The cell payload.

Calculating MBS for non-switched Media Gateway

For a VCC that has no silence suppression for voice traffic, or that has no voice traffic, the traffic stream is smooth. Calculate the minimum value for MBS using the following equation. Round the result up to the nearest multiple of 50.

```
MBS = 1.2 x SCR traffic sampling interval (in sec) x SCR
```

For traffic where silence suppression is enabled, set the MBS to 2000, which corresponds to just over half a second of burst.

Generally, the AAL5 VCC that carries the PRI (CCS) signaling for the Media Gateway connection has an MBS value of 50.

Determining congestion thresholds

Nortel Networks Multiservice Switch Media Gateway manages congestion by using a series of thresholds. As traffic levels rise and fall around these thresholds, Media Gateway invokes different congestion management measures. The default values for congestion threshold attributes satisfy typical configurations and should be used in most cases. However, there are cases where you can change one or more settings. For example, if you configure the system with silence suppression off (non-switched mode only), set the *scrLowCongThreshold* attribute to 100%.

Multiservice Switch Media Gateway provides semantic checks that prevent you from configuring invalid congestion thresholds. For example, the value for the *pcrHighCongThreshold* attribute must be set higher than the value for the *pcrLowCongThreshold* attribute. However, semantic checks do not prevent you from configuring values that do not work for your configuration.

Adjusting hold-over time

Always use caution when you adjust the hold-over time (*holdOverTime* attribute). The hold-over time is the maximum amount of time the system waits before sending a cell onto the ATM link. During periods of low traffic, the hold-over time affects both the system's efficiency in using ATM bandwidth and the end-to-end delay in the system.

As you decrease the hold-over time, the system sends cells onto the ATM link more frequently. During periods of low traffic, many of these cells contain padding. This padding consumes bandwidth that could otherwise be used to transport other types of traffic, for example, frame relay.

Conversely, as you increase the hold-over time, the system transmits cells onto the ATM link less frequently. During periods of low traffic, fewer of these cells contain padding, as it is likely another packet arrives and fills the cell before the hold-over time timer expires. The longer hold-over time increases bandwidth efficiency, but introduces extra delay into the system, which can affect call quality.

The hold-over time has a direct relationship with both SCR and the packet delay variation tolerance at the far end. For more information, see the following sections:

- "Hold-over time and SCR" (page 155)
- "Hold-over time and PDVT" (page 156)

Hold-over time and SCR

There is a direct relationship between the settings for the SCR and the hold-over time (*holdOverTime* attribute). If the value you set for the SCR is too low in relation to the hold-over time, the system can detect congestion even during times of low traffic.

When Media Gateway compresses voice calls from 32 kbit/s to 24 kbit/s or 16 kbit/s (non-switched mode only), the packet size reduces proportionately, but the rate at which the system generates packets remains constant. Packet sizes are as follows:

- at 32 kbit/s, packets are 40 bytes in length
- at 24 kbit/s, packets are 30 bytes in length
- at 16 kbit/s, packets are 20 bytes in length
- at 8 kbit/s, packets are 10 bytes in length

The packet header adds an additional 3 bytes to each packet.

For PCM voice, the inter-packet arrival time is 5 milliseconds. For ADPCM voice calls, the inter-packet arrival time is 10 milliseconds. This means that when a call is in process, the system generates a packet every 5 milliseconds for PCM voice and every 10 milliseconds for ADPCM voice.

During periods of low traffic, cells usually contain a single packet. There is not enough traffic to fill the cell before the hold-over time timer expires, so the system sends the cell out onto the link. The system pads any space in the cell that the packets do not fill.

For example, if you are using ADPCM voice and the hold-over time is set to 2.0 milliseconds, packets arrive every 10 milliseconds and are sent out at least every 2 milliseconds. Using this scenario, suppose there are five active voice calls. At its most inefficient state, packets can arrive from each voice call at 2, 4, 6, 8, and 10 milliseconds. The system sends each packet across the link (in an ATM cell) as soon as the hold-over timer expires, at 4, 6, 8, 10, and 12 milliseconds, generating traffic at a rate of 500 cell/second.

If the SCR is set below 500 cell/second, the system detects congestion even when it is sending cells that contain a single packet. The system attempts to compress calls to relieve congestion. However, because the cells already contain a single packet, congestion is not relieved. The only difference is that the cells contain more padding because the compressed packets are smaller.

Hold-over time and PDVT

You must set the hold-over time at the near end so that it is compatible with the setting for PDVT (the *pdvt* attribute) at the far end. Similarly, the PDVT setting on the near end must be compatible with the hold-over time at the far end.

If you increase the hold-over time without also appropriately increasing the PDVT, buffer underflow can occur. If you decrease the hold-over time without decreasing the PDVT appropriately, buffer overflow (loss of cells) can occur.

Adjusting PDVT and buffer size

There is a direct relationship between the settings for PDVT and the buffer size. If the minimum configured voice rate is 32, 24, or 16 kbit/s ADPCM (non-switched mode only) or 8 kbit/s CS-ACELP, the setting for PDVT on the far end must be twice the inter-packet arrival time plus the expected ATM cell

delay variation (CDV). For ADPCM, inter-packet arrival time is 10 milliseconds. Set the PDVT to twice that value, plus ATM CDV—for example, 23 milliseconds.

If the minimum configured voice rate is 64 kbit/s PCM, the setting for PDVT on the far end must also be twice the value of inter-packet arrival time plus the expected ATM CDV. For PCM, inter-packet arrival time is 20 milliseconds. Set the PDVT to twice that value plus ATM CDV—for example, 43 milliseconds.

If you set the PDVT to less than 10 milliseconds, or if the difference between the *bufferSize* attribute and the PDVT is less than 10 milliseconds, buffer underflow can occur. If you configure these types of settings, Nortel Networks Multiservice Switch systems warn you when it checks the provisioning.

Considerations for switched ATM connections

When provisioning Media Gateway to use switched ATM connections, such as provisioned switched virtual connections (PSVCs) or soft permanent virtual connections (SPVCs), you must set the following attributes to specify ATM traffic management parameters:

- AtmServiceCategory
- PCR
- SCR
- MBS

For an explanation of how these parameters are used, see

- “ATM service category” (page 157)
- “Connection admission control” (page 158)
- “Other parameters” (page 159)

ATM service category

For switched Media Gateway using ATM

- the *rt-vbr* and *cbr* service categories are available for the AAL2 VCCs carrying bearer traffic.

- the *nrt-vbr* and *cbr* service categories are available for the AAL5 VCCs carrying control information.

For switched Media Gateway using IP

- the *rt-vbr* and *cbr* service categories are available for the AAL5 VCCs carrying bearer traffic.
- the *nrt-vbr* and *cbr* service categories are available for the AAL5 VCCs carrying control information.

  Note: If *cbr* is selected then SCR and MBS must both equal zero and the *cell delay variation tolerance* attribute on the ATM network FP must be set to 59 nanoseconds.

Connection admission control

Connection admission control (CAC) is the procedure used to decide if a request for a connection can be accepted based on the attributes of both the requested connection and the existing connections. Connection admission control looks at the PCR, SCR and MBS of the requested connection as well as at the available capacity of the ATM link.

When establishing a new ATM connection, ATM CAC is invoked on both the source and destination Media Gateways to determine if the requested quality of service is supported and if there is enough bandwidth left on the ATM link to accommodate the new connection without affecting the existing connections.

The congestion threshold for CAC is set by provisioning the *ccsClearDataMaxChannels*, *voicebandDataMaxChannels*, and *ccdTimeslotList* attributes. The *ccsClearDataMaxChannels* attribute specifies the number of CCD calls allowed per ATM VCC with guaranteed quality of service during congestion periods. This attribute is only valid for the CCS and monitored service interfaces. The *voicebandDataMaxChannels* attribute specifies the number of modem and fax calls allowed per ATM VCC with guaranteed quality of service during congestion periods. The *ccdTimeslotList* attribute specifies the number of channels allowed per ATM VCC. The congestion threshold is the upper bound for traffic on the non-switched Media Gateway.

Other parameters

Other parameters include

- cell delay variation tolerance
- per-connection queuing
- traffic shaping
- usage parameter control

These parameters are specified for the entire ATM interface. All switched VCCs of the same ATM interface use the same values for these parameters.

Voice-band connection admission control

Media Gateway ensures that the resources of an external VoAAL2 VCC are not exceeded by ensuring that the number of active voice connections over that VCC does not exceed the provisioned attribute *Nsta/n Vgs AtmTConn/n maxNumberAal2Trunks* for end-point provisioned VCCs or the provisioned attribute *Nsta/n Vgs Aal2SvcService Prof/n maxNumberAal2Trunks* for on-demand generated SVCs. It is up to the user provisioning *maxNumberAal2Trunks* and the ATM parameters of the VCC to ensure that the aggregate ATM bandwidth caused by that number of voice connections, using voice compression as used in that particular network, do not exceed the signalled or provisioned ATM parameters of the VCC.

Chapter 9
Fault management for Media Gateway

Nortel Networks Multiservice Switch systems generate alarms and state change notifications whenever it detects a problem. For general guidelines on troubleshooting Media Gateway, see the following sections:

Alarms

Alarms indicate faults or failure conditions on a node. A component generates an alarm to indicate that it is in need of repair or has detected a fault elsewhere on the node.

Alarms are an integral part of fault management. The following situations generate alarms:

- degradation/quality of service conditions (for example, the onset of severe congestion)
- processing errors (for example, protocol errors)
- engineering alarms (for example, insufficient memory for a required component)
- out-of-service conditions (for example, hardware failures such as a function processor or power supply failure)
- software errors (that is, an unexpected condition has been detected in software)
- administrative conditions (such as using the lock command to temporarily lock a component)
- security violations (for example, successive invalid login attempts)

Nortel Networks Multiservice Switch alarms include open systems interconnection (OSI) state information. You can use alarm information in combination with the OSI state to determine the cause of a failure. For more information about alarms, see NN10600-500 *Nortel Networks Multiservice Switch 6400/7400/15000/20000 Alarms Reference*. For information about Media Gateway OSI states, see either NN10600-781 *Nortel Networks Media Gateway 7480/15000 Non-switched Service Configuration Management* or NN10600-782 *Nortel Networks Media Gateway 7480/15000 Switched Service Configuration Management*.

State change notifications

When the OSI operational or procedural status of a component changes, the system automatically generates a state change notification (SCN). Components use SCNs to notify the components above and below them on the component hierarchy that they are no longer in service. Like alarms, state change notifications contain OSI state information and can help you determine the impact of a failure.

The following examples describe conditions that cause Nortel Networks Multiservice Switch systems to generate a state change notification.

- The voice services FP has failed. The *Nsta* component generates a proxy state change notification.
- When a virtual channel connection (VCC) is enabled and the system starts to collect traffic statistics, the system generates a state change up notification.
- When a VCC is disabled and the system stops collecting traffic statistics, the system generates a state change down notification.

Fault handling for Media Gateway

Nortel Networks Multiservice Switch Media Gateway faults can be categorized as TDM interface, ATM interface, and buffer underflow faults. And, depending on your configuration, you can change how Media Gateway communicates ATM failures to the narrowband node to which it connects. See the following sections for more information:

- “TDM interface faults” (page 163)
- “ATM interface faults” (page 165)
- “Buffer underflow faults” (page 168)
- “Configuring the response to failures” (page 168)

TDM interface faults

Nortel Networks Multiservice Switch systems generate the following types of alarms for the TDM interface:

- loss of signal (LOS)
- loss of frame (LOF)
- alarm indication signal (AIS)
- degraded signal (DS)
- remote alarm indication (RAI)
- idle signal (IS) for DS3 ports
- far end alarm indication (FAI) for DS3 ports with C-bit parity enabled

- C-bit mismatch alarm, C-bit parity mode mismatch between near end and far end.

The TDM interface has the following fault categories:

- "Non-switched Media Gateway faults" (page 164)
- "Switched Media Gateway faults" (page 164)

Non-switched Media Gateway faults

Nortel Networks Multiservice Switch systems report all alarm conditions to the fault management system. No further action occurs for DS and FAI alarms. With all other alarms, the system informs the remote interworking function using fault indication packets (FIP).

When RAI, LOS, LOF, or AIS alarms occur, Multiservice Switch systems create an FIP that shows all local conditions. The system sends this FIP continually every few seconds on all affected AAL2 channels, even if no change occurs in the fault status. When fault conditions change, the system sends an updated FIP.

When a FIP with one or more fields showing an alarm condition arrives on an AAL2 channel, Multiservice Switch systems react differently depending on the type of fault. For RAI faults, the system transmits RAI fault indications to the TDM network. For all other faults, the system transmits either AIS fault indications or trunk conditioning data on the corresponding service interface time slot, depending on how the *Brag* component is provisioned. Trunk conditioning stops only after the AAL2 channel receives a FIP in which all fault indication fields are set to zero.

Switched Media Gateway faults

Detection of TDM fault conditions and port management type reactions to TDM failures are identical to those of non-switched Media Gateway. Nortel Networks Multiservice Switch Media Gateway reports all alarm conditions to the fault management system; however, the alarm actions are different.

When an individual facility becomes unavailable because of a network fault, Nortel Networks Multiservice Switch Media Gateway does not propagate the fault indication to the far end TDM interface. Instead, Media Gateway deletes any narrowband calls using that trunk and notifies the media gateway controller of the state change of the TDM interface.

For switched Media Gateway using ATM connections, an unsolicited change notification is sent.

For switched Media Gateway using IP connections, a change notification is sent when ASPEN is used or a unsolicited ServiceChange message is sent when H.248 control protocol is used.

During the time that the facility is unavailable, Media Gateway responds to control commands (such as Create Connection) for any endpoint on the affected trunk with a negative acknowledgement. When the fault clears, Media Gateway sends another notification or RSIP to the controller and begins to accept control commands again.

ATM interface faults

Nortel Networks Multiservice Switch systems generate the following types of alarms for the ATM interface:

- loss of signal (LOS)
- loss of frame (LOF)
- alarm indication signal (AIS), including OAM F5 AID
- degraded signal (DS)
- remote alarm indication (RAI)
- loss of cell delineation
- OAM F5 remote defect indication (RDI)
- OAM F5 loop back failure

Multiservice Switch systems follow OAM fault management procedures defined in ITU-T I.610. The system supports both end-to-end and segment F5 fault management flows.

If Media Gateway is using ATM PVCs, its behavior towards ATM interface faults is described in:

- "Behavior of non-switched Media Gateway" (page 166)
- "Behavior of switched Media Gateway" (page 166)

If Media Gateway is using ATM PSVCs or SPVC, its behavior towards ATM interface faults is described in:

- "Bearer VCC failure" (page 167)
- "Control VCC failure" (page 167)

Behavior of non-switched Media Gateway

Nortel Networks Multiservice Switch systems interpret all ATM alarms as ATM VCC loss of connectivity. Therefore, Multiservice Switch nodes condition all service interface time slots related to the troubled VCC. Trunk conditioning stops after ATM VCC connectivity is restored and the channel receives an FIP in which all fault indication fields are set to zero.

Behavior of switched Media Gateway

Nortel Networks Multiservice Switch Media Gateway continues to interpret all ATM alarms (except CPS) as ATM VCC loss of connectivity; however, in switched mode, Media Gateway reacts differently. When any media ATM trunk receives loss of continuity (LOC) alarms, Media Gateway does not propagate the fault condition to the near end TDM interface. Instead, Media Gateway immediately deletes the affected narrowband connections and notifies the media gateway controller. While the VCC is in LOC fault, the VCC is not available within the trunk selection algorithm. When the LOC alarm is removed, the media gateway controller is once again able to assign traffic to the ATM VCC trunk.

The ATM system has inherent backoff mechanisms for large-scale failures. The recovery time for large numbers of failed trunks can be 5 or more minutes depending on how busy the ATM cards are when trying to recover lost connections.

If an active connection fails to receive any voice or comfort noise for a period greater than the *PacketLossIntegration* period. Multiservice Switch Media Gateway deletes the affected narrowband connection and sends a delete

connection request to the controller. Until the first voice or comfort noise packet is received, this timer uses a timout period which is double the *PacketLossIntegration* period. During the timeout, the de-jitter buffer can underflow and the TDM stream plays out idle or comfort noise.

Bearer VCC failure

If network failures cause a bearer VCC to lose connectivity, the Media Gateway ATM trunks can re-route themselves by using PSVCs or SPVCs.

For switched Media Gateway using ATM, if a VCC transporting bearer traffic is torn down because of a failure in the ATM network, a hold-off timer for the associated *atmTconn* component is started. At the same time, the *Aap* or *SpvcAp* component attempts to re-establish a new VCC as described in "Retry mechanism" (page 137). The retry mechanism continues to operate until the VCC is re-established. If the VCC is successfully re-established before the hold-off timer expires, the media gateway controller is not notified of the failure and narrowband calls on the VCC are maintained. Note that bearer data is lost on associated narrowband calls while the *Aap* or *SpvcAp* component attempts to re-establish the VCC.

If the *Aap* or *SpvcAp* component cannot set up a new PSVC or SPVC before the hold-off timer expires, any associated narrowband calls are deleted and notification is sent to the media gateway controller. If the VCC is re-established after the hold-off timer expires, the media gateway controller is not informed, but the VCC becomes available for use again by the Media Gateway's trunk selection algorithm.

While the hold-off timer is running, no new narrowband connections can be allocated to the ATM trunk until it is re-established.

The hold-off mechanism also applies to switched Media Gateway using IP.

Control VCC failure

When a VCC transporting control information loses ATM connectivity, the Media Gateway application (that is, the *Aap* or *SpvcAp* component) attempts to re-establish the trunk on an alternative route. If more than one remote ATM address is specified, the application also attempts to connect to a different

ATM address. Multiple ATM addresses are used when more than one router is available in the network (through router sparing) between the media gateway controller and the Media Gateways.

Existing narrowband calls are maintained on the Media Gateway except if the control VCC is broken for a period longer than the media gateway controller allows (VGCP heartbeat failure).

Buffer underflow faults

If the de-jitter buffer underflows, Nortel Networks Multiservice Switch systems monitor the time it takes to refill the buffer. If the time exceeds the value configured for the *lossIntegrationPeriod* attribute, the system sets a buffer underflow fault. The system then applies trunk conditioning to the affected time slot and sends out a fault indication packet (FIP). The system sends this FIP continually every few seconds on all affected AAL2 channels, even if no change occurs in the fault status. Trunk conditioning stops only after the buffer underflows or the call clears and the channel receives an FIP in which all fault indication fields are set to zero.

The system begins transmitting after the buffer fills to the configured packet delay variation tolerance level. Fault status remains in effect until the system transmits for the period set by the *lossClearPeriod* attribute.

Configuring the response to failures

The *tdmResponseForFailures* attribute of the *Brag* component is used to determine what the TDM egress response is when the ATM interface becomes disabled and when a FIP is received. A FIP is created as a result of a far end LOS, LOF, LOMF, AIS, Chan locked, and TDM lp down. By default, Media Gateway sets this attribute to an AIS, which instructs the system to transmit AIS toward the TDM interface in all cases. The *tdmResponseForFailures* attribute can also be provisioned to transmit trunk conditioning (TC) regardless of the interface or type of signaling.

The noServiceResponse attribute of the DS1 or E1 Channel (Chan) TrunkConditioning (TC) component determines whether TC or alarm AIS is transmitted when the channel does not have a service provisioned or the service is unavailable. The noServiceResponse attribute can be provisioned to either TC or AIS.

Troubleshooting general Media Gateway problems

Nortel Networks Multiservice Switch systems notify you of problems with Media Gateway by generating one or more alarms. Use the alarm text and the OSI state information to find possible causes of the problem. Other troubleshooting activities involve running tests on hardware. For procedures and tests supported by specific FPs, see NN10600-520 *Nortel Networks Multiservice Switch 7400/15000/20000 Fault and Performance Management: Troubleshooting* or NN10600-551 *Nortel Networks Multiservice Switch 7400/15000/20000 FP Configuration Reference*.

To troubleshoot at the service level, display the values for individual operational and statistical attributes using the procedures in either NN10600-781 *Nortel Networks Media Gateway 7480/15000 Non-switched Service Configuration Management* or NN10600-782 *Nortel Networks Media Gateway 7480/15000 Switched Service Configuration Management*.

See "Troubleshooting general Media Gateway problems" (page 169) to help diagnose and correct problems. For additional troubleshooting information, see NN10600-520 *Nortel Networks Multiservice Switch 7400/15000/20000 Fault and Performance Management: Troubleshooting* and NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*.

Table 6
Troubleshooting general Media Gateway problems

Symptom	Probable causes	Corrective measures
There is a loss of signal (LOS) or loss of frame (LOF) alarm on the *DS3* component of the DS3C TDM FP.	A cable is broken or disconnected.	Verify the cabling for the DS3C TDM FP.
	There is an incorrect *lineLength* attribute configuration.	Verify that the *lineLength* attribute is set according to the length of the cable, to a value between 0 and 450.
There is an alarm indication signal (AIS) alarm on the *DS3* component of the DS3C TDM FP.	There is a fault in the equipment or cabling upstream from the Multiservice Switch node.	Verify the cabling.
(Sheet 1 of 6)		

Table 6 (continued)
Troubleshooting general Media Gateway problems

Symptom	Probable causes	Corrective measures
There is a remote alarm indication (RAI) signal alarm on the *DS3* component of the DS3C TDM FP.	There is a fault in the equipment or cabling downstream from the Multiservice Switch node.	Verify the cabling and check the far end device for problems.
There is a C-Bit parity alarm on the *DS3* component of the DS3C TDM FP (non-switched mode only).	The setting for the *cBitParity* attribute does not match at both ends.	Verify that the settings for C-Bit parity for the DS3C TDM FP match the device to which it connects.
There is a LOS or LOF alarm on multiple E1 components of the 32-port E1 TDM FP.	A cable is broken or disconnected.	Verify the cabling for the 32-port E1 TDM FP and the multiport aggregate device.
	A multiport aggregate device has failed.	Replace the multiport aggregate device.
There is an LOF alarm on a *DS1* component of the DS3C TDM FP or on an E1 component of the 32-port E1 TDM FP.	The setting for the DS3 *clockingSource* attribute is not compatible with the device to which it connects.	Verify that the clocking source for the *DS3* component is compatible with the device to which it connects.
	There is a fault in the equipment or in the DS1 or E1 line cabling.	Verify the DS1 or E1 level cabling. If, for example, the FP connects to a multiplexer, check the DS1 cabling for that link. For the 32-port E1 TDM FP, verify the cabling for the multiport aggregate device.
	The setting for the DS1 *lineType* attribute does not match the setting for the equipment to which it connects, or is not compatible with the service.	Verify that the DS1 *lineType* attribute matches the equipment to which it connects and is compatible with the service.

(Sheet 2 of 6)

Table 6 (continued)
Troubleshooting general Media Gateway problems

Symptom	Probable causes	Corrective measures
There is an LOF alarm on a *DS1* component of the DS3C TDM FP (non-switched mode only).	The setting for the *zeroCoding* attribute does not match the setting for the equipment to which it connects.	Verify that the *zeroCoding* setting matches the device to which it connects.
There is an AIS alarm on the *DS1* component of the DS3C TDM FP or on an E1 component of the 32-port E1 TDM FP.	There is a fault in the equipment upstream from the Multiservice Switch node.	Check the far end device for problems.
There is a remote alarm indication (RAI) signal alarm on the *DS1* component of the DS3C TDM FP or on an E1 component of the 32-port E1 TDM FP.	There is a fault in the equipment downstream from the Multiservice Switch node.	Check the far end device for problems.
The Media Gateway service is not operational and no calls are possible. The *Nsta* component is disabled.	The voice services FP is locked.	Unlock the voice services FP.
	The voice services FP has failed and there is no spare FP.	Lock and unlock the voice services FP. Restart the voice services FP. Replace the voice services FP.
	The provisioning for the *PModule* attributes for the voice services FP does not match the physical placement of modules on the FP.	Check that the provisioning for the attributes of the *PModule* component matches the physical placement of modules on the FP.
	All of the *Connection* components are locked or disabled.	Check the status of all the *Connection* components.

(Sheet 3 of 6)

Table 6 (continued)
Troubleshooting general Media Gateway problems

Symptom	Probable causes	Corrective measures
Calls are not possible for a connection.	The *Connection* component is locked.	Check the status of the *Connection* component.
	If the *failureCause* attribute for the *Brag* component is set to vspNotReady, either the voice services FP is initializing, or the voice services FP has failed.	Wait for the voice services FP to initialize. Or, if there is a problem with the FP, reset it. If the card does not initialize properly, replace the voice services FP.
Calls are not possible for a connection.	(non-switched mode only) If the *layer2Status* attribute for the *Ccst* component is down, the layer 2 connection from end to end has failed. Or, the signaling VCC does not have enough bandwidth to carry the signaling traffic.	Check the far end devices, for example, the narrowband node on one end and the PABX on the other. Verify that the signaling VCC has sufficient bandwidth.
	If the *failureCause* attribute for the *Brag* component is set to *operatorLock*, either a parent component or a related component, such as the *Vsp* or *Channel* component, is locked.	Verify whether or not any parent or related components are locked.
	There is a problem with the ATM interface.	Investigate possible problems with the ATM interface. For troubleshooting information, see NN10600-700 *Nortel Networks Multiservice Switch 7400/15000/20000 ATM Technology Fundamentals*.
	The system is receiving errored AAL2 packets or non-AAL2 packets.	Check the far-end ATM device to ensure that the VPI.VCI values match those configured for the connection. Verify that the far end device is sending AAL2 packets.
(Sheet 4 of 6)		

Table 6 (continued)
Troubleshooting general Media Gateway problems

Symptom	Probable causes	Corrective measures
There is no speech on voice calls.	The setting for cell scrambling on the ATM interface does not match the device to which it connects. If this problem occurs, Multiservice Switch systems generate a common part sublayer alarm.	Verify that the setting for cell scrambling matches the device to which it connects.
There is no speech or data on a call.	If the *packetLossStatus* attribute of the *Nsta Conn Brag Brac* component is set to *loss* and trunk conditioning has started on the TDM interface, no ATM packets are being received from the far end.	Check the ATM device at the far end for problems.
Speech on voice calls is distorted.	If the *currentRate* attribute for the *Brag* component displays a rate lower than the rate configured as the maximum voice rate, the ATM link is congested.	Wait for congestion to be relieved on the link, which increases the bandwidth for voice calls. If congestion occurs frequently, the system has not been engineered to effectively handle the traffic. Therefore, the traffic management settings need to be re-engineered.
	The setting for the *bufferSize* attribute for that *Brag* component is not compatible with the setting for the *packetDelayVariation-Tolerance* attribute.	Verify that the settings for the *bufferSize* attribute and the *packetDelayVariation-Tolerance* attribute are compatible. Generally, ensure that the buffer size is twice the setting for the *packetDelay-VariationTolerance* attribute.

(Sheet 5 of 6)

Table 6 (continued)
Troubleshooting general Media Gateway problems

Symptom	Probable causes	Corrective measures
Modem/Fax calls not working.	Clock-timing source of Media Gateway is different from other nodes in the connected network.	Check the clock-timing sources of the Media Gateway and other network nodes in the connected network. For information, see NN10600-125 *Nortel Networks Multiservice Switch 15000/20000 Planning Site Requirements*.
	Insufficient bandwidth for call at interfaces.	Verify bandwidth settings at interfaces.
	An initial address message (IAM) from a media gateway controller (MGC) such as Nortel Networks Succession Networks CS2000 or CS3000, does not have 64-bit/s clear data set.	Verify the IAM message.
(Sheet 6 of 6)		

Troubleshooting local announcements

The table "Troubleshooting local announcements" (page 175) provides additional guidelines to help you solve problems that may be associated with the transfer and playout of local announcements.

Table 7
Troubleshooting local announcements

Symptom	Probable causes	Corrective measures
Multiservice Switch Media Gateway issues a warning when you provision the *fileName* attribute of the *LocalAnnouncements* component.	The required index and audio files are not in the correct location on the CP	Verify that the announcement files share the same name (excluding extension). Verify that the announcement files are in the correct the following directory: /user/PVG/announcements.
You fail your attempt to provision the *fileName* attribute of the *LocalAnnouncements* component.	The file format is incorrect.	Verify that the files are stored in UAS format 2.1b or 3.0a. Verify that the files use an encoding rate of 64 kbps (G.711) or 32 kbps (G.726). If necessary, regenerate the files with the APS and re-transfer them to the Media Gateway CP.
	The files were incorrectly transferred.	The files must be transferred as binary files. Re-transfer them to the Media Gateway CP.
	The files on the CP are corrupted.	Re-transfer the files to the Media Gateway CP.

(Sheet 1 of 2)

Table 7 (continued)
Troubleshooting local announcements

Symptom	Probable causes	Corrective measures
The Media Gateway Controller is recording a large number of failed announcement requests, or many announcement requests generate NACK responses from the Media Gateway.	If no alarms are set against the *LocalAnnouncements* component and the value of the *unknownNameRequests* attribute is large and incrementing, the MGC is requesting an announcement name and language combination that the Media Gateway does not have.	Verify that the catalog file has an entry for each combination of announcement alias used and the language setting on all basic rate groups.
	If no alarms are set against the *LocalAnnouncements* component and the value of the *blockedRequests* attribute is large and incrementing, the MGC is overloading the Media Gateway with announcement requests.	Verify the value of the *announcementResourceInUse* attribute that shows how close to exhaustion the announcement resource currently is. Verify the value of the *peakAnnouncementResource Used* attribute that shows how close to exhaustion the announcement resource has been in the past. Remedial actions may include: • using G.726 (compressed) announcements rather than G.711 (uncompressed) announcements • shortening the length of announcements that are used often • using the universal audio server (UAS) or tones instead of local announcements

(Sheet 2 of 2)

Troubleshooting G.729 Annex A and B voice compression, silence suppression and DTMF upspeed

The table “Troubleshooting G.729 Annex A and B voice compression, silence suppression and DTMF upspeed” (page 177) provides additional guidelines to help you solve problems that may be associated with G.729 Annex A and B functionality.

Table 8
Troubleshooting G.729 Annex A and B voice compression, silence suppression and DTMF upspeed

Symptom	Probable causes	Corrective measures
Speech on voice calls is distorted.	The G.729 Annex A and B Media Gateway trunk is misconnected to a G.726 trunk.	Verify that the G.729 Annex A and B and G.726 trunks are connected correctly.
Size and Sequence Errors	The G.729 Annex A and B Media Gateway trunk is misconnected to a G.726 trunk.	Verify that the settings for sizeErr and seqErr attributes are compatible with G.729 Annex A and B. Verify that the G.729 Annex A and B and G.726 trunks are connected correctly.
DTMF tone distortion	The dtmfTransport attribute is set to disabled	Set dtmfTransport attribute to upspeed to enable DTMF tones to be sent at G.711 as tone distortion can occur when tones are sent through the G.729 Annex A and B codec.

Note: Upspeeding is not currently supported for multi-frequency (MF) tones.

Troubleshooting PRI backhaul

The table “Troubleshooting PRI backhaul” (page 178) provides additional guidelines to help you solve problems that may be associated with PRI backhaul.

Table 9
Troubleshooting PRI backhaul

Symptom	Probable causes	Corrective measures
There is a layer 2 failure of the D-channel alarm	A cable is broken or disconnected.	Verify the cabling.
	Transmission problems.	Verify if there are transmission problems such as error bursts and slips.
	D-channel disabled at PRI-controlled device.	Verify if the D-channel has been disabled by an operator at the PRI-controlled device.
	The PRI side (network or user) is not configured correctly.	Verify the configuration of the user and network at both ends of the PRI trunk. The same value of *user* or *network* should not be set on both ends.

Appendix
Definitions of audible tones by country

This section defines the audible tones that Nortel Networks Multiservice Switch Media Gateway can generate for the following countries:

Argentina

Table 10
Definition of supported tones for Argentina

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	425 (+/- 25)	continuous	20	-10 (+/- 1)
(audible) ringing	cg/rt	425 (+/- 25)	1 on, 4 off	infinite	-10 (+/- 1)
busy	cg/bt	425 (+/- 25)	0.3 on, 0.2 off	infinite	-10 (+/- 1)
congestion	cg/ct	425 (+/- 25)	0.3 on, 0.4 off	infinite	-10 (+/- 1)
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.333 (f1) on, 0.333 (f2) on, 0.333 (f3) on, 1.0 off	1 cycle	-10/ -10/ -10
warning	cg/wt	1400 (+/- 50)	0.1 on	1 cycle	-10 (+/- 1)
pay phone recognition	cg/prt, cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	425 (+/- 25)	0.3 on	1 cycle	-14 (+/- 1)
caller waiting	cg/cr	425 (+/- 25)	1.0 on, 4.0 off	infinite	-10 (+/- 1)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

(Sheet 1 of 2)

Table 10 (continued)
Definition of supported tones for Argentina

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2600 (+/-2%) (VSP2 / VSP3-o) 1400 + 2060 + 2450 + 2600 (+/-2%) (VSP3)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (+/-1.5 dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 +/-1.5dB0 (VSP3)
negative acknowledge	xcg/nack	425 (+/- 25)	0.3 on, 0.4 off	60	-10 (+/- 1)
vacant number	xcg/vac	425 (+/- 25)	0.3 on, 0.4 off	infinite	-10 (+/- 1)
special conditions dial tone	xcg/spec	425 (+/- 25)	1.0 on, 0.25 off	20	-10 (+/- 1)
recall dial tone	srvtn/rdt	425 (+/- 25)	continuous	20	-10 (+/- 1)
confirmation	srvtn/conf	350 + 440 (+/- 0.5%)	0.1 on, 0.1 off (+/- 10%)	3 cycles	-13 + -13 (+/- 1.5 dB)-
held	srvtn/ht	425 (+/- 25)	0.4 on, 0.2 off, 0.4 on, 4.0 off	infinite	-10 (+/- 1)
message waiting	srvtn/mwt	425 (+/- 25)	1.0 on, 0.25 off	20	-10 (+/- 1)

(Sheet 2 of 2)

Australia

Table 11
Definition of supported tones for Australia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
dial	cg/dt	400 + 425 + 450	continuous	20	-18 + -18 + -18
(audible) ringing	cg/rt	400 + 425 + 450	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-18 + -18 + -18
busy	cg/bt	425	0.375 on, 0.375 off	infinite	-13
congestion	cg/ct	425 (f1)/ 425(f2)	0.375 (f1) on, 0.375 off, 0.375 (f2) on, 0.375 off	infinite	-13 (f1)/-23 (f2)
special information	cg/sit	950 + 1400 + 1800 (+/- 50)	0.33 on, 0.33 off, 0.33 on, 1.0 off	1 cycle	-13 + -13 + -13
warning	cg/wt	1400 (+/- 1.5%)	0.5 on, (+/- 10%)	1 cycle	-34
pay phone recognition	cg/prt cg/pt (ASPEN)	1100+1750 (f1) 750+1450 (f2)	0.075 (f1), 0.15 traffic, 0.075 (f2)	1 cycle	-23 + -23 -23 + -23
call waiting	cg/cw	425	0.2 on, 0.2 traffic, 0.2 on	1 cycle	-13

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Table 11 (continued)
Definition of supported tones for Australia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
caller waiting	cg/cr		cg/rt for 30, followed by cg/bt for remainder	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	3200	continuous	infinite	-8
negative acknowledge	xcg/nack	mapped to xcg/vac		60	mapped to xcg/vac
vacant number	xcg/vac	425	2.5 on, 0.5 off	infinite	-13
special conditions dial tone	xcg/spec	425	continuous	20	-13
recall dial tone	srvtn/rdt	425	continuous	20	-13
confirmation	srvtn/conf	425	0.06 on, 0.06 off	1 cycle	-12
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	400 + 425 + 450	0.1 on, 0.04 off	10	-18 + -18 + -18

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Austria

Table 12
Definition of supported tones for Austria

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s) (+/- 20%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 3.5 dB)**
dial	cg/dt	420	continuous	20	-10 (+/- 10%)
(audible) ringing	cg/rt	420	1 on, 5 off	infinite	-10 (+/- 10%)
busy	cg/bt	420	0.4 on, 0.4 off	infinite	-10 (+/- 10%)
congestion	cg/ct	420	0.2 on, 0.2 off	infinite	-10 (+/- 10%)
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07), 1 off (+/- 0.25)	1 cycle	-10 (+/- 10%)
warning	cg/wt	1400 (+/- 1.5%)	0.5 on, (+/- 10%)	1 cycle	-34 (+/-1 dB)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1)/ 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-20/ -20 (+/- 2 dB)
call waiting	cg/cw	420	0.4 on	1 cycle	-3 (+/- 10%)
caller waiting	cg/cr		cg/rt for 30 (+/- 10%), followed by cg/bt for remainder	infinite	-10 (+/- 10%)

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Table 12 (continued)
Definition of supported tones for Austria

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s) (+/- 20%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 3.5 dB)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1404 + 2060 + 2604 (VSP2/ VSP3-o) (+/- 15) 1404 + 2060 + 2452 + 2604 (VSP3) (+/- 15)	continuous	infinite	-5 + -5 + -5 (+/- 1dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/- 1dB) (VSP3)
negative acknowledge	xcg/nack	380 + 420	0.4 on, 0.4 off	60	-13 (+/- 10%)
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	380 + 420	continuous	20	-13 (+/- 10%)
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	380 + 420	1.0 on, 5.0 off	1 cycle	-13 (+/- 10%)
held	srvtn/ht	450 (+/- 15)	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-8 (+/-1 dB)

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Table 12 (continued)
Definition of supported tones for Austria

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s) (+/- 20%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 3.5 dB)**
message waiting	srvtn/mwt	420	(0.1 on, 0.1 off) x 10 then continuous	20	-10 (+/- 10%)
intrusion pending	int/pend	silence (no frequency), signal complete immediate			
intrusion	int/int	420	0.15 on, 0.15 off, 0.15 on	1 cycle	-10 (+/- 10%)
intrusion reminder	int/rem	silence (no frequency), signal complete immediate			
toll break-in	int/tbi	silence (no frequency), signal complete immediate			
intrusion queue	int/intque	silence (no frequency), signal complete immediate			
busy verification	int/bv	silence (no frequency), signal complete immediate			

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Belgium

Table 13
Definition of supported tones for Belgium

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s) (+/-10%)	Level (dBm) (+/- 0.5 dB)
dial	cg/dt	425 (+/- 5)	continuous	20	-4.5
(audible) ringing	cg/rt	425 (+/- 5)	1.0 on, 3.0 off (+/-0.1)	infinite	-4.5
busy	cg/bt	425 (+/- 15)	0.5 on, 0.5 off (+/- 10%)	infinite	-4.5
congestion	cg/ct	425 (+/- 15)	0.167 on, 0.167 off (+/-0.012)	infinite	-4.5
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07), 1 off (+/- 0.25)	1 cycle	-4.5/ -4.5/ -4.5
toneburst on answer (replaces warning tone)	cg/wt	1111 (+/- 5%)	0.18 on (+/- 0.02)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-20/ -20 (+/- 2 dB)

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Table 13 (continued)
Definition of supported tones for Belgium

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 0.5 dB)**
call waiting	cg/cw	1400 (+/- 50)	0.175 on (+/-0.075), 0.175 traffic (+/-0.075), 0.175 on (+/-0.075)	1 cycle	-15 (+/- 2 dB)
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	440 (+/- 2%)	0.05 on, 0.05 off (+/- 10%)	infinite	-11 (+/- 2 dB)
off-hook warning	xcg/roh	1404 + 2060 + 2604 (+/-15) (VSP2/ VSP3-o) 1404 + 2060 + 2452 + 2604 (+/-15) (VSP3)	continuous	infinite	-5 + -5 + -5 (+/-1 dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/-1 dB) (VSP3)
negative acknowledge	xcg/nack	450 (+/- 15)	0.12 on, 0.12 off	60	-8 (+/- 1 dB)

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Table 13 (continued)
Definition of supported tones for Belgium

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/- 0.5 dB)**
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	425 (+/- 5)	1.0 on. 0.25 off (+/- 0.05)	20	-4.5
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	425 (+/- 5)	0.04 on, 0.04 off (+/-0.005)	1 cycle	-4.5
held	srvtn/ht	1400 (+/- 50)	0.4 on, 15 off (+/- 10%)	infinite	-15 (+/- 2 dB)
message waiting	srvtn/mwt	425 (+/- 5)	(0.1 on, 0.1 off) x 10 then continuous	20	-4.5

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Brazil

Table 14
Definition of supported tones for Brazil

Tone name	Package / identifier	Characteristics			
		Frequency (Hz) (+/- 25 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 0.5 dB)**
dial	cg/dt	425	continuous	20	-15
(audible) ringing	cg/rt	425	1.0 on, 4.0 off	infinite	-15
busy	cg/bt	425	0.25 on, 0.25 off repeated	infinite	-10
congestion	cg/ct	425	0.5 on, 0.5 off	infinite	-10
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/ -50)	0.33 (f1) on (+/- 0.04), 0.33 (f2) on (+/- 0.04), 0.33 (f3) on (+/- 0.04), 1 off (+/- 0.1)	1 cycle	-10/ -10/ -10 (+/- 1.5 dB)
warning	cg/wt	392 (f1) 494 (f2) 587 (f3)	0.5 (f1) on, 0.5 (f2) on, 1.5 (f3) on	1 cycle	-17/ -17/ -17
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	425	0.06 on, 0.25 traffic, 0.06 on	1 cycle	-10
caller waiting	cg/cr	425	0.4 on, 5.0 off	infinite	-10

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Table 14 (continued)
Definition of supported tones for Brazil

Tone name	Package / identifier	Characteristics			
		Frequency (Hz) (+/- 25 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 0.5 dB)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	300	continuous	infinite	-15
off-hook warning	xcg/roh	1400 + 2066 + 2600 (+/-1%) (VSP2/ VSP3-o) 1400 + 2066 + 2467 + 2600 (+/-1%) (VSP3)	0.1 on, 0.1 off	infinite	-6 + -6 + -6 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	xcg/nack	425	0.1 on, 0.1 off	60	-10
vacant number	xcg/vac	425	0.25 on, 0.25 off, 0.75 on, 0.25 off	infinite	-10
special conditions dial tone	xcg/spec	425	(0.1 on, 0.1 off) x3, 19.4 on	20	-10
recall dial tone	srvtn/rdt	425	continuous	20	-15
confirmation	srvtn/ conf	425	0.1 on, 0.1 off, 0.25 on, 0.1 off	15	-10

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Table 14 (continued)
Definition of supported tones for Brazil

Tone name	Package / identifier	Characteristics			
		Frequency (Hz) (+/- 25 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 0.5 dB)**
held	srvtn/ht	Not requested or defined for Brazil. If necessary, map with ITU E.180			
message waiting	srvtn/mwt	425	0.1 on, 0.1 off	20	-10

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Canada

Table 15
Definition of supported tones for Canada

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/- 1.5 dB)**
dial	cg/dt	350 + 440 (+/- 0.5%)	continuous	20 (+/- 10%)	-13 + -13 (+/- 1.5 dB)
(audible) ringing	cg/rt	440 + 480 (+/- 0.5%)	2.0 on, 4.0 off (+/- 10%)	infinite	-19 + -19 (+/- 1.5 dB)
busy	cg/bt	480 + 620 (+/- 0.5%)	0.5 on, 0.5 off (+/- 10%)	infinite	-24 + -24 (+/- 1.5 dB)
congestion	cg/ct	480 + 620 (+/- 0.5%)	0.25 on, 0.25 off (+/- 10%)	infinite	-24 + -24 (+/- 1.5 dB)
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50 Hz)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on 1.0 off (+/- 10%)	1 cycle	-24/ -24/ -24 (+/- 1.5 dB)
warning	cg/wt	1400 (+/- 1.5%)	0.5 on (+/- 10%)	1 cycle	-7 (+/- 1.5 dB)
pay phone recognition	cg/prt cg/pt (ASPEN)	1100 (f1) 750 (f2)	(0.2 (f1) on 0.2 (f1) off, 0.2 (f2) on 2.0 traffic) x 5	13	-6 (f1) -7 (f2)
call waiting	cg/cw	440 (+/- 0.5%)	0.3 on (+/- 10%)	1 cycle	-13 (+/- 1.5dB)

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Table 15 (continued)
Definition of supported tones for Canada

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/- 1.5 dB)**
caller waiting	cg/cr	440 + 480 (f1) 440 (f2)	2.0 (f1) 0.3 (f2) 3.7 off (repeating)	infinite	f1 = -19 + -19 f2 = -13
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2060 + 2600 (VSP2/ VSP3-o) (+/- 2%) 1400 + 2060 + 2450 + 2600 (VSP3) (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (+/- 1.5dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/- 1.5dB) (VSP3)
negative acknowledge	xcg/nack	480 + 620	0.25 on, 0.25 off (repeating)	infinite	-24 + -24
vacant number	xcg/vac	map to cg/ct		infinite	
special conditions dial tone	xcg/spec	map to cg/dt			

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Table 15 (continued)
Definition of supported tones for Canada

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/- 1.5 dB)**
recall dial tone	srvtn/rdt	350 + 440 (+/- 0.5%)	(0.1 on, 0.1 off) x 3, then continuous (+/- 10%)	20 (+/- 10%)	-13 + -13 (+/- 1.5dB)
confirmation	srvtn/conf	350 + 440 (+/- 0.5%)	0.1 on, 0.1 off (+/- 10%)	3 cycles	-13 + -13 (+/- 1.5dB)
held	srvtn/ht	620	0.25 on, 0.25 off, 0.25 on, 3.25 off (repeating)	infinite	-24
message waiting	srvtn/mwt	350 + 440 (+/- 0.5%)	(0.1 on, 0.1 off) x 10, then continuous (+/- 10%)	20 (+/-10%)	-13 + -13 (+/- 1.5dB)
carrier dial	carr/cdt	400 (+/- 0.5%)	continuous	20 (+/- 10%)	-10 (+/- 1.5 dB)
carrier answer	carr/ans	silence (no frequency), signal complete immediate			
carrier charging	carr/chg	silence (no frequency), signal complete immediate			
long distance indicator	carr/ldi	silence (no frequency), signal complete immediate			

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Chile

Table 16
Definition of supported tones for Chile

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	400 (+/- 2.5%)	continuous	20	-10 (+/- 5)
(audible) ringing	cg/rt	400 (+/- 2.5%)	1.0 on, 3.0 off	infinite	-10 (+/- 5)
busy	cg/bt	400 (+/- 2.5%)	0.5 on, 0.5 off	infinite	-10 (+/- 5)
congestion	cg/ct	400 (+/- 2.5%)	0.2 on, 0.2 off	infinite	-10 (+/- 5)
special information	cg/sit	950 (f1)/ 1400 (f2)/ 1800 (f3) (+/- 50)	0.333 f1 on, 0.333 f2 on, 0.333 f3 on, 1.0 off	1 cycle	-10/ -10/ -10 (+/- 5)
warning	cg/wt	1400	0.5 on	1 cycle	-10 (+/- 5)
pay phone end of period	cg/prt cg/pt (ASPEN)	1400 (+/- 2.5%)	0.5 on	1 cycle	-10 (+/- 5)
call waiting	cg/cw	400	0.3 on	1 cycle	-10 (+/- 5)
caller waiting	cg/cr	400	(0.1 on 0.1 off) x 2; 0.6 on, 3.0 off	infinite	-10 (+/- 5)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 16 (continued)
Definition of supported tones for Chile

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
off-hook warning	xcg/roh	1400 + 2060 + 2450 (VSP2/ VSP3-o) (+/- 2%) 1400 + 2060 + 2450 + 2600 VSP3 only) (+/- 2%)	0.1 on, 0.1 off	infinite	-3.5 + -3.5 + -3.5 (VSP2/ VSP3-o) (+/- 1.5 dB) -5 + -5 + -5 + -5 (VSP3) (+/- 1.5 dB)
negative acknowledge	xcg/nack	400 (+/- 2.5%)	0.2 on, 0.2 off	60	-10 (+/- 5)
vacant number	xcg/vac	1000/1400/ 1800	0.33/0.33/ 0.33 on, 1.0 off	infinite	-10/-10/-10 (+/- 5)
special conditions dial	xcg/spec	425	(0.1 on, 0.1 off) x 3, 19.4 on	20	-10
recall dial tone	srvtn/rdt	400 (+/- 2.5%)	continuous	20	-10 (+/- 5)
confirmation	srvtn/conf	400	0.17 on, 0.14 off, 0.34 on	1 cycle	-10 (+/- 5)
held	srvtn/ht	400	0.05 on, 2.0 off	infinite	-10 (+/- 5)
message waiting	srvtn/mwt	400	(0.16 on, 0.16 off) x 10, then on continuous	20	-10 (+/- 5)

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China

Table 17
Definition of supported tones for China

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 3)**
dial	cg/dt	450 (+/- 25)	continuous	10	-10
(audible) ringing	cg/rt	450 (+/- 25)	1.0 on, 4.0 off	infinite	-10
busy	cg/bt	450 (+/- 25)	0.35 on, 0.35 off	infinite	-10
congestion	cg/ct	450 (+/- 25)	0.7 on, 0.7 off	infinite	-10
special information	cg/sit	950 (+/- 50)	0.4 on, 10.0 off	1 cycle	-20
warning	cg/wt	450 (+/- 25)	0.2 on, 0.2 traffic, 0.2 on,	1 cycle	-20
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1366 (f2)	0.2 (f1) on 0.2 traffic, 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	450 (+/- 25)	0.4 on	1 cycle	-20
caller waiting	cg/cr	450 (+/- 25)	1.0 on, 4.0 off	infinite	-10
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 17 (continued)
Definition of supported tones for China

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 3)**
off-hook warning	xcg/roh	950 (+/- 50)	increasing loudness in 4 phases: -25 dB for 15 s, -18 dB for 15 s, -9 dB for 15 s, 0 dB for 15 s	infinite	see values at Cadence.
negative acknowledge	xcg/nack	450 (+/- 25)	0.7 on, 0.7 off	60	-10
vacant number	xcg/vac	450 (+/- 25)	(0.1 on, 0.1 off) x 3, 0.4 on 0.4 off	infinite	-10
special conditions dial	xcg/spec	450 (+/- 25)	0.4 on, 0.04 off	60	-10
recall dial	srvt/rdt	450 (+/- 25)	continuous	10	-10
confirmation	srvt/conf	950 (+/- 50)	continuous	2	-20
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	450 (+/- 25)	0.4 on, 0.04 off	60	-10

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Czech Republic

Table 18
Definition of supported tones for Czech Republic

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	425 (+/- 10%)	0.33 on, 0.33 off, 0.66 on 0.66 off all +/- 10%	20	-5 (+/- 1)
(audible) ringing	cg/rt	425 (+/- 10%)	1.0 on, 4.0 off all +/- 10%	infinite	-5 (+/- 1)
busy	cg/bt	425 (+/- 10%)	0.33 on, 0.33 off all +/- 10%	infinite	-5 (+/- 1)
congestion	cg/ct	425 (+/- 10%)	0.165 on, 0.165 off all +/- 10%	infinite	-5 (+/- 1)
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on, 1.0 off	1 cycle	-5/ -5/ -5
warning	cg/wt	1400	0.5 on	1 cycle	-5
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-5/ -5
call waiting	cg/cw	425 (+/- 10%)	0.33 on +/-0.03	1 cycle	-5 (+/- 1)

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Table 18 (continued)
Definition of supported tones for Czech Republic

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
caller waiting	cg/cr	425 (+/- 10%)	1.0 on (+/- 0.1), 0.170 off (+/- 0.03), 0.33 on (+/- 0.03), 3.5 off (+/- 0.3)	infinite	-5 (+/- 1)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2060 + 2600 (VSP2/ VSP3-o) (+/- 2%) 1400 + 2060 + 2450 + 2600 (VSP3) (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (+/-1.5 dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/-1.5 dB) (VSP3)
negative acknowledge	xcg/nack	425 (+/- 10%)	0.165 on, 0.165 off all +/- 10%	60	-5 (+/- 1)

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Table 18 (continued)
Definition of supported tones for Czech Republic

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
vacant number	xcg/vac	950 (f1) 1400 (f2) 1800 (f3) all +/- 10%	0.33 (f1) on (+/- 0.07), 0.03 off, 0.33 (f2) on (+/- 0.07), 0.03 off, 0.33 (f3) on (+/- 0.07), 1.0 off (+/- 0.25)	infinite	-5 + -5 + -5 (+/- 1 dB)
special conditions dial tone	xcg/spec	425 (+/- 10%)	(0.165 on, 0.165 off) x 3, 0.66 on, 0.66 off, (+/- 0.016)	20	-5 (+/- 1)
recall dial tone	srctn/rdt	425 (+/- 10%)	0.33 on, 0.33 off 0.66 on, 0.66 off all +/- 10%	20	-5 (+/- 1)
confirmation	srvtn/conf	351 + 439 (+/- 2%)	0.1 on, 0.1 off, 0.3 on, 0.1 off	1 cycle	-10 + -10 (+/- 2 dB)
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	400 + 425 (+/- 7 Hz)	continuous	20	-6 + -6

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France

Table 19
Definition of supported tones for France

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm)**
dial	cg/dt	440 (+/- 2)	continuous	20	-3.5 (+/- 0.5 dB)
(audible) ringing	cg/rt	440 (+/- 2)	1.5 on, 3.5 off	infinite	-11 (+/- 2 dB)
busy	cg/bt	440 (+/- 2)	0.5 on, 0.5 off	infinite	-11 (+/- 2 dB)
congestion	cg/ct	440 (+/- 2)	0.5 on, 0.5 off	infinite	-11 (+/- 2 dB)
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.3 (f1) on, 0.03 off, 0.3 (f2) on, 0.03 off, 0.3 (f3) on, 1.0 off	1 cycle	-10/ -10/ -10 (+/- 2 dB)
toneburst on answer (replaces warning tone)	cg/wt	1111 (+/- 5%)	0.18 on (+/- 0.02)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-20/ -20 (+/-2 dB)
call waiting	cg/cw	440 (+/- 2)	0.3 on (+/- 0.05)	1 cycle	-11 (+/- 2 dB)
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	

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Table 19 (continued)
Definition of supported tones for France

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			
comfort	xcg/cmft	440 (+/- 2)	0.05 on, 0.05 off	infinite	-11 (+/- 2 dB)
off-hook warning	xcg/roh	1404 + 2060 + 2604 (+/-15) (VSP2/ VSP3-o) 1404 + 2060 + 2452 + 2604 (+/- 15) (VSP3)	continuous	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) (+/-1 dB) -6 + -6 + -6 + -6 (VSP3) (+/-1 dB)
negative acknowledge	xcg/nack	450 (+/- 15)	0.12 on, 0.12 off	60	-8 (+/- 1 dB)
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	440 (+/- 2)	continuous	20	-11 (+/- 2 dB)
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	450 (+/- 15)	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-8 (+/- 1 dB)

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Table 19 (continued)
Definition of supported tones for France

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm)**
held	srvtn/ht	440 (+/- 2)	0.2 on, 0.2 off, 0.2 on, 5.0 off	infinite	-11 (+/- 2 dB)
message waiting	srvtn/mwt	440 (+/- 2)	(0.1 on, 0.1 off) x 10 then continuous	20	-3.5 (+/- 0.5 dB)
(Sheet 3 of 3)					

Germany

Table 20
Definition of supported tones for Germany

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
dial	cg/dt	425 (+/- 7)	continuous	20	-3
(audible) ringing	cg/rt	425 (+/- 7 Hz)	1 on, 4 off (+/- 8%)	infinite	-3
busy	cg/bt	425 (+/- 7)	0.48 on, 0.48 off (+/- 3%)	infinite	-3
congestion	cg/ct	425 (+/- 7)	0.24 on, 0.24 off (+/- 3%)	infinite	-3
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07), 1.0 off (+/- 0.25)	1 cycle	-3/ -3/ -3
warning	cg/wt	1400 (+/- 1.5%)	0.5 on (+/- 10%)	1 cycle	-34 (+/- 1.5 dB)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-9/ -9
call waiting	cg/cw	425 (+/- 7)	0.2 on, 0.2 traffic, 0.2 on	1 cycle	-9

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Table 20 (continued)
Definition of supported tones for Germany

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
caller waiting	cg/cr		cg/rt for 30 (+/- 10%) followed by cg/bt for remainder	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			
comfort	xcg/cmft	undefined. nothing played signal complete immediately			
off-hook warning	xcg/roh	1400 + 2066 + 2600 (+/-2%) (VSP2/ VSP3-o) 1400 + 2066 + 2450 + 2600 (+/-2%) (VSP3)	0.1 on, 0.1 off	infinite	-5+ -5 + -5 (+/-2 dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/-2 dB) (VSP3)
negative acknowledge	xcg/nack	425 (+/- 15)	0.12 off, 0.12 on	60	-3
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	400 + 425 (+/- 7)	continuous	20	-6 + -6
recall dial tone	srvtn/rdt	mapped to cg/dt			

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Table 20 (continued)
Definition of supported tones for Germany

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
confirmation	srvtn/conf	425 (+/- 7)	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-3
held	srvtn/ht	425 (+/- 7)	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-3
message waiting	srvtn/mwt	425 (+/- 7)	(0.1 on, 0.1 off) x 10 then continuous	20	-3

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Greece

Table 21
Definition of supported tones for Greece

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	425	0.2 on, 0.3 off 0.7 on, 0.8 off	20	-10
(audible) ringing	cg/rt	425	1.0 on, 4 off	infinite	-10
busy	cg/bt	425	0.3 on, 0.3 off	infinite	-13
congestion	cg/ct	425	0.15 on, 0.15 off	infinite	-11
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.333 (f1) on, 0.333 (f2) on, 0.333 (f3) on, 1.0 off	1 cycle	-10/ -10/ -10
warning	cg/wt	1400	0.5 on	1 cycle	-34
pay phone recognition	cg/prt, cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-13/ -13
call waiting	cg/cw	425	0.3 on	1 cycle	-13
caller waiting	cg/cr	425	1.0 on, 4.0 off	infinite	-10
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 21 (continued)
Definition of supported tones for Greece

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2450 (+/-15) (VSP2/ VSP3-o) 1400 + 2060 + 2450 + 2600 (+/- 15) (VSP3)	0.1 on, 0.1 off	infinite	-3.5 + -3.5 + -3.5 (+/-1.5 dB) (VSP2/ VSP3-o) -5 + -5 + -5 +5 (+/-1.5 dB) (VSP3)
negative acknowledge	xcg/nack	425	0.15 on, 0.15 off	60	-11
vacant number	xcg/vac	450	continuous	infinite	-13
special conditions dial tone	xcg/spec	400 (f1) 425 (f2)	0.2 (f1) on, 0.3 off, 0.7 (f2) on, 0.8 off	20	-10 (f1) / -10 (f2) (+/- 2 dB)
recall dial tone	srvtn/rdt	425	0.2 on, 0.3 off, 0.7 on, 0.8 off	20	-10
confirmation	srvtn/conf	450 (+/- 5%)	0.04 on, 0.04 off	1 cycle	-9.8 (+/- 0.4)
held	srvtn/ht	900	0.5 on, 0.5 off	infinite	-10
message waiting	srvtn/mwt	400 (f1) 425 (f2)	0.2 (f1) on, 0.3 off, 0.7 (f2) on, 0.8 off	20	-10 (f1) / -10 (f2) (+/- 2 dB)

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Hong Kong

Table 22
Definition of supported tones for Hong Kong

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	350 + 440	continous	20	-13 + -13 (+/- 5 dB)
(audible) ringing	cg/rt	440 + 480	0.4 on, 0.2 off, 0.4 on, 3.0 off	infinite	-13 + -13 (+/- 5 dB)
busy	cg/bt	480 + 620	0.5 on, 0.5 off	infinite	-13 + -13 (+/- 5 dB)
congestion	cg/ct	480 + 620	0.25 on, 0.25 off	infinite	-13 + -13 (+/- 5 dB)
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3) (+/- 50)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on, 1.0 off (+/- 10%)	1 cycle	-10/ -10/ -10 (+/- 5 dB)
warning	cg/wt	440	1.0 on	1 cycle	-13 (+/- 1)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-13/ -13 (+/- 1)
call waiting	cg/cw	440	0.5 on, 0.5 traffic, 0.5 on, 0.5 traffic, 0.5 on	1 cycle	-13 (+/- 1)
caller waiting	cg/cr	mapped to cg/rt		infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			

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Table 22 (continued)
Definition of supported tones for Hong Kong

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2060 + 2450 (+/- 2%) (VSP2/ VSP3-o only) 1400 + 2060 + 2450 + 2600 (+/- 2%) (VSP3)	0.1 on, 0.1 off	infinite	-3.5 + -3.5 + -3.5 (+/- 1.5 dB) (VSP2/ VSP3-o) -5 + -5 + -5 + -5 (+/- 1.5dB) (VSP3)
negative acknowledge	xcg/nack	mapped to cg/ct		60	
vacant number	xcg/vac	480 + 620	continuous	infinite	-13 + -13 (+/- 5 dB)
special conditions dial tone	xcg/spec	350 + 440	(0.1 On, 0.1 Off) for 4 seconds, followed by continuous tone	20	-16 + -16 (+/- 5 dB)
recall dial tone	srvtn/rdt	350 + 440	(0.1 on, 0.1 off) x 3, followed by continuous tone	20	-16 + -16 (+/- 5 dB)
confirmation	srvtn/conf	350 + 440	0.1 on, 0.1 off, 0.3 on, 0.3 off	1 cycle	-16 + -16 (+/- 5 dB)

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Table 22 (continued)
Definition of supported tones for Hong Kong

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
held	srvtn/ht	350 + 440	0.5 on, 2.5 off	infinite	-16 + -16 (+/-5 dB)
message waiting	srvtn/mwt	350 + 440	(0.2 on, 0.2 off, 0.5 on, 0.2 off) x 4, followed by continous tone	20	-16 + -16 (+/- 5 dB)

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India

Table 23
Definition of supported tones for India

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	400 modulated by 25 at 100% depth	continuous	20	-10 (+/- 5)
(audible) ringing	cg/rt	400 modulated by 25 at 100% depth	0.4 on, 0.2 off, 0.4 on, 2.0 off (repeated)	infinite	-10 (+/- 5)
busy	cg/bt	400	0.75 on, 0.75 off (repeated)	infinite	-10 (+/- 5)
congestion	cg/ct	400	0.25 on, 0.25 off (repeated)	infinite	-10 (+/- 5)
special information	cg/sit	400	1.0 on, 4.0 off	infinite	-10 (+/- 5)
warning	cg/wt	800	0.12 on	1 cycle	-10 (+/- 5)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-10/ -10 (+/- 1)
call waiting	cg/cw	400	0.2 on, 0.1 traffic, 0.2 on	1 cycle	-10 (+/- 5)

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Table 23 (continued)
Definition of supported tones for India

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
caller waiting	cg/cr	400 modulated by 25 at 100% depth	0.4 on, 0.2 off, 0.4 on, 2.0 off (repeated)	infinite	-10 (+/- 5)
pay	bcg/bpy	silence. (no frequency), signal complete immediate			
comfort	xcg/cmft	silence. (no frequency), signal complete immediate			
off-hook warning	international ROH tone	400	continuous	infinite	-10
negative acknowledge	xcg/nack	400	0.25 on, 0.25 off	60	-10 (+/- 5)
vacant number	xcg/vac	400	2.8 on, 0.2 off	infinite	-10 (+/- 5)
special conditions dial tone	xcg/spec	400 + 300	continuous	20	-13 + -13 (+/- 5)
recall dial tone	srvtn/rdt	400 modulated by 25 at 100% depth	continuous	20	-10 (+/- 5)
confirmation	srvtn/conf	400	1.0 on, 4.0 off	1 cycle	-10 (+/- 5)
held	srvtn/ht	400	0.25 on, 0.25 off, 0.25 on, 3.25 off (repeated)	infinite	-10 (+/- 5)
message waiting	srvtn/mwt	400 + 300	continuous	20	-13 + -13 (+/- 5)

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Ireland

Table 24
Definition of supported tones for Ireland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
dial	cg/dt	425	continuous	20	-12
(audible) ringing	cg/rt	425	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-10
busy	cg/bt	425 (+/- 15)	0.5 on, 0.5 off	infinite	-12
congestion	cg/ct	mapped to cg/bt			
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	1.0 off (+/- 0.25), 0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07)	1 cycle	-13/ -13/ -13
toneburst on answer (replaces warning tone)	cg/wt	1111 (+/- 5%)	0.18 on (+/- 0.02)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	1100+1750 (f1) 750 + 1450 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-23 + -23 / -23 + -23
call waiting	cg/cw	400	0.2 on, 0.2 traffic, 0.2 on	1 cycle	-13

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Table 24 (continued)
Definition of supported tones for Ireland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	
pay	bcg/bpy	silence. (no frequency), signal complete immediate			
comfort	xcg/cmft	425 (+/- 5)	0.06 on, 0.06 off	infinite	-13
off-hook warning	xcg/roh	1400 + 2067 + 2600 (VSP2/ VSP3-o) 1400 + 2067 + 2467 + 2600 (VSP3)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	xcg/nack	mapped to xcg/vac			
vacant number	xcg/vac	400	continuous	infinite	-7
special conditions dial tone	xcg/spec	mapped to cd/dt			
recall dial tone	srvtn/rdt	400	continuous	20	-7
confirmation	srvtn/conf	425	0.2 on, 0.1 off	1 cycle	-10
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	400 (f1) 440 (f2)	0.32 (f1), 0.04 (f2)	20	-13/ -13

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Israel

Table 25
Definition of supported tones for Israel

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	400	continuous	20	-6
(audible) ringing	cg/rt	400	1.0 on, 3.0 off	infinite	-6
busy	cg/bt	400	0.5 on, 0.5 off	infinite	-6
congestion	cg/ct	400	0.25 on, 0.25 off	infinite	-6
special information	cg/sit	1000 (f1) 1400 (f2) 1800 (f3)	0.333 (f1) on, 0.3333 (f2) on 0.333 (f3) on, 1.0 off	1 cycle	-6 + -6 + -6
warning	cg/wt	1400	0.425 on	1 cycle	-6
pay phone recognition	cg/prt cg/pt (ASPEN)	1209 (f1) 852 (f2)	0.2 (f1) on, 0.2 traffic 0.2 (f2) on	1 cycle	-6/ -6
call waiting	cg/cw	400	0.3 on	1 cycle	-10
caller waiting	cg/cr	400	(0.1 on, 0.1 off) x 2, 0.6 on, 3.0 off	infinite	-6
pay	bcg/bpy	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 25 (continued)
Definition of supported tones for Israel

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2600 (VSP2/ VSP3-o) 1400 + 2060 + 2450 + 2600 (VSP3)	0.12 on, 0.08 off	infinite	-6 + -6 + -6 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	cg/nack	1000 (f1) 1400 (f2) 1800 (f3)	0.333 (f1) on, 0.3333 (f2) on 0.333 (f3) on, 1.0 off	60	-6/ -6/ -6
vacant number	xcg/vac	1000 (f1) 1400 (f2) 1800 (f3)	0.333 (f1) on, 0.3333 (f2) on 0.333 (f3) on, 1.0 off	infinite	-6/ -6/ -6
special conditions dial tone	xcg/spec	400	(0.1 on, 0.1 off) x 3 followed by cg/dt	20	-6
recall dial tone	srvtn/rdt	400	continuous	20	-6
confirmation	srvtn/conf	400	0.17 on, 0.17 off, 0.34 on	1 cycle	-6

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Table 25 (continued)
Definition of supported tones for Israel

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
held	srvtn/ht	400	0.05 on, 2.0 off	infinite	-16
message waiting	srvtn/mwt	400	(0.16 on, 0.16 off) x 10 followed by cg/dt	20	-6

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Italy

Table 26
Definition of supported tones for Italy

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
dial	cg/dt	425	continuous	20	-15
(audible) ringing	cg/rt	425	1.0 on, 4.0 off	infinite	-25
busy	cg/bt	425	0.5 on, 0.5 off	infinite	-25
congestion	cg/ct	425	(0.2 on, 0.2 off) x 2 0.2 on, 0.6 off (+/- 5%)	infinite	-25
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on 0.01 off, 0.33 (f2) on 0.01 off, 0.33 (f3) on 1.0 off	1 cycle	-23/ -23/ -23
toneburst on answer (replaces warning tone)	cg/wt	1111 +/- 5%	0.18 on (+/- 20)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-20/ -20 (+/- 2 dB)
call waiting	cg/cw	425	1.0 on	1 cycle	-13
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	

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Table 26 (continued)
Definition of supported tones for Italy

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	300	continuous	infinite	-15
off-hook warning	xcg/roh	1404 + 2060 + 2604 (VSP2/ VSP3-o) 1404 + 2060 + 2452 + 2604 (VSP3)	continuous	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	xcg/nack	450 (+/- 15)	0.12 on, 0.12 off	60	-8
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	425	1.0 on, 0.1 off (+/- 5%)	20	-15
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	450 (+/- 15)	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-8

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Table 26 (continued)
Definition of supported tones for Italy

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15 Hz)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
held	srvtn/ht	450 (+/- 15)	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-8
message waiting	srvtn/mwt	425	(0.1 on, 0.1 off) x 10 then continuous	20	-15

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Japan

Table 27
Definition of supported tones for Japan

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	400	continuous	60	-16
(audible) ringing	cg/rt	400 modulated by 16 at 85% depth	1.0 on, 2.0 off	infinite	-5
busy	cg/bt	400	0.5 on, 0.5 off	infinite	-5
congestion	cg/ct	400	0.5 on, 0.5 off	infinite	-5
special information	cg/sit	400	0.5 on	1 cycle	-16
warning	cg/wt	1400	0.35 to 0.5 on	1 cycle	-34 (+/- 1.5 dB)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic 0.2 (f2) on	1 cycle	-13/ -13, (+/- 2 dB)
call waiting	cg/cw	(f1) 400 modulated by 16 at 85% depth (f2) 400	f1: 0.5 on, 0.0 to 4.0 traffic f2: 0.05 on, 0.45 traffic, 0.05 on, 3.45 traffic	f1 for 0.5 to 4.5 once followed by f2 for 4.0 1 cycle	-12/ -12
caller waiting	cg/cr	400 modulated by 16 at 85% depth	1.0 on 2.0 off	infinite	-5

(Sheet 1 of 3)

Table 27 (continued)
Definition of supported tones for Japan

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	400	a tone that increases loudness during first 3 or 15 period	infinite	+36 at steady condition
negative acknowledge	xcg/nack	400	0.5 on, 0.5 off	60	-5
vacant number	xcg/vac	400	0.5 on, 0.5 off	infinite	-5
special conditions dial tone	xcg/spec	400	0.15 on 0.1 off	60	-16
recall dial tone	srvtn/rdt	400	continuous 0.125 on 0.125 off	60	-16
confirmation	srvtn/conf	400	0.125 on, 0.125 off, 0.125 on, 0.625 off	repeated	-16

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Table 27 (continued)
Definition of supported tones for Japan

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
held	srvtn/ht	(f1) 400 modulated by 16 at 85% depth (f2) 400	f1: 0.5 on, 0.5 off f2: 0.5 on, 2.5 off	infinite	-12/ -12
message waiting	srvtn/mwt	400	0.15 on, 0.1 off	60	-16
(Sheet 3 of 3)					

Japanese fire and police trunks (JFPT)

The supported tones for Japanese fire and police trunks (JFPT) are the same as in “Definition of supported tones for Japan” (page 225) except for the following definition in “Definition of supported tones for JFPT (exception to supported tones for Japan)” (page 228).

Note: JFPT tones are only supported by VSP3-o (not supported by VSP2 and VSP3).

Table 28
Definition of supported tones for JFPT (exception to supported tones for Japan)

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
(audible) ringing	cg/rt	400 modulated by 16 at 85% depth	continuous	infinite	-5

Korea

Table 29
Definition of supported tones for Korea

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	350 + 440	continuous	16	-10 + -10
(audible) ringing	cg/rt	440 + 480	1.0 on, 2.0 off	infinite	-15 + -15
busy	cg/bt	480 + 620	0.5 on, 0.5 off	infinite	-20 + -20
congestion	cg/ct	480 + 620	0.3 on, 0.2 off	infinite	-20 + -20
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on 1.0 off	1 cycle	-10/ -10/ -10
warning	cg/wt	397 (f1) 494 (f2) 587 (f3)	0.5 (f1) on, 0.5 (f2) on 1.5 (f3) on,	1 cycle	-10/ -10/ -10
pay phone recognition	cg/prt, cg/pt (ASPEN)	1633 (f1) 1336(f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycles	-10/ -10
call waiting	cg/cw	350 + 440	0.25 on, 0.25 traffic, 0.25 on	1 cycle	-10 + -10
caller waiting	cg/cr	440 + 480	1.0 on, 2.0 off	infinite	-15 + -15
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 29 (continued)
Definition of supported tones for Korea

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2060 + 2600 (+/-2%) (VSP2/ VSP3-o) 1400 + 2060 + 2450 + 2600 (+/-2%) (VSP3)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) (+/-1.5 dB) -6 + -6 + -6 + -6 (VSP3) (+/-1.5 dB)
negative acknowledge	xcg/nack	480 + 620	0.3 on, 0.2 off	60	-20 + -20
vacant number	xcg/vac	480 + 620	0.3 on, 0.2 off	infinite	-20 + -20
special conditions dial tone	xcg/spec	397 (f1) + 494 (f2) + 587 (f3)	0.25 on, - 0.25 off, 0.25 on, 32.5 off	1 cycle	-10 + -10 + -10
recall dial tone	srvtn/rdt	350 + 440	1.0 on, 0.25 off	15	-10 + -10
confirmation	srvtn/conf	397 (f1) + 494 (f2) + 587 (f3)	0.25 on, 0.25 off, 0.25 on, 32.5 off	1 cycle	-10 + -10, + -10

(Sheet 2 of 3)

Table 29 (continued)
Definition of supported tones for Korea

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
held	srvtn/ht	440 (f1) + 480(f2) + 350(f3)	0.5 (f1 + f2) on 0.5 off, 0.5 (f1 + f3) on, 2.5 off	infinite	(-10 + -10)/ (-10 + -10)
message waiting	srvtn/mwt	397 (f1) + 494 (f2) + 587 (f3)	0.25 on, 0.25 off, 0.25 on, 32.5 off	1 cycle	-10 + -10 + -10

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Malaysia

Table 30
Definition of supported tones for Malaysia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 3)**
dial	cg/dt	425	continuous	20	-12
(audible) ringing	cg/rt	425	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-12
busy	cg/bt	425	0.5 on, 0.5 off	infinite	-12
congestion	cg/ct	425	0.25 on, 0.25 off	infinite	-12
special information	cg/sit	900 (f1) 1400 (f2) 1800 (f3)	1.0 (f1) on, 1.0 (f2) on, 1.0 (f3) on, 1.0 off	infinite	-19/ -19/ -19
warning	cg/wt	900	0.1 on, 0.1 traffic, 0.1 on, 0.1 traffic, 0.1 on	1 cycle	-19
pay phone recognition	cg/prt cg/pt (ASPEN)	1400 (f1), 950 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-8/ -8 (+/- 2)
call waiting	cg/cw	425	0.5 on, 0.25 traffic, 1.0 on	1 cycle	-12

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Table 30 (continued)
Definition of supported tones for Malaysia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm) (+/- 3)
caller waiting	cg/cr	425	0.4 on, 0.2 off, 0.4 on, 0.2 off, 0.1 on, 0.2 off, 0.1 on, 1.6 off	infinite	-12
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	3200	continuous	infinite	-8 (+/- 2 dB)
negative acknowledge	xcg/nack	425	continuous	60	-12 (+/- 2)
vacant number	xcg/vac	425	2.5 on, 0.5 off	infinite	-12
special conditions dial tone	xcg/spec	425	0.25 on, 0.25 off, 0.25 on, 0.25 off	20	-12
recall dial tone	srvtn/rdt	425	continuous	20	-12
confirmation	srvtn/conf	425	0.06 on, 0.06 off	1 cycle	-12 (+/- 2)
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	425	0.16 on, 0.16 off	20	-8 (+/- 2)

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Mexico

Table 31
Definition of supported tones for Mexico

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	425	continuous	15	-10
(audible) ringing	cg/rt	425	1.0 on, 4.0 off	infinite	-10
busy	cg/bt	425	0.25 on, 0.25 off	infinite	-10
congestion	cg/ct	425	0.25 on, 0.25 off	infinite	-10
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3) (+/- 50)	0.33 (f1) (+/- 0.07), 0.33 (f2) (+/- 0.07), 0.33 (f3) (+/- 0.07), 1.03 off (+/- 0.25)	1 cycle	-10/ -10/ -10
warning	cg/wt	1400 (+/- 1.5%)	0.5 on	1 cycle	-10
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2)	1 cycle	-10/ -10
call waiting	cg/cw	425	0.1 on, 0.1 traffic, 0.1 on	1 cycle	-10
caller waiting	cg/cr	425	1.0 on, 4.0 off	infinite	-10
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			

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Table 31 (continued)
Definition of supported tones for Mexico

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2067 + 2600 (VSP2/ VSP3-o only) 1400 + 2067 + 2467 + 2600 (VSP3 only)	0.1 on, 0.1 off	infinite	-6 (1400 Hz) -5 (2067 Hz) -6 (2600 Hz) (VSP2/ VSP3-o) -6 (1400 Hz) -5 (2067 Hz) -6 (2467 Hz) -6 (2600 Hz) (VSP3) only)
negative acknowledge	xcg/nack	425	0.12 on, 0.12 off	60	-10
vacant number	xcg/vac	425	0.25 on, 0.25 off	infinite	-10
special conditions dial	xcg/spec	425	0.4 on, 0.04 off	15	-10
recall dial tone	srvtn/rdt	425	continuous	20	-10
confirmation	srvtn/conf	425	0.1 on, 0.1 off, 0.2 on	1 cycle	-10
held	srvtn/ht	425	0.2 on, 0.5 off, 0.2 on, 10.0 off	infinite	-10
message waiting	srvtn/mwt	425	0.3 on, 0.1 off, 0.3 on, 1.3 off	15	-10

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Netherlands

Table 32
Definition of supported tones for the Netherlands

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/- 10%)**	**Level (dBm)**
dial	cg/dt	425 (+/- 15)	continuous	20	-5 (+/- 3 dB)
(audible) ringing	cg/rt	425 (+/- 15)	1.0 on, 4.0 off (+/- 10%)	infinite	-5 (+/- 3 dB)
busy	cg/bt	425 (+/- 15)	0.5 on, 0.5 off (+/- 10%)	infinite	-5 (+/- 3 dB)
congestion	cg/ct	425 (+/- 15)	0.25 on, 0.25 off (+/- 0.012)	infinite	-5 (+/- 3 dB)
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07), 1.0 off (+/- 0.25)	1 cycle	-12.5/ -12.5/ -12.5 (+/- 2.5 dB)
toneburst on answer (replaces warning tone)	cg/wt	1111 (+/- 5%)	0.18 on (+/- 20)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1)/ 1336 (f2) (+/- 8%)	0.2 (f1), 0.2 traffic, 0.2 (f2)	1 cycle	-20/ -20 (+/- 2 dB)
call waiting	cg/cw	425	0.17 on, 0.17 traffic, 0.17 on	1 cycle	-15 (+/- 2 dB)

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Table 32 (continued)
Definition of supported tones for the Netherlands

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s) (+/- 10%)**	**Level (dBm)**
caller waiting	cg/cr		cg/rt for 30 (+/-10%) followed by cg/bt for remainder	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	440 (+/- 2%)	0.05 on, 0.05 off (+/-10%)	infinite	-11 (+/- 2 dB)
off-hook warning	xcg/roh	1404 + 2060 + 2604 (+/-15) (VSP2/ VSP3-o) 1404 + 2060 + 2452 + 2604 (+/-15) (VSP3)	continuous	infinite	-5 + -5 + -5 (+/-1 dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/-1 dB) (VSP3)
negative acknowledge	xcg/nack	425 (+/- 15)	0.0625 on, 0.0625 off (+/- 10%)	60	-10 (+/- 1 dB)
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	425 (+/- 5)	1.0 on (+/- 0.05), 0.25 off (+/- 0.05)	20	-4.5 (+/- 0.5 dB)

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Table 32 (continued)
Definition of supported tones for the Netherlands

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s) (+/- 10%)	Level (dBm)
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	425 (+/- 5)	0.04 on, 0.04 off (+/- 0.005)	5	-4.5 (+/- 0.5 dB)
held	srvtn/ht	425 (+/- 5)	0.4 on, 15.0 off (+/- 10%)	infinite	-15 (+/- 2 dB)
message waiting	srvtn/mwt	425 (+/- 15)	(0.1 on, 0.1 off) x 10 then continuous	20	-5 (+/- 3 dB)

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New Zealand

Table 33
Definition of supported tones for New Zealand

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	400	continuous	20	-9 (+/- 1)
(audible) ringing	cg/rt	400 + 450	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-12 + -12 (+/- 1)
busy	cg/bt	400	0.5 on, 0.5 off	infinite	-9 (+/- 1)
congestion	cg/ct	400	0.25 on, 0.25 off	infinite	-9
special information	cg/sit	1400	continuous	infinite	-11 (+/- 1)
warning	cg/wt	1400	0.5 on	1 cycle	-11 (+/- 1)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	2 cycles	-10/ -10
call waiting	cg/cw	400	0.2 on, 3.0 traffic, 0.2 on, 3.0 traffic, 0.2 on, 3.0 traffic, 0.2 on	1 cycle	-21 (+/- 2)
caller waiting	cg/cr	1400	0.2 on, 0.2 off	infinite	-19 (+/- 1)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	not defined. Signal complete immediately			

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Table 33 (continued)
Definition of supported tones for New Zealand

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
off-hook warning	xcg/roh	2500 modulated by 25 at 100% depth	continuous	infinite	-3 (+/- 1)
negative acknowledge	xcg/nack	400	0.25 on, 0.25 off	infinite	-9
vacant number	xcg/vac	400	0.075 on, 0.1 off, 0.075 on, 0.1 off, 0.075 on 0.1 off 0.075 on, 0.4 off	infinite	-12 (+/- 1)
special conditions dial tone	xcg/spec	400 + 450	0.2 on, 0.4 off 2.0 on, 0.4 off	20	-12 (+/- 1)
recall dial tone	srvtn/rdt	400	0.1 on, 0.1 off, 0.1 on, 0.1 off, 0.1 on, 0.1 off, then continuous	20	-9 (+/- 1)
confirmation	srvtn/conf	1400	continuous	20	-11 (+/- 1)

(Sheet 2 of 3)

Table 33 (continued)
Definition of supported tones for New Zealand

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
held	srvtn/ht	400 (f1) 400+450 (f2)	0.5 (f1) on, 0.5 off, 0.5 (f2) on, 2.5 off	infinite	-19 (+/- 2)
message waiting	srvtn/mwt	400	(0.1 on, 0.1 off) for 2.5 seconds, then continuous	20	-12 (+/- 1)
(Sheet 3 of 3)					

Panama

Table 34
Definition of supported tones for Panama

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	425	continuous	20	-10 (+/- 5)
(audible) ringing	cg/rt	425	1.2 on, 4.65 off	infinite	-10 (+/- 5)
busy	cg/bt	425	0.5 on, 0.5 off	infinite	-10 (+/- 5)
congestion	cg/ct	425	0.25 on, 0.25 off	infinite	-10 (+/- 5)
special information	cg/sit	425	0.4 on, 0.04 off	5 cycles	-10 (+/- 5)
warning	cg/wt	1400	0.5 on	1 cycle	-10 (+/- 5)
pay phone recognition	cg/prt cg/pt (ASPEN)	1000 (f1) 1400 (f2)	0.2 (f1) on, 0.2 traffic 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	425	0.3 on	1 cycle	-10 (+/- 5)
caller waiting	cg/cr	425	1.2 on, 4.65 off	infinite	-10 (+/- 5)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 34 (continued)
Definition of supported tones for Panama

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2066 + 2600 (+/-2%) (VSP2/ VSP3-o only) 1400 + 2066 + 2450 + (+/-2%) (VSP3)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (+/-1.5 dB) (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (+/-1.5 dB) (VSP3)
negative acknowledge	xcg/nack	425	0.25 on, 0.25 off	60	-10 (+/- 5)
vacant number	xcg/vac	425	(0.12 on, 0.12 off) x 2 0.36 on, 0.12 off	infinite	-10 (+/- 5)
special conditions dial tone	xcg/spec	425	continuous	20	-10 (+/ -5)
recall dial tone	srvtn/rdt	425	continuous	20	-10 (+/- 5)
confirmation	srvtn/conf	425	0.1 on, 0.1 off 0.3 on, 0.1 off	2 cycles	-10 (+/- 5)
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	425	continuous	20	-10 (+/- 5)

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Philippines

Table 35
Definition of supported tones for the Philippines

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	425	continuous	20	-12 (+/- 1)
(audible) ringing	cg/rt	425	1.75 on, 3.25 off	infinite	-12 (+/- 1)
busy	cg/bt	425	0.5 on, 0.5 off	infinite	-10 (+/- 1)
congestion	cg/ct	425	0.2 on, 0.2 off	infinite	-10 (+/- 1)
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on, 1.0 off	infinite	-10/ -10/ -10 (+/- 5)
warning	cg/wt	440	0.25 on	1 cycle	-12 (+/- 1)
pay phone recognition	cg/prt ct/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2(f1)on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-10/ -10 (+/- 1)
call waiting	cg/cw	480	0.5 on	1 cycle	-17 (+/- 1)
caller waiting	cg/cr	425	0.4 on, 0.2 off, 4.0 on, 4.0 off (repeating)	30, followed by busy tone	-10 (+/- 5)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

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Table 35 (continued)
Definition of supported tones for the Philippines

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
off-hook warning	xcg/roh	1400 + 2067 + 2467 (VSP2/ VSP3-o) 1400 + 2067 + 2467 + 2600 (VSP3 only)	0.1 on 0.1 off	infinite	-4.5/ -4.5/ -4.5 (VSP2/ VSP3-o) (+/- 1dB) -6/ -5/ -6/ -6 (VSP3 only) (+/- 1dB)
negative acknowledge	xcg/nack	425	0.2 on, 0.2 off	60	-10 (+/- 1)
vacant number	xcg/vac	480 + 620	2.5 on, 0.5 off	infinite	-13 + -13 (+/- 5)
special conditions dial tone	xcg/spec	425 (+/- 10)	0.1 on, 0.1 off	20	-12 (+/- 1)
recall dial tone	srvtn/rdt	400 + 425	0.25 on, 0.25 off	20	-13 + -13 (+/- 5)
confirmation	srvtn/conf	400	0.1 on, 0.1 off, 0.3 on, 0.3 off	single cycle	-10 (+/- 5)
held	srvtn/ht	400	0.5 on, 2.5 off	infinite	-10 (+/- 5)
message waiting	srvtn/mwt	425	0.16 on, 0.16 off	20	-6 to -10

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Poland

Table 36
Definition of supported tones for Poland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	425 (+/- 7)	continuous	60	-6 (+/- 2)
(audible) ringing	cg/rt	425 (+/- 7)	1.0 on, 4.0 off (+/- 8%)	infinite	-3
busy	cg/bt	425 (+/- 7)	0.5 on, 0.5 off (+/- 3%)	infinite	-5
congestion	cg/ct	425 (+/- 7)	0.5 on, 0.5 off (+/- 3%)	infinite	-3
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3) (+/- 50)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/-0.07), 0.33 (f3) on (+/- 0.07), 1.0 off (+/- 0.25)	1 cycle	-3/ -3/ -3
warning	cg/wt	1400 (+/- 1.5%)	0.5 on (+/- 10%)	1 cycle	-34 (+/- 1.5 dB)
pay phone recognition	cg/prt, ct/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-9/ -9
call waiting	cg/cw	425 (+/- 7)	0.15 on, 0.15 traffic, 0.15 on	1 cycle	-9

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Table 36 (continued)
Definition of supported tones for Poland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
caller waiting	cg/cr		cg/rt for 30 (+/- 10%), then cg/bt for remaining time	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2066 + 2450 (+/-2%) (VSP2/ VSP3-o) 1400 + 2066 + 2450 + 2600 (+/-2%) (VSP3)	0.1 on, 0.1 off	infinite	-3.5 + -3.5 + -3.5 +/- 2 dB) (VSP2/ VSP3-o) -5 + -5 + -5 + -5 (+/-2 dB) (VSP3)
negative acknowledge	xcg/nack	425 (+/- 15)	0.12 off, 0.12 on	60	-3 (+/- 1 dB)
vacant number	xcg/vac	Mapped to cg/ct			
special conditions dial tone	xcg/spec	350 + 425 (+/- 7)	continuous	20	-6 + -6
recall dial tone	srvtn/rdt	Mapped to cg/dt			

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Table 36 (continued)
Definition of supported tones for Poland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
confirmation	srvtn/conf	425 (+/- 7)	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-3 (+/- 1 dB)
held	srvtn/ht	425 (+/- 7)	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-3 (+/- 1 dB)
message waiting	srvtn/mwt	425 (+/- 7)	(0.1 on, 0.1 off) x 10 then continuous	20	-6 (+/- 2)
(Sheet 3 of 3)					

Portugal

Table 37
Definition of supported tones for Portugal

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
dial	cg/dt	425	continuous	20	-13
(audible) ringing	cg/rt	425	1.0 on, 5.0 off	infinite	-14
busy	cg/bt	425	0.5 on, 0.5 off	infinite	-12
congestion	cg/ct	425	0.2 on, 0.2 off	infinite	-10
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on 1.0 off	1 cycle	-13/ -13/ -13
warning	cg/wt	1400 (+/- 1.5%)	0.5 on	1 cycle	-34
pay phone recognition	cg/prt cg/pt (ASPEN)	1477(f1) 941(f2)	0.2(f1), 0.2 traffic, 0.2 (f2)	1 cycle	-20/ -20
call waiting	cg/cw	425	0.2 on, 0.2 traffic, 0.2 on	1 cycle	-13
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	300	continuous	infinite	-13

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Table 37 (continued)
Definition of supported tones for Portugal

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1 dB)**
off-hook warning	xcg/roh	950 + 1400 + 2600 (VSP2/ VSP3-o only) 950 + 1400 + 1800 + 2600 (VSP3 only)	0.1 on, 0.1 off	infinite	-18 + -18 + -18 (VSP2/ VSP3-o) -19 + -19 + -19 + -19 (VSP3)
negative acknowledge	xcg/nack	950(f1) 1400(f2) 1800(f3)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on 1.0 off	60	-5/ -5/ -5
vacant number	xcg/vac	425	0.2 on, 0.2 off	infinite	-7
special conditions dial tone	xcg/spec	425	1 on, 0.2 off	20	-10
recall dial	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	425	1 on, 0.2 off	1 cycle	-13
held	srvtn/ht	450	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-8
message waiting	srvtn/mwt	425	(0.1 on, 0.1 off) x 10 then continuous	20	-13

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Romania

Table 38
Definition of supported tones for Romania

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm))**
dial	cg/dt	450	continuous	15	-4.5
(audible) ringing	cg/rt	450	1.5 on, 3.5 off	infinite	-4.5
busy	cg/bt	450	0.168 on, 0.168 off	infinite	-4.5
congestion	cg/ct	450	0.5 on, 0.5 off	infinite	-4.5
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33(f1)on 0.33 (f2) on 0.33(f3) on 1.0 off	1 cycle	-4.5 + -4.5 + -4.5
warning	cg/wt	450	0.1 on, 0.5 traffic	3 cycles	-12
pay phone recognition	cg/prt cg/pt (ASPEN)	1100 (f1), 1750 (f2), 750 (f3), 1450 (f4)	0.1 (f1 + f2) on, 0.1 (f3 + f4) on, 0.2 traffic	3 cycles	-4.5 + -4.5 / -4.5 + -4.5
call waiting	cg/cw	450	0.2 on, 0.2 traffic, 0.2 on	1 cycle	-12
caller waiting	cg/cr	450	1.5 on, 3.5 off	infinite	-4.5
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	3000	continuous	infinite	3

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Table 38 (continued)
Definition of supported tones for Romania

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm))**
negative acknowledge	xcg/nack	450	0.5 on, 0.5 off	60	-8
vacant number	xcg/vac	450	0.362 on, 0.11 off, (0.092 on, 0.11 off) x 6	infinite	-4.5
special conditions dial	xcg/spec	450 modulated by 25 at 100% depth	0.4 on, 0.04 off	20	-4.5
recall dial	srvtn/rdt	350 + 450	continuous	20	-4.5 + -4.5
confirmation	srvtn/conf	351 + 439 (+/- 2%)	0.1 on, 0.1 off, 0.3 on, 0.1 off	1 cycle	-10 + -10 (+/- 2 dB)
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	450 modulated by 25 at 100% depth	0.4 on, 0.4 off	20	-4.5

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Russia

Table 39
Definition of supported tones for Russia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm))
dial	cg/dt	425 (+/-3)	continuous	20	-10 (+/-1)
(audible) ringing	cg/rt	425 (+/-3)	1.0 (+/-0.1) on, 4.0 (+/-0.4) off	infinite	-10 (+/-1)
busy	cg/bt	425 (+/-3)	0.4 on 0.4 off (all +/-0.04)	infinite	-10 (+/-1)
congestion	cg/ct	425 (+/-3)	0.2 on, 0.2 off	infinite	-10 (+/-1)
special information	cg/sit	950 (f1), 1400 (f2), 1800 (f3) (all +/-5)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on (all +/-0.07) 1.0 (+/- 0.25) off repeated	infinite	-13 (f1), -13 (f2), -13 (f3)
warning	cg/wt	1420 (+/- 20)	0.4 (+/- 0.04) on, 15 (+/-3) off	infinite	-15 (+/-1)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1), 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2 traffic	5 cycles	-10 (+/ -1) (f1), -10 (+/ -1) (f2)
call waiting	cg/cw	425 (+/-3)	0.2 (+/- 0.02) on	1 cycle	-15 (+/-1)

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Table 39 (continued)
Definition of supported tones for Russia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm))**
caller waiting	cg/cr	425 (+/-3)	0.2 (+/- 0.02) on, 5 (+/-0.5) off repeated	infinite	-10 (+/-1)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 (f1), +2067 (f2), +2467 (f3), +2600 (f4) ***Note:*** f3 is only supported by VSP3	0.1 on, 0.1 off	infinite	-6 (f1), -5 (f2), -6 (f3), -6 (f4) (all +/-0.2)
negative acknowledge	xcg/nack	950 (f1), 1400 (f2), 1800 (f3), (all +/-5)	0.33 on (f1), 0.33 on (f2), 0.33 on (f3), (all +/-0.07) 1.0 (+/-0.25 off repeated	infinite	-13 (f1), -13 (f2), -13 (f3)

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Table 39 (continued)
Definition of supported tones for Russia

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm))**
vacant number	xcg/vac	950 (f1), 1400 (f2), 1800 (f3), (all +/-5)	0.33 on (f1), 0.33 on (f2), 0.33 on (f3) (all +/-0.07) 1.0 (+/-0.25 off repeated	infinite	-13 (f1), -13 (f2), -13 (f3)
special conditions dial tone	xcg/spec	425 (+/-3)	0.4 (+/-0.04) on, 0.04 (+/-0.004) off	20	-10 (+/-1)
recall dial tone	srvtn/rdt	425 (+/-3)	continuous	20	-10 (+/-1)
confirmation	srvtn/conf	425 (+/-3)	continuous	20	-10 (+/-1)
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	425 (+/-3)	(0.1 on, 0.1 off) repeated 10 times, continuous on (+/-10%)	20 (+/-10%)	-10 (+/-1)

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Singapore

Table 40
Definition of supported tones for Singapore

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	425	continuous	20	-15
(audible) ringing	cg/rt	425 modulated by 24 at 100% depth	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-10
busy	cg/bt	425	0.75 on, 0.75 off	infinite	-10
congestion	cg/ct	425	0.25 on, 0.25 off	infinite	-10
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on, 1.0 off	1 cycle	-10/ -10/ -10
warning	cg/wt	425	0.624 on 4.376 off (+/-5%)	1 cycle	-20
pay phone recognition	ct/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-20/ -20 (+/- 2 dB)
call waiting	cg/cw	425	0.5 on, 0.25 traffic, 1.0 on	1 cycle	-12
caller waiting	cg/cr	425 modulated by 24 at 100% depth	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-10

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Table 40 (continued)
Definition of supported tones for Singapore

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	3200	continuous	infinite	-8 (+/- 2 dB)
negative acknowledge	xcg/nack	425	0.25 on, 0.25 off	60	-10
vacant number	xcg/vac	425	2.5 on, 0.5 off	infinite	-10
special conditions dial tone	xcg/spec	425	0.25 on, 0.25 off, 0.25 on, 0.25 off	20	-12
recall dial tone	srvtn/rdt	425	continuous	20	-15
confirmation	srvtn/conf	425	0.06 on, 0.06 off	1 cycle	-12
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	425	0.25 on, 0.25 off, 0.25 on, 0.25 off	20	-12

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Spain

Table 41
Definition of supported tones for Spain

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 5%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
dial	cg/dt	425	continuous	20	-6
(audible) ringing	cg/rt	425	1.5 on, 3.0 off	infinite	-6
busy	cg/bt	425	0.2 on, 0.2 off	infinite	-6
congestion	cg/ct	425	(0.2 on, 0.2 off) x 2 0.2 on, 0.6 off	infinite	-6
special information	cg/sit	950(f1)/ 1400(f2)/ 1800(f3) (+/- 50 Hz)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07), 1 off (+/- 0.25)	1 cycle	-17/ -17/ -17
toneburst on answer (replaces warning tone)	cg/wt	1111 (+/- 5%)	0.018 on (+/- 20)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	1600	0.05 on	1 cycle	-20
call waiting	cg/cw	425	0.175 on, 0.175 traffic, 0.175 on	1 cycle	-6

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Table 41 (continued)
Definition of supported tones for Spain

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 5%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
caller waiting	cg/cr		cg/rt for 30 (+/-10%) followed by cg/bt for remainder	infinite	
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			
comfort	xcg/cmft	300	continuous	infinite	-6
off-hook warning	xcg/roh	1404 + 2060 + 2604 (VSP2/ VSP3-o) 1404 + 2060 + 2452 + 2604 (VSP3)	continuous	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	xcg/nack	450	0.12 on, 0.12 off	60	-8
vacant number	xcg/vac	425	0.2 on, 0.2 off, 0.2 on, 0.6 off	infinite	-6
special conditions dial tone	xcg/spec	425	1.0 on, 0.1 off	20	-6
recall dial tone	srvtn/rdt	600	continuous	20	-6

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Table 41 (continued)
Definition of supported tones for Spain

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 5%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
confirmation	srvtn/conf	450	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-8
held	srvtn/ht	450	3.25 off, 0.25 on, 0.25 off, 0.25 on	infinite	-8
message waiting	srvtn/mwt	425	(0.1 on, 0.1 off) x 10 then continuous	20	-6

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Sweden

Table 42
Definition of supported tones for Sweden

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
dial	cg/dt	425	continuous	20	-9
(audible) ringing	cg/rt	425	1.0 on, 5.0 off	infinite	-9
busy	cg/bt	425	0.25 on, 0.25 off	infinite	-9
congestion	cg/ct	425	0.25 on, 0.75 off	infinite	-9
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50 Hz)	0.33 (f1) on (+/- 0.07), 0.33 (f2) on (+/- 0.07), 0.33 (f3) on (+/- 0.07), 1.0 off (+/- 0.25)	1 cycle	-12/ -12/ -12
warning	cg/wt	1400 (+/- 1.5%)	0.35 on	1 cycle	-34
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2) (+/- 8%)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	425	0.2 on, 0.5 traffic, 0.2 on	1 cycle	-12
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	

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Table 42 (continued)
Definition of supported tones for Sweden

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	300	continuous	infinite	-9
off-hook warning	xcg/roh	1404 + 2060 + 2604 (VSP2/ VSP3-o) 1404 + 2060 + 2452 + 2604 (VSP3)	continuous	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	xcg/nack	mapped to cg/ct frequency and cadence		60	map to cg/ct
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	425	0.32 on, 0.02 off	20	-9
recall dial tone	srvtn/rdt	425	continuous	20	-9
confirmation	srvtn/conf	450	0.16 off, 0.16 on, 0.16 off, 0.32 on, 0.48 off	1 cycle	-8

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Table 42 (continued)
Definition of supported tones for Sweden

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/-10%)**	**Duration (s) (+/-10%)**	**Level (dBm) (+/-1 dB)**
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	425	(0.1 on, 0.1 off) x 10 then continuous	20	-9

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Switzerland

Table 43
Definition of supported tones for Switzerland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1.5 dB)**
dial	cg/dt	425	continuous	20	-1.5
(audible) ringing	cg/rt	425	1.0 on, 4.0 off	infinite	-6.5
busy	cg/bt	425	0.5 on, 0.5 off	infinite	-6.5
congestion	cg/ct	425	0.2 on, 0.2 off	infinite	-6.5
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50)	0.33 (f1) on (+/- 0.04), 0.33 (f2) on (+/- 0.04), 0.33 (f3) on (+/- 0.04), 1.0 off (+/- 0.1)	1 cycle	-6.5/ -6.5/ -6.5
warning	cg/wt	1400 (+/- 50)	0.45 on (+/- 0.1)	1 cycle	-14 (+/- 3)
pay phone recognition	cg/prt cg/pt (ASPEN)	800(f1) 1200(f2) (+/- 1%)	0.2 (f1) on, 0.2 off, 0.2 (f2) on	1 cycle	-20/ -20
call waiting	cg/cw	425	0.2 on, 0.2 traffic, 0.2 on	1 cycle	-14 (+/- 3)
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	

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Table 43 (continued)
Definition of supported tones for Switzerland

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 15)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 1.5 dB)**
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	300	continuous	infinite	-11 (+/- 2 dB)
off-hook warning	xcg/roh	400 (f1) (+/- 50)/ 1000 (f2) (+/- 100)/ 2700 (f3) (+/- 150)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on (+/- 0.02)	infinite	3/ 3/ 3
negative acknowledge	xcg/nack	mapped to cg/ct frequency cadence and level		60	
vacant number	xcg/vac	mapped to cg/ct			
special conditions dial tone	xcg/spec	425 (f1) 340 (f2)	1.1 (f1+f2), 1.1 (f1) (+/- 0.1)	20	-4.5 + -4.5 / -1.5
recall dial tone	srvtn/rdt	mapped to cg/dt			
confirmation	srvtn/conf	425 (f1) 850 (f2) (+/- 50)	(0.2 (f1) on, 0.2 (f2) on) x 2, 1.0 off (+/- 0.25)	1 cycle	-6.5
held	srvtn/ht	1400 (+/- 50)	0.4 on, 15.0 off	infinite	-15 (+/- 2 dB)
message waiting	srvtn/mwt	425	(0.1 on, 0.1 off) x 10 then continuous	20	-1.5

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Taiwan

Table 44
Definition of supported tones for Taiwan

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	350 + 440	continuous	16	-13 + -13
(audible) ringing	cg/rt	440 + 480	1.0 on, 2.0 off	infinite	-19 + -19
busy	cg/bt	480 + 620	0.5 on, 0.5 off	infinite	-24 + -24
congestion	cg/ct	480 + 620	0.25 on, 0.25 off	infinite	-24 + -24
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33 (f1) 0.33 (f2) 0.33 (f3) 1.0 off	1 cycle	-10/ -10/ -10
warning	cg/wt	392 (f1) 494 (f2) 587 (f3)	0.5 (f1) on, 0.5 (f2) on, 1.5 (f3) on	1 cycle	-17/ -17/ -17
pay phone recognition	cg/prt, cg/pt (ASPEN)	1633 (f1) 1336(f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	440 + 480	1.5 on	1 cycle	-13 + -13
caller waiting	cg/cr	350 + 440	0.25 on, 0.25 off, 0.25 on, 5.25 off	infinite	-13 + - 13
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	300	continuous	infinite	-13
off-hook warning	xcg/roh	480	continuous	infinite	-3

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Table 44 (continued)
Definition of supported tones for Taiwan

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
negative acknowledge	xcg/nack	480 + 620	0.25 on, 0.25 off	60	-24 + -24
vacant number	xcg/vac	480 + 620	0.25 on, 0.25 off	infinite	-24 + -24
special conditions dial tone	xcg/spec	350 + 440	(0.1 on, 0.1 off) x 3 then continuous	20	-13 + -13
recall dial tone	srvtn/rdt	350 + 440	continuous	16	-13 + -13
confirmation	srvtn/conf	350 + 440	0.1 on, 0.1 off, 0.3 on	1 cycle	-13 + -13
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	350 + 440	(0.1 on, 0.1 off) x 3 then continuous	20	-13 + -13

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Thailand

Table 45
Definition of supported tones for Thailand

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	**Cadence (s)**	**Duration (s)**	**Level (dBm)**
dial	cg/dt	400 modulated by 50 at 100% depth	continuous	20	-10
(audible) ringing	cg/rt	400	1.0 on, 4.0 off	infinite	-10
busy	cg/bt	400	0.5 on, 0.5 off	infinite	-10
congestion	cg/ct	400	0.5 on, 0.5 off	infinite	-10
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on, 0.99 off	infinite	-13/ -13/ -13
warning	cg/wt	1400	0.5 on	1 cycle	-10
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2), 2.0 traffic	5 cycles	-10/ -10 (+/- 1)
call waiting	cg/cw	400	0.5 on, 0.25 traffic, 1.0 on	1 cycle	-12 (+/- 3)
caller waiting	cg/cr	400	1.0 on, 4.0 off	infinite	-10
pay	bcg/bpy (H.248 only)	silence (no frequency), signal completed immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			

(Sheet 1 of 2)

Table 45 (continued)
Definition of supported tones for Thailand

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
off-hook warning	xcg/roh	400	0.3 on, 0.3 off	infinite	-10
negative acknowledge	xcg/nack	400	0.5 on, 0.5 off	60	-10
vacant number	xcg/vac	400	0.1 on, 0.1 off 0.1 on, 0.1 off, 0.1 on, 0.1 off, 0.3 on, 0.1 off	infinite	-9
special conditions dial tone	xcg/spec	400	0.25 on, 0.25 off, 0.25 on, 0.25 off	20	-12 (+/- 3)
recall dial tone	srvtn/rdt	400 modulated by 50 at 100% depth	continuous	20	-10
confirmation	srvtn/conf	400	0.06 on, 0.06 off	1 cycle	-12
held	srvtn/ht	silence		infinite	
message waiting	srvtn/mwt	400	0.25 on, 0.25 off, 0.25 on, 0.25 off	20	-12 (+/- 3)

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Turkey

Table 46
Definition of supported tones for Turkey

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 0.4)**
dial	cg/dt	450	continuous	20	-9.8
(audible) ringing	cg/rt	450	2.0 on, 4.0 off	infinite	-9.8
busy	cg/bt	450	0.5 on, 0.5 off	infinite	-9.8
congestion	cg/ct	450	(0.2 on, 0.2 off) x 3 0.6 on, 0.2 off	infinite	-9.8
special information	cg/sit	950 (f1) 1400 (f2) 1800 (f3)	0.3 (f1) 0.3 (f2) 0.3 (f3) 1.0 off	1 cycle	-9.8/ -9.8/ -9.8
warning	cg/wt	450	0.2 on, 0.2 traffic, 0.6 on	1 cycle	-11.8
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on	1 cycle	-10/ -10
call waiting	cg/cw	450	0.2 on, 0.6 traffic, 0.2 on	1 cycle	-11.8
caller waiting	cg/cr	450	2.0 on, 4.0 off	infinite	-9.8
pay	bcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			

(Sheet 1 of 3)

Table 46 (continued)
Definition of supported tones for Turkey

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 0.4)**
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2060 + 2600 (VSP2/ VSP3-o only) 1400 + 2060 + 2450 + 2600 (VSP3)	0.1 on, 0.1 off	infinite	0 + 0 + 0 (VSP2/ VSP3-o) -1 + -1 + -1 + -1 (VSP3)
negative acknowledge	xcg/nack	950 (f1) 1400 (f2) 1800 (f3)	0.3 (f1) 0.3 (f2) 0.3 (f3) 1.0 off	60	-9.8/ -9.8/ -9.8
vacant number	xcg/vac	450	0.2 on, 0.2 off	infinite	-9.8
special conditions dial tone	xcg/spec	450	1.0 on, 0.25 off	20	-9.8
recall dial tone	srvtn/rdt	450	continuous	20	-9.8
confirmation	srvtn/conf	450	0.04 on, 0.04 off	1 cycle	-9.8

(Sheet 2 of 3)

Table 46 (continued)
Definition of supported tones for Turkey

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 5%)	**Cadence (s)**	**Duration (s)**	**Level (dBm) (+/- 0.4)**
held	srvtn/ht	350 (f1) 450 (f2)	0.5 (f1+f2) on, 0.5 off, 0.5 (f2) on, 2.5 off	infinite	-11.8 + -11.8 / -11.8
message waiting	srvtn/mwt	450	0.2 on, 0.2 off, 0.2 on, 0.6 off	20	-11.8

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United Kingdom

Table 47
Definition of supported tones for the United Kingdom

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	Cadence (s) (+/- 10%)	Duration (s) (+/- 10%)	Level (dBm) (+/- 2 dB)
dial	cg/dt	350 + 440	continuous	20	-10 + -10
(audible) ringing	cg/rt	400 + 450	0.4 on, 0.2 off, 0.4 on, 2.0 off	infinite	-16 + -16
busy	cg/bt	400	0.375 on, 0.375 off	infinite	-13
congestion	cg/ct	400 (f1) 400 (f2)	0.4 (f1) on, 0.35 off, 0.225 (f2) on, 0.525 off	infinite	-19/ -13
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50 Hz)	0.33 (f1), 0.33 (f2), 0.33 (f3), 1.0 off	1 cycle	-10/ -10/ -10
toneburst on answer (replaces warning tone)	cg/wt	1111 (+/- 5%)	0.18 on (+/- 20)	once then signal complete	-13 (+/- 2)
pay phone recognition	cg/prt cg/pt (ASPEN)	400	0.125 on	1 cycle	-13
call waiting	cg/cw	400	2.5 on	1 cycle	-13
caller waiting	cg/cr		cg/rt for 30 followed by cg/bt for remainder	infinite	

(Sheet 1 of 3)

Table 47 (continued)
Definition of supported tones for the United Kingdom

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
pay	xcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2066 + 2600 (+/-2%) (VSP2/ VSP3-o) 1400 + 2066 + 2450 + 2600 (+/-2%) (VSP3)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (VSP2/ VSP3-o) -6 + -6 + -6 + -6 (VSP3)
negative acknowledge	xcg/nack	mapped to xcg/vac frequency, cadence and level		60	
vacant number	xcg/vac	400	continuous	infinite	-13
special conditions dial tone	xcg/spec	350 (f1) + 440 (f2)	0.75 on, 0.75 off (f1), continuous (f2)	20	-10 (f1) + -10 (f2)
recall dial tone	srvtn/rdt		map to cg/dt	20	

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Table 47 (continued)
Definition of supported tones for the United Kingdom

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 2%)	**Cadence (s) (+/- 10%)**	**Duration (s) (+/- 10%)**	**Level (dBm) (+/- 2 dB)**
confirmation	srvtn/conf	351 + 439	0.1 on, 0.1 off, 0.3 on, 0.1 off	1 cycle	-10 + -10
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	350 + 440	(0.1 on, 0.1 off) x 10 then continuous	infinite	-10 + -10

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United States

Table 48
Definition of supported tones for the United States

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/-1.5 dBm)**
dial	cg/dt	350 + 440 (+/- 0.5%)	continuous	20 (+/- 10%)	-13 + -13 (+/- 1.5 dB)
(audible) ringing	cg/rt	440 + 480 (+/- 0.5%)	2.0 on, 4.0 off (+/- 10%)	infinite	-19 + -19 (+/- 1.5 dB)
busy	cg/bt	480 + 620 (+/- 0.5%)	0.5 on, 0.5 off (+/- 10%)	infinite	-24 + -24 (+/- 1.5 dB)
congestion	cg/ct	480 + 620 (+/- 0.5%)	0.25 on, 0.25 off (+/- 10%)	infinite	-24 + -24 (+/- 1.5 dB)
special information	cg/sit	950(f1) 1400(f2) 1800(f3) (+/- 50 Hz)	0.33 (f1) on 0.33 (f2) on 0.33 (f3) on 1.0 off (+/- 10%)	1 cycle	-24/ -24/ -24 (+/- 1.5 dB)
warning	cg/wt	1400 (+/- 1.5%)	0.5 on (+/- 10%)	1 cycle	-7 (+/- 1.5 dB)
pay phone recognition	cg/prt cg/pt (ASPEN)	1100 (f1) 750 (f2)	(0.2 (f1) on 0.2 (f1) off, 0.2 (f2) on 2.0 traffic) x 5	13	-6 (f1) -7 (f2)
call waiting	cg/cw	440 (+/- 0.5%)	0.3 on (+/- 10%)	1 cycle	-13 (+/- 1.5dB)

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Table 48 (continued)
Definition of supported tones for the United States

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/-1.5 dBm)**
caller waiting	cg/cr	440 + 480 (f1) 440 (f2)	2.0 (f1) 0.3 (f2) 3.7 off (repeating)	infinite	f1 = -19 + -19 f2 = -13
pay	xcg/bpy (H.248 only)	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1400 + 2060 + 2600 (VSP2/ VSP3-o) (+/- 2%) 1400 + 2060 + 2450 + 2600 (VSP3) (+/- 2%)	0.1 on, 0.1 off	infinite	-5 + -5 + -5 (+/- 1.5dB) (VSP2) -6 + -6 + -6 + -6 (+/- 1.5dB) (VSP3/ VSP3-o)
negative acknowledge	xcg/nack	480 + 620	0.25 on, 0.25 off (repeating)	infinite	-24 + -24
vacant number	xcg/vac	map to cg/ct		infinite	
special conditions dial tone	xcg/spec	map to cg/dt			

(Sheet 2 of 3)

Table 48 (continued)
Definition of supported tones for the United States

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz) (+/- 0.5%)	**Cadence (s) (+/- 10%)**	**Duration (s)**	**Level (dBm) (+/-1.5 dBm)**
recall dial tone	srvtn/rdt	350 + 440 (+/- 0.5%)	(0.1 on, 0.1 off) x 3, then continuous (+/- 10%)	20 (+/- 10%)	-13 + -13 (+/- 1.5dB)
confirmation	srvtn/conf	350 + 440 (+/- 0.5%)	0.1 on, 0.1 off (+/- 10%)	3 cycles	-13 + -13 (+/- 1.5dB)
held	srvtn/ht	620	0.25 on, 0.25 off, 0.25 on, 3.25 off (repeating)	infinite	-24
message waiting	srvtn/mwt	350 + 440 (+/- 0.5%)	(0.1 on, 0.1 off) x 10, then continuous (+/- 10%)	20 (+/-10%)	-13 + -13 (+/- 1.5dB)
carrier dial	carr/cdt	400 (+/- 0.5%)	continuous	20 (+/- 10%)	-10 (+/- 1.5 dB)
carrier answer	carr/ans	silence (no frequency), signal complete immediate			
carrier charging	carr/chg	silence (no frequency), signal complete immediate			
long distance indicator	carr/ldi	silence (no frequency), signal complete immediate			

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Venezuela

Table 49
Definition of supported tones for Venezuela

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
dial	cg/dt	425 (+/-10)	continuous	20	-10
(audible) ringing	cg/rt	425 (+/- 10)	1.0 on, 4.0 off	infinite	-10
busy	cg/bt	425 (+/- 10)	0.5 on, 0.5 off	infinite	-10
congestion	cg/ct	425 (+/- 10)	0.25 on, 0.25 off	infinite	-10
special information	cg/sit	950 (f1) 1440 (f2) 1800 (f3) (+/- 50)	0.33 (f1) on, 0.33 (f2) on, 0.33 (f3) on, (+/-.07) 1.0 off (+/- 0.25)	single cycle	-10
warning	cg/wt	800 (+/- 50)	1.0 (+/- 0.1)	single cycle	-21 + -21 (+/- 1.5 dB)
pay phone recognition	cg/prt cg/pt (ASPEN)	1633 (f1) 1336 (f2)	0.2 (f1) on, 0.2 traffic, 0.2 (f2) on, 2.0 traffic	5 cycles	-10
call waiting	cg/cw	400 + 450	0.3 on	single cycle	-13 + -13
caller waiting	cg/cr	425 (+/- 10)	1.0 on, 4.0 off	infinite	-10
pay	bcg/bpy	silence (no frequency), signal complete immediate			
comfort	xcg/cmft	silence (no frequency), signal complete immediate			
off-hook warning	xcg/roh	1440	0.5 on, 0.5 off	infinite	+3

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Table 49 (continued)
Definition of supported tones for Venezuela

Tone name	Package/ identifier	Characteristics			
		Frequency (Hz)	Cadence (s)	Duration (s)	Level (dBm)
negative acknowledge	xcg/nack	425 (+/- 10)	0.25 on, 0.25 off	60	-10
vacant number	xcg/vac	425 (+/- 10)	0.25 on, 0.25 off	infinite	-10
special conditions dial	xcg/spec	425	(0.1 on, 0.1 off) x 3, 19.4 on	20	-10
recall dial tone	srvtn/rdt	425 (+/- 10)	continuous	20	-10
confirmation	srvtn/conf	425 (+/- 10)	0.1 on, 0.1 off, 0.3 on, 0.1 off	single cycle	-10
held	srvtn/ht	silence (no frequency), signal complete immediate			
message waiting	srvtn/mwt	425	0.1 on, 0.1 off	20	-10

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